SUSTAINABLE ENERGY AUTHORITY OF IRELAND

LEU electricity emissions reporting framework

Recommendations for design and implementation

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Report prepared for SEAI by:
Frontier Economics

Sustainable Energy Authority of Ireland
SEAI is Ireland's national energy authority investing in, and delivering, appropriate, effective, and sustainable solutions to help Ireland's transition to a clean energy future. We work with the public, businesses, communities, and the Government to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies.

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Definitions and abbreviations

AIB – Association of Issuing bodies
CAP – Climate Action Plan
CSO – Central Statistics Office
ETT – Energy track and trace
DUoS – Distribution Use of System
GO – Guarantee of origin
IBs – Issuing Bodies
LEU – Large energy users
MTU – Market time unit
M-RETS - Midwest Renewable Energy Tracking System
RECs – Renewable Energy Certificates
RED – Renewable Energy Directive
REGO – Australian Renewable Guarantee of Origin
SEAI – Sustainable Energy Authority of Ireland
SEMO - Single Electricity Market Operator
TSOs – Transmission System Operators

DUoS - ESB Networks defines DUoS groups from DG8 and DG9 as those distribution-connected at 38kV (based on maximum demand), while DG10 includes those connected at 110kV. We note too, the TCON category of users, which are those connected to the transmission system.

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1. Executive summary

Ireland implemented the Climate Action and Low Carbon Development (Amendment) Act 2021, which legally binds the Republic to achieve a 51% reduction in GHG emissions by 2030 and net zero emissions by 2050.[1] The forecasted continued growth of demand from Large Energy Users (LEUs) and, in particular, data centres, poses a challenge to these emissions targets. Figures released by the Central Statistics Office in 2023 showed that data centres consumed 21% of Ireland's metered electricity in 2023, up from 14% in 2021 and 5% in 2015,[2] and by 2032, 30% of all electricity demand is expected to come from data centres and other new large energy users.[3]

Ireland's Climate Action Plans set out a roadmap to deliver on its climate ambitions and acknowledge the challenge from data centres. Specifically, action 99 of the Climate Action Plan (CAP) 2021[4] included a sub-task to *"Develop an enhanced reporting framework and implementation plan for electricity emissions for LEUs to facilitate reduced carbon intensity across their demand profile and promote grid efficiency".* The Sustainable Energy Authority of Ireland (SEAI) was assigned to lead the execution of a study to inform the development of that framework. SEAI convened a Steering Group to assist with specifying the study and direct its execution. Following a competitive tendering process, SEAI appointed Frontier Economics to complete the study.

This report sets out high-level recommendations for how the framework could be structured. The decision to implement the scheme in the manner recommended (or not), whether to adopt and how to phase each of the different elements of the scheme will be made by the Department of the Environment, Climate and Communication (DECC), taking into account the recommendations and challenges highlighted in the report, along with other stakeholder engagement. These risks include the fact that Ireland is taking action before other Member States and in advance of an EU wide approach to granular reporting[5], and the potential challenges of aligning this scheme with wider policy decisions. There are also a number of implementation challenges, including defining the appropriate timeline for adoption, that will require further consideration and cooperation between DECC, Commission for Regulation of Utilities (CRU) and Eirgrid and Single Electricity Market Operator (SEMO).

The most relevant current reporting framework is built on the Guarantee of Origin (GO) scheme. A GO is an energy attribute certificate, in the form of an electronic document, that provides proof to a final customer that a given share or quantity of supplied energy was produced from renewable sources, and each GO unit represents one megawatt-hour (MWh) of generated electricity. In Europe, Directive 2001/77/EC (2001) introduced the use of GOs as a basis for proof of the origin of renewable energy to consumers, and subsequent Renewable Energy Directives reinforced the use of GOs.

GOs are currently aggregated at a monthly and annual level, and it is possible to cancel a GO certificate for any time period within the year for which the certificate is valid, regardless of when the electricity has been used. GOs are not defined with detailed spatial information. A consumer in one location, for example, Germany, can purchase the corresponding volumetric amount of its consumption in the form of GO certificates, even though the generation to which those certificates correspond is elsewhere, for example, in Spain. The result is that the purchase of GOs does not necessarily relate to the physical availability of renewable generation or the constraints of the electricity grid and, therefore, the GO regime does not provide additional incentives to match consumption with renewable generation.

A number of commercial schemes are emerging in this space, to produce Granular Renewable Energy Certificates (RECs) - sometimes referred to as time-based energy attribution certificates (T-EACS) - that track renewable energy consumption on an hourly basis. The roles of different stakeholders vary between schemes, but are generally a collaboration between energy producers, energy suppliers/consumers (who provide the meter data), and software providers (hosting 24/7 renewable energy matching tools). These schemes offer a guide to the data requirements and potential structure of an enhanced reporting framework.

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[1] Climate Action and Low Carbon Development (Amendment) Act 2021, available here
[2] Central bureau of statistics, available here
[3] Eirgrid Generation Capacity Statement 2023-2032, available here
[4] CAP 2021 available here
[5] We note that there are also potential benefits to moving first, see Section 5.2

In contrast, public schemes across the world predominantly share the same key principles as the EU GO, with certificates being issued with a monthly or yearly time stamp. However, there is a clear movement towards more granular tracking and certification. Two of the tracking systems in North America, the Midwest Renewable Energy Tracking System (M-RETS)[6] and Pennsylvania-Jersey-Maryland Interconnection, commonly known as PJM[7], now offer limited functionality for hourly tracking on a voluntary basis. The Australian Renewable Energy Guarantee of Origin (REGO) scheme will issue certificates that include grid location and a timestamp reflecting the hour in which the electricity was dispatched. In Europe, Energy Track & Trace (ETT)[8] is a joint initiative of European Transmission System Operators (TSOs) and Issuing Bodies (IBs)[9] to develop a system with granular certificates to enable hourly tracking.

Building on this experience, we have assessed the options for an enhanced reporting framework for Ireland, focusing on two high-level frameworks: an Enhanced GO scheme built on the principles of the existing scheme and an Emissions Accounting scheme, where meter data for LEUs and associated generators is matched centrally, and certificates are not required. A central registry where certificates or matches are recorded would be a core component of either scheme.

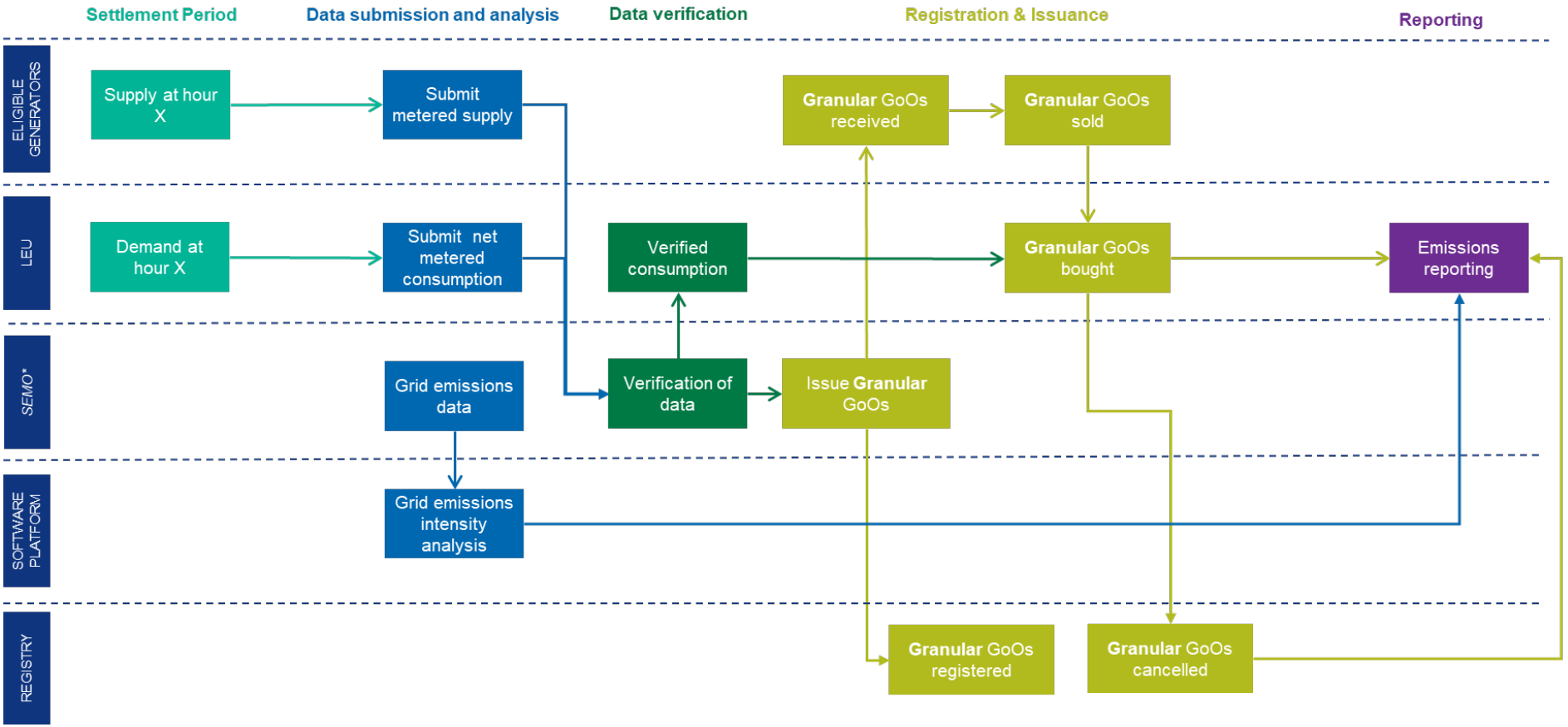
Our recommendations for government are divided into three categories:

- **Decide now**: Where there is sufficient information for government to make a decision now. This is primarily for high-level, strategic choices.
- **Act now**: Where there is sufficient understanding of the options available to the government, but further action is required before a decision can be made.
- **Investigate now**: Where the full details of the options are less clear and would benefit from additional work before any action is taken.

We recommend building on the principles of the existing GO scheme as the evidence suggests an enhanced GO offers the best high-level framework for LEU Electricity Emissions Reporting. It builds on the principle of issuing guarantee of origin certificates, with all the standard data on existing GOs,[10] albeit with a greater level of data granularity. The certificates would include a time-stamp of the hour of generation, and a location.[11] It therefore remains in conformity with the current EC Directive requirements and indeed, anticipates emerging requirements. The diagram showing how an enhanced GO scheme would work is shown in Figure 1 below.

[6] Overview of M-RETS hourly tracking available here
[7] Overview of PJM hourly tracking available here
[8] Overview of ETT available here
[9] 50Hertz (Germany), Elering (Estonia), Elia (Belgium), Energinet (Denmark) overview available here
[10] AIB specifies the standard data included, here
[11] This could also be set at 30 minutes or 15 minutes (see section 4.2)

Figure 1 : Enhanced GO scheme overview.



Source – Frontier Economics
Note: The roles and responsibilities of SEMO, the Software platform, and the registry are illustrative and could be combined under different design options

Under this proposed scheme, SEMO, the body responsible for issuing GOs in Ireland, issues granular GOs to the generator, which are then sold to LEUs to match their verified consumption. The registry records the issuance and cancellation of granular GOs. At the point of cancellation, the LEU meter data is matched to the certificate data. SEMO verifies the metered supply and consumption data and provides grid emissions data to the software platform so that the emissions intensity of the LEU's residual load[12] can be calculated. We note that the exact roles and responsibilities are illustrative and would need to be defined during implementation.

We assessed the option of implementing an intermediate scheme based on the design of commercial schemes while the new reporting framework is being established. Our recommendation is that it is likely to be best to avoid the risk of wasted effort unless implementation of the enhanced GO scheme could be significantly delayed. We note in this context that the intention to have a full reporting scheme (as per our recommendations in this report) in place by Q4 2024, as required by Ireland's Climate Action Plan 2024[13], is extremely challenging.

Beyond the question of the high-level design of a scheme, there are a number of detailed design choices and

To deliver on action 99 of the Climate Action Plan (CAP) 2021[1] **we recommend that DECC decide now to use enhanced GOs for any granular LEU reporting scheme.**

methodological issues to consider, all of which represent policy decisions for DECC to make. We have assessed what we believe to be a sensible starting point and how refinements to the framework could then be phased over time. The scheme's design and design choices will determine the costs, benefits, and risks to Irish consumers.

Our assessment is based on an understanding that the intention is for the reporting framework to be mandatory for some consumers. In a number of areas, we have been able to come to relatively "clear-cut" recommendations. These are set out in Table 1 and are based on the priority of designing a reporting framework that can be operational as soon as possible, and with the intention that the design should allow the framework to evolve through future phases.

Having made the decision to pursue a reporting scheme based on enhanced GOs as referred to above, **we recommend the government act now to consult** on the more clear-cut design choices.

[12] See section 5.5

[13] Climate Action Plan 2024 Annex of Actions, available here

Table 1: Recommendations

Design choice	Recommendation
Technology scope	• The initial scope of power generation technologies included in the framework should be consistent with the existing RED II definition of RES. • The framework should be designed such that it can evolve to include green hydrogen and CCS, if and when appropriate and in line with the future needs of the existing framework.
LEU scope	• The initial scope of the reporting framework should be set to include LEUs that are transmission connected (TCON) plus DUoS group DG8 level – DG10 inclusive (connected between 38kV to 110kV). • This should not exclude any other users from participating in the scheme on a voluntary basis, assuming that they bear their fair share of any costs their inclusion imposes on the scheme administration.
Legal basis	• The scheme should be mandated for LEUs in scope once the legal framework is established. • Without the legal framework, the scheme should be established on a voluntary basis. • Announce mandatory participation in the scheme a minimum of 12 months ahead. This would allow sufficient time for all valid legacy GO certificates to expire.
Time granularity	• Certificates should include a time stamp equivalent to the market time unit (MTU), currently one hour at the day-ahead stage, which constitutes the majority of near-term trading volumes. • This should evolve in line with any changes to the MTU.
Behind the meter generation	• Behind-the-meter generation should be included in the scheme's scope, in relation to establishing a site's net emissions, but in a second phase. • This should ensure that identifying and registering the units does not delay the scheme's initial phase.
Storage	• A methodology should be established to include grid-connected storage in the second phase of the scheme. • This should be applied to behind-the-meter storage when appropriate.

In some other areas, while we have made recommendations, they are less clear-cut and should be subject to future confirmation. These are set out in Table 2.

We recommend the government investigate now the implications of recommendations in these areas and alternative options. This could be done in parallel with the public consultation above or separately.

Table 2: Less "clear cut" recommendations

Policy design	Recommendation	Aspects for investigation
Eligibility	• All generators in Ireland that are within the technology scope, whether subsidised or not, should be considered eligible to receive granular GOs.[14] • This is a departure from the implementation in Ireland of the existing GO scheme and impacts upon other policies, but in our view makes sense due to the low number of unsubsidised renewable generators in Ireland and the importance of ensuring a minimum level of market liquidity. • If seen as desirable, in order to support the demonstration of additionality, the granular GOs could indicate whether they originate with an unsubsidised generator, and this could be part of overall reporting.	**Investigate** the policy implications of including subsidised generators in the scheme. In particular, the impact on market liquidity of including only non-subsidised generation in the scheme (i.e. to what extent would this result in significant and persistent excess demand, and what issues would this create?).
Location	• The scheme's locational boundary should initially be set to the Republic of Ireland. • Moving to a locational definition based on constraint zones could send more efficient signals to future LEUs and generators and could also incentivise flexibility from existing stakeholders. • However, there may be significant imbalances between demand and supply within locations, which might mean generators in some zones are able to charge LEUs a material premium. • In our view, this may not be the most appropriate context within which to initiate the reporting framework.	**Investigate** the potential impacts of moving to a scheme with location boundaries set at a constraint zone level. In particular, assess how this would impact market liquidity and the potential level and persistence of excess demand in some locations.
Residual emissions methodology	• Residual emissions should initially be calculated on the basis of average emissions. • We note that, from the viewpoint of incentives, there are arguments to use a marginal calculation as the basis for residual emissions. • Doing so is, however, more complex and may create the impression that LEUs are responsible for more emissions than is the case. • Our view is that this is not the right basis on which to initiate the reporting framework, but that nothing should be done to prevent a move to a marginal approach in the future.	**Investigate** the benefits of a marginal approach and whether they outweigh the average approach. In particular, what would be the impact of a marginal approach in the overall context of national emissions reporting.

Our assessment is based on an understanding that the intention is for the reporting framework to operate in parallel with the existing GO scheme, at least in the short-term or until the existing scheme is replaced at an EU level. When implementing a new framework alongside the EU-wide continuation of the existing GO scheme, it will be important to manage the process to prevent double-counting[15], and, also, to prevent any adverse impacts on market participants not in the eventual mandatory scope of the new scheme. The fact that subsidised renewable generators

[14] We note that this might have implications for the support arrangements for RES generation already contracted under the Renewable Electricity Feed-In Tariff (REFIT) and the Renewable Electricity Support Scheme (RESS) regimes and funded via the PSO. This would need to be considered during implementation.
[15] See section 6.2

in Ireland are ineligible for existing GOs limits the double counting risk to the few unsubsidised generators in Ireland that are currently receiving GOs. This residual risk could be managed in a number of ways, including by ensuring that the registries for the two schemes are aligned and that when Granular GOs are issued to generators in the scope of the standard scheme, their account in the standard registry is adjusted by the corresponding amount. [16]

This would reduce the supply of locally generated GOs for other reporting schemes, e.g. Fuel Mix disclosure[17] and therefore lead to suppliers relying more on the import of GOs from other EU jurisdictions. However, this is a necessary corollary of avoiding double counting, and since the GO market is EU wide, we do not expect this to have a significant impact on the price of standard GOs.

The existence of two schemes means that different consumers (i.e. LEUs vs. others) will report renewable purchases on a different basis. The contracting for renewable power of non-LEU consumers will cease to be a reasonable benchmark for LEU consumers in the granular scheme, and the risks associated with the lack of comparability between the two schemes will need to be managed.

We recommend that the government investigates now the risks and benefits of maintaining the existing GO scheme for non-LEUs while establishing a new scheme for LEUs. This should include the preferred approach to managing double counting risk and the adverse impacts of establishing different reporting frameworks for LEUs and non-LEUs for any period where schemes are operated in parallel.

Implementing a new, more granular scheme will also increase the data requirements and likely require the establishment of new systems to operate the registry, collect data, and issue certificates. Consideration will need to be given to the time allowed for this transition to happen.

We recommend that, in parallel with the above investigations, the government acts now to engage with CRU, SEMO, Eirgrid to understand the potential implementation activities and timetable associated with the scheme.

[16] Energy Track and trace (ETT) provides an example of how registries can be aligned. See slide 7 here
[17] Fuel Mix and Guarantees of origin, see here

2. Project context and approach

2.1 Project context

It is an accepted fact that climate change is happening across the world. The sixth IPCC report has found the mean global temperature has increased by 1.1 degrees since 1850.[18] Increasing global temperatures are driven by GHG emitted into the atmosphere when burning fossil fuel. We describe Ireland's policy responses to reduce GHG emissions in the next section.

In 2016, the Irish government ratified the Paris Agreement and thereby committed to keep the global temperature rise well below 2 degrees Celsius, aiming for 1.5 degrees Celsius compared to the pre-industrial levels of 1850. Building on this, the 2020 European Green Deal commits to an overall 55% reduction in GHG emissions by 2030, to reach net zero emissions by 2050.[19] Ireland implemented this deal through the Climate Action and Low Carbon Development (Amendment) Act 2021, which legally binds the Republic to achieve a 51% GHG emissions reduction by 2030 and net zero emissions by 2050.[20]

European ambitions are further set out in the "Fit for 55" package. The package includes a revision of the 2018 Renewable Energy Directive (RED), which binds the EU to a combined 40% share of renewable energy sources in its final energy consumption by 2030.[21]

Demand growth represents an important challenge to Ireland's long-term plans. Ireland has emerged as a thriving hub for data centres and this industry has not only generated employment opportunities but has also attracted substantial investments, making a significant contribution to the national economy. Figures released by the Central Statistics Office in 2024 show that data centres consumed 21% of Ireland's metered electricity in 2023 up from 14% in 2021 and 5% in 2015[22] and by 2032, 30% of all electricity demand is expected to come from data centres and other new large energy users.[23] While welcome from an economic point of view, this growth makes achieving a 51% reduction in GHG by 2030 and net zero by 2050, more challenging.

Ireland's Climate Action Plans set out a roadmap to deliver on its climate ambitions, with a foreseen expansion of renewable energy capacities playing a major role. As set out in the National Development Plan 2021-2030[24], the Irish government is planning to reach 5 GW of offshore renewable electricity generation by 2030 through the Renewable Energy Support Scheme (RESS). In combination with other renewable energy sources, renewable electricity is to account for 80% of generation by 2030. Specifically, Action 99 of the Climate Action Plan (CAP) 2021[25] included a sub-task to "*Develop an enhanced reporting framework and implementation plan for electricity emissions for LEUs to facilitate reduced carbon intensity across their demand profile and promote grid efficiency*". SEAI was assigned with leading the execution of a study to inform the development of that framework.

In line with this sub-task, after a competitive tendering process, SEAI appointed Frontier Economics to make recommendations for a next-generation electricity emissions attribution framework, after convening a Steering Group with members from the Department of the Environment, Climate and Communications (DECC), Department of Enterprise, Trade and Unemployment (DETE), the Commission for the Regulation of Utilities (CRU), Eirgrid, IDA Ireland (Ireland's Development Agency), Enterprise Ireland, ESB Networks (Distribution Markets and System

[18] IPCC, available here
[19] EC European Climate Law available here
[20] Climate Action and Low Carbon Development (Amendment) Act 2021, available here
[21] EC, available here
[22] Central bureau of statistics, available here
[23] Eirgrid Generation Capacity Statement 2023-2032, available here
[24] National Development Plan 2021, available here
[25] CAP 2021 available here

Operations), National Treasury Management Agency (NTMA), Environmental Protection Agency (EPA) and Central Statistics Office (CSO), to guide the project.[26]

SEAI will provide a report to Government, on the options for implementing the enhanced electricity emissions reporting framework for large energy users. The Updated CAP 2024, Action EL/24/22, provided that this is due by Q2 2024, and to be implemented by Q4 2024.

We note that the extent of any legal requirement, for some large energy users, to report in such a framework is a question that will need to be decided by the government. Our understanding is that the preference within government is for the scheme to be mandatory for some users, but that primary legislation would be required to enforce this.

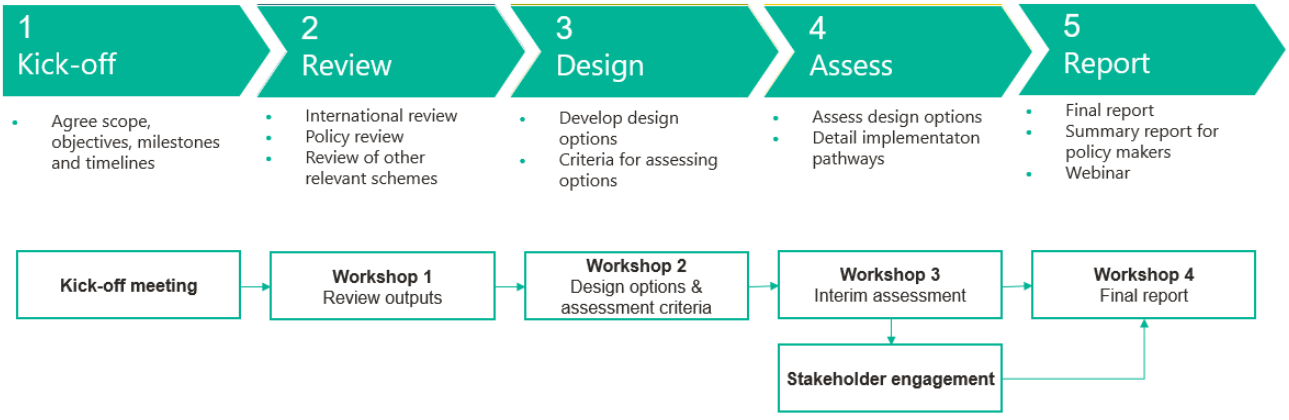
Finally, it is important to note that the framework is for emissions *reporting*. The aim is to have LEUs accurately reporting the carbon emissions associated with their electricity use, which may or may not be reduced through forward contracting with low carbon power producers. The decision as to whether and how to contract with such producers is one for LEUs and is not defined by the framework.

2.2 Project approach

We undertook the project across five stages between January and May 2024. We first agreed on scope, objectives, and timelines in a kick-off meeting with the Steering Group. We then carried out an initial international and policy review (stage 2), following which we drew on the resulting insights to design a number of possible options for the reporting framework (stage 3). We then undertook an assessment of the options, coming to some initial recommendations. These were then tested with the Steering Group, and through an industry engagement workshop, to allow stakeholders to contribute to the final recommendations. We then wrote up our analysis and recommendations in this final report. The main comments and questions raised in the engagement workshop have been listed in Annex 2 to this final report.

Figure 2 below shows the different stages of the project and the timing of the workshops with the Steering Group.

Figure 2 - Project overview stages



Source – Frontier Economics

2.3 EU Guarantee of Origin (GO)

A Guarantee of Origin (GO) is an electronic document which provides proof to a final customer that a given share or quantity of energy was produced from renewable sources. Each GO unit represents one-megawatt hour (MWh) of generated electricity.

[26] The membership of the steering group is listed in Annex 1 of this report.

Requirements in relation to GOs are set out in European legislation. Article 19 of the Renewable Energy Directive requires Member States to ensure that a GO is issued on request by producers of electricity, gas, hydrogen, heating or cooling from eligible renewable energy sources.[27] It states that Member States shall ensure that a GO is issued in response to a request from a producer of energy from renewable sources, that a GO shall be of the standard size of 1 MWh, that no more than one GO shall be issued in respect of each unit of energy produced, and that GOs shall be valid for 12 months after the production of the relevant energy unit. The system is purely voluntary, and individual producers can decide whether or not they wish to make such a request.

EU law also requires that GOs are tradable across the EU. As such, there is no fixed price for a GO, and its value depends on market demand. Irish electricity suppliers can buy GOs to certify that a share of their electricity demand is covered by renewable sources, although since GOs can be traded across the EU, there is no direct link between this certification and physical flows of electricity. Certification for an individual supplier that a proportion of electricity supplied is from renewable sources in country A could result from a supplier buying GOs produced in a different time period, from renewable producers in country B, at the other side of the EU, and with no direct interconnection.

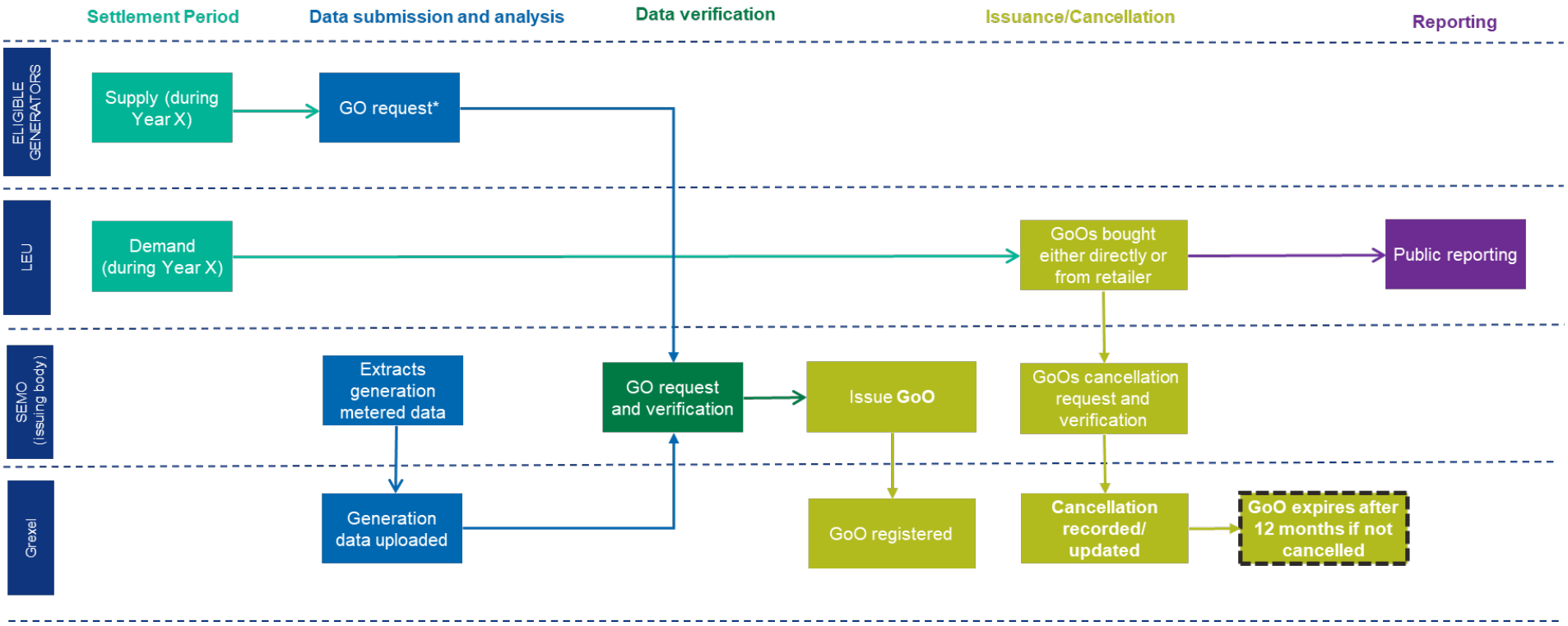
GO scheme in Ireland

In Ireland, GOs are issued by SEMO. SEMO is a member of the Association of Issuing Bodies (AIB), which facilitates the international exchange of Guarantees of Origin in Europe via the inter-registry telecommunications hub (AIB hub) and ensures that there is no double counting. The AIB hub allows suppliers to purchase (or sell) the renewable benefit of renewable generators across Europe and include their net purchase in their fuel mix declaration. In Ireland, SEMO operates the registry for GOs through Grexel, part of the EEX group.[28]

In Ireland, any electricity producer not in receipt of support or any supplier active in the Irish market can register as an account holder in the GO scheme through SEMO. They can then trade GOs with other account holders in Ireland or in other EU states. Figure 3 below represents a high-level summary of the operation of the current scheme.

[27]Article 19, available here. Directive 2001/77/EC (2001) introduced the use of GOs
[28] The register is available at G-REX.

Figure 3 – Flow diagram of the current GO scheme



Source : Frontier Economics based on the business processes described by SEMO here

We note that data on the number of GOs issued by SEMO is not publicly available. The AIB, however, publishes an annual report that contains reports from its members, including SEMO. The most recent report[29] states that there was a 4% increase in the registered GO scheme participants, which is open to licenced suppliers and generators.[30] There were 57 registered scheme participants in 2021 in Ireland. Certified RES certificate production was 1839 GWh compared to national RES production of 10937 GWh, approximately 17% of national RES production.

2.4 Potential drawbacks

There are several drawbacks of the current GOs system. GOs do not represent the physical availability of renewable generation at a given point in time or the constraints of the electricity grid. In other words, GOs are completely decoupled from the underlying renewable electricity production, leading to emissions accounting problems, when electricity consumers use GOs in support of claims of emissions reductions arising from their procuring renewable electricity.

The ensuing claims of emission free electricity use are incorrect and leads to conflation of purchasing green electricity products, or direct PPA's for 100% renewable supply, with zero emissions electricity. Currently an entity can claim to be powered by 100 % renewable generation when, in fact, a large part of their physical demand may come from the local grid, and from electricity generated from fossil fuels. This is due to the fact that, in the annual GO system, consumption of electricity at a particular location and point in time can be claimed to be associated with renewable energy production at a different location and different point in time.

In particular, since supported renewable generation in Ireland cannot issue GOs, it is likely to be the case that the majority of GOs purchased by Irish suppliers or final consumers relate to electricity produced elsewhere in the EU.

The annual and EU-wide nature of GOs (and the resulting potential for temporal and locational mismatch between GOs and the demand to which they are allocated) means that there is no GO related price signal to indicate when and where there may be too much or too little renewable generation, and so where increasing renewable investment (with different technologies), load, or storage would be valuable. Put simply, there is no incremental incentive from GOs to match renewable production and consumption. A regime that contained such an incentive could be expected to lead to more efficient investment in renewable generation, storage, demand response and energy efficiency.

2.5 Benefits of a new framework

In recognition of the drawbacks described above, there is a trend towards a more granular reporting standard. Several organisations have published commentary and position papers on the subject, identifying the benefits of moving to a more granular reporting standard. For example:

- ENSTO-E published a position paper[31] in 2022 on its views for a market design for GOs, which referred to the temporal and locational benefits from a more refined emission reporting framework.
- Eurelectric[32] has cited its view of the potential benefits of moving towards 24/7 matching, including greater transparency, RES investment, electricity decarbonisation, innovation, and better alignment with the grid.
- EnergyTag[33] has opined on the same benefits.
- NordPool, AFRY, and Granular Energy published a joint paper[34] that refers to the application of granular certificates and their potential to accelerate the deployment of technologies that can deliver green energy when it is demanded.

We summarise the benefits of a more granular reporting framework according to these papers below.

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[29] AIB 2022 Annual Report available here, page 58/59
[30] Currently 'Trader only' accounts are not permitted in the Guarantees of Origin scheme in Ireland.
[31] Entso-e (2022): Views on a Future-Proof Market Design for Guarantees of Origin, available here
[32] Eurelectric, available here
[33] EnergyTag: EnergyTag and granular certificates. Available here
[34] Nordpool, AFRY, and Granular Energy: "About time: How incorporating timestamped energy certificates into electricity markets could accelerate the energy transition". Available here

- **Improved price signals through temporal matching.** A granular system more accurately shows the temporal dynamics of renewable power generation and consumption. Shifting the time window for matching production and consumption of green electricity from a yearly basis to hourly or 15-minute basis, would better reflect the real value of producing and consuming green electricity dynamically at each moment in time.

- **Market signals to drive investment in the right generation technology.** A granular reporting framework can help to develop investment in RES assets by reflecting the location and time they are most (and least) needed, and therefore give LEUs information to assess strategically which RES generation is best suited to match their demand. Increasing the time granularity of the matching system can be particularly beneficial when a higher penetration of renewables in the system is reached, by stimulating the synchronisation of demand with times of greater renewable energy production and thereby enabling the grid to be used more efficiently. This could lead to greater geographical and technological diversity of generation, greater demand response, or greater investment in storage. For example, if there is excess solar at a point in time but a lack of certificate demand because demand is concentrated at nighttime, certificate prices could be significantly higher at night, which would send an investment signal for more investment in technologies like wind generation, which can generate at those times. It could also send a signal for demand to respond flexibly where technically possible, or to invest in storage.

- **Increasing transparency and trust around emissions reporting**. A granular reporting framework better shows the temporal nature of electricity generation, in particular that of variable renewable generation. It therefore allows LEUs to more accurately report the result of their energy procurement and compensates for the distrust in existing certificate systems and accusations of greenwashing. For example, in Ireland, the Advertising Standards Authority recently ruled that energy companies following existing standards, to offer 100% renewable energy products, are misleading the public.[35]

- **Potential improvements to carbon emissions calculations.** Currently under the GHG protocol Scope 2 emissions guidance[36], emissions are calculated and reported using a location-based method and a market-based method, both using the volume of energy consumed over the course of the period. multiplied by an emissions factor. In both cases, using more granular reporting framework would improve the accuracy of emissions calculations:
    - The location-based method requires an emissions factor that reflects the emissions from the defined grid distribution region. The Guidance allows the use of granular, time-of-day usage to apply to GHG emissions, but most users still use grid-average emissions factors based on annual emissions. Using data that represents time-differentiated grid emissions would allow more accurate emissions to be calculated, particularly in countries with relatively high renewables penetration.
    - Under the market-based method, emissions are attributed to consumers on the basis of their contractual instruments and associated certificates, including GOs, but this can only be applied on a monthly or yearly basis at present. Increasing the time granularity of such certificates would allow LEUs to calculate their emissions on an hourly basis and therefore improve the accuracy.

[35] Euronews, available here and as cited in the Nordpool joint paper, here

[36] See here. The GHG Protocol, officially known as the Greenhouse Gas Protocol Initiative, is a set of accounting and reporting standards for greenhouse gas (GHG) emissions. It provides organisations with a consistent approach for calculating and reporting emissions, facilitating comparisons between different entities. There are three scopes under the Protocol. The main relevant scope for LEUs under the protocol is scope 2 emissions, which are indirect emissions from purchased electricity, heat, or cooling, although some LEUs may also report under Scope 1, which includes direct emissions from owned or controlled sources, such as fuel combustion in boilers.

3. Review

3.1 Policy review

Our policy review covered several EU directives that are pertinent to renewable energy generation support and to reporting, as well as key Irish policy documents and statements. We examined the EU Directives on renewable integration (RED), on energy efficiency, and on financial reporting. Turning to Irish policy documents, we looked at the Climate Action Plans, Ireland's Enterprise Strategy, and the Corporate PPA (CPPA) Roadmap. We also reviewed standards for renewable fuels in the EU and the low carbon hydrogen standard in GB. We describe these in more detail in Annex 3. In our review of these policies, we focussed on the relevant aspects for incentivising or mandating reporting electricity-related emissions by LEUs:

EU policies

The RED (2023) is relevant as it specifically allows for the reporting of energy at an hourly or sub-hourly interval, or in accordance with the imbalance settlement period for renewable electricity.[37] The Directive on energy efficiency is also relevant, as it identifies the ICT sector and data centres in particular as requiring the collection and the publication of data with a significant footprint. It specifies that data centre sustainability indicators could be established on the basis of data collected, and it specifies the scope of the reporting in terms of the types of data centre activity.[38]

We found the financial reporting and CSR directives less directly relevant, although we noted that they set out standards for reporting in a transparent way.

Low carbon hydrogen standards

We also reviewed the standards for renewable fuels in the EU and the low carbon hydrogen standard in GB. While not formally relevant to commercial and industrial LEUs, further insight can be drawn from standards for renewable fuel and in particular, green hydrogen (produced via electrolysis from renewable electricity), called a renewable fuel of non-biological origin (RFNBO). The standards adopted in this area can inform the approach to be taken in relation to LEU consumption reporting.

The current standard for reporting on electricity used for RFNBO production was established in the Renewable Energy Directive (2018/2001), which states that "*To ensure that renewable fuels of non-biological origin contribute to greenhouse gas reduction, the electricity used for the fuel production should be of renewable origin. The Commission should develop, by means of delegated acts, a reliable Union methodology to be applied where such electricity is taken from the grid. That methodology should ensure that there is a temporal and geographical correlation between the electricity production unit with which the producer has a bilateral renewables power purchase agreement and the fuel production.*"[39]

The European Commission adopted two Delegated Acts as required in this RED. In particular, the RFNBO delegated act (2023/1184) sets out rules on how fuel producers can source electricity that is fully renewable. The rules are to ensure that these fuels can only be produced from "additional" renewable electricity generated at the same *time* and in the same *area* as their own production. For this to be possible, some form of granular assessment of electricity used will be required. These rules are described in further detail in Annex 3.

Similarly in GB, the Low Carbon Hydrogen Standard (LCHS)[40] sets out a definition for "low carbon hydrogen" in the UK and is used as an eligibility criterion for government subsidy schemes. The LCHS sets a maximum threshold

[37] See the RED 2023 here, page 42
[38] See the Directive here, page 16.
[39] See here
[40] Annex B, UK Low Carbon Hydrogen Standard, Greenhouse Gas Emissions Methodology and Conditions of Standard Compliance, v3 (December 2023) available here

(20gCO2e/MJLHV of produced hydrogen) for greenhouse gas emissions allowed in the production process for hydrogen to be considered 'low carbon hydrogen'.
And a methodology for calculating these emissions. The LCHS specifies the evidence requirements for hydrogen production facilities using electricity inputs, which may come from different sources (from the electricity grid, a private network, a specific generator via a PPA, or through curtailment). Whichever the source, it is necessary for the production facility to prove the physical delivery and a temporal match. These rules are also described in more detail in Annex 3.

Irish policy

In terms of national legislation and policy documents, the Irish Climate Action Plan is key, as it addresses LEU demand specifically, and mandates a more granular certification of emissions processes, specifically with 'time stamped' guarantees of origin. In particular:

- It lists electricity demand management as a key aspect within the proposed pathway for the electricity sector. Within this, LEUs are called to moderate their demand and undertake enhanced reporting on their increased level of carbon-free or low-carbon demand. The plan recognises LEUs as having a critical role in delivering high levels of flexibility across time and geographical locations, and matching energy consumption with renewable energy generation on an hourly basis.
- More granular certification of emissions processes is mandated under the Plan, with 'time stamped' guarantees of origin, so LEUs can demonstrate that they are using zero emissions electricity during the same hour and geographical location to match all of their consumption on a 24/7 basis. It calls for LEUs to make a higher proportional contribution to flexible energy demand targets. LEUs are expected to work with the SEAI, CRU and Sos to achieve enhanced reporting.

The CAP does not provide any further detail on the format and content of enhanced reporting or how LEUs will work with other industry stakeholders. Nor does the CAP define or give further definition of 'geographical location.'

The Government's Statement on the role of data centres in Ireland's Enterprise Strategy (July 2022) is also highly relevant. It sets out principles that aim to support data centre infrastructure while promoting national decarbonisation objectives. Several of these principles are relevant to a reporting framework including:

- demonstrating efficient use of the grid
- demonstrating renewables additionality and co-location with renewable supply
- building net zero data centres by design

Lastly, the CPPA Roadmap sets out considerations and principles for LEU reporting. It identifies several aspects that need to be addressed to align CPPAs with wider policy and that are relevant to a good reporting framework, including:

- Additionality and avoiding greenwashing – focussing on new non-subsidised or repowered sources
- Prioritising temporal and spatial matching of the contracted RES electricity generation to demonstrate the efficient use of the grid, mitigate grid investment costs, and achieve otherwise unattainable emissions reductions for the sector and electricity system
- Matching supply and demand based on hour-by-hour grid emissions transparency, and facilitating LEUs to monitor, optimise and report the carbon intensity of their energy use
- Alignment with broader Government policy to align with reporting standards and guidelines

In conclusion, the Irish CAP, Enterprise Strategy, and Corporate PPA Roadmap establish guiding principles that can underpin a next-generation reporting framework and implementation plan for electricity emissions for LEUs. They also build on the direction of travel indicated in the EU Directives, which point towards more temporal and geographical correlation between supply and demand. We note that none of the policy documents provide detail on the design of a reporting framework.

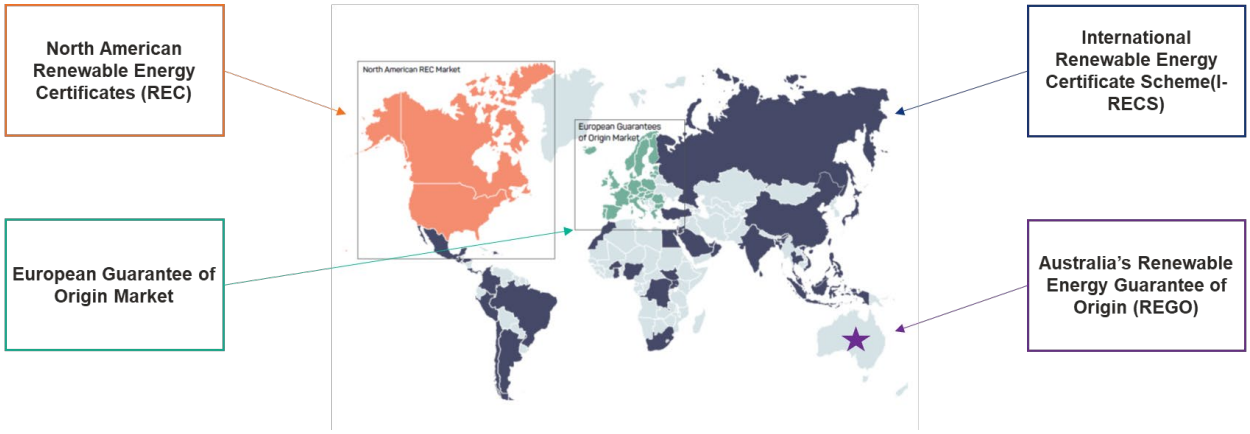
3.2 International review

We reviewed a number of the most established public schemes and prominent commercial schemes to inform the options design work.

Public schemes

The most established public schemes are REC in North America[41] and the EU (i.e. GOs). Outside of Europe and North America, I-RECs[42] are the most recognised EAC scheme and they are available in over 50 countries in Asia, Africa, and Latin America. Australia is currently designing a new more granular Renewable Energy Guarantee of Origin (REGO) scheme.[43]

Figure 4: Renewable Energy Attribution Certificate (EAC) schemes



Source – EnergyTag, Frontier Economics

Public schemes across the world predominantly share the same key principles as the GO (see section 2.3), with certificates issued with a monthly or yearly time stamp. However, there is a clear movement towards more granular tracking and certification. The I-REC Standard Foundation recognises the trend toward increased disclosure requirements and the associated hike in demand for highly granular certificates. Accordingly, the Standard allows third parties (with permissions) to source, share, and integrate highly granular data on product certificates."[44]

Two of the tracking systems in North America, M-RETS[45] and PJM[46], now offer limited functionality hourly tracking on a voluntary basis. The forthcoming Australian REGO scheme will issue certificates that include the grid location of the power station or storage facility and a timestamp reflecting the hour in which the electricity was dispatched. In Europe, Energy Track & Trace (ETT)[47] is a joint initiative of European Transmission System Operators (TSOs) and Issuing Bodies (Ibs)[48] to develop a system with granular certificates to enable hourly tracking. Further details of the public schemes can be found in Annex 4.

[41] North American, Renewable Energy Certificates (REC). Overview available here
[42] International Renewable Energy Certificates (I-REC). Overview available here
[43] Australian REGO. Overview available here
[44] International Renewable Energy Certificates (I-REC). Quote available here
[45] Overview of M-RETS hourly tracking available here
[46] Overview of PJM hourly tracking available here
[47] Overview of ETT available here
[48] 50Hertz (Germany), Elering (Estonia), Elia (Belgium), Energinet (Denmark) overview available here

Commercial schemes

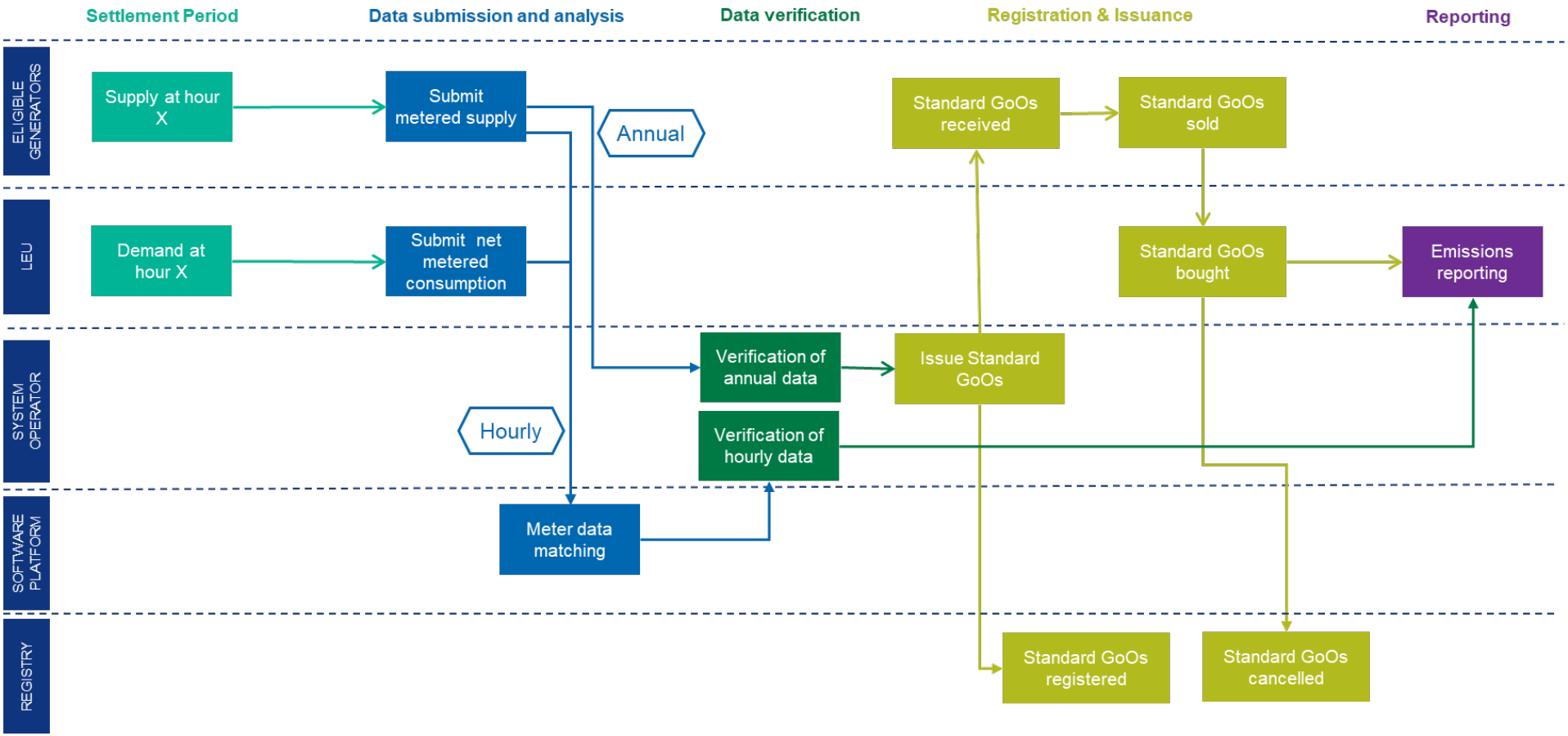
A number of commercial schemes are emerging that track renewable energy consumption on an hourly basis. The roles of different stakeholders vary between schemes, but they are generally a collaboration between energy producers, energy suppliers/consumers (who provide the data), and software providers (hosting 24/7 renewable energy matching tools).

A number of influential non-profit organisations are working to set guidelines and principles for commercial schemes, most notably Energy Tag.[49] Figure 5 shows the broad structure of commercial schemes and the roles of the different stakeholders.

- Generators included in the scheme submit meter data to the software platform.
- The consumer (or the supplier on their behalf) submits metered consumption data to the software platform.
- The software platform matches the meter data for the scheme's participants and provides the consumer with the percentage of their consumption that is provided by renewable generation.
- The consumer reports their renewable share alongside the annual certificates they have purchased through the existing GO scheme.

[49] Energy Tag – Granular Certificate Scheme Standard (v2), available here

Figure 5: Illustrative commercial scheme [50]



Source – Frontier Economics

[50] This diagram is illustrative. The exact roles and responsibilities vary between the commercial schemes.

Table 3 includes some of the most prominent commercial schemes we covered in our review. Annex 5 provides further details of each scheme.

Table 3: Commercial schemes offering granular renewable certificates.

Scheme		Energy supplier	Software provider	Customer	Region
Google	Google 24/7 Carbon-Free Energy[51]	Various	FlexiDAO	Google	Global
Microsoft	Matching Microsoft's datacentre hourly energy consumption with Dutch offshore wind[52]	Eneco	FlexiDAO	Microsoft	Amsterdam
Good Energy	Good Energy provides time-based energy matching as standard to all half-hourly metered business consumers[53]	Good energy Engle	Granular Energy	Multiple	UK
Iron Mountain	Iron Mountain data centres to achieve carbon-free energy across all its global operations 24/7 by 2040[54]	Engie	FlexiDAO	Iron Mountain data centres	Global
JP Morgan	Cleartrace is matching JP Morgan's energy consumption from EDF renewable generation[55]	EDF	Cleartrace	JP Morgan chase	UK
Energy Origin	Project Energy Origin is a system operator driven project in Denmark that is developing a system to issue granular certificates[56]	Energinet	Energinet	Danish companies	Denmark
Enel	Enel Green Power piloted a holistic solution to match production and consumption via in-house software in Chile[57]	Enel Green Power	Enel Green Power	Corporate consumers	Chile / Global

Key takeaways

There are a number of key takeaways from our review which informed the design phase of our work:

[51] Overview of Google 24/7 available here
[52] Overview of Microsoft project available here
[53] Overview of Good Energy hourly matching available here
[54] Overview of Iron Mountain project available here
[55] Overview of ClearTrace project available here
[56] Overview of Energy Origin project available here
[57] Overview of Enel project available here

- Public schemes currently only issue certificates that include basic location information and annual time stamps. However, some are moving towards tracking systems that offer granular certificates based on hourly generation data.
- There is a lot of experience from commercial schemes that match consumption with renewable production on an hourly basis.
- There are no examples of schemes that offer a comprehensive template that would cover all the requirements of the framework in Ireland. However, commercial schemes that enable consumers to report the percentage of their consumption matched to renewable generation may offer a template for an intermediate scheme.

4. Emissions reporting framework

Drawing on the findings of the review, we constructed options for a reporting framework differentiated by three levels of policy choice:

- The high-level design, e.g. whether certificates are issued or not.
- The detailed design, e.g. which technologies and LEUs are in scope of the reporting framework.
- The methodological challenges, e.g. how to calculate residual emissions.

We discuss options under each level below.

4.1 High level design

Option 1 – Enhanced GO scheme

This option builds on the principles of the existing GO scheme and the principle of issuing guarantee of origin certificates, albeit with a higher level of data granularity. The certificates would include all the standard data on existing GOs,[58] with an enhancement to include a time-stamp of the hour of generation, [59] grid location and whether the generator has received a subsidy.

Figure 6 below sets out how this scheme would work, noting that the exact roles and responsibilities are illustrative and would need to be defined during implementation:

- Eligible generators submit metered supply data which is verified. by the scheme operator.
- SEMO issues Granular GOs to the generator which are recorded in the registry.
- LEUs submit net metered consumption data which is verified by the scheme operator.
- LEUs can then buy Granular GOs for generators to match their verified consumption.
- When purchased, Granular GOs are cancelled in the registry by matching the LEU consumption to the certificate data.
- SEMO provides grid emissions data to the software platform to calculate the emissions intensity of the LEU's residual load.[60]
- LEUs report their total emissions, taking account of the matched certificates and the residual emissions for unmatched consumption.

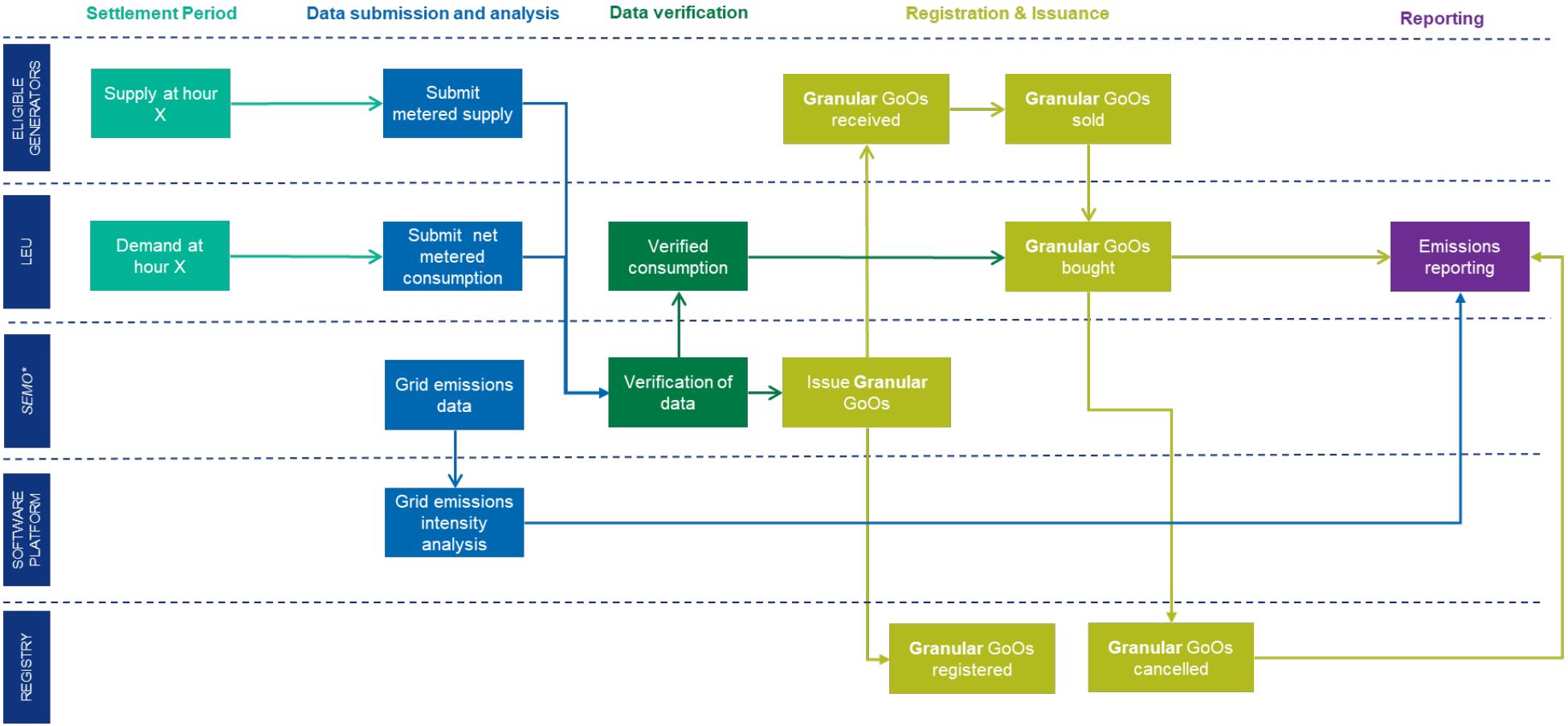
The roles of the different stakeholders could vary under different approaches to implementing the scheme, but this would not change the principles of how the scheme operates. For example, SEMO, as the system operator, could manage and operate the software platform and/or the registry, or alternatively, those functions could be outsourced to a third party.

[58] AIB specifies the standard data included, here

[59] This could also be set at 30 minutes or 15 minutes (see section 4.2)

[60] For the Fuel Mix disclosure, emissions data for each generator in the SEM is supplied annually to SEMO by the EPA (Environmental Protection Agency) for Ireland, 'Fuel Mix disclosure and CO_2 emissions 2022' p18, available here

Figure 6: Enhanced GO scheme overview



Source – Frontier Economics
Note: The roles and responsibilities of SEMO, the Software platform, and the registry are illustrative and could be combined under different design options

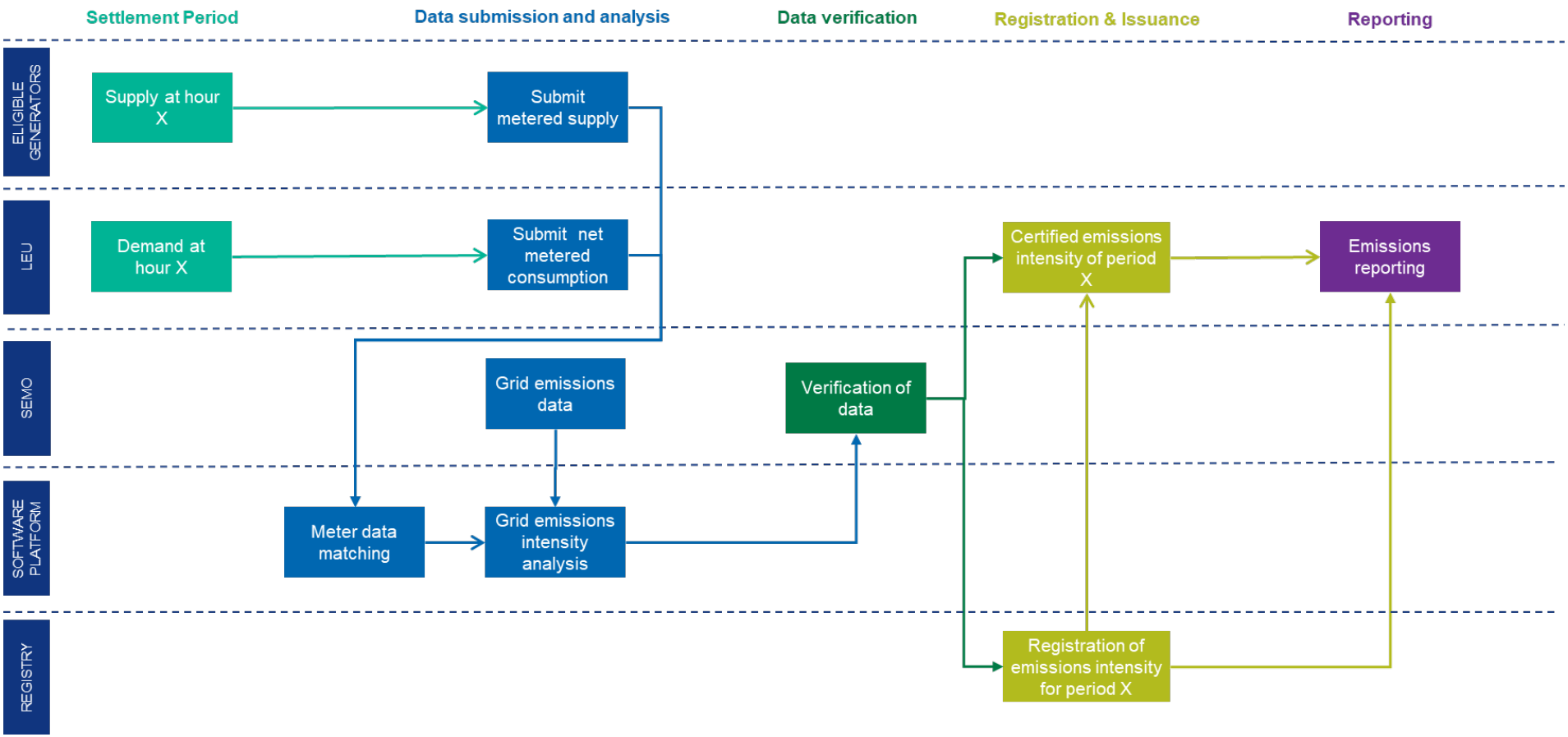
Option 2 – Emissions accounting scheme

An alternative option could be to create a scheme where certificates are no longer issued and the process follows that of the voluntary commercial schemes, built on registering and matching meter data for LEUs and their contracted eligible generators.

Figure 7 below sets out how this scheme would work, noting that the exact roles and responsibilities are illustrative and would need to be defined during implementation:

- Eligible generators submit meter data to the software platform.
- LEUs register any agreements they have with eligible generators, e.g. PPAs.
- LEUs submit net metered consumption data to the software platform.
- The software platform matches the meter data for registered agreements.
- SEMO provides grid emissions data to the software platform to calculate the emissions intensity of the LEU's residual load (Section 5.5).
- All data is submitted to SEMO for verification.
- LEUs are issued with confirmation of their verified emissions for the period, and report on this basis.
- Verified emissions are recorded on the registry.

Figure 7: Emissions accounting scheme overview



Source – Frontier Economics
Note: The roles and responsibilities of SEMO, the Software platform, and the registry are illustrative and could be combined under different design options

Comparing the options

There are a number of core features that are similar between the two options and that are fundamental to an effective granular emissions reporting framework.

Table 4: Similarities between Options 1 and 2

Feature	Enhanced GO	Emissions accounting
Accurate emissions reporting	The scheme would produce certificates that are cancelled once 'used' so there is no double counting. Certificates are unique and immutable.	The scheme would match uniquely identified LEUs' emissions by matching metered consumption data against uniquely identified contracted RES (or other supply), which would avoid double counting.
Location and time granularity	The enhanced GO would include a time stamp with at least hourly granularity and a location stamp with a delimited geographical boundary.	Data would be matched with at least hourly time resolution and within a delimited geographical boundary.
Central registry	The appointed issuing body would facilitate the exchange of GOs via the inter-registry hub.	A registry governed by a central body allows the matching of demand and production profiles.
Relevance for green hydrogen[61]	The enhanced GO scheme would be compatible with the EU's requirements for renewable hydrogen in RED III.	The matching scheme should provide data required by the EU's renewable hydrogen rules given its temporal and geographic definition.

Source – Frontier Economics

There are, however, a number of differences between the two schemes.

Table 5: Scheme differences

Feature	Enhanced GO	Emissions accounting
Use of certificates	Generators are issued with certificates which can be sold and traded in an open market (noting that trade would only happen within the defined geographical boundaries of the scheme).	Scheme achieves the matching of LEU demand with RES supply through their energy contract relationships but without certificates issued or traded.
Bundled or unbundled 'green-ness'	Unbundled – GO trade is decoupled from the physical power.	Bundled – Green-ness of the energy is inherently attached to the energy.
Ownership of 'green-ness'	Generators are granted GOs according to their metered generation. Ownership will depend on the precise terms of the contracts these generators have struck with suppliers.	If existing generation has contracted to sell energy via a PPA, 'green-ness' ownership lies with the supplier.

[61] See section 3.1.

Additionality	Unbundling of electricity and 'green-ness' makes it more difficult for the owner of 'green-ness' to categorically demonstrate the additionality. However, the risk can in part be mitigated by including any subsidy received within the certificate data.	Separate registration of subsidised and un-subsidised plant, in combination with bundled energy and 'green-ness' would provide clearer basis on which to demonstrate additionality.

Source – Frontier Economics

Intermediate scheme

We note that, while a new scheme is being established, there is scope for an intermediate scheme to be implemented to incentivise more accurate emissions reporting in the short term.

There are reputational benefits to LEUs associated with more accurate emissions reporting, and some are already reporting their emissions on a granular level on a voluntary basis. An intermediate scheme could rely on matching LEU consumption meter data with their contracted renewable generator meter data and reporting this alongside their existing annual GO certificates. Some LEUs are already tracking and reporting emissions on this basis.[62]

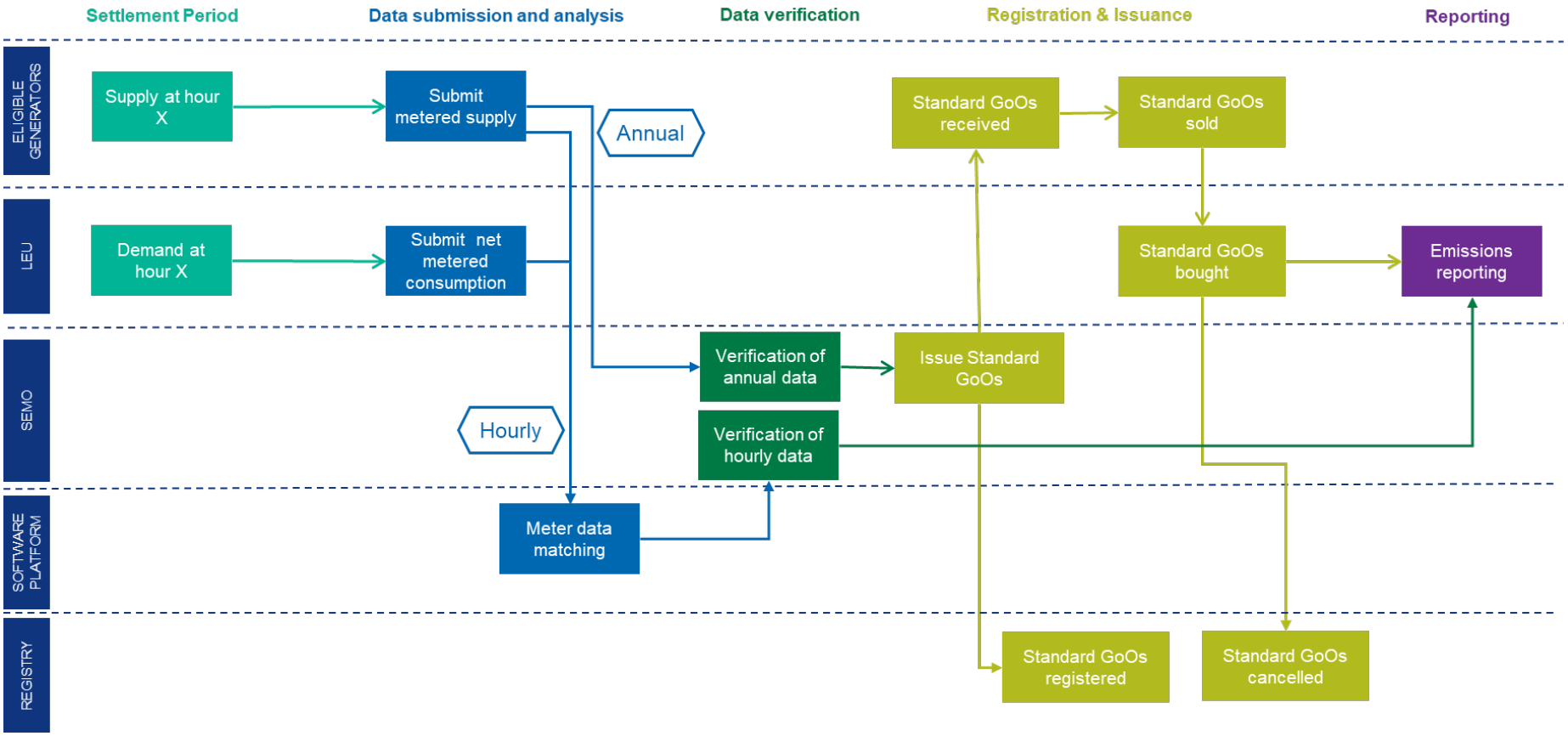
Figure 8 below sets out how this scheme would work:

- Eligible generators[63] submit metered supply data which is verified by SEMO.
- SEMO issues standard GO certificates to the generator which are recorded in the registry.
- LEUs submit net metered consumption data to a software platform.
- The software platform matches the meter data on an hourly basis and outputs the percentage of LEU consumption matched to renewable generation.
- LEU buys annual GOs (from Ireland and other EU states) to address residual demand.
- LEUs report their share of renewable generation alongside the purchased annual GO certificates.
- LEU also continues to report annual GOs via the existing route.

[62] For example: Google 24/7.

[63] In Ireland this currently does not include subsidised generators, however in line with our recommendations in Section 6.1 we recommend that all generators would be eligible.

Figure 8: Intermediate option



Source – Frontier Economics
Note: The roles and responsibilities of SEMO, the Software platform, and the registry are illustrative and could be combined under different design options

4.2 Detailed policy options

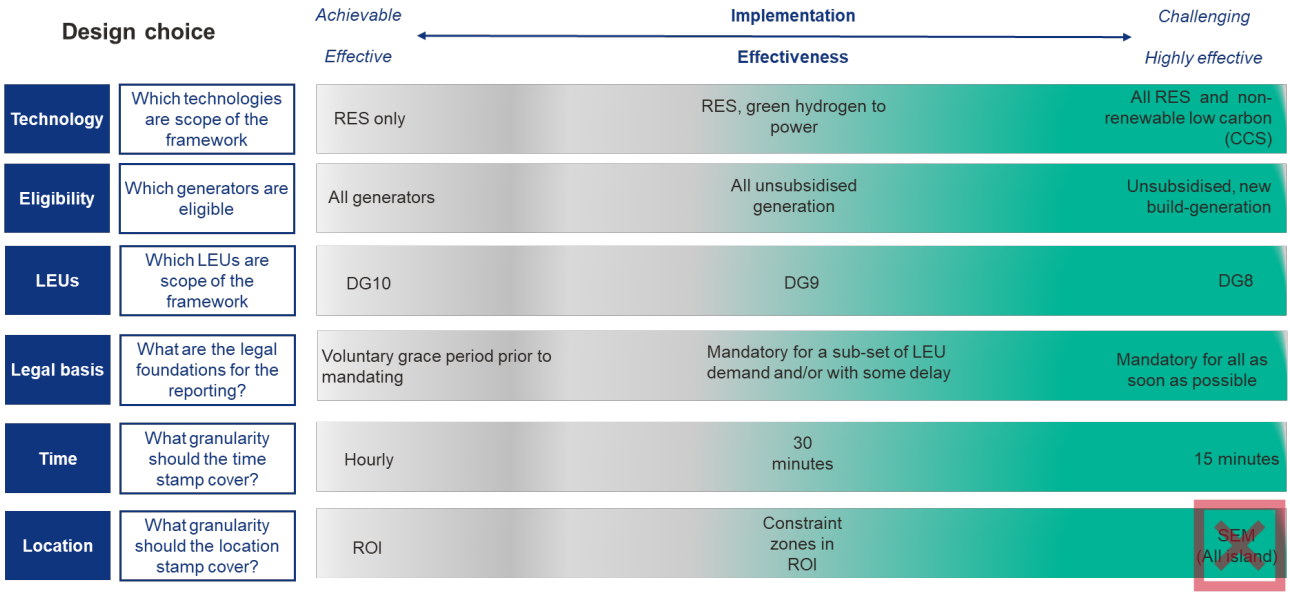
Beyond these high-level design options, there are more detailed design questions which remain important in defining the overall framework, and in particular the trade-off adopted between ease of implementation and effectiveness. The scheme could:

- **Technology scope**[64] – use the existing definition of renewable technologies[65] or a more expanded definition to include other low-carbon technologies, e.g. carbon capture and storage (CCS) or green hydrogen.
- **Eligible generation –** set parameters to determine the eligibility of generators. This could exclude plants that have received a subsidy (in line with the current GO scheme)[66] or set a window of eligibility relative to the commercial operation date of the plant. The eligibility of repowered plants should also be defined.
- **LEU scope**[67] **–** include in scope only the extra-large energy users, for example as defined by transmission connected demand (TCON) plus distribution connected users at a DG10 level, or a wider set of LEUs (e.g. including DG10, DG9 and DG8).[68] We note that LEUs below DG8 who participate in the existing GO scheme would be impacted if that scheme is replaced and they are not in scope of the new scheme.
- **Legal basis** — involve Immediate mandated compliance for a set of consumers or a voluntary grace period to all or a subset of LEUs within its scope. This should not exclude smaller energy users from voluntarily participating in the scheme. Their participation would be on the assumption that they absorbed their fair share of any additional costs of administering the scheme incurred due to their participation.
- **Time** – be based on the Market Time Unit (currently an hour) or it could mandate a more granular unit of either 30 or 15 minutes.
- **Location** – have a locational boundary defined as the bidding zone. However, given the cross-border nature of the I-SEM and the complex issues likely to be involved with mandating compliance across this geography, this was ruled out. The boundary could therefore be set at the level of the Republic of Ireland, or at the more granular constraint zone level.

It should be noted that any trading of granular GOs would be limited to the scheme's geographical boundaries. LEUs buying unbundled certificates would only purchase them from generators within Ireland, which in practice would significantly limit trading. Trading would be even further reduced if the geographical boundary is set at a more granular constraint zone level.

[64] This relates to the scope of generation technologies – the storage impact of the relevant technology will need to be accounted for in the emissions methodology.
[65] For example, as cited in the Irish statute book here
[66] SEMO: EECS Domain Protocol for Ireland, available here
[67] ESB Networks defines DUoS groups from DG8 and DG9 as those distribution-connected at 38kV (based on maximum demand), while DG10 includes those connected at 110kV. The TCON category of users, which are those connected to the transmission system.
[68] See ESB Networks "Description of Characteristics of Connection - DUoS and MCC Codes", available here

Figure 9: Detailed policy choices



Source – Frontier Economics

4.3 Methodological issues

Regardless of the high-level design of the framework, and the detailed design choices, we also considered three key methodological issues that need to be addressed and will require policy decisions, specifically the treatment of:

- Behind the meter generation
- Storage
- Residual emissions

Behind the meter generation

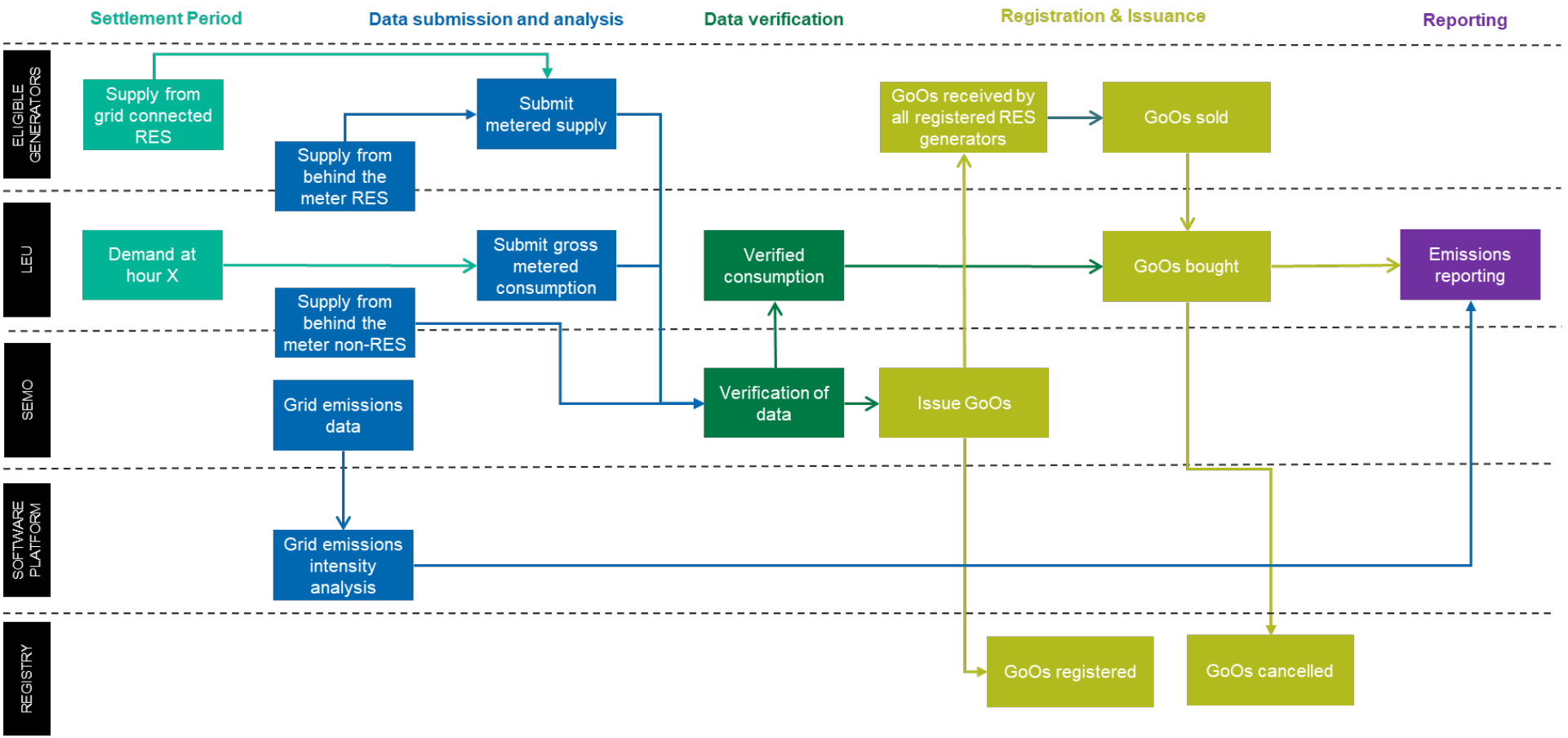
The current GO scheme only covers grid-connected renewable generation. To accurately report emissions from LEUs, the reporting framework should also include behind the meter-generation. This could be renewable generation, e.g. on-site solar PV, or non-renewable generation, e.g. a backup diesel generator.

Figure 10 below sets out how behind the meter generation could be incorporated into Option 1 – Enhanced GO scheme. The key changes are that:

- LEU submits gross (rather than net) metered consumption
- Behind the meter generators are registered and submit meter data
- Eligible generators receive Granular GOs for their generation that can be sold
- Non-eligible generators are assigned a technology emissions factor which is used to calculate the associated emissions

An important pre-requisite to the inclusion of behind the meter generation in the scheme is therefore the registration of the sites and their associated metering equipment.

Figure 10: Enhanced GO scheme including behind the meter generation.

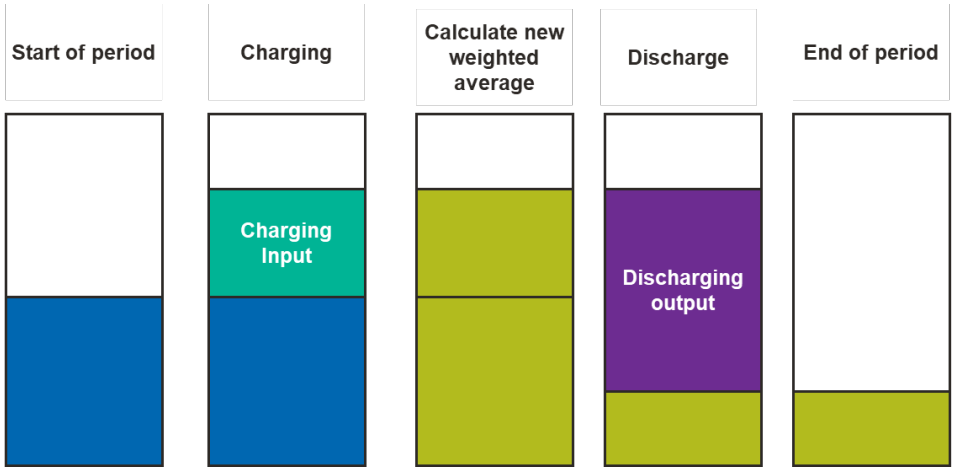


Source – Frontier Economics
Note: The roles and responsibilities of SEMO, the Software platform, and the registry are illustrative and could be combined under different design options

Storage

Incorporation of storage into the scheme is complex, irrespective of whether it is grid-connected or behind the meter. Regardless of location, to incorporate storage, each unit would need to be registered, and have its injection and dispatch metered, and software would need to be designed to monitor the rolling average emissions intensity of energy in the store (Figure 11).

Figure 11: Storage rolling average emissions intensity.



Source – Frontier Economics, adapted from UK Low Carbon Hydrogen Standard Greenhouse Gas Emissions Methodology and Conditions of Standard Compliance, available here

We note that an alternative approach has been described by EnergyTag in its updated guidelines, whereby an energy storage device is treated both as a consumption point and as a production facility. Under this approach, granular certificates would be cancelled or retired to reflect the energy fed into the energy storage device, and new granular certificates would be issued to reflect the release of the stored energy. The registry would need to support the linkage of issued certificates for stored energy with the cancelled certificates from which the energy originates.[69] EnergyTag acknowledges that storage tracking is complex and is still in an early stage of development and implementation.

Residual emissions

Different approaches could be used to calculate the emissions intensity for the residual consumption of LEUs not associated with supply from eligible generators. The two primary options are:

- **Average carbon intensity,** under which the residual intensity is calculated based on the emissions of all generation sources used to meet electricity consumed in a given period.
- **Marginal carbon intensity,** under which the residual intensity is calculated based on the emissions associated with the additional plant required to meet demand in a given period.

[69] EnergyTag : "Granular Certificate Scheme Standard V2", available here

5. Options assessment

Having set out the options above, we undertook an assessment. This assessment is based on an understanding that the intention is for the reporting framework eventually to be mandatory for some consumers, that the reporting framework should ideally be operational as soon as possible, and that the framework can (and should) evolve through future phases.

5.1 Assessment criteria

We assessed the options against the following criteria.

Table 6: Assessment criteria

Criteria	Sub-criteria	Description
Effectiveness	Transparency	Are the outputs of the scheme easily understood?
	Accuracy	Are emissions measured and reported in a way that accurately reflects actual emissions reduction from final energy use? Does it treat different RES technologies and contracting approaches appropriately?
	Additionality	Can the extent to which electricity is coming from existing subsidised generation or new build/re-powered be assessed?
	Efficient use of the grid	Does the scheme prioritise temporal and spatial matching of the contracted RES electricity generation? Does the scheme provide locational incentives?
Implementation	Feasibility	Is the data currently available to meet the reporting requirements? Are the systems in place to comply – record, store, and report data? Is it replicable for all LEUs in scope?
	Costs/Effort	Is the scheme and its requirements easily understood by participants? What is the level of burden placed on LEUs?
	Target timeline	Can this be implemented within the target timeline?
Consistency	EU policy alignment	Is there any inconsistency with EU policy or the direction of travel of key policies?
	National policy alignment	Does the scheme align with broader government policy in particular the targets, measures and actions set out in the CAP?
	GO scheme in Ireland	Is the scheme compatible with existing GO scheme?
Wider impacts	Innovation	Does the scheme stimulate innovation including new technologies and innovative grid/hybrid solutions?
	Economic impact	Does the scheme change or unduly effect the incentives to LEUs to locate in Ireland?

Source – Frontier Economics

5.2 Assessment of high-level design

We have carried out a relative assessment of the two high-level design options, summarised in Table 7.
Option 1, the Enhanced GO scheme, performs equally well or better than Option 2, Emissions accounting, against all the criteria, except additionality.

This assessment reflects the fact that the unbundling of electricity and 'greenness' under an enhanced GO scheme makes it more difficult for the owner of 'greenness' to categorically demonstrate the additionality. That said, the Enhanced GO scheme can still offer some assurances by mandating that characteristics such as the receipt of subsidy and date of construction of the plant be included on certificates. This would ensure that even when the GOs are bought unbundled from the energy, the certificate can still help to demonstrate additionality.

Our assessment is that the granular GO scheme is the most consistent with EU policy. That being said, we note that although the direction of travel of EU policy is towards granular emissions reporting and some other Member States are taking similar action to Ireland, there is a risk of moving in advance of EU policy mandating the use of granular GOs. This risk should be considered alongside the benefits to Ireland of not waiting to implement granular GOs (for example, earlier impetus for LEUs to engage in emissions reduction activities and earlier incentives in relation to matching demand over time and renewable procurement).

If government decides to pursue a reporting scheme based on enhanced GOs, **we recommend that the government investigates the risks and benefits of implementing the scheme in advance of EU policy and** includes this in any consultation on the scheme's design.

Table 7: High-level design options assessment

Criteria		Enhanced GoO	Emissions accounting	Assessment
Effectiveness	Accuracy			• Both schemes have a high level of accuracy over time and location.
	Transparency			• Issuing certificates increases the transparency of the reporting process compared to a centralised accounting system.
	Additionality			• Proving additionality is harder through an unbundled certificate scheme where electricity and greenness can be obtained separately.
	Efficient use of the grid			• No significant differences between the schemes.
Implementation	Feasibility			• No significant feasibility issues under either scheme although an Emissions accounting scheme that requires contractual agreements to be registered would likely require relatively more time to implement.
	Cost/effort			
	Timeline			
Consistency	EU Policy Alignment			• The matching scheme carries a greater risk of future inconsistency with EU policy, which starts from the use of annual GOs.[70] • Both schemes are consistent with national CAP policy.
	National policy alignment			
Wider impact	Innovation			• No significant differences to innovate or wider economic impact between the schemes.
	Economic Impact			

5.3 Assessment of an intermediate scheme

Alongside the high-level design options, we identified the potential to implement an intermediate scheme based upon commercial scheme designs. We assessed whether such an intermediate scheme makes sense and identified that this largely depends on the end state expectations, the time needed to implement the end state solution, and the imperative for the scheme to commence.

[70] Directive 2001/77/EC (2001) introduced the use of GOs and the RED Directive, Article 19 (2018) continued to underpin the use of GOs.

Table 8: Assessment of the case for an intermediate scheme

Criteria	Assessment
Effectiveness	Adding an intermediate scheme will only improve effectiveness in the short term (assuming no change in the date of "end state").
Implementation	The cost/effort impact of an intermediate scheme depends on the preferred end scheme. If the end-state scheme is: • Emissions Accounting - then an intermediate scheme could reduce the cost due to the similarity of some of the building blocks (e.g. registering agreements). • Enhanced GO scheme - then an intermediate scheme could involve material redundant effort.
Consistency	The implementation of an intermediate scheme will not change consistency, which is really driven by the end state.
Wider impacts	An intermediate scheme would bring forward wider impacts, as a result of bringing forward effectiveness.

We conclude that if the preferred end state is an Emissions Accounting scheme, an intermediate step could be beneficial. However, if the preferred end state an Enhanced GO scheme (in line with our assessment above), then it is likely to be best to avoid risk of wasted effort unless it is thought possible that implementation of the end state could be very delayed, and there is an action under the CAP 2024 to have the scheme implemented by Q4 2024. We note that this Q4 2024 date[71] for the implementation of an end state solution is extremely challenging.

We recommend that the government acts now to engage with CRU, SEMO, Eirgrid to understand the potential implementation activities and timetable associated with the scheme and makes a decision to maintain or change this timeline.

5.4 Assessment of detailed design choices

Consistent with our overall assessment approach, our assessment of the options for the detailed design choices reflects the objective to ensure a reporting framework can be implemented quickly, with scope for future evolution. Our assessment therefore weights ease of implementation as significantly as effectiveness, recognising scope for the scheme to evolve.

In a number of areas, we have been able to come to relatively "clear-cut" recommendations. Our assessment in these areas is set out in Table 9.

[71] Climate Action Plan 2024 Annex of Actions, available here

Table 9: Summary of policy choices

Design choice	Assessment		Phasing and evolution
	Preferred starting point	Rationale	
Technology scope	RES only (as defined by current GO scheme)	Deployment of other low carbon technologies is low, so the added benefit of a wider scope is currently limited.	The scope could be expanded to include green hydrogen and CCS within an appropriate time frame.
LEU scope	TCON plus DG8-10, noting the importance of aligning with wider definitions of LEUs[72]	DG8-10 users make up the majority of LEU demand and are few in number.	The scheme could be expanded to include further LEUs or be available for them to participate on a voluntary basis, noting the importance of policy consistency.
Legal basis	Voluntary grace period prior to mandating	We understand primary legislation would be required for mandatory scheme.	This will depend on the pace of legal powers and the decision over LEU scope.
Time	Hourly (current MTU)	Granularity aligned with the MTU.	This could evolve to align with any chance in MTU subject to an assessment of the relative costs and benefits.
Eligible generation	All generators within the technology scope	The number of GOs issued in Ireland is likely to be low,[73] so limiting eligibility on the basis of subsidy would shrink the market disproportionately.	A clear distinction should be made between subsidised and unsubsidised generation. Setting a defined period of eligibility for subsidised generators could enable a natural phasing to increased additionality.
Location	ROI	Effective and easier for initial take-up and would mitigate any potential negative economic impact on existing stakeholders.	Subject to an assessment of the costs, a move to the constraint zone level would send more efficient signals to future LEU and generator locational choices and could also incentivise flexibility from existing stakeholders.

Source – Frontier Economics

If government decides to pursue a reporting scheme based on enhanced GOs as referred to above, **we recommend the government act now to consult** on the more clear-cut design choices.

In some other areas, while we have made recommendations, they are less clear-cut and should be subject to future confirmation:

[72] See the consultation and responses here

[73] As referred to in Section 2.3 above, data on GOs issued is not publicly available but AIB data gives an order of magnitude of the size of the production from GO scheme participants.

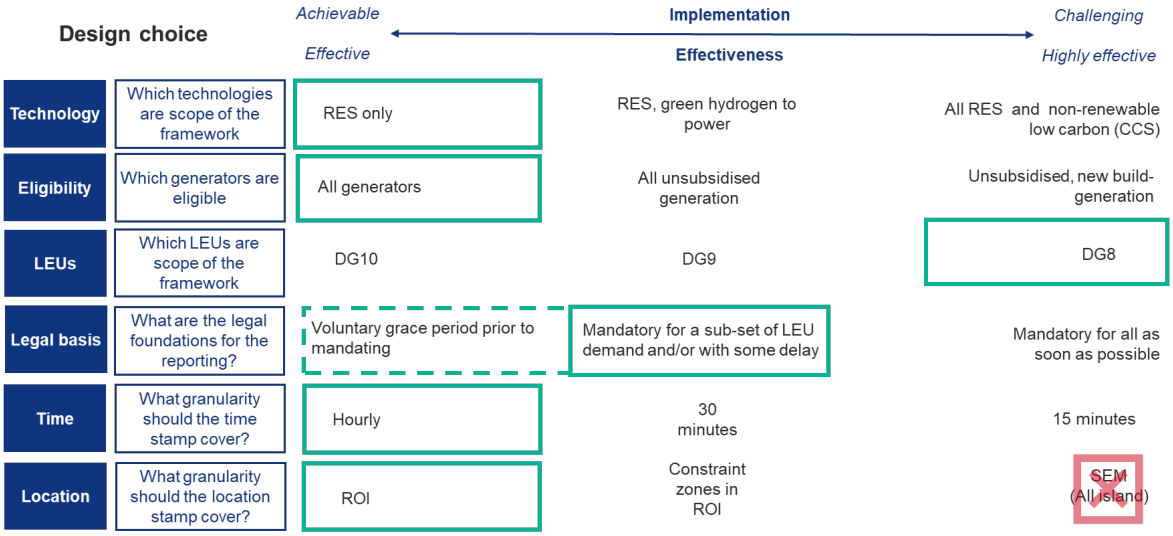
- **Eligible generation**: Determining all generators in Ireland that are within the technology scope, whether subsidised or not, as eligible to receive granular GOs is a departure from the implementation in Ireland of the existing GO scheme. However, in our view, it makes sense due to the low number of unsubsidised renewable generators in Ireland and the importance of ensuring a minimum level of market liquidity in order to avoid high premia charged to LEUs. If seen as desirable in order to support the demonstration of additionality, the granular GOs could indicate where they originate with an unsubsidised generator, and this could be part of overall reporting.[74]

- **Location**: We recommend that the scheme's locational boundary should initially be set to the Republic of Ireland. Moving to a locational definition based on constraint zones could send more efficient signals to future LEUs and generators and could also incentivise flexibility from existing stakeholders. However, there may be significant imbalances between demand and supply within locations, which might mean generators in some zones are able to charge LEUs a material premium. In our view, this may not be the most appropriate context within which to initiate the reporting framework.

If government decides to pursue a reporting scheme based on enhanced GOs **we recommend the government investigates now** the implications of following our recommendations in these areas and alternative options.

[74] We note that the interaction of additional revenue with subsidy revenue streams would need to be considered as part of the implementation, including in relation to state aid constraints.

Figure 12: Assessment of wider design choices



Source – Frontier Economics

5.5 Assessment of methodological issues

Finally, we defined a number of options for methodological issues. The first two of these related to how to deal with behind-the-meter generation and storage. Given the overriding principle of designing a scheme that can be operational as soon as possible and the low level of behind-the-meter generation and grid-connected storage, in our view there is a strong case for incorporating these elements into the scheme in subsequent phases rather than at the start. A roadmap for the evolution of the scheme is set out in Table 10.

Table 10: Assessment and phasing of behind the meter generation and storage

Design choice	Implementation task(s)	Phasing and evolution
Grid connected RES	Will be covered by the scheme from the start.	Initial phase.
Behind the meter RES	Assets to be identified and meters registered.	Behind-the-meter generation could be included in the second phase of the scheme.
Behind the meter non-RES	In addition to assets being identified and meters registered, technology emissions factors to be assigned.	
Grid connected storage	Requires an agreed methodology to track the entry and discharge of power into storage units (see Figure 11).	A methodology should be agreed to include grid-connected storage in the third phase of the scheme, and this should be applied to behind the meter storage when appropriate.
Storage on RES site		
Behind the meter storage		

Source – Frontier Economics

If government decides to pursue a reporting scheme based on enhanced GOs, **we recommend the government include in the consultation,** alongside the more clear-cut design choices referred to above, the **recommendation to address these issues in the second phase of the scheme**.

The third methodological issue for which we identified options relates to the approach used to calculate the emissions intensity for the residual consumption of LEUs not covered by enhanced GOs or matched with supply from eligible generators. Table 11 sets out how the options compare against a range of considerations.

Table 11: Residual emissions methodology

Consideration	How the options compare
Economic incentives	Using a marginal emissions intensity versus an average intensity should result in more appropriate economic incentives as far as emissions to meet incremental demand from an LEU require the most expensive plant (likely to be higher emitting) to run more.
Overall consistency	Applying an average approach should help ensure that, across the whole customer base, attributed emissions sum to total power generation emissions (excluding losses, etc.). With a marginal approach, attributed emissions across the whole customer base will be higher than total emissions (because typically the marginal emissions factor will be higher than the average emissions factor).
Impact on LEUs	Marginal emissions could give the impression that LEUs are responsible for proportionately more emissions.
Complexity	A marginal approach requires software that can correctly identify the marginal plant per reporting period. The software needs to identify the type of plant (fuel, e.g. gas), the specific emissions factor for that plant (e.g. efficiency) and ensure it can appropriately address dependencies between time periods (e.g. allocating emissions during start and warm-up). Such calculations can be performed by a dispatch model – but are clearly more complex (and potentially subjective) than calculating average emissions.

Source – Frontier Economics

On balance, given our assessment above, we believe an average emissions basis for reporting residual emissions appears more appropriate.

If government decides to pursue a reporting scheme based on enhanced GOs as referred to above, **we recommend the government investigate now** the implications of following our recommendation in for a residual emissions methodology or alternative options.

6. Recommendations

6.1 Recommendations

Based on the assessment set out above, we have developed a set of recommendations for the reporting framework.

We assessed the option of implementing an intermediate scheme based on the design of commercial schemes while the new reporting framework is being established. Our recommendation is that it is likely to be best to avoid the risk of wasted effort unless implementation of the enhanced GO scheme could be significantly delayed. We note in this context that the intention to have a full reporting scheme (as per our recommendations in this report) in place by Q4 2024, as required by Ireland's Climate Action Plan 2024[75], is extremely challenging.

Beyond the question of the high-level design of a scheme, there are a number of detailed design choices and methodological issues to consider, all of which represent policy decisions for DECC to make. We have assessed what we believe to be a sensible starting point and how refinements to the framework could then be phased over time. The scheme's design and design choices will determine the costs, benefits, and risks to Irish consumers.

To deliver on action 99 of the Climate Action Plan (CAP) 2021[1] **we recommend that DECC decides now to use enhanced GOs for any granular LEU reporting scheme.**

Our assessment is based on an understanding that the intention is for the reporting framework to be mandatory for some consumers. In a number of areas, we have been able to come to relatively "clear-cut" recommendations. These are set out in Table 12 and are based on the priority of designing a reporting framework that can be operational as soon as possible, and with the intention that the design should allow the framework to evolve through future phases.

Having made the decision to pursue a reporting scheme based on enhanced GOs as referred to above, **we recommend the government act now to consult** on the more clear-cut design choices**.**

In some other areas, while we have made recommendations, they are less clear-cut and should be subject to future confirmation. These are set out in Table 13.

We recommend the government investigate now the implications of following our recommendations in these areas and alternative options. This could be done in parallel with the consultation above or separately.

[75] Climate Action Plan 2024 Annex of Actions, available here

Table 12: Recommendations

Design choice	Recommendation
Technology scope	• The initial scope of power generation technologies included in the framework should be consistent with the existing RED II definition of RES. • The framework should be designed such that it can evolve to include green hydrogen and CCS, if and when appropriate and in line with the future needs of the existing framework.
LEU scope	• The initial scope of the reporting framework should be set to include LEUs that are transmission connected (TCON) plus DUoS group DG8 level – DG10 inclusive (connected between 38kV to 110kV). • This should not exclude any other users from participating in the scheme on a voluntary basis, assuming that they bear their fair share of any costs their inclusion imposes on the scheme administration.
Legal basis	• The scheme should be mandated for LEUs in scope once the legal framework is established. • Without the legal framework, the scheme should be established on a voluntary basis. • Announce mandatory participation in the scheme a minimum of 12 months ahead. This would allow sufficient time for all valid legacy GO certificates to expire.
Time granularity	• Certificates should include a time stamp equivalent to the market time unit (MTU), currently one hour at the day-ahead stage, which constitutes the majority of near-term trading volumes. • This should evolve in line with any changes to the MTU.
Behind the meter generation	• Behind-the-meter generation should be included in the scheme's scope, in relation to establishing a site's net emissions, but in a second phase. • This should ensure that identifying and registering the units does not delay the scheme's initial phase.
Storage	• A methodology should be established to include grid-connected storage in the second phase of the scheme. • This should be applied to behind-the-meter storage when appropriate.

Table 13: Less "clear cut" recommendations

Policy design	Recommendation	Aspects for investigation
Eligibility	• All generators in Ireland that are within the technology scope, whether subsidised or not, should be considered eligible to receive granular GOs.[76] • This is a departure from the implementation in Ireland of the existing GO scheme and impacts upon other policies, but in our view makes sense due to the low number of unsubsidised renewable generators in Ireland and the importance of ensuring a minimum level of market liquidity. • If seen as desirable, in order to support the demonstration of additionality, the granular GOs could indicate whether they originate with an unsubsidised generator, and this could be part of overall reporting.	**Investigate** the policy implications of including subsidised generators in the scheme. In particular, the impact on market liquidity of including only non-subsidised generation in the scheme (i.e. to what extent would this result in significant and persistent excess demand, and what issues would this create?).
Location	• The scheme's locational boundary should initially be set to the Republic of Ireland. • Moving to a locational definition based on constraint zones could send more efficient signals to future LEUs and generators and could also incentivise flexibility from existing stakeholders. • However, there may be significant imbalances between demand and supply within locations, which might mean generators in some zones are able to charge LEUs a material premium. • In our view, this may not be the most appropriate context within which to initiate the reporting framework.	**Investigate** the potential impacts of moving to a scheme with location boundaries set at a constraint zone level. In particular, assess how this would impact market liquidity and the potential level and persistence of excess demand in some locations.
Residual emissions methodology	• Residual emissions should initially be calculated on the basis of average emissions. • We note that, from the viewpoint of incentives, there are arguments to use a marginal calculation as the basis for residual emissions. • Doing so is, however, more complex and may create the impression that LEUs are responsible for more emissions than is the case. • Our view is that this is not the right basis on which to initiate the reporting framework, but that nothing should be done to prevent a move to a marginal approach in the future.	**Investigate** the benefits of a marginal approach and whether they outweigh the average approach. In particular, what would be the impact of a marginal approach in the overall context of national emissions reporting.

6.2 Implementation

Our assessment is based on an understanding that the intention is for the reporting framework to operate in parallel with the existing GO scheme, at least in the short-term or until the existing scheme is replaced at an EU level. When implementing a new framework alongside the EU-wide continuation of the existing GO scheme, it will be important

[76] We note that this might have implications for the support arrangements for RES generation already contracted under the Renewable Electricity Feed-In Tariff (REFIT) and the Renewable Electricity Support Scheme (RESS) regimes and funded via the PSO. This would need to be considered during implementation.

to manage the process to prevent double-counting, and, also, to prevent any adverse impacts on market participants not in the eventual mandatory scope of the new scheme. The fact that subsidised renewable generators in Ireland are ineligible for existing GOs limits the double counting risk to the few unsubsidised generators in Ireland that are currently receiving GOs. This residual risk could be managed in a number of ways, including by ensuring that the registries for the two schemes are aligned and that when Granular GOs are issued to generators in the scope of the standard scheme, their account in the standard registry is adjusted by the corresponding amount. [77]

This would reduce the supply of locally generated GOs for other reporting schemes, e.g. Fuel Mix disclosure[78] and therefore lead to suppliers relying more on the import of GOs from other EU jurisdictions. However, this is a necessary corollary of avoiding double counting, and since the GO market is EU wide, we do not expect this to have a significant impact on the price of standard GOs.

The existence of two schemes means that different consumers (i.e. LEUs vs. others) will report renewable purchases on a different basis. The contracting for renewable power of non-LEU consumers will cease to be a reasonable benchmark for LEU consumers in the granular scheme, and the risks associated with the lack of comparability between the two schemes will need to be managed.

We recommend that the government investigates now the risks and benefits of maintaining the existing GO scheme for non-LEUs while establishing a new scheme for LEUs. This should include the preferred approach to managing double counting risk and the adverse impacts of establishing different reporting frameworks for LEUs and non-LEUs for any period where schemes are operated in parallel.

Implementing a new, more granular scheme will also increase the data requirements and likely require the establishment of new systems to operate the registry, collect data, and issue certificates. Consideration will need to be given to the time allowed for implementation activity associated with these new requirements to happen.

We recommend that, in parallel with the above investigations, the government acts now to engage with CRU, SEMO, Eirgrid to understand the potential implementation activities and timetable associated with the scheme.

[77] Energy Track and trace (ETT) provides an example of how registries can be aligned. See slide 7 here
[78] Fuel Mix and Guarantees of origin, see here

Annexes

Annex 1 – Project steering group

The steering group included representatives from the following organisations:

Organisation
DECC - Department of the Environment, Climate and Communications
DETE - Department of Enterprise, Trade and Employment
CRU - Commission for Regulation of Utilities
Eirgrid – Electricity Transmission System Operator
SEAI - Sustainable Energy Authority of Ireland
NewERA - New Economy and Recovery Authority
IDA Ireland – Industrial Development Agency
Enterprise Ireland
Distribution Markets and System Operations, ESB Networks
Environmental Protection Agency
CSO - Central Statistics Office

Annex 2 – Industry stakeholder workshop summary

- As part of stage 4 of the project to make recommendations for a carbon emissions reporting framework for large energy users, Frontier and the SEAI held a stakeholder workshop on April 16, 2024. This annex summarises the main points of feedback from that workshop.
- We have considered these comments in the process of our final recommendations for the reporting framework but do not describe our specific response to these points in this summary.
- Attendees joined from a variety of organisations, including, for example, the steering committee, SEAI, DECC (Department of the Environment, Climate and Communications), the former Department of Enterprise, Trade and Employment (DETE), ESB (Distribution Markets and System Operations), Google, EnergyTag, and Amazon. The list of attendees is in at the end of this annex.

Summary of main comments and questions

General comments

- A number of stakeholders expressed their strong willingness to move quickly towards granular reporting, articulating the reputational benefits. This has the potential to positively impact the estimated time to implement a new reporting scheme.
- A question was asked about whether the framework was on reporting or procurement. Frontier clarified that the framework is for reporting emissions and will not mandate procurement to lower emissions.

Option design – high-level

- On the two design options presented, an 'Enhanced GO scheme' and a 'Emissions Accounting, some stakeholders expressed their belief that a hybrid option that includes both matching data and issuing certificates could be considered.
- Stakeholders asked how the two options compared to the Energy Tag Guidelines. Energy Tag confirmed in response that its proposal included elements of the two options.
- A comment was made that the two options are not mutually exclusive and that it may be practical to consider a progressive 'crawl-walk-run' approach to implementing the scheme. The two schemes could be implemented together and then the best one could be evaluated afterwards.
- There was also a comment that a scheme with certificates, such as the Enhanced GO option, would allow consumers to improve their emissions position.

Effectiveness

- The benefit of the matching was also questioned compared to having the certificates and registry as part of the enhanced GO option.
- It was commented that it is possible to achieve additionality through the certification (enhanced GO option) scheme, but further detail was not provided. Further information was referenced in subsequent communication with Frontier Economics.
- Stakeholders queried whether projects in Ireland receiving support under PO would be eligible for GOs; previously they have not been, but it is for member states to choose. A new scheme would enable that choice on scope to be made.

Implementation

- Stakeholders asked why the assessment suggested that the matching scheme would take longer to implement. Frontier clarified that the assumption was that a matching scheme would require an extra step to register the PPA agreements in place, hence the orange rating. We noted this as a reflection point for the final version.

- It was asked if there would be any link to existing Energy Efficiency Directive (EED) reporting requirements or whether the mandatory nature of EED could help with making reporting mandatory. We do not think there would be or that there is at present. The reporting requirements under the Large Plant Combustion Directive were also mentioned. LCPD is a European Union directive which required member states of the European Union to legislatively limit flue gas emissions from combustion plant having thermal capacity of 50 MW or greater, but it was superseded by the Industrial Emissions Directive from 2016, which requires reporting on environmental data.

Consistency

- Stakeholders questioned why a matching scheme might be less consistent with EU policy than an enhanced GO scheme. Frontier clarified that the absence of a certificate and the different starting point compared to the existing GO scheme were the reasons for the different assessment rating (orange vs green).

- Multiple stakeholders expressed the need to ensure consistency with other reporting requirements (under the EED, and Corporate Sustainability Reporting Directive CSRD) in mind. LEUs have done a lot of work on messaging and reporting different numbers as a result of different technology scopes can cause confusion.

Wider impacts

- Frontier clarified that the assessment of wider impacts at the high-level scheme design was a relative assessment and that there would be impacts. These impacts are considered in the detail design options.

- PPAs were mentioned as bringing hedging benefits. The report by Pexapark for Eurelectric entitled "24/7 CFE Hedging Analysis" was cited. Matching gives better hedging, and this supports competitiveness.

Wider design choices

Technology

- A wide consensus for the technology scope to be as wide as possible, and from the outset of the reporting scheme to create the right incentives. The risk of a narrow scope would be to disincentivise investment in new low-carbon technologies. There was agreement the right incentives are in place for offshore wind for example, and the focus should be on flexibility, etc.

LEUs

- A question was raised about the need to use primary legislation for a sub-set of user groups (e.g., DG10), but no other points were raised about the mandatory nature being enabled by primary legislation with the agreement that the reporting should be mandatory.

Legal basis

- A question was raised about the need to use primary legislation for a sub-set of user groups (e.g., DG10), but no other points were raised about the mandatory nature being enabled by primary legislation with the agreement that the reporting should be mandatory.

Time

- No points were raised regarding the time granularity of the reporting, which would correspond to the MTU, and which would, therefore, be hourly at the outset.

Location

- The reporting scheme should try and go beyond ROI. If not, it should at least offer the chance for bespoke projects to be in scope. For example, investments in Northern Ireland could be included by exception.

Detailed design issues

Behind the meter generation

- Stakeholders considered that behind-the-meter generation should be within the scope of reporting from the outset, in the same way as storage should be (point below). The reporting would be inaccurate and would distort the incentives for LEUs to install non-RES back-up generation if behind the meter was not included.

Storage

- Storage should be included as early as possible. It was commented that there is a methodology to capture storage flows by tracking GOs from their (RES) generation through to storage and subsequent withdrawal to use to meet demand. The approach is informed by storage operators in the EU/US and is quite new and requires strong guardrails and proper loss calculations.

- Frontier clarified that the final report would include additional detail with regard to how storage could be included in phase 1.

Residual emissions methodology

- Stakeholders commented that while a marginal basis for assessing residual emissions is accurate, the challenges of getting the data to do so is a barrier. However, data availability should not prevent using a marginal basis if it is the better option.

- Using marginal data incentivises real-time behaviour while average emissions blunt signals. Load optimising to marginal emissions may have the reverse effect. Research by NREL was cited.

- It was noted that SEMO and Eirgrid buy-in and cooperation are important (also as enablers for data)
- Stakeholders commented that a marginal approach would be more adapted to the size of LEU load and its ensuing impact on the type of marginal plant in the stack.

- The question was asked of how emissions from "must-run" thermal plants would be included in the residual emission calculation.

- It was asked how would 'surplus' green energy be treated in the methodology. This is in the case where contracted RES exceeds demand for the relevant timeframe.

- A stakeholder asked how the scheme would address interconnector flows between GB and FR with respects to the effect on residual emissions.

Attendees to the workshop

The list below reflects the organisations who accepted the invitation to the workshop where delegates provided their organisation's information.

- SEAI
- DECC
- Dept of Enterprise, Trade and Employment (DETE)

- National Treasury Management Agency
- Distribution Markets and System Operations, ESB Networks
- EnergyTag
- Google
- Net Zero Energy
- K2 Datacentres
- IBEC
- Amazon
- Viotas
- The DRAI
- Cenergise
- Aughinish Alumina
- Intel
- Electroroute
- Apleona
- EA Ireland

Annex 3 – Policy review – summary of sources reviewed.

EU directives:

- Directive 2018/2001 and revised Directive EU 2023/2431 on renewable integration – this established a framework to promote renewable energy with binding targets and sets an overall energy target of at least 42.5% binding at EU level by 2030.
- Directive 2012/27 and revised Directives 2018/2002 and 2023/1791 on energy efficiency – the revised directive raised the EU energy efficiency target, making it binding for EU countries to collectively ensure an additional 11.7% reduction in energy consumption by 2030, on top of the national efficiency targets of 32.5% by 2030, and put energy efficiency at the core of policy decisions.
- Directive 2013/34/EU on financial reporting including 2013/34/EU and 2004/109/EC, as well as 2022/2464 on corporate sustainability reporting – these set out principles for general financial and sustainability reporting including auditing and transparency requirements.

Irish policy documents:

- Ireland's Climate Action Plan (2023) – the plan implements Ireland's carbon budgets and sectoral emissions ceilings and sets out a roadmap for halving emissions (51%) by 2030 and reaching net zero no later than 2050.
- Ireland's Government Statement on the role of data centres in Ireland's Enterprise Strategy (July 2022) – this sets out principles that aim to support data centre infrastructure while promoting national decarbonisation objectives.
- Renewable Electricity Corporate Power Purchase Agreements Roadmap - the first Climate Action Plan 2019 included a target of 15% of electricity demand to be delivered by renewable energy CPPAs. No specific supporting target for renewable energy CPPAs was included in the Climate Action Plan 21 but the CAP2023 includes actions to develop incentives to match electricity demand with renewable energy generation including renewable PPAs.

GB low-carbon hydrogen standard:

GB low-carbon hydrogen standard

LCHS sets a maximum threshold of 20gCO2e/MJLHV of produced hydrogen for greenhouse gas emissions allowed in the production process for hydrogen to be considered low carbon.

The Low Carbon Hydrogen Standard (LCHS) sets out a definition for "low carbon hydrogen" in the UK and is used as an eligibility criterion for government subsidy schemes. The LCHS sets a maximum threshold for greenhouse gas emissions allowed in the production process for hydrogen to be considered 'low carbon hydrogen', and a methodology for calculating these emissions.

The key aspects of the LCHS standard – Greenhouse Gas Emissions Methodology and Conditions of Standard Compliance

The LCHS specifies the evidence requirements for hydrogen production facilities using electricity inputs, which may come from the different sources. Whichever the source, the production's metered consumption shall be broken down into the percentage volumes of electricity that are stated to come from each of the sources in each reporting unit (defined as a 30-minute period of time used to calculate and report GHGs).

Source of electricity	Criteria	Transaction evidence needed
Electricity grid	Electricity sourced from grid import not linked to any specific generator may be claimed at the GHG Emission Intensity of the applicable GB or NI Electricity Grid average per Reporting Unit	All volumes consumed by the production facility must be evidenced by metered consumption data and the % stated to be sourced from grid import
Private network	Electricity sourced from several generation assets on a Private Network can be claimed at the weighted average GHG Emission Intensity of the Private Network generators per Reporting Unit	Metering data is required to show the sum of the metered data of the electricity generators on the network exceeds or matches the Hydrogen Production Facility's metered data for electricity consumed. Metering data is also required to show any grid import onto the private network to determine the share of grid imported electricity.
Specific generator (via PPA)	Electricity sourced from a specific generator may be claimed at the delivered GHG Emission Intensity from the generator per Reporting Unit	Metering data is needed to prove physical delivery and the temporal match of electricity from the generator(s).The GHG emissions intensity of the volumes supplied must also be shown
Electricity curtailment avoidance	Electricity demand by a H2 production facility may reduce the need for curtailment on the gird. This can be claimed either at the regional GHG emissions intensity figure or the grid level intensity, depending on the location of the facility	Proof of electricity consumed via a bid offer acceptance (BOA) in the balancing mechanism based on metered consumption data for the corresponding settlement period

Annex 4 – International review – summary of public schemes

North American Renewable Energy Certificates (REC)

RECs are the legal instrument through which renewable energy generation and use claims are substantiated in the North American renewable electricity market.

Roles and responsibilities

- **Issuer**: State or regional electronic tracking systems issue RECs. Some of these allow registration from locations not covered by any regional tracking system. Tracking infrastructure for all regions is provided by APX.*
- **Recipient**: Renewable electricity generators
- **Buyer**: Electricity suppliers or organisations with clean energy goals purchase directly from generators or via brokers.**
- **Verification/certification**: The Green-e program, administered by the nonprofit Center for Resource Solutions, verifies RECs.

Implementation / Methodology

- A tradeable market-based instrument created for every megawatt-hour (MWh) generated.
- RECs cover monthly or annual volumes.
- Include all relevant information on the generation of their underlying green power, including location (place of production), fuel type and month or quarter of generation. Exact eligibility and compliance requirements vary between states.
- RECs are used to:
  - Track compliance with mandatory energy targets, e.g. Renewable Portfolio Standards (RPS).
  - Verify electricity supplier statements
  - Validate voluntary commercial claims

Outcomes / Benefits

- RECs verify ownership of the attributes of the energy generation from the point of generation to the point of use.
- The REC owner has the right to claim the attributes of the renewable electricity and can use the certificates for a variety of requirements, including Scope 2 reporting*** and national energy reporting.

Future framework characteristics

- Two of the tracking systems, M-RETS and PJM, now offer limited functionality hourly tracking.
- Both conform to the Energy Tag standards (slide-34)
- Grid location is not included alongside hourly tracking.

Key Takeaways

- The **direction of travel is towards a 24/7 matching scheme**, but to date, this is on a voluntary/commercial basis in select regions.
- Reports estimate that nationwide implementation of hourly tracking **would require state support** and take between 1-5 years.

International Renewable Energy Certificate Scheme (I-RECS)

Outside of Europe and North America, I-RECs are the most recognised EAC scheme. They are available in over 50 countries in Asia, Africa, and Latin America..

Roles and responsibilities

- **Recipient**: Renewable electricity generators
- **Buyer**: Suppliers or organisations with clean energy goals
- **Issuer**: can be a variety of entities such as for-profit organisations, non-profit organisations, or governmental bodies.*
- **Verification**: Issuers are responsible for registration of generators, issuing certificates, and verifying data.
- **Software:** Evident manages the registry to provide a fully auditable chain of custody.
- **Standards**: The International Tracking Standard Foundation: Founder of I-REC (I-TRACK Foundation) is a non-profit that provides standards for tracking systems via the I-REC(E) code.**

Implementation / Methodology

- A tradeable market-based instrument created for every megawatt-hour (MWh) generated.
- I-RECs cover monthly or annual volumes.
- The trade is performed via the I-REC registry, where participants may either transfer from one account to another or by the seller redeeming the certificates on behalf of the buyer.
- The I-REC is a voluntary scheme and exists independently or alongside national schemes in some regions, e.g. China.***
- I-RECs hold standard information on the generation of their underlying green power including location (but not grid location).

Outcomes / Benefits

- I-REC(E)s can be used for a variety of voluntary requirements, including Scope 2 reporting under the GHG Protocol
- They can also be used in some countries for national energy reporting.

Future framework characteristics

"The I-REC Standard Foundation (Foundation) **recognises the trend toward increased disclosure requirements and the associated hike in demand for highly granular certificates**. Accordingly, the Standard allows third parties (with permissions) to source, share, and integrate highly granular data on product certificates."

Key Takeaways

- The I-REC scheme does not mandate 24/7 reporting but allows more granular data and certification.

Australia's Renewable Electricity Guarantee of Origin (REGO)

Australia is currently designing a new REGO, to certify renewable electricity and provide certainty to underpin investment in renewables in Australia.*

Roles and responsibilities

- **Policy development:** Department of Climate Change, Energy the Environment and Water.
- **Recipient**: Renewable electricity generators.
- **Buyer**: Suppliers or organisations with clean energy objectives.
- **Administration/verification**: The Clean Energy regulator will be responsible for administering the scheme, including compliance monitoring and assurance functions.
- **Software:** It will be administered through an online public registry.

Implementation / Methodology

- A tradeable market-based instrument created for every megawatt-hour (MWh) of electricity generated.
- It is proposed that REGOs can be created for all renewable generation, including electricity exported overseas, electricity generated by small-scale solar PV and renewable electricity dispatched from storage facilities.
- Participation in the proposed REGO scheme would be voluntary.
- The primary legislation in 2024 will set out the detailed data requirements for REGO certificates

Outcomes / Benefits

- will deliver the capability to create time-stamped certificates so that Australian businesses can demonstrate time matching of their electricity consumption

Future framework characteristics

It is expected that the new scheme will require REGOs to include:

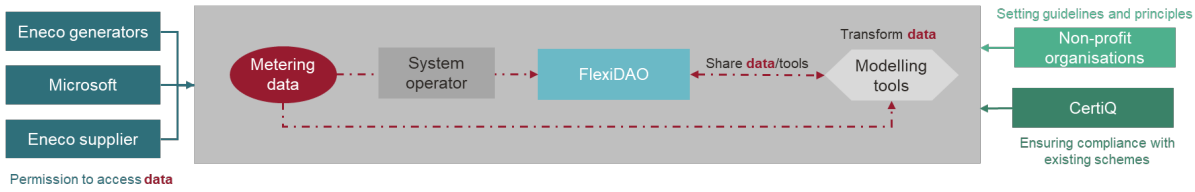
- the **grid location** of the power station or storage facility creating the certificates.
- a **timestamp reflecting the hour** in which the electricity was dispatched by the power station or storage facility
- it **would not publish any emissions intensity** information when the scheme commences. It may reconsider this in the future.

Key Takeaways

- The new REGO scheme design is a move towards a 24/7 framework, requiring grid location and hourly timestamps.
- It is anticipated that legislation will be in place in 2024 and that the REGO scheme will commence on 1 January 2025.

Annex 5 – International review – summary of commercial schemes

Matching Microsoft's datacentre hourly energy consumption with Dutch offshore wind



Roles & Responsibilities

- Eneco
  - Producer and supplier of natural gas and electricity
- FlexiDAO
  - Software provider that enables the issuance, transfer and claim of Granular Certificates
- CertiQ
  - Dutch GOs issuing body, ensuring the compliance of claims with Dutch GOs scheme
  - Oversee the regulatory feasibility of issuing, transferring and claiming Granular Certificates in sync with the existing system.
- Microsoft
  - Consumer/investor providing data access

Implementation approach

- Carbon-free power is produced by Eneco's Dutch Princess Amalia wind farm. The generation consumed by one of Microsoft's data centres is matched hourly
- All GCs created on FlexiDAO's platform are pegged to the official GOs issued by CertiQ to avoid a mismatch between the two certification layers.
- The GCs are transferred and matched to the data centre's hourly load profile
- Metering data used for certification will be third-party certified settlement data, provided to FlexiDAO by a Dutch-regulated metering company after receiving permission from Eneco and Microsoft

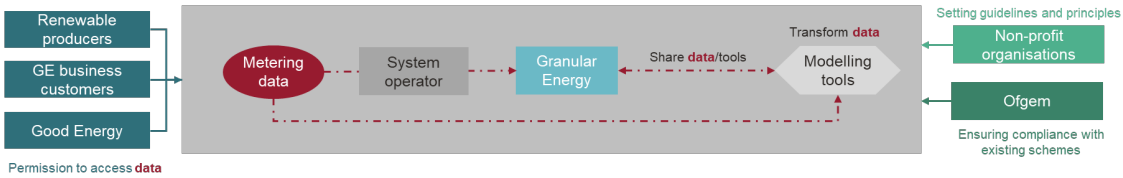
Outcomes

Microsoft is now able to

- Monitor and calculate the 24/7 synchronicity score of its CPPA supported by the claim of GCs – it knows what percentage of electricity consumed comes from a renewable source.
- Calculate the location-based and market-based CO2 emissions hour-by-hour in line with the GHG Protocol Scope 2 guidelines

- No detail is publicly available on the assumptions made over the non-renewable component

Good Energy provides time-based energy matching as standard to all half-hourly metered business customers



Roles & Responsibilities

- Good Energy
  - UK energy supplier providing services in the electrification of transport and decentralised renewable energy generation
  - Long term PPAs with a community of more than 2000 independent UK generators
  - 100% renewable fuel mix
- Granular Energy
  - Software provider to manage and trade clean energy
  - Good Energy business customers
  - Using around 0.25TWh of electricity in a year, allow access to data.

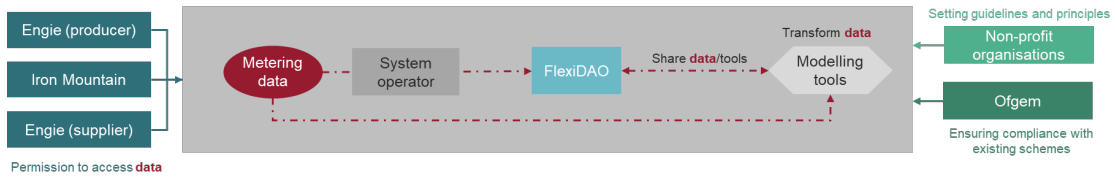
Implementation approach

- GE matches its customer demand volume with the power it procures from the renewable generators it contracts with on a half-hourly basis (400 renewable energy generators at the moment, with hopes to expand to 2000)
- Energy generators need to grant permission to share the following data with Granular Energy
  - Meter Point Allocation Number (to ensure no double counting)
  - Site's renewable technology type
  - Amount of energy supplied to Good Energy on an ongoing half-hourly basis

Outcomes

- Good Energy claims to reach 90% matching for its metered B2B customers on a half-hourly basis, and 100% on an annual basis.
- For every hour of the day, the new service will provide customers with data on what type of renewable power they are using and where it has come from
  - Paves the way for new levels of transparency in carbon reporting
  - Enables businesses to shift when they use energy to reduce their emissions.
  - Allows customers to focus on activities that will genuinely reduce their carbon footprint

Iron Mountain data centres to achieve carbon-free energy across all its global operations 24/7 by 2040



Roles & Responsibilities

- **FlexiDAO**
  - Software provider – provides tools to understand Carbon-Free Energy status
- **Engie**
  - Utility partner operating in electricity generation and distribution providing access to data.
- **Iron Mountain**
  - Consumer providing access to consumption data from their data centres and offices in the UK

Implementation approach

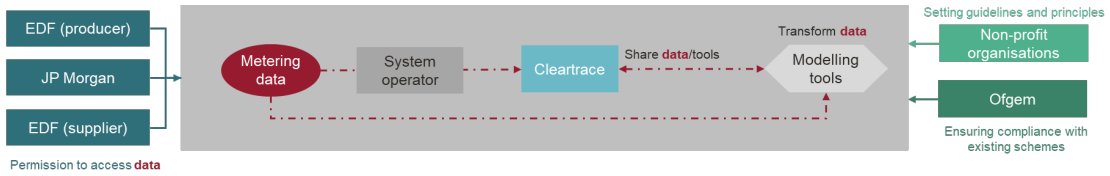
- FlexiDAO collects and analyses hourly production and consumption data using its software CFE Inventory.
  - The analysis includes modelling and evaluating procurement scenarios against performance metrics such as RE100 and scope 2 emissions.
  - The carbon content of all the electricity Iron Mountain procures from Engie over the whole of UK is looked at hourly

Outcomes

- FlexiDAO provides an overview of Iron Mountain's UK energy portfolio and how carbon-intensive it is at all points of the day. This allows Iron Mountain to measure and track their carbon footprint.

- No detail is publicly available on the detail of the calculations, and what assumptions are made over the non-renewable component of IM's consumption.

Cleartrace are matching JP Morgan's energy consumption from EDF renewable generation



Roles & Responsibilities*

- **EDF**
  - Producer of zero-carbon electricity from wind, nuclear, and solar sources.
  - Supplier of renewables via PPA
- **Cleartrace**
  - Energy-tracking and carbon accounting software company
- **JPMorgan Chase**
  - Consumer providing access to data

Implementation approach

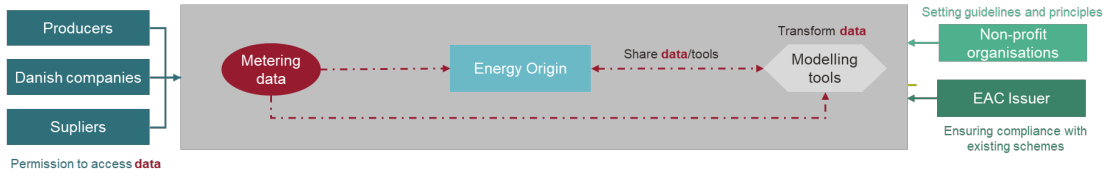
- Matching will take place on a half-hourly basis, through source-specific access to EDF's 8 TWh of PPA portfolio
- EDF will provide JPMorgan Chase with approximately 120,000 MWh of renewable electricity each year to power JPMorgan Chase's UK offices
- Energy production and consumption will be monitored using tracking technology from Cleartrace

Outcomes

- The Cleartrace platform will provide an accurate, real-time view into JPMorgan Chase's carbon footprint, enabling auditable, around-the-clock monitoring of energy generation and consumption

- There are no publicly available details on what assumptions are made over the non-renewable component of consumption

Project Energy Origin is a project in Denmark that is developing a system to issue granular certificates



Roles & Responsibilities

- Energinet
  - Independent public enterprise owned by the Danish Ministry of Climate and Energy
  - Owns, operates, and develops the transmission systems for electricity and natural gas in Denmark
- Consumers
  - The current version of the platform offers services to Danish companies.
  - Data for private users will follow in future versions

Implementation approach

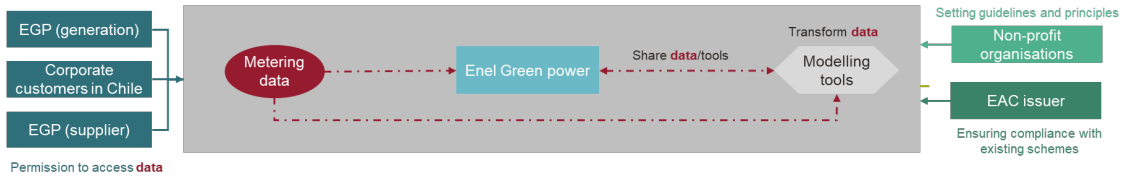
- Project-Origin is an open-source collaboration that develops the technology needed for registries to issue Granular (hourly) Certificates
  - i.e. creating "verifiable and unique objects" that ensures the registry is tamper-evident, auditable, and that the individual entries are unique and verifiable

Outcomes

- This provides a trustworthy, publicly verifiable way to prove the origin of the electricity one uses with a high granularity
- Now able to issue granular certificates based on renewable energy production within Denmark

- There is limited information on how data is shared with Energy Origin and the type of data that the platform hosts

Enel Green Power piloted a holistic solution to match production and consumption via in-house software in Chile



Roles & Responsibilities

- Enel Green Power
  - Italian multinational renewable energy corporation
  - Operates in five continents generating energy from solar, geothermal, wind and hydropower sources.
  - Acts as both supplier and software provider
- EGP customers' local registries ensure compliance with existing schemes.
- EGP customers grant access to data.

Implementation approach

- Renewable electricity generation is time and location tracked according to EGP's power plants' official metering data.
- Time is tracked hourly but there is no specifics provided on the location data.
- Matching between energy and consumption is via an in-house ranking allocation algorithm.
  - Constraints derived from the customer's preferences and contractual arrangements, such as preferred/avoided generation sources are also included.

Outcomes

- A dashboard provides customers with easy access to the matching information and official EACs related information.
- EACs that certify that 1 MWh comes from renewable energy sources and has been consumed by an end consumer.

- Publicly available details of the project are limited.
- EPG projects are a closed-loop solution using EPG producers, consumers and in-house software.

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Rialtas na hÉireann
Government of Ireland

Sustainable Energy Authority of Ireland
Three Park Place
Hatch Street Upper
Dublin 2
Ireland
D02 FX65

e info@seai.ie
w www.seai.ie
t +353 1 808 2100