



# D-REC

## INITIATIVE

# ASSESSMENT OF THE I-REC STANDARD DESIGN ON D-REC IMPLEMENTATION

*Authored by  
Ricky Buch*

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## Overview

The objective of this document is to assess the applicability of key International REC Standard (I-REC) code aspects in the context of implementing the objectives identified by the D-REC Initiative, namely the ability to accelerate distributed renewable energy deployment in emerging markets by monetizing the environmental benefit provided by distributed renewable energy systems, including off-grid applications. This document is organized along key I-REC lifecycle elements: entity, account and device registration; issuance of certificates; transfer and redemption of certificates, and other associated aspects of the I-REC standard.

In addition to specific comparisons with the I-REC code, an assessment also will be made with regard to how the D-REC can implement the standards and principles outlined by the I-REC governing board. Further, initial recommendations will be made as to how the D-REC can closely align with the I-REC in the market to further the collective mission of expanding access to environmental markets for small-scale renewable systems.

## Introduction to the International REC (I-REC) Code and Service

The I-REC Service is a global electricity environmental attribute tracking system. It is designed to facilitate reliable Scope 2 carbon accounting consistent with various international GHG accounting standards. I-RECs allow all electricity users to make a conscious and evidence-based choice for renewable electricity, in any country around the world.

An I-REC is a unique statement representing all environmental attributes associated with a specific MWh of electricity produced, including any avoided emissions or similar market instrument that might be available to the registrant or device owner.

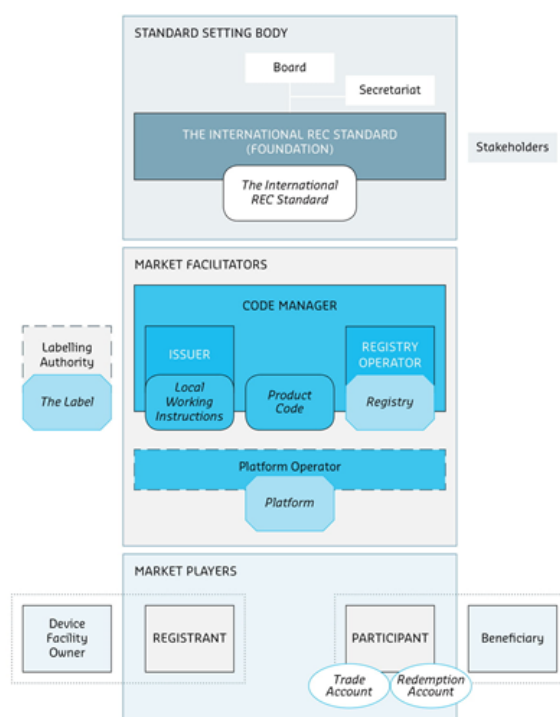
## Introduction to the D-REC Initiative and the Distributed REC

The D-REC Initiative is an industry-led multi-stakeholder initiative seeking to accelerate the energy transition in emerging markets by connecting local renewable energy developers with global environmental markets. The primary focus of the D-REC initiative is to introduce the Distributed REC, which shall monetize the environmental and social benefits associated with

deploying distributed renewable energy (DRE). This encompasses individual solar products (e.g. lanterns, solar home systems, etc.), community-scale mini grids, campus microgrids, community solar, and C&I solar/microgrids. The D-REC Initiative will utilize a technology-driven approach to automate the issuance of certificates against generation evidence from DRE systems. The initiative also seeks to develop new commercial structures involving the D-REC that will catalyze new project capital into the DRE space, thereby enabling project developers to drive capacity growth.

### I-REC Stakeholder map

The following diagram outlines the various stakeholders in the I-REC ecosystem:



The above diagram represents the I-REC Standard ecosystem in that it encapsulates the various stakeholders who may play a role in any environmental certificate which aligns with the prevailing I-REC electricity code (henceforth referred to as the I-REC product standard as opposed to the I-REC electricity code). Key stakeholders include:

Issuer	An organization formally authorized by I-REC Services (or by a code operator for other environmental certificates) to issue I-RECs within a particular country or region; performs validation on evidence prior to issuing certificate
Participant	An organization holding one or more I-REC (or other environmental certificate) trading accounts

Registrant	The owner of a production device or group of devices
I-REC Services B.V.	The organization providing I-REC services
Code manger	Entity responsible for defining and coordinating stakeholders for a particular environmental product
Platform operator	An entity which facilitates changes within a registry structure which maintains the ownership structure of an environmental certificate
Labeling authority	An independent credentialing authority which specifies that a particular certificate meets certain specified criteria
Registry operator	An entity that operates a registry, which is a database that maintains the ownership of an environmental certificate for its entire lifecycle

In the case of the I-REC electricity code, I-REC services sit at the center, approving both participants/registrants and issuers. They also maintain the registries that keep track of I-REC ownership. The designated Issuer then plays a role both in approving production devices and validating I-RECs prior to their issuance.

#### Additional D-REC stakeholders

It is clear how the Participant and Registrant roles can map directly to the D-REC stakeholder ecosystem; Registrants will continue to remain the owners of devices, and Participants will be those who trade or redeem D-RECs.

However, the manner in which these stakeholders interact with the D-REC system may need to be different. Moreover, the D-REC ecosystem likely will introduce two additional stakeholders: the Aggregator, and the Marketplace.

The Aggregator would be an entity that could act as a liaison between developers and the D-REC system. These are software platforms whose primary objective involves providing some type of service to the DRE ecosystem other than managing D-RECs, but in order to achieve their primary objective, must maintain a data connection with individual DRE devices. Aggregators could include remote monitoring providers, PAYGO platform operators, or RBF managers. Aggregators are in a position to assume some of the roles currently provided by the I-REC Services and I-REC Issuers, as they must collect and validate information regarding market participants for their own objectives. In particular, they can act as a conduit for participant registration information, validate any needed data fields and submit this information to the D-REC system. In addition, aggregators may also choose to connect potential buyers and sellers (which would fall under the Marketplace role). By distributing the responsibility of validating certain participant information, D-REC adoption likely could be accelerated. It is important to note that it is not expected that Aggregators will assume the role of D-REC certification; rather, they will interact with the D-REC platform, providing necessary account, device and generation information to create D-RECs.

The Marketplace could be another entity which allows Participants to trade active D-RECs. Unlike the Aggregator, these entities would not manage the registration of developers or

devices. Rather, they would simply connect with the D-REC system to enumerate available D-RECs for trading among participants, and facilitate the redemption, thereby allowing the D-REC to be used for climate accounting objectives.

As noted later in the document, while it is expected there will be a clear delineation between the D-REC and the I-REC, the D-REC will be compatible with the I-REC. The goal of the D-REC Initiative is not to introduce a new environmental standard, but rather introduce a new mechanism which will extend the existing environmental standards into the DRE sector. Therefore, the D-REC will be designed such that it can seamlessly be integrated into the existing I-REC workflow. To achieve this compatibility, the D-REC will need to be accessible by Issuers, I-REC Services, and other I-REC ecosystem stakeholders.

### I-REC Lifecycle and Implications on D-REC Design

As the D-REC will serve as an extension of the I-REC standard, it is critical to understand various aspects of the I-REC lifecycle, as the D-REC will mirror those key lifecycle steps in order to maintain alignment with the standard. In the lifecycle of an I-REC, there are several key events:

- The entity which owns (or represents) the devices which will be generating I-RECs registers with the I-REC service
- The registrant then provides information about each device (or collection of devices) which will generate I-RECs
- The asset is then commissioned and begins exporting electricity to the grid; at some point, the registrant will submit a request to an I-REC Issuer to review evidence of generation and create one or more I-RECs
- The I-REC is then assigned to an account, and can be actively traded until it is redeemed, after which it not longer can change ownership – the entity which redeems it, or for whose benefit it is redeemed – can then make a public claim around the purchase of renewable energy represented by the I-REC

### D-REC Implications

By design, the D-REC will closely mirror the I-REC lifecycle. Accounts corresponding to market stakeholders will be created; devices will be registered; production will occur and generation data will be submitted for review; a certificate corresponding to a unit of generation will be created, and can be traded until redeemed. Similar to an I-REC, a D-REC will encompass all of the environmental benefits associated with a unit of generation from a distributed renewable asset.

### **D-REC Alignment with the I-REC product standard**

The foundational element of the I-REC Standard is the I-REC, a certificate encompassing the environmental benefits associated with 1 MWH of renewable energy. As noted in the I-REC product certificate standard, certain elements of the certificate and associated processes must be met in order to maintain alignment with the I-REC standard objectives:

- A certificate is issued in accordance with verified historical facts relating to a particular event over a period of time at a specific facility, and cannot be issued for future events
- 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
- A certificate must always be recorded in a registry
- The certificate can only be issued against independently verified evidence

The D-REC will seek to encapsulate all of these attributes. It will only be issued against production data that is submitted from one or more devices, and is verified by an entity or process that is independent of the producer, and who possesses no financial stake in the outcome. The D-REC will be assigned a unique serial number upon creation; the platform will ensure its custody will be documented in an immutable form.

Establishing provenance and chain-of-custody, and assigning a unique serial number for a certain amount of generation for a particular device for a particular time period, is imperative to upholding key tenets of environmental markets, namely that no double-counting of a particular environmental attribute will be possible. The D-REC Initiative proposes to accomplish this by partnering with the Energy Web Foundation, and utilizing the record-keeping capabilities of the Energy Web Chain. In such an implementation, each critical step in the D-REC lifecycle will be logged on-chain: when a participant or device registers, when a particular device issues a D-REC certificate, or when that certificate is redeemed, and by whom. As each transaction stage is written to the chain, the chain of custody becomes apparent as each event is written to the Energy Web Chain, and subsequently available to the ecosystem as a matter of public record.

### **Participant Registration**

The D-REC seeks to achieve several outcomes critical to expanding access to environmental markets for distributed renewable systems, in particular:

- Lowering barriers to entry: reducing the complexity of allowing assets and market actors of all types to participate in environmental markets and monetize or redeem associated environmental benefits with distributed renewable energy
- Automation: utilize software to support high transaction volumes at low cost

In the I-REC electricity code, participant information must flow via I-REC services, while registrant information must be approved by the designated Issuers. With D-RECs, this

information can enter either directly into the platform or via an Aggregator that already is managing account data for a participant. A key design consideration will be: should an entity be established to validate data that is entered into the D-REC platform directly, such as via a web form? In the case of data coming via an Aggregator, it could be expected that they will perform sufficient diligence in order to ensure the validity of the data. Moreover, the data can be “signed” to indicate that it was approved by a particular Aggregator.

In the event of a direct registration by a DRE developer or other market participant, some form of validation likely will be required; and therefore a key question is whether there should be an established D-REC service, akin to an I-REC service, which must validate the account information; or whether this can be handed to a data validator independent of the D-REC service, in which case the data can similarly be signed as it would when originating from an aggregator platform.

I-REC Services	Need for a D-REC Central Management Service
<ul style="list-style-type: none"> <li>● Accepts applications for I-REC participants; validates data</li> <li>● Approves national issuers for I-RECs</li> </ul>	<p>Pros of having a central entity manage participant accounts</p> <ul style="list-style-type: none"> <li>● Clear accountability for validating information provided by market participants</li> <li>● Single authority to establish rules and criteria for the data fields needed by a D-REC participant; no variation in the process by which data is validated</li> </ul> <p>Cons of having a central authority:</p> <ul style="list-style-type: none"> <li>● Limited scalability as number of market participants requiring validation increases</li> <li>● Lack of local customization to reflect local needs / requirements</li> <li>● Higher transaction fees needed to support larger admin overhead</li> </ul>

At present, the D-REC Initiative is considering establishing a central service, the D-REC Organization, which will oversee the overall D-REC code, maintain the software platform, and lead overall market advocacy. This organization could also be tasked with the need to validate account information for registrants who interact directly with the D-REC platform via a web form.

### Account Registration

Accounts are the foundational element of managing I-REC transactions.

- An account is owned and managed by an I-REC participant. These accounts are used to transfer I-RECs between a buyer and a seller. A single participant may hold multiple accounts, such as an account per country.
- The applicant for an account must be a legal entity, such as a private individual or corporate body; proof of identity is required during the registration process. A participant’s application for an account is reviewed by I-REC services.
- The I-REC electricity code registry application form is used by an applicant to file for an account. A snapshot of the form is shown. It requires the individual or corporate buyer to

**Appendix 1 – I-REC Registry Application Form**

<b>New Application / Declaration of Changes*</b>		<b>Date</b>	
Role(s) requested under this application (please tick box)		I-REC Participant <input type="checkbox"/>	Registrant <input type="checkbox"/>
<b>Applicant Details</b>			
Applicant Legal Name:		Website URL:	
Registered address line 1:		Main business (e.g. food retailer):	
Registered address line 2:		Year of registration:	
Registered address line 3:		Approximate number of employees:	
Postal (ZIP) code:		Name of the Chief Executive Officer/General Manager:	
Country:		Chief Executive Officer/General Manager passport number:	
Legal Status	Registered incorporated body/ Public sector entity/ Private individual/ Other (please state)*	Please state in which countries the organisation is active:	
Country of company registration/private residence:		Please list the main (>10%) shareholders :	
Corporate registration number/passport number:		Balance sheet total for last financial year (in USD):	
<b>Primary Contact Details (where different from the registered details)</b>			
Organisation Name:		Contact person:	
Address line 1:		e-mail:	
Address line 2:		Telephone:	
Address line 3:		Fax:	
Postal code:			
Country:			
Existing I-REC Registry organisation(s) to become subsidiary:			
<b>Lead User Details</b>			
Family Name (surname)			
Other (Given) Names			
Title	Dr/Mr/Mrs/Ms/Other (please specify)*		
e-mail:			
Telephone:			
Fax:			

provide address, business size, and contact information.

→The list of I-REC participants is public and searchable.

Implications for the D-REC code

For transaction documentation, it is important to record the buyer and seller of the D-REC. This will allow both parties to make publicly verifiable claims, as the transaction will be recorded between the two parties.

As noted earlier, the likely architecture for the D-REC service will mirror the requirements of the I-REC product certificate standard to capture information regarding participants in the D-REC ecosystem via a registry structure which will record participants.

Data fields required for participant registration

The current I-REC participant registration process asks for extensive information about the participant. In the case of D-RECs, certain fields may not be as applicable given the DRE context. For example, while I-REC participants disclose their annual revenue, for small-scale DRE developers who may be starting out, providing such information may be less informative than the types of projects they are developing, and the associated social impact.

Accounts generally are considered one of two types: trade, and redemption. An “active” I-REC that has not been claimed will reside in the trade account once it has been issued. Once a buyer purchases an I-REC, it will then be transferred into a redemption account corresponding to a beneficiary. This will ensure that the I-REC cannot subsequently be double-counted by essentially transacting in another trade account.

Implications for D-REC

Separating a trade account from a redemption account is a clear way to eliminate potential double counting, as any one I-REC can only reside in one account. The D-REC code likely would need to ensure that active D-RECs which have not been redeemed by a buyer remain “live” within a participant’s account, once the D-REC has been verified. Moreover, each D-REC, when issued, will be assigned a unique serial number. A key design consideration will be if a time limit should be imposed on how long a D-REC can be viable, although it can be noted that the carbon emissions associated with the D-REC, during the time period corresponding to the D-REC, would not expire, and therefore it can be asked whether a similar “statute of limitations” should apply. In the case of I-RECs, it is 12 months; this could be the same time period that would apply to D-RECs.



Upon a buyer redeeming a D-REC, there may be multiple ways to reflect such a transaction. First, as discussed earlier, all D-REC lifecycle events will be logged on the Energy Web Chain, thereby serving as a public record for all D-REC transactions. When a D-REC is redeemed, that redemption event will be logged on-chain. However, separate consideration should be given to whether a redemption state for a particular D-REC must also be reflected in the redemption account of the market participant. At present, the D-REC Initiative is considering not having a separate list of D-RECs which will have been redeemed in the registry, as the redemption state will be logged on the Energy Web Chain. However, in the event that faster access to a redeemed D-REC is needed, it may be necessary to maintain a separate account which houses a list of all D-RECs redeemed by a particular participant.

I-REC Account Structure	D-REC implications
<p>I-REC participants have two primary accounts:</p> <ul style="list-style-type: none"> <li>● Trade accounts, in which I-RECs that are verified by not redeemed by a buyer reside</li> <li>● Redemption accounts, in which verified I-RECs are transferred and “canceled”</li> </ul> <p>I-RECs are validated by an issuer and placed into a trade account. Once a buyer purchases that I-REC, it is then transferred to the buyer’s redemption account.</p>	<p>The D-REC code can either mirror the I-REC code in establishing trade accounts and redemption accounts, or simply have trade accounts which contain unredeemed D-RECs and record the redemption separately via a transaction record on the Energy Web Chain.</p> <p>Pros for having both trade and redemption accounts:</p> <ul style="list-style-type: none"> <li>● Easy accounting for the buyer on all redeemed D-RECs</li> <li>● Clear “state” of the D-REC - either active or redeemed</li> <li>● Rapid query on the state of a particular D-REC</li> </ul> <p>Cons of having two accounts:</p> <ul style="list-style-type: none"> <li>● Unnecessary account management, as the redemption will be logged on-chain and be reflected in the registry</li> <li>● Storage for data that is duplicated on a separate transaction ledger that will ensure data remains immutable may add to the cost of providing such a service</li> </ul>

Regardless of whether or not there will be a static redemption account, each stage in the D-REC lifecycle will be recorded on the Energy Web Chain ledger. For example, if a D-REC is generated by a solar home system in Rwanda, transferred to a financial intermediary, and then redeemed by a corporate buyer, these transitions would all be written to the chain. Therefore, during an audit trail, the provenance of the D-REC and associated transactions are clear. At present, the D-REC Initiative likely will not implement a redemption account structure, and rely on events logged via the Energy Web Chain to establish proof of redemption.

### Registry Operation and Structure

As noted in the I-REC product standard, a registry operator will manage the registry infrastructure, which is defined to be a set of databases that records the full lifecycle ownership

of a particular product certificate. The D-REC infrastructure can approach the registry management either in a similar centralized approach, or in a distributed manner.

According to the I-REC product standard, a registry operator is an entity which manages one or more databases which support the roles of a participant / registrant, issuer, and public user. Data fields which must be recorded by a registry operator include: production assets, certificate issuing events, the certificates themselves, transfer or redemption events, and access control.

With increasing focus on the applicability of blockchain in environmental markets, further consideration must be given to whether the registry infrastructure can be managed via a distributed ledger. Therefore, the D-REC Initiative must explore whether it would be feasible to implement a registry infrastructure on a distributed ledger. Such a design could remove the need for a central authority; a clear disadvantage would be the complexity associated with simple queries such as evaluating which D-RECs are active but not yet redeemed, as the entire chain would need to be analyzed in order to determine such a state.

To that end, the D-REC Initiative will consider establishing a central service which will take ownership of the registry information which will manage account information for the different participants along with the state of active D-RECs. This will expedite the ability to identify those D-RECs which remain available for trade. In the case of a D-REC being redeemed, the distributed ledger can function as a record providing immutable proof of redemption. To this end, any event associated with a D-REC lifecycle (e.g. account creation, D-REC instantiation, trade and redemption) can be recorded on the distributed ledger, and only analyzed when provenance must be established or queried.

### **Production Device and Production Group Registration**

Each production device that will be generating I-RECs must be registered with the corresponding country Issuer, which will then submit registration data to the I-REC registry. In the event there is no issuer, the I-RECs central Issuer would then validate the registration.

The Registrant who is registering the device with I-RECs must supply information as indicated in the following table. The Registrant provides address and contact details, and also provides information about the generation device, such as its location, output, and method of production verification (e.g. settlement data, meter data, etc.).

On occasion, a device verifier may visit the site to validate the information provided. This also may be undertaken to audit registration records. The device verifier will confirm the following data points:

- Location of device
- Energy sources / types
- Capacity
- Any parasitic loads
- Metering equipment
- Grid connection
- Export voltage
- Validate SLD

**Appendix 1 – Production Device Registration Form**

<b>New registration / Declaration of changes*</b>		<b>Date</b>	
<b>Registrant details</b>			
Is the Registrant also the owner of the Device? (provide evidence)			Yes/No*
Registrant Name:	Contact person:		
Address line 1:	e-mail:		
Address line 2:	Telephone:		
Address line 3:	Fax:		
Postal code:			
Country:			
<b>Production Device details</b>			
Device Name:	Latitude		
Address line 1:	Longitude		
Address line 2:	TSO's ID for measurement point		
Address line 3:	Installed capacity (kW)		
Postal code:	Number of generating units		
Country:	Date of commissioning		
Owner of the network to which the Production Device is connected and the voltage of that connection:			
If the Production Device is not connected directly to the grid, specify the circumstances, and additional relevant meter registration numbers:			
Expected form of volume evidence		Metering data/contract sales invoice/other*	
If other please specify			
<b>Energy Sources</b>			
Energy (fuel) Input – see Appendix 2		Technology – see Appendix 2	
On-site consumer present?		Yes/No*	
If yes give details			
Auxiliary/standby energy sources present?		Yes/No*	
If yes give details			
Please give details of how the site can import electricity by means other than through the meter(s) specified above.			
Please give details (including registration id) of any carbon offset or energy tracking scheme for which the Production Device is registered. State 'None' if that is the case.			
Please identify any labelling schemes for which the Device is accredited.			
Has the Device ever received public (government) funding (e.g. Feed in Tariff)?		No/Investment/production*	
If public (government) funding has been received when did/will it finish?			

\*Delete as appropriate

Upon filing the device registration form, the applicant also must select from a set of pre-approved device verifiers in the event that a site visit and additional validation is required. A site visit may be considered a normal step in the verification process. Note that if the central issuer or a country-designated issuer is not available, then the device must be commissioned prior to applying for I-REC registration.

It is worth noting that the I-REC code allows for a single production device to be registered in multiple attribute tracking schemes as long as the Issuer is notified of such registration. If the Issuer feels all data requests have been satisfactorily addressed, the Issuer will then register the device on the central I-REC registry. The effective registration date can be no earlier than 12 months from the first application; moreover, the registration must be renewed every five years.

**Implications for D-REC Code**

There are several areas which may pose potential issues to the D-REC lifecycle given the

targeted adoption of the instrument. Select ones are as follows:

- Registration timeline prior to commissioning - for larger DRE projects, it may be possible to understand details more than 12 months ahead of commissioning. However, a key benefit of DRE systems is their capacity to deploy quickly; therefore, systems may come online and begin generating power mere hours after a contract is signed. It will be important to develop a registration system to enable such scenarios.
- Site visit and associated data collection points - as the D-REC is being designed to be adopted by any number of DRE installations, it is unlikely to be possible for any individual or entity to physically visit each DRE installation prior to validating the registration. Therefore, an alternative validation method that does not rely on a site visit will be needed.
- Necessary data points: DRE systems generally are less complicated to install than utility-scale installations, and they also require less balance-of-plant equipment. It likely would not be necessary to acquire single line diagrams or similar validation data sources.

There are also elements of the existing I-REC device registration code which are applicable in the D-REC context, namely:

- Registration upon commissioning: in the event that there is no I-REC issuer present in a particular country, the I-REC electricity code allows for a registration application to the I-

REC registry after a system has been commissioned. For DRE systems, given the rapid deployment timelines in certain instances, a registration system that validates after commissioning, and that does not require a site visit, likely will be needed.

- Registration among multiple attribute tracking schemes: In addition to registering the same device in an I-REC-compliant tracking system, the DRE project developer may decide to register the device in another EAC (e.g. Gold Standard). Moreover, if the role of an Aggregator is approved, then there may be multiple market platforms for the device to register, although all of these aggregators will register on the same underlying D-REC tracking registry.

Assessing these aspects in totality, it is clear that the D-REC code likely will need to support both device registration prior to commissioning, as well as post-commissioning. As part of this registration process, additional metadata which describes the installation will be needed, for example type, nameplate capacity, off-taker type, etc. However, in lieu of site visits or providing detailed supporting documentation, an alternative mechanism to validate the installation will be required. This validation may need to occur after the system is commissioned; perhaps a device can achieve conditional approval prior to commissioning, and once it becomes generating power, the metadata which was supplied during the registration process can be validated, and the conditional label can be removed. Some form of further validation likely will be needed when a registration occurs via a web form, and not via an Aggregator, who may have an ability through their own means to validate a particular installation. Note that the above does not eliminate the value of a site visit to validate the metadata provided during registration; in the event that a device verifier can validate the installation, this information should be captured in the device's metadata.

Moreover, the manner in which the registration data is transferred to the D-REC platform will need to be established. There are essentially two mechanism in which the necessary registration data can be transferred to the D-REC platform:

- Via Aggregators - in this instance, the developer already has registered the production device on the Aggregator's platform. The Aggregator can then push this information to the D-REC platform device registry
- Directly - Either through a web interface or via script-accessible APIs, the device owner can simply place the needed device data on the registry without having to go through an Aggregator

In the latter case, some type of validation will be needed to ensure that the data is valid. In such an instance, perhaps validating serial numbers or SKU data with an OEM can verify the technology and nameplate capacity. In the former case, the Aggregator presumably would have validated this information, and therefore the data on the registry via the Aggregator can be trusted. Each device registration can be "signed" with a unique code which corresponds to an individual Aggregator, so should there be any issue with the registration data, it can be traced back to the Aggregator's validation method.

### **Issuing I-RECs and the role of the Issuer**

I-RECs are only valid within the context of a particular account, and only can be issued against the provision of evidence that the production event has occurred. The I-REC code provides a hierarchy of evidence to be presented in order to issue I-RECs:

- For a device that is connected to an electricity system, the evidence should be electricity market settlement data
- When such data is not available, appropriate metering data may be used
- When such metering data is not available, measured volume documentation of an energy transfer between producer and consumer can be used
- If none of the above three mechanisms are available, then I-REC Services will allow for issuance if the measured volume is agreed by the energy purchaser and the independent auditor, the volume cannot be claimed by another person, and the volume produced is a reasonable representation of the production device over the measurement period
- The measured volume should be given to the nearest kWh; also, any auxiliary or parasitic loads should be removed, as only energy available to consumers is I-REC certifiable
- If production information is being aggregated across device, the production of each device should be known on a granular level (hour-to-day)

The following request form is submitted by the Registrant to issue an I-REC:

Registrant and Device details			
Registrant name:		Registrant Id:	
Production Device/ Production Group:		Production Device/Production Group Id:	
Labelling scheme(s):		Last registration date:	
Production details			
Production Period Start Date: (dd.mm.yyyy)		Total kWh Produced in this period:	
Production Period End Date: (dd.mm.yyyy)		Percentage of eligible total applied for:	
Evidence details			
Type a: Settlement Metering data	<input type="checkbox"/>		Attached Y/N*
Type b: Non-settlement Metering data	<input type="checkbox"/>		Attached Y/N*
Type c: Measured Volume Transfer documentation	<input type="checkbox"/>		Attached Y/N*
Type d: Other	<input type="checkbox"/>		Attached Y/N*
Receiving account details			
I-REC Participant name:			
Account number:			
National statistics			
Is the production of this electricity counted towards a national, sub-national or regulatory target ?			Yes/No*
Public consumption obligation			
Is any of this production subject to a public consumption obligation?			Yes/No*

Evidence that is collected must be validated by an independent entity, and is normally submitted for validation within a year of the generation event occurring. Upon receipt of an issuance request, the Issuer will ensure that the measured volume has not been presented to any other carbon tracking system.

<b>Carbon Offsets (countries where legislation permits independent offsets only)</b>	
Do you retain the right to obtain emissions reduction certificates or carbon offsets for the energy nominated in this Issue Request?	Yes/No*
If no, the Registrant warrants that the energy for which I-REC certificates are being applied has not and will not be submitted for any emissions reduction certificate or carbon offset.	

The kWhs in the request will be summed, and the number of I-RECs that will be issued will correspond to the number of whole MWhs. If there are kWhs from the issuance period that were not included in an I-REC issuance (from the immediately preceding period), they can be included in this issuance. The Issuer will then create a record on the I-REC registry; if there are rights to obtain carbon offsets for the same MWh, then this will be noted on the I-REC record.

In the case of a self-consumption I-REC, the Registrant should nominate an account held by the Issuer, to ensure that the I-REC is not transferred to a trading account. The I-REC should be noted as a self-consumption I-REC.

The normal period to issue an I-REC is approximately 5 business days.

### Implications for D-REC Code

D-RECs are expected to be generated both by off-grid and on-grid devices. However, in the case of off-grid devices, and most likely in the case of on-grid “behind-the-meter” devices as well, there will not be any electricity operator or settlement agency present. Therefore, the issuance of D-RECs in those situations will need to rely entirely on meter data, inverter / device data, or proxy data from which generation data can be calculated (e.g. daily payments in a PAYGO system). Relying on meter data, or other settlement data, is aligned with the present I-REC code, although it is not the preferred method of validation.

As there likely will not be capacity to visit every site to ensure the meter which will be used to collect the production data was installed correctly or was not tampered with, additional checks may need to be performed in order to ensure data veracity. This may entail using “verified” metering hardware (and which would be designed to be tamperproof), or to use data from other system components, such as the inverter. For example, it may be possible to connect with an OEM’s inverter monitoring platform to gather production data; this will also ensure that any reported production data would be within the bounds of the device. In short, as D-REC verification will rely on measured data reported from devices, rather than data supplied by a settlement authority or independent auditor, and care will need to be taken to ensure data validity.

Further to this point, the D-REC platform can consider employing a “digital twin” approach. Production data from a device (which would include the device metadata and the production period) can be compared with a digital twin algorithm which would estimate the production given the metadata associated with the device (e.g. weather, location, capacity, production period, etc.) If the submitted generation data is within an expected band (e.g. two standard deviations), then the production data can be accepted. If not, it can be sent to an anomaly detection algorithm which would then determine if the submitted production data would at all be possible. As more production data is gathered, the more the model “learns” what expected production data would indicate.

### Supporting the Issuer archetype in the D-REC model

As noted earlier, issuers are authorized by the I-REC Services to make certificate entries in the I-REC registry; they must be formally accredited, and have a particular geography and product remit. It is preferred that the I-REC Issuer be recognized by relevant national authorities. Upon filing to be recognized as an I-REC Issuer, I-REC Services will engage an auditor to assess the application, and will assess the likelihood of the potential issuer to adhere to the I-REC code. Upon successful completion, the Issuer will be given access to the I-REC Registry, and will be able immediately to begin registering production devices and issuing I-RECs. The Issuer also will undergo period audits to ensure it provides robust transparency and traceability. In countries

where the total production device registration is below a threshold, or there are no active issuers in a particular country, the Central Issuer assumes responsibility.

In the case of the D-REC, a key design element will be to use an automated approach (with an independently-verified algorithm) to validate the generation data before creating a corresponding D-REC, using the methodologies described previously. However, a key design tenet is that, because the D-REC is not a new standard but rather an extension of the existing I-REC framework, the Issuer should be involved in the issuance process should they be present in a particular geography. This important aspect will ensure that the D-REC does not undermine the I-REC approach in any way, and will uphold the role of the Issuer and its relevance in their particular country's governance construct.

In consultation with the I-REC Standard, the D-REC Initiative proposes an approach where the Issuer will play a key role in the certification of D-RECs, in those countries where an I-REC Issuer is established. The D-REC platform will issue D-RECs in accordance with the principles laid out earlier, with each D-REC being assigned to a particular participant account. At some recurring time period, a set of D-RECs will then be forwarded to the assigned Issuer. The Issuer would then review the submitted metadata, and contact the Registrant if further validation is needed. At this point, the D-REC can either receive an additional label indicating that it has been checked by this verifying party, and if the total D-REC volume is at least 1 MWh, then the Issuer can create an I-REC, and capture the serial numbers of the underlying D-RECs which comprise that I-REC.

It is important to note that understanding the proposed verification methodology in detail is necessary to ensure that market participants can trust the data stored within the D-REC platform. As noted by the I-REC product code standard, Issuers are necessary independent verifiers who serve as an auditor on the certificate data submitted by the registrant. Because the D-REC is an extension of the I-REC code, it is necessary to utilize Issuers where available. However, with the potential scale of D-RECs, workflow modifications may be required to ensure the Issuer certification and D-REC certification remain aligned.

### Registry structure for managing active certificates

The I-REC registry is a single central registry which can be accessed by the internet. It consists of two primary elements:

- A list of accounts held by I-REC participants; these accounts are private unless the account holder designates access. I-RECs are transferred between accounts by the sender nominating a receiving account
- A list of production devices or production device groups; only this registration is publicly accessible

The following are the user types in the I-REC scheme and their permissions to adjust the I-REC registry:

Participants	Create and update records on the I-REC Registry (their account and reporting areas only)
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Registrants	Place I-REC issue requests
Issuers	Access and modify information regarding Production Device, Production Groups and Issued I-RECs
Registry administrator	I-REC Services can create I-REC Participant, Registrant and Issuer records, and conduct general administration)

Implications for D-REC

There are expected to be two states for the D-REC: active, or redeemed. An active state refers to a D-REC which has been created (and therefore verified) but needs to be redeemed by a buyer. Redeemed refers to a D-REC that has been claimed by a buyer. Within the context of the registry, an I-REC must exist in one of these two accounts. Similarly, for the D-REC, there will be at least one account - the Trade Account - with further deliberation needed on whether a Redemption account is needed (or redemption information simply can be gleaned from the Energy Web Chain).

With respect to access control for these accounts, a similar construct to the I-REC registry likely would be needed. Registrants would only be able to modify their participant account or information about the production devices that have been registered; buyers would only be able to modify their account information. At present, however, all changes must be routed via I-REC Services, as they are the ultimate arbiter of changes to the registry. In the case of D-RECs, there are two potential design considerations for any registry updates regarding accounts:

Central Service for registry updates:	<p>Building upon the I-REC Services construct, there could be a single entity that is responsible for ensuring that any data which is used to modify the account or device registry is valid</p> <ul style="list-style-type: none"> <li>• Pros: Single entity which will ensure access control, quality control on data in registry</li> <li>• Cons: Scalability may be an issue as the number of participants and devices scales across regions</li> </ul>
Distributed approach:	<p>Multiple entities (e.g. Aggregators) are authorized to make changes to the account registry with permission from the associated participants.</p> <ul style="list-style-type: none"> <li>• Pros: Scalability - any authorized party can make changes, ensuring the registry reflects any changes in real-time</li> <li>• Cons: Ensuring data integrity in the registry when multiple parties have access to make changes</li> </ul>

Utilizing the I-REC registry

In the event that a centralized registry approach is the expected design, one solution would be to leverage the existing I-REC registry to implement the D-REC account structure. As noted earlier, D-RECs will mirror the I-REC lifecycle and account structure, and therefore a single registry implementation could be possible. However, there are certain considerations should such an approach be evaluated.



Firstly, the D-REC will be denominated in kWh. While evidence presented to the I-REC Issuer is done so with kWhs, the I-REC is issued, and therefore tracked in the account structure, with a MWh denomination. Secondly, the number of devices and market participants is expected to be significantly greater than those who develop utility-scale systems; having the I-REC Services process any account update likely may not be as scalable.

As noted earlier however, because the D-REC will serve as an extension of the I-REC protocol, there will need to be clearly defined data interchange points if the D-REC and I-REC registries are operated in parallel. In particular, when a group of D-RECs are consolidated into an I-REC, information will need to be exchanged between the I-REC and D-REC account structures. The connection points between the D-REC and I-REC registries is described further below in this document.

As an aside, one consideration to address the “rogue actor” scenario in the distributed registry approach, in which multiple parties have access to modify the registry, would be to utilize a consensus algorithm. In such a case, all aggregators to which the accounts are linked would need to validate that the change made by one is indeed valid. In such an instance, the account holder, or authorized agent, would need to confirm with the different aggregators that the changes are valid. Only when a certain number of aggregators have agreed to the change would any account information be modified.

### Issuing I-RECs from D-RECs

In certain instances, buyers may seek to purchase I-RECs, even though the underlying data from those devices is tracked via the D-REC platform. Because the D-REC is a fractional representation of an I-REC (i.e. 1000 D-RECs correspond to an I-REC), an I-REC buyer may instead decide to purchase one or more of the underlying D-RECs. One proposed mechanism in which both registries enable such an approach is as follows:

- As the D-RECs are issued, a request will come via an Aggregator or Marketplace, or perhaps directly via the D-REC platform web form, to aggregate a set of 1,000 D-RECs to an I-REC. This would be in instances where there is a predetermined approach to aggregating D-RECs; it may also be the case that no aggregation is specified, in which case D-RECs within a specific geographic boundary may be aggregated to create an I-REC
- The associated D-RECs are then sent to an Issuer for validation; at this point, a basic generation check has been done by the “digital twin” algorithm, but the Issuer may choose to do additional validation, including auditing specific records from the Registrant
- The Issuer will then issue an I-REC, and place the I-REC in the associated trading account; if it is for self-consumption, then it will be placed in an Issuer-owned redemption account for the Registrant as beneficiary
- If the Issuer was not able to undertake any further validation, then the I-REC that will be issued will include a “D-REC Verified” label, thereby informing market participants that the Issuer has approved the creation of the I-REC utilizing the D-RECs automated verification approach.
- At this point, both the D-RECs and the overarching I-REC are in circulation and available for trading

Many of the metadata fields that likely would be needed to be associated with the D-REC are already identified in the I-REC attestation form. Namely, these fields would include:

- Device or Production Group ID
- Registrant name and ID
- Production dates and times

In the case of the registrant ID, those will be stored on the D-REC registry, and therefore they may be retrieved based upon the device ID. Many of these fields ultimately may only reside in the D-REC platform, with any I-REC “upgraded” from D-RECs simply showing that the source was the D-REC platform.

As noted earlier, in the I-REC issuance request form, the registrant must notify if there will be a separate environmental claim that will be made on the same kWhs reflected in the I-REC. There may be a similar need to consider additional labels for each D-REC, as there may be associated environmental standards or other attributes which may need to be associated with the D-REC. This likely could be included in the metadata fields in addition to the different IDs noted earlier.

Once both an I-REC and the corresponding D-RECs have been created and available for trading, a buyer may choose either to purchase the I-REC or the underlying fractional D-RECs. Both registries will reflect this transaction:

- In the event that the buyer purchases the I-REC, then the I-REC registry will inform the D-REC platform about the trade; the D-REC platform will then reflect the new ownership status
- If the buyer then subsequently redeems the I-REC, then all of the 1,000 underlying D-RECs will show a redemption status
- If a buyer, however, purchases a D-REC, then no change will be reflected in the I-REC registry; it will still show in the account of the device owner, even though some portion of the underlying D-RECs would be in a different account
- If a buyer then redeems one or more D-RECs, then the corresponding I-REC will be redeemed, *regardless of whether there are remaining available D-RECs for trade or not*. In such a situation, the fractional D-RECs are still tradeable, but the overarching I-REC will not be in circulation
- In such a case, the D-REC platform will inform the I-REC registry of the trade or redemption; in the case of the trade, only if all 1,000 D-RECs change ownership will such a transaction be reflected in the I-REC registry. Redemptions will be reflected in both registries.
- If an I-REC is created from underlying D-RECs, the I-REC will house all of the serial numbers that correspond to the D-RECs; an open design consideration remains whether each underlying D-REC must also reflect the I-REC’s serial number.

The above section highlights another design consideration where the D-REC Initiative still seeks feedback, namely to what extent participant and device metadata must be reflected in both the I-REC and D-REC registries. Certainly the trade and redemption of a D-REC/I-REC must be reflected in both registries, but there are multiple approaches to linking the participant and device metadata between the registries:

- In one instance, any participant or device information that is received by the D-REC platform is subsequently written into the I-REC registry. However, this may not be the

most amenable solution as it may not be preferable to have individual solar home systems or solar lanterns listed in the I-REC registry, while such a case will be true in the D-REC registry

- In a second design approach, the D-REC platform is considered an I-REC market participant. Therefore, only a single registry entry exists for the D-REC platform. Should a buyer require further information, a query to the D-REC platform will need to be issued. This approach will abstract the complexity associated with registering discrete small solar devices. Any I-REC that is issued from underlying D-RECs would then be assigned to the D-REC platform's trade account.
- A third option would be to identify some form of grouping which will allow for greater granularity to be surfaced through the I-REC registry, but should further detail be required, the D-REC platform should then be queried.

## Other I-REC Aspects

Other aspects of the I-REC code, and their underlying D-REC implications:

### An I-REC is unique

The D-REC also will be designed to be unique. In other words, a device that generates a D-REC cannot submit another request to generate another D-REC covering that same time period for that device. This can be managed by ensuring each device is assigned a unique ID, and each D-REC which is created to correspond to a generation amount over a certain time period also is assigned a unique ID, and is tracked on a public ledger to assure all parties that no double-counting occurred. The algorithm that generates the ID for the D-REC will use a combination of data inputs to ensure that no two D-RECs will share an ID at any point (e.g. 128-bit Globally Unique Identifier)

### An I-REC must be owned by a participant - it's ownership is exclusive

If the D-REC infrastructure mirrors the I-REC construct, there will at least be a trading account, and perhaps a redemption account as well, although the redemption event may be noted on the public Energy Web Chain. Buyers cannot make public claims regarding a particular D-REC unless that D-REC has been redeemed - again, where the event must be recorded on the Energy Web Chain. Otherwise, it is owned by the Registrant / Production Device owner, and is associated with their trading account. This will ensure that the D-REC is owned by a participant.

### Labeling schemes

The I-REC code supports the inclusion of additional labels when issuing an I-REC; the Registrant makes the Issuer aware of such approved labels prior to issuing an I-REC, likely with the intended goal of allowing the Issuer to make any necessary verification of the label.

In aligning the D-REC with the I-REC, any I-REC that is issued against 1,000 D-RECs would have a label associated with the verification. As noted earlier, in the case an Issuer cannot further validate an issuance request, the Issuer may rely on the validation from the D-REC platform. As such, the resulting I-REC will be labeled as "D-REC Verified." This I-REC may further be validated for other non-generation aspects, such as its impact on a humanitarian situation.

Because the D-REC issuance is automated, it may be difficult to support a labeling step prior to the issuance being executed. However, given the D-REC is simply a fractional representation of the I-REC, additional labeling can continue to be supported by the resulting I-REC which is created from the D-RECs. Moreover, the D-REC will support rich metadata, which may include information such as the system type, offtaker type, etc.

### An I-REC corresponds to 1 MWh; the measurement point is at the entry to the network

As noted earlier, the D-REC will correspond to a kWh, and serve as a fractional representation of an I-REC, which will continue to be measured in MWhs.

Moreover, while both the I-REC and D-REC rely on evidence to support generation data, the D-REC can be derived from multiple measurement points, none of which may involve a measuring of power exported to the grid. The more the number of different measurement points, the higher

the trust or reliability of the data. For example, a higher level of confidence can be assigned to generation data that is measured both from a production meter and from inverter data.

#### Right to associated environmental attribute certificate

An I-REC cannot be Issued without inclusion of any avoided emissions, carbon offsets or similar market instrument that might be available to the registrant or device owner. In requesting issuance of an I-REC, the Registrant must confirm that they hold the right to any such avoided emissions, carbon offsets or similar market instruments and irrevocably assign such rights within each issued I-REC. Similarly, a device owner must attest that the environmental attribute which shall be represented by the D-REC is not accounted for through another mechanism, such as a feed-in tariff.

#### Self-Consumption

To support Scope 1 accounting for self-consumption, the resulting I-REC is issued into the account of the Issuer and redeemed on behalf of the device owner / registrant. Similarly, a D-REC that is created for Scope 1 accounting can be assigned to the trade account of the registrant, and then redeemed by the system on behalf of the registrant.

## Summary

The D-REC Initiative seeks to establish the D-REC to extend the existing environmental standards more broadly into the DRE sector, and allow more types of renewable energy devices and market participants to monetize environmental attributes in the global market. To this end, the D-REC initiative seeks to align closely with the I-REC Standard, Gold Standard, VERRA, and other applicable standards. This analysis was prepared in order to better understand what aspects of the existing I-REC code may be applicable to a D-REC context, one in which off-grid devices and greater automation play a larger role.


Key findings / proposals in this report include:

- Designing the D-REC to be a fractional representation of the I-REC: 1,000 D-RECs, each denoted in kWhs, can be aggregated to represent an I-REC
- The D-REC platform will consist of on-chain and off-chain components:
  - Off-chain components include a participant account and device registry which will record metadata about market participants and generation devices
  - On-chain aspects will record each stage in the D-REC lifecycle, as well as account creation and device registration events
  - A verification module which will utilize a “digital twin” approach to validating generation data using multiple evidence points (e.g. production meter, inverter data, etc.)
  - A trade account which will house active D-RECs for trade
  - An ability to record when a D-REC has been redeemed
  - All key aspects of the D-REC lifecycle - participant registration, device registration, D-REC instantiation, D-REC trading, and D-REC redemption - will be recorded on the Energy Web Chain
- The D-REC code will be designed to closely align with the I-REC standard such that buyers can purchase either an I-REC or one or more of the underlying D-RECs

## D-REC / I-REC GAP Analysis

- Issuers, where designated by the I-REC Standard, will play a role in issuing an I-REC from the underlying D-RECs
- The D-REC will introduce both a Marketplace and an Aggregator archetype; the latter will focus on serving as an intermediary between the devices and the D-REC platform
- The D-REC platform will closely align with the I-REC registries at key stages in the D-REC / I-REC lifecycle

This report was prepared by the D-REC Initiative with the intent of soliciting feedback from market participants. A proof-of-concept for the D-REC platform also is being implemented to operationalize some of the aspects discussed in this report, and also will be presented to market participants for feedback.



# Thank you for reading



[ricky.buch@positive.capital](mailto:ricky.buch@positive.capital)



[d-recs.energy](http://d-recs.energy)



With funding and support from







The D-REC Initiative is a not-for-profit, multi-stakeholder, industry-led initiative. Our membership includes climate and impact oriented philanthropic organizations, climate investors, leading global corporations, international standards organizations, technology providers, international development organizations, environmental market agents, sustainability advisors, renewable energy industry associations and project developers in emerging markets.

The Funding Partners have appointed the Secretariat to lead the coordination of the multi-stakeholder project.

## Secretariat

