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# Introduction to CO2 metering specification – Section F, 1.1 to 7.3 of CCS Network Code HoTs, December 2023.

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# Disclaimer

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# Background:

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*Section F of the Network Code specifies the requirements Users delivering CO2 to the T&S network shall comply with:*

- *Section F, para 1.4 of states “A user may not deliver CO2 into the T&S network at any Delivery Point unless there is a connection agreement between the User and T&Sco which:*
  - A) Identifies the User Facility*
  - B) Identifies the Delivery Point; and*
  - C) Specifies the **Entry Provisions** applicable to that Delivery Point*

***Entry Provisions** are:*

- *CO2 specifications,*
- ***Measurement Requirements;** and*
- *Local Requirements*

# Context (Network Code):

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## User responsibilities:

Section F, 4.2-4.4 states the following:

1. A User may not deliver any carbon dioxide at a Delivery Point until and unless Measurement Equipment which complies with the requirements of this section has been **installed by the User** at the Delivery Point.
2. The User shall **at its own cost** install, commission, operate and maintain the Measurement Equipment in accordance with the requirements of this Section F.
3. The User shall obtain **T&SCo's prior approval** in relation to the **siting, specifications and installation** of the Measurement Equipment and any such installation and commissioning shall, to the extent relevant, comply with the Measurement Requirements.

# Context (Emitter contracts):

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Emitter Contracts (DPA, ICC, BECCS, H2) will require measurement of both **CO2 pure stream and CO2 Rich Stream exported** on to a T&S Network to determine capture rate and mass of CO2 captured, which informs subsidy payments (Fiscal purpose).

## *Undertakings: CO2 Metering Obligation*

*21.2 With effect from the Start Date, the Generator undertakes to the DPA Counterparty to:*

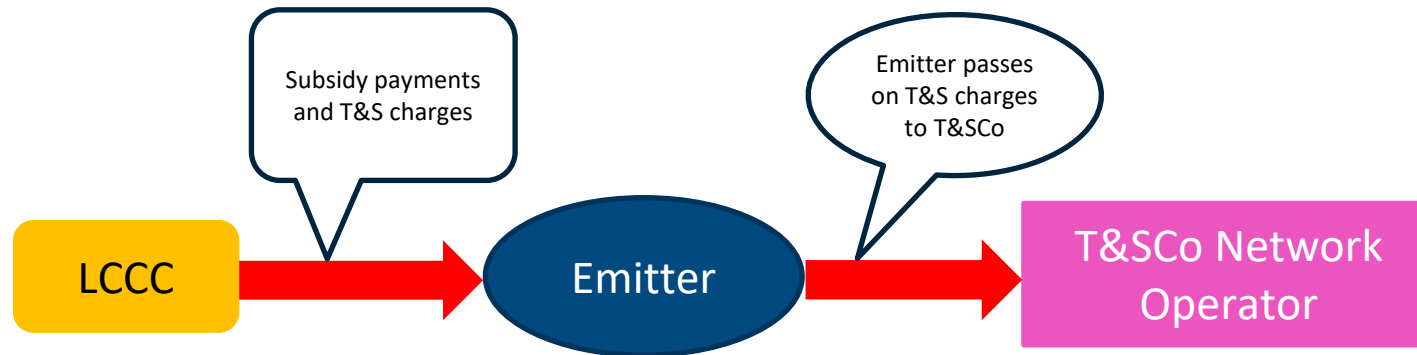
*(A) ensure that at all times the CO2 Metering Equipment relating to the Facility:*

*(i) has been installed at the CO2 Delivery Point(s) identified in the Agreement; 132*

*(ii) has been and is installed, configured, registered, operated and maintained in accordance with **the requirements of the CO2 Metering Specification**, including to ensure that captured CO2 Rich Stream which fails to comply with the Delivery CO2 Quality Standards is not exported to a T&S Network.*

# Why CO2 metering required – triple purpose.

1. Emitter contracts payments based on capture quantity (£/tonne of CO2 pure stream)
  - Also used for determination of CO2 capture rates and Capture Factor.
2. Transport & Storage Network charges passed through via emitter to the T&SCo (£/tonne of CO2 Rich Stream).
3. CO2 stream T&S entry specification: determines the quality of the CO2 to avoid harm to the T&S Network.



# CO2 metering Specs – outcome based approach.

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- Set maximum measurement uncertainty requirements to be achieved.

**Metered CO2 Output to T&S Network** (aka pure stream, **RELEVANT TO EMITTER CONTRACTS ONLY**).

- The overall uncertainty of the Metered CO2 Output to T&S shall at all times be equal to or less than **+/-1.5%** of the measured value at 95% confidence interval (the "CO2 Uncertainty Requirement").

**Metered CO2 Rich Stream output to T&S (aka Rich Stream)** - all components of CCS plant output into T&S Network e.g., CO2, CO, H2O NOx, Ar, O2, Amines, Ammonia) **(RELEVANT to CCS CODE)**

- The overall uncertainty of the Metered CO2 Rich Stream Output to T&S shall at all times be equal to or less than **+/-1%** of the measured value at 95% confidence interval (the "CO2 Rich Stream Uncertainty Requirement").

Calculated in accordance with internationally and accepted standards including but not necessarily limited to ISO.IEC Guide 98 ("Guide to the expression of uncertainty in measurement (GUM)").

# CO2 metering Specs – instrument requirements.

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## Flow meter:

- Flexible approach, either Coriolis mass flow meter or volumetric flow meter – this may be influenced by T&SCo requirements. For fiscal purposes, emitter must be able to satisfy and demonstrate the uncertainty budget is achieved with selected instrumentation.
  - If not a mass flow meter, e.g., orifice plate, then Densitometer instrument also required to provide mass flow.

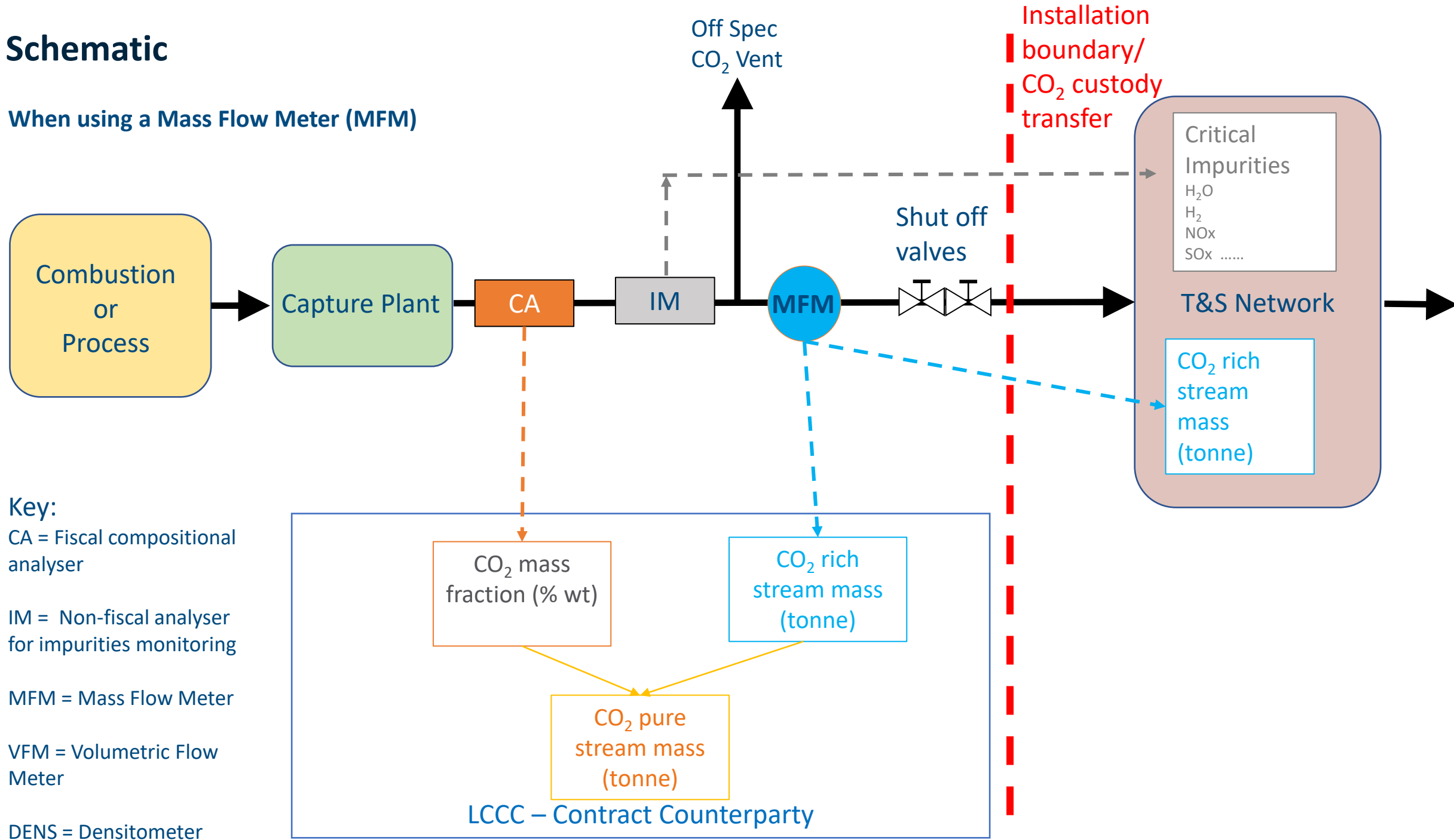
## Compositional analyser – fiscal purpose in emitter contracts only (NOT IN CCS CODE).

- ~~Contemplating Direct measurement of CO2 concentration or indirect by measuring the required measurement impurities.~~
  - Require direct measurement of CO2 only given complexities of variable flue gasses, instrument performance and T&S Network composition requirements.
- Instrument approach – online gas chromatograph optimised for high-purity CO2 (as recommended in ISO/TR27919-1 Carbon dioxide capture — Part 1: Performance evaluation methods for post-combustion CO2 capture integrated with a power plant)
- **Or**, suitable alternative method which meets the uncertainty budget requirement and can be verified / assured by the Counterparty.



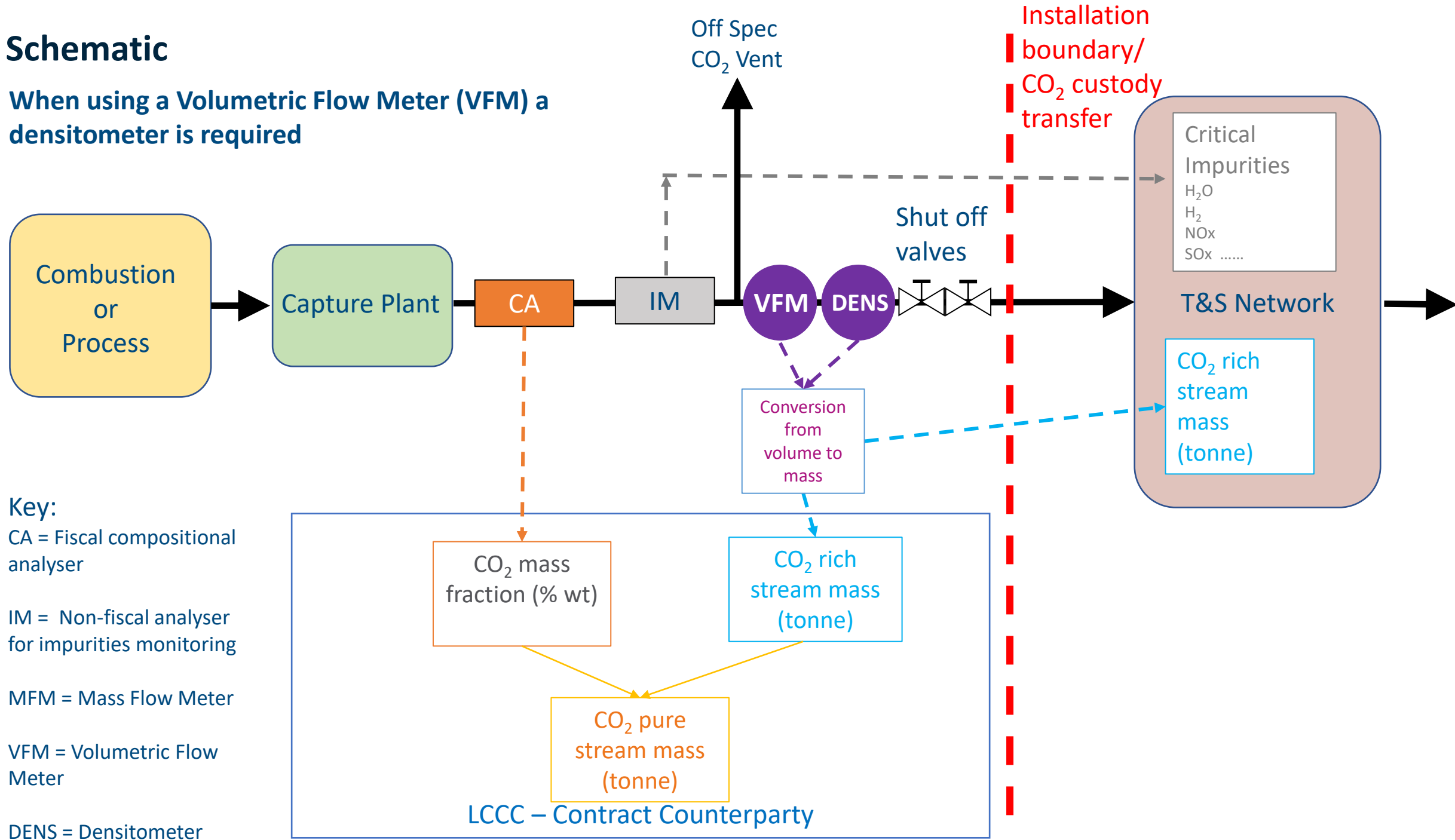
# Schematic

## When using a Mass Flow Meter (MFM)











# Schematic

When using a Volumetric Flow Meter (VFM) a densitometer is required



# Where will instruments specifications sit?

	Emitter contracts	T&S Network Code / Connection Agreement	Comments
CA			CO <sub>2</sub> mass fraction data needed by <b>LCCC only</b> to determine CO <sub>2</sub> pure stream. <ul style="list-style-type: none"> <li>Included in Emitter contracts</li> </ul>
IM			Impurity monitoring data needed by <b>T&amp;S Co only</b> for pipeline integrity purposes. <ul style="list-style-type: none"> <li>Included in T&amp;S Network Code/Connection agreement.</li> </ul>
MFM			Mass flow data needed by <b>LCCC and T&amp;S Co</b> for CO <sub>2</sub> pure stream and T&S charges determination. <ul style="list-style-type: none"> <li>Instrument requirements duplicated in Emitter Contracts and T&amp;S Network Code/ Connection Agreement</li> </ul>
VFM DENS			Mass flow data needed by <b>LCCC and T&amp;S Co</b> for CO <sub>2</sub> pure stream and T&S charges determination. <ul style="list-style-type: none"> <li>Instrument requirements duplicated in Emitter Contracts and T&amp;S Network Code/ Connection Agreement</li> </ul>

# Next Steps and Detailed session

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- We have developed a detailed CO2 outlet metering specification with our legal and technical advisers – shared the proposed metering specification technical requirements Late December 2023.

## Questions for feedback:

- ~~General thoughts on workability of proposals.~~
- ~~Is it possible to go beyond the maximum uncertainty requirement of 1.5% for CO2 Metered Output?~~ Industry feedback & research demonstrates this is achievable.
- Any other relevant points we have not considered? Minimum flow requirements clarified. <10% of maximum metered Flow Rate, uncertainty requirements reduced to 3% at 95% CI.

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**CO2 Re-use proposal for inclusion in CCS Codes, Section F, para 8 – 9.3.**

**Power CCUS Team.**

**Stephen Glenville.**

**Kusum Trikha.**

**30/01/2024.**

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# Background and Purpose

## Background

The purpose of CO2 Re-use is to temporarily allow a network user to use pressurised CO2 drawn from the Transport and Storage (T&S) Network, before returning it all back to the T&S Network for permanent storage.

We are proposing to enable the CCS Network Code to contemplate the ability of a T&SCo to offer this service to users.

## Purpose

The CO2 Re-use proposal is to address the low pressure (LP) compressor start-up requirements, which may cause CO2 to be vented until the LP compressor is sufficiently pressurised. This proposal seeks to speed up the LP compressor optimisation time and thereby minimising residual CO2 emissions.

For a Dispatchable user, where frequent start-ups are anticipated, cumulative residual emissions of CO2 pre LP optimisation for export could be significant.

This proposal is not to be confused with enabling CO2 to be **utilised** in other applications i.e. food and drink etc.

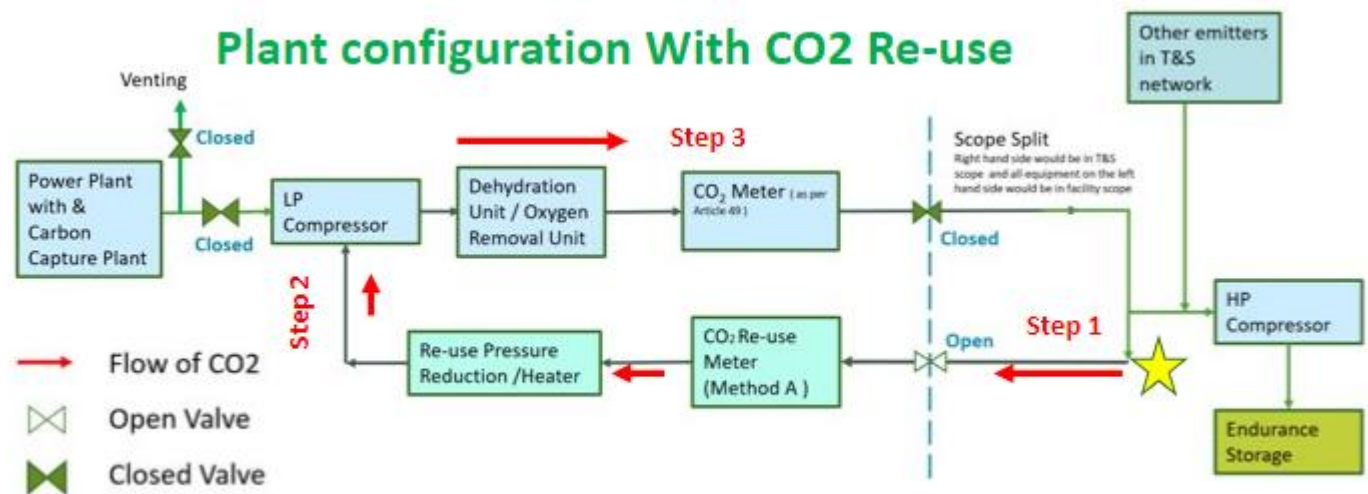
## Benefits

Reduce fugitive emissions of CO2 during Start-up process, mitigating capture rate impact, maximise the overall CO2 captured and stored.

CO2 Re-use would be beneficial for emitters that have very tight emissions requirements, venting of CO2 during start-up could push them outside acceptable limits e.g. Blue hydrogen may not be considered to be blue if start-up emissions are considered in the calculation.

Future proofing for any NPT, balancing line for shipping of CO2.

# Conceptual diagram



## Mode of Operation – With CO2 re-use

Step 1: To pressurise LP compressor, CO2 from TS Network or from intermediate stage of compression is extracted and returned to emitter.

Step 2: CO2 used in LP compressor optimisation, recirculated in the LP compression stage.

Step 3: CO2 from capture Plant is returned back to T&S via CO2 De-Ox, De-Hydration, fiscal metering skid and CO2 delivery point for storage



# Implications for Users and the Code

## Technical

The emitter bears the responsibility for designing, engineering, and constructing the CO2 Re-Use equipment while ensuring safety measures are in place

## Commercial

Subject to agreement from the respective T&SCo.

Cost of service provision to be agreed on a cost reflective basis.

CO2 Re-use equipment and additional pipeline work is included in the emitter project's scope.

Commercial arrangements, responsibilities and liability of accidental leak would be stated in the T&S connection agreement.

## Contractual

T&SCo reserve right to suspend or refuse the service if its operations are impacted.

CO2 would be metered and returned to the network after use. Emitter and T&S Co would have visibility of CO2 entering and leaving the site.

Amendment to emitter contracts including payment mechanism and metering requirements in order to net off any returned CO2 from the payment calculations. Inclusion in Connection Agreements.

## Regulatory

ETS compliance – we understand this is compatible with the UK ETS regulations. Emitter requires specified activity adding to its GHG permit to ensure it is responsible for costs relating to surrendering allowances for any emitted CO2 lost as a consequence of ‘borrowing’ it from the T&S Network.

## Next Steps

The CCS Network Code consultation proposes the ability of the code to contemplate provision of this service. We are seeking feedback on the workability of this proposal.

Welcome feedback.

# CCS Network Code

## Section I (Data)

# Disclaimer

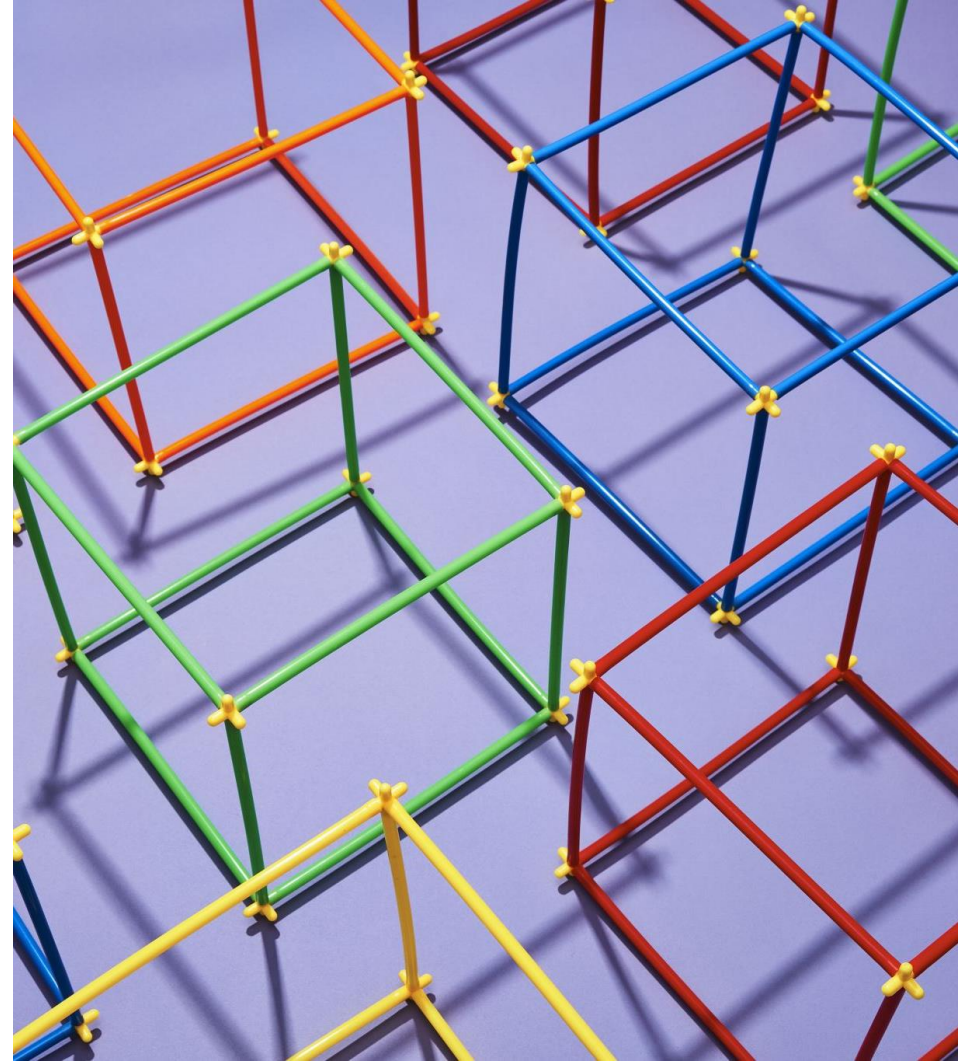
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# Structure and Purpose of Section I

Contains central principles relating to data and information sharing, specifically:

- Information and confidentiality
- Categories of data
- Access to and storage of data
- Processing of data (CDS)
- Verification of data



# Information and Confidentiality: General Obligations

Mutual obligations on T&Scos and Users to ensure Protected Information is not:

- Disclosed, with permitted exceptions; and
- Used, other than for permitted purposes.

Protected Information means:

- **In relation to T&Scos:** any information relating to the affairs of a User which is obtained by T&SCo pursuant to or in the course of the negotiation, implementation or performance of the Code, the Code Agreement or any Ancillary Agreement to which that User is party.
- **In relation to Users:** any information relating to the affairs of T&SCo or of another User which is obtained by the User pursuant to or in the course of the negotiation, implementation or performance of the Code, the Code Agreement or any Ancillary Agreement to which the User and (in relation to another User) that other User are party.
- **In relation to T&Scos and Users:** the terms of any Ancillary Agreement.

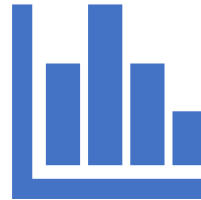
# Information and Confidentiality: Exceptions and Terms of Disclosure

- **Permitted exceptions include:**
  - Express consent;
  - Information which is already in the public domain;
  - Compliance with:
    - the Energy Act or requirements of Competent Authorities;
    - Licence;
    - Legal Requirements
    - Requirements of stock exchange or other regulatory authorities
    - any judicial or arbitral process
  - Disclosure to finance providers (with written confidentiality undertakings);
  - Disclosure to regulator in relation to Licence breaches;
  - Disclosure for the purposes of new connections (where reasonably required to support T&S charges or connection process and with confidentiality agreement)
- **Terms of Disclosure:**
  - Recipient to be made aware of Disclosing Party's obligations and to not use or disclose Protected Information other than as permitted.

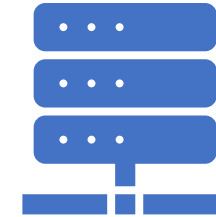
# Categories of Data



User-Specific Data



Measurement Data



T&S Network Data



# Categories of Data: User-Specific Data

User-Specific Data	
All data held by a T&SCO in relation to a specific User including:	All data held by a User about User networks including:
<ul style="list-style-type: none"> <li>User's Registered Capacity</li> </ul>	<ul style="list-style-type: none"> <li>details of planned maintenance/outages in</li> <li>relation to User facilities</li> </ul>
<ul style="list-style-type: none"> <li>accepted and rejected Nominations</li> </ul>	<ul style="list-style-type: none"> <li>forecast flow data</li> </ul>
<ul style="list-style-type: none"> <li>invoices</li> </ul>	<ul style="list-style-type: none"> <li>actual flow data</li> </ul>
<ul style="list-style-type: none"> <li>metered quantities</li> </ul>	<ul style="list-style-type: none"> <li>nominations</li> </ul>
<ul style="list-style-type: none"> <li>outages affecting specific Users</li> </ul>	<ul style="list-style-type: none"> <li>capacity bookings</li> </ul>
<ul style="list-style-type: none"> <li>information required to be provided by the User to a Support Contract counterparty (pursuant to its Support Contract) or any other body pursuant to legal requirements</li> </ul>	<ul style="list-style-type: none"> <li>any information which is required to be provided by T&amp;SCo to the Authority (pursuant to its licence), the North Sea Transition Authority (pursuant to its licence/permit) or any other body pursuant to legal requirements</li> </ul>
<ul style="list-style-type: none"> <li>User's Measurement Equipment</li> </ul>	
<ul style="list-style-type: none"> <li>User Type</li> </ul>	
<ul style="list-style-type: none"> <li>User contact details</li> </ul>	

# Categories of Data: Measurement Data & T&S Network Data



"Measurement Data" means all data generated by Measurement Equipment installed pursuant to paragraph 5 of Section F which is not User-Specific Data

"T&S Network Data" means all data related to the CCS Network which is not User-Specific Data or Measurement Data

# Access to and storage of User-Specific Data and Measurement Data: Data Transfer Procedures



Each T&SCo must, no later than 6 months prior to COD, establish written procedures to address the exchange of or access to User-Specific Data and Measurement Data between the T&SCos and Users, known as the Data Transfer Procedures.



Must cover minimum topics set out in para 6.3 of Section I



All Users and T&Scos are required to comply with the Data Transfer Procedures once published

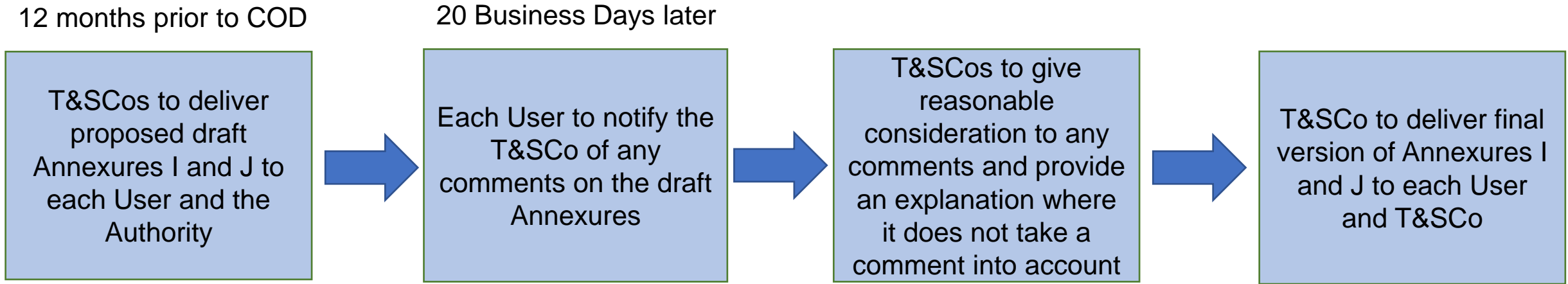


Data Transfer Procedures must comply with the requirements for format, naming, and minimum transfer intervals in relation to the User-Specific Data and the Measurement Data set out in Annexure I.



Procedures themselves not part of the Code and are T&S Network specific.

# Data Transfer Procedures: Preparation of Data Annexures



T&SCos may review and/or revise the contents of final versions of Annexures I and J:

- when they consider necessary
- upon the request of a User
- in order to resolve a dispute

provided that the above process is followed, other than where a revision is of a routine nature and does not have a material impact on a User's cost base or operational processes.

# T&S Network Data

**Each T&SCo shall procure that certain T&S Network Data is accessible to Users at all times via the T&S Network Portal:**



- existing connections and new connections applications;
- Network Capacity available (in accordance with the requirements of paragraph 3.2 of Section E (network use and capacity));
- annual Maintenance Programme;
- information on Capacity Constraints (in accordance with the requirements of paragraph 12.1(a) of Section E (network use and capacity));
- network expansion and development information;
- process and timelines for capacity releases;
- aggregate Registered Capacity of all Users;
- daily aggregate physical flow (gross);
- aggregate metered quantities of all Users per calendar month;
- Charges;
- certain historic data in respect of the above.

# T&S Network Portal

No later than 6 months prior to its COD, each T&SCo must procure a T&S Network Portal provider for its T&S Network, responsible for the publication of T&S Network Data.

<b>Terms of Reference</b>	The terms of the T&S Network Portal Contract must comply with the Network Portal Terms of Reference, set out in Annexure N.
<b>T&amp;S requirements</b>	Each T&SCo shall be required to: <ul style="list-style-type: none"><li>• manage the Network Portal Service contract;</li><li>• bear the fees incurred under the Network Portal Service Contract; and</li><li>• ensure the Network Portal Service Contract is in place at all times.</li></ul>

# Central Data Service (CDS)

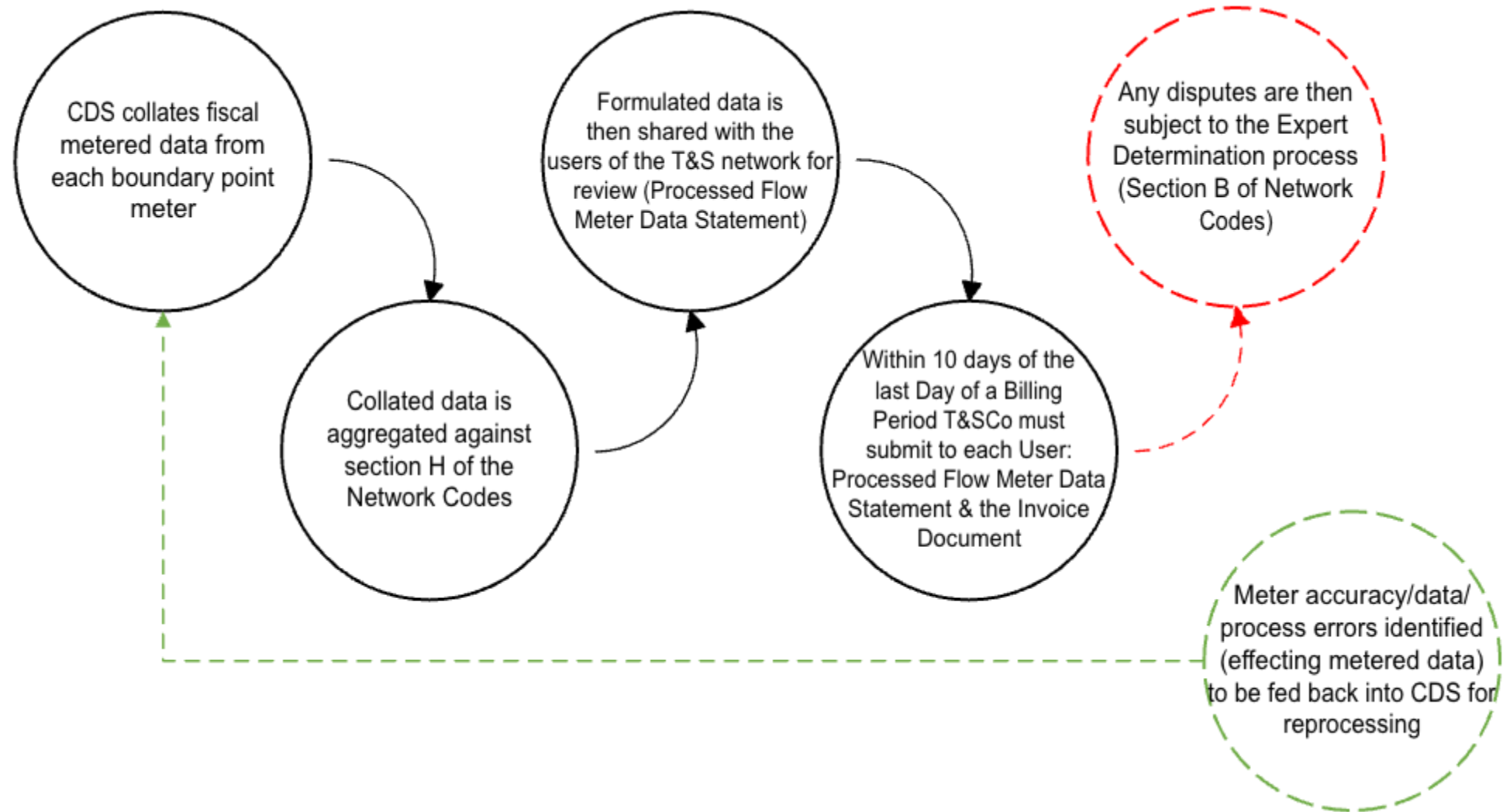
<b>Context</b>	The flow of CO <sub>2</sub> from a User to a T&S Co is measured at the boundary flow meter - this raw data is aggregated and used as inputs to the calculation of Onshore and Offshore Flow Charges and payments by <b>both</b> T&S Co (for the purposes of invoicing under the Code) and the LCCC (for payments under the User revenue support contracts).
<b>Purpose</b>	<p>For effective management of public money and to minimise invoice disputes, the system needs to limit the risk of this flow meter data from multiple network Users becoming misaligned in T&amp;S Co, User and/or LCCC systems.</p> <p>As a minimum for appropriate management of public funds by LCCC, there needs to be:</p> <ul style="list-style-type: none"><li>- A “single source of truth” for data used for <b><u>fiscal purposes only</u></b> by both Users, the LCCC and T&amp;S Co, including transparency of data processing and aggregation;</li><li>- Centralised and agreed flow meter data aggregation principles with governance in place to manage any changes; and</li><li>- Outputs of any disputes on data to be reflected within the central data system.</li></ul>

# CDS

<b>CDS</b>	<p>T&amp;SCos are required to jointly procure an independent Central Data Service (“CDS”) which will be responsible for providing the Processed Flow Meter Data Statement, to be used by T&amp;SCos to calculate the Onshore and Offshore Flow Charges.</p> <p><b>Note:</b> The timing of the procurement of the CDS will need to be reviewed once the scheduled COD dates for each of the T&amp;S Cos have been confirmed.</p>
<b>CDS Contract</b>	<p>Code sets out minimum scope of the CDS Contract through a Terms of Reference. T&amp;S Cos are required to jointly manage CDS Contract and bear all fees under the CDS Contract equally between T&amp;S Cos. T&amp;S Cos to ensure a CDS is appointed at all times.</p> <p>New T&amp;S Cos required to accede to the CDS Contract via a CDS Accession Agreement.</p>
<b>CDS Data Disputes</b>	<p>A Party can dispute the content of the Processed Flow Meter Data Statement provided by the CDS, which will be referred to Expert Determination in accordance with Section B (Governance). Outcomes of Flow Meter Adjustments will be provided by the T&amp;S Cos to the CDS as under Section F of the Network Code.</p>



# CDS Diagram View



# CDS Procurement

<b>Context</b>	The T&SCos shall be required, acting jointly: to procure an independent Central Data Service Provider ("CDS") under a contract ("CDS Contract").
<b>Purpose</b>	<ul style="list-style-type: none"><li>• The procurement of the CDS should be self-standing within the T&amp;S Network and not tied to the LCCC or government ownership.</li><li>• The CDS procurement is a collaborative effort, encompassing multiple T&amp;S Co's, Users, and Clusters to aggregate fiscal metered data, ensuring a unified and accurate source of information.</li><li>• Ensure that the CDS is appointed by the date which is 6 months prior to the earliest Commercial Operations Date.</li><li>• The Licensees will jointly procure a single CDS for the system with a requirement in the Code for future T&amp;S Co to accede to this CDS Contract, with governance set out within the ToRs.</li><li>• The procurement of the CDS will allow for potential expansion of the T&amp;S Networks.</li><li>• Ensure that there's coverage across all T&amp;S Networks.</li><li>• Provisions in the HoT (Section I:Data, No.12) for the CDS to be modified in the future if required.</li></ul>

# CDS Data

<b>Context</b>	Reliable accurate and verifiable data that is aligned across the CCUS eco-system is critical for managing public money effectively and public's perception of a reliable and functional industry being subsidised at this level.
<b>Purpose</b>	<ul style="list-style-type: none"><li>• A “single source of truth” for data used for fiscal purposes by both Users, the LCCC and T&amp;S Co, including transparency of data processing and aggregation.</li><li>• A central data service helps maintain consistency across the network by ensuring that all data is stored and managed in a standardised manner. It also helps maintain data integrity by enforcing data quality standards and ensuring that only accurate and validated information is stored.</li><li>• Centralised and agreed flow meter data aggregation principles with governance in place to manage any changes.</li><li>• Principles are based on similar processes in Electricity &amp; Gas industry, but altered to be appropriate for the differences of CCUS.</li><li>• The aggregated data produced by the CDS will be accessible by T&amp;S Co, Users and LCCC.</li></ul>

# CDS ToR Development

Context	The CDS ToR is currently being scoped and developed to be included in the Network Codes. The development of the ToR is essential to facilitate the provision of precise and dependable fiscal metered data for all stakeholders within the industry.
Purpose	<ul style="list-style-type: none"><li>• The development of the CDS ToR is underway, with the aim for it to be included in the T1 full form Network Codes in Q2 2024.</li><li>• Engaging in collaborative efforts with industry partners and experts will enhance the refinement of the ToR.</li><li>• Feedback from the consultation will be collated, analysed and will be considered in the ToR.</li></ul>

# Verification of Data: Independent Verifier

No later than 6 months prior to its COD, each T&SCo must procure an Independent Verifier for validating compliance with the Measurement Requirements.

<b>Terms of Reference</b>	The terms of the Independent Verifier Appointment must comply with the Independent Verifier Terms of Reference, set out at Annexure M.
<b>T&amp;S requirements</b>	<p>Each T&amp;SCo shall be required to:</p> <ul style="list-style-type: none"><li>• manage the Independent Verifier Appointment;</li><li>• (subject to Section E) bear the fees incurred under the Independent Verifier Appointment; and</li><li>• ensure an Independent Verifier is in place at all times.</li></ul>

# Revisions to Terms of Reference

Where a party wishes to revise either the CDS ToRs, the Independent Verifier ToRs or the Network Portal ToRs, it must comply with the following procedure:

