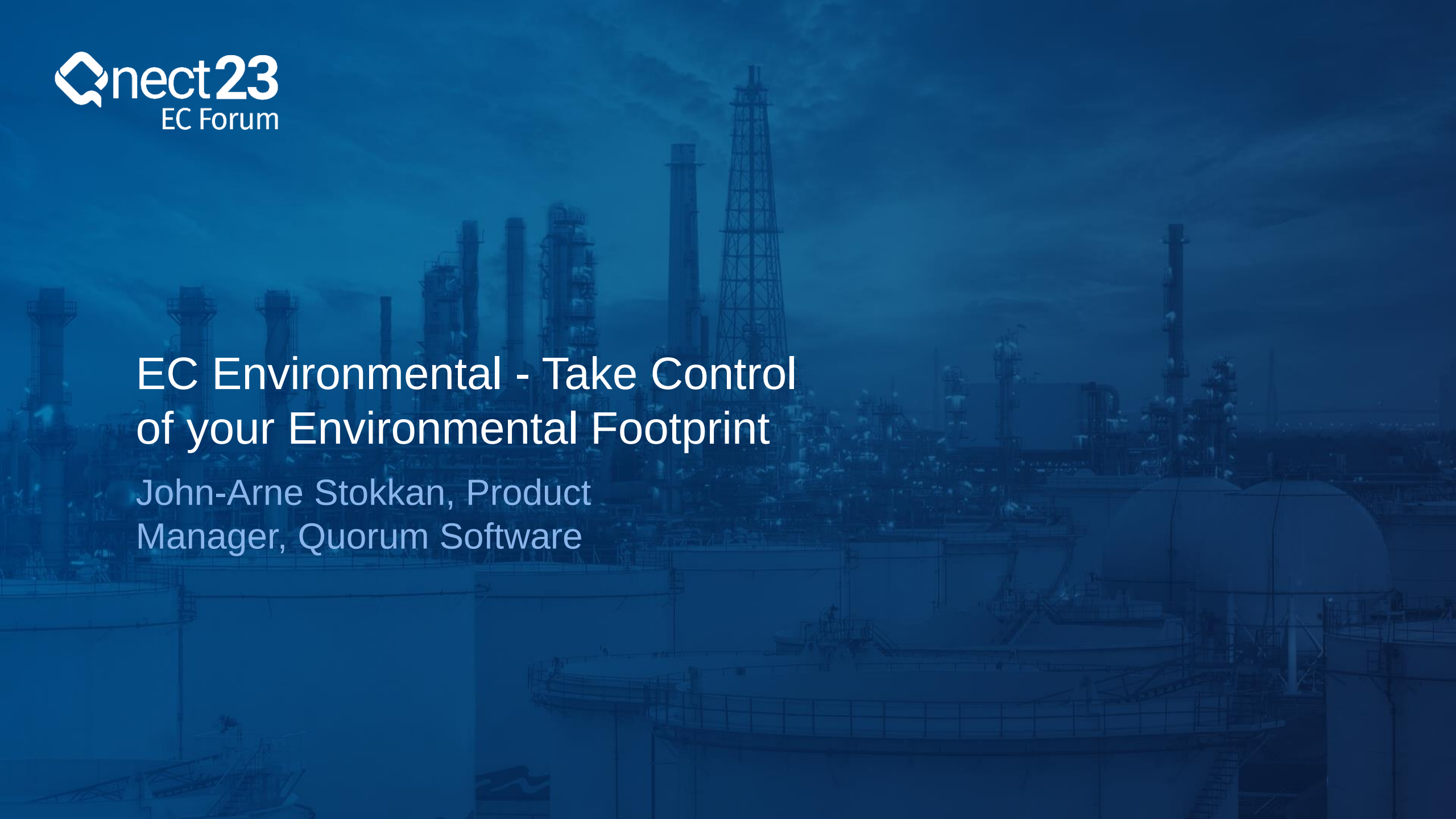


EC Environmental - Take Control of your Environmental Footprint

John-Arne Stokkan, Product Manager, Quorum Software

The hydrocarbon emission accounting challenge

You cannot manage what you cannot measure.

Reporting emissions is only one dimension.

Net zero goals are set by global (COPS), governments and companies.

Reducing emissions requires a baseline, targets and the ability to monitor emissions.

Monitoring and reducing emissions work best when coupled to managing the source of emissions.

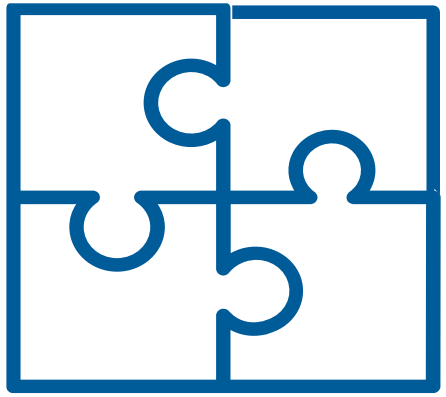
Hydrocarbon accounting is one such source where emissions is one of its value indicators.

Data Capture & Data Quality

Need to measure and model emission from known and unknown sources.

Reporting & Monitoring

Regulatory governments and industry set standards.



Audit trails

Required to validate and verify emissions from results to source.

Direct and indirect emissions

Account for all GHG and non-GHG emissions throughout the values chain.

Emission scopes

Scope 1 - Direct

From own or controlled sources*

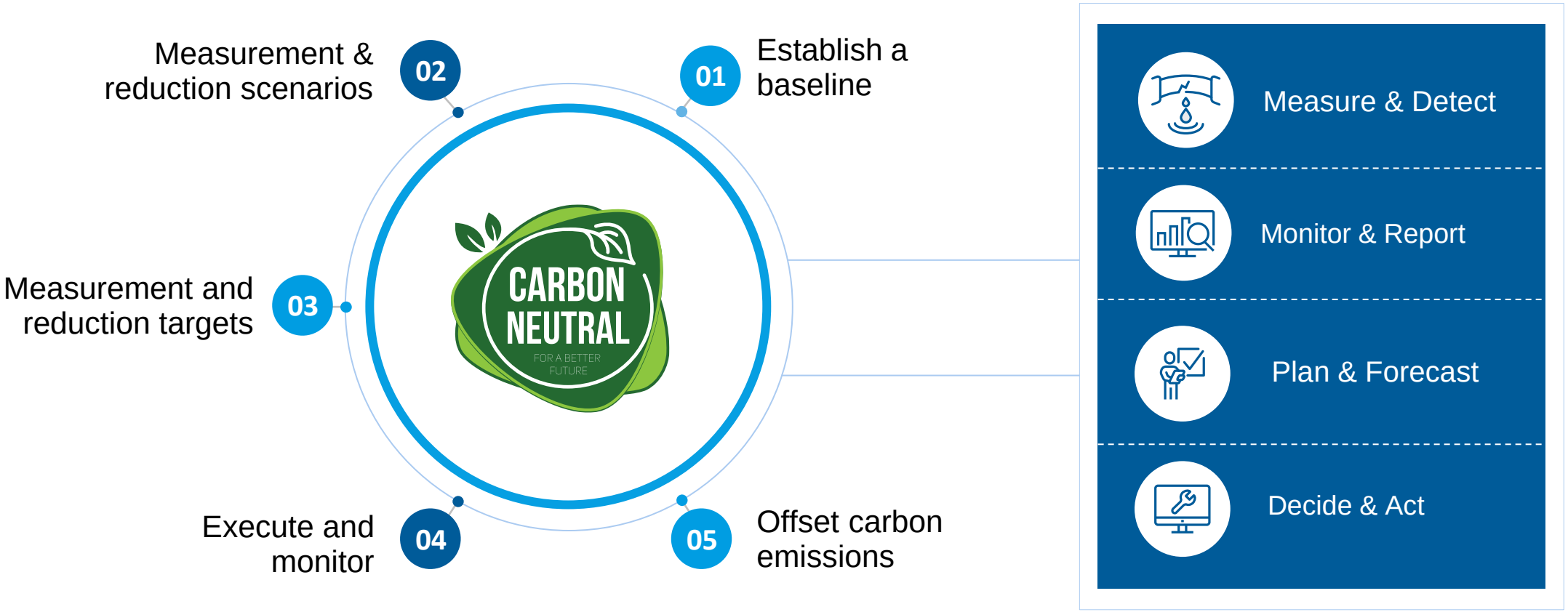
Scope 2 - Indirect

From generation of purchased energy + tie-ins

Scope 3 - Indirect

Upstream / downstream (XEM 3.0)

Emission strategy – a proactive approach



Emission inventories defined

Sum emission inventory

$$E = \sum_{i=1}^{\#sources} EF_i \cdot A_i$$

*Currently not included in EC Env.

Emission inventories defined

Sum emission inventory

$$E = \sum_{i=1}^{\#sources} EF_i \times A_i$$

CO_2 equivalents as a "common currency"

$$E_{CO_2e} = \sum_{i=1}^{\#GHG\ sources} EF_i \times A_i \times GWP_{GHG_i}$$

*Currently not included in EC Env.

Emission inventories defined

Sum emission inventory

$$E = \sum_{i=1}^{\#sources} EF_i \cdot A_i$$

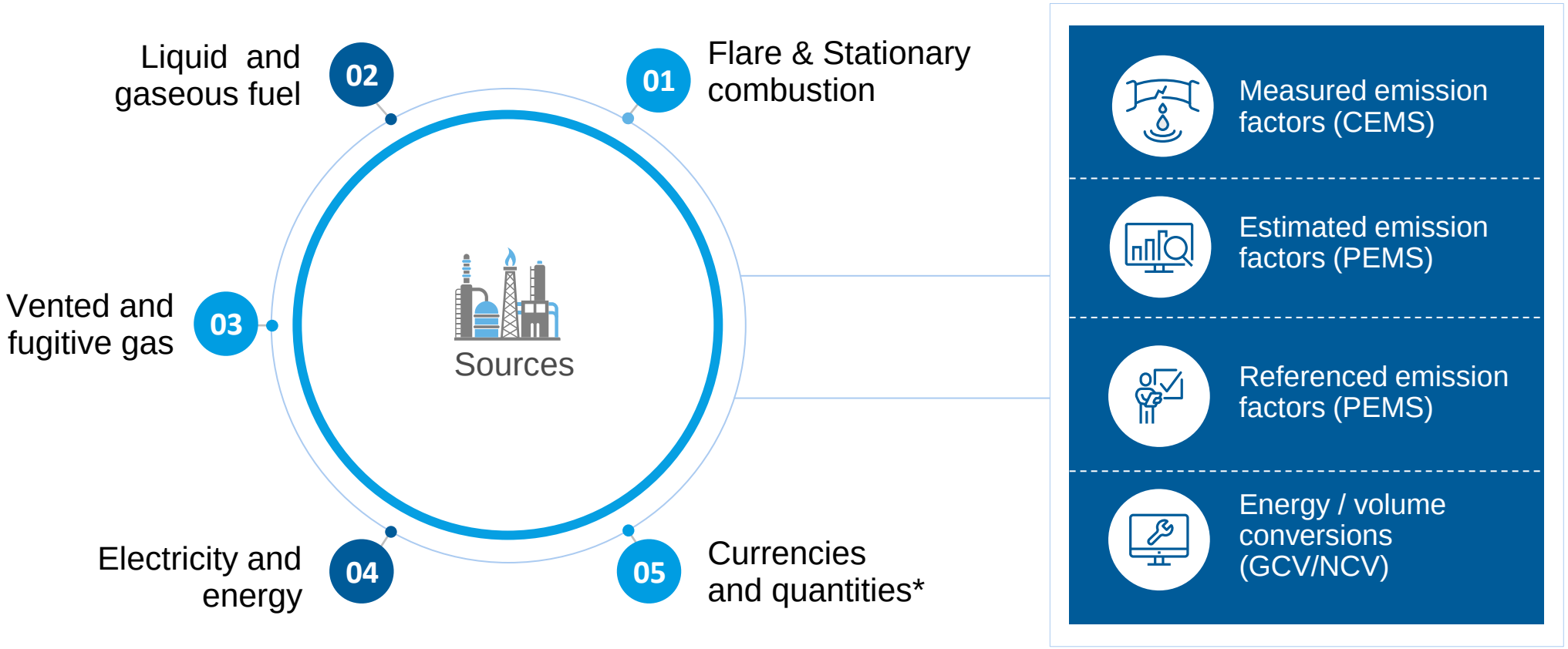
GHG Inventory

$$E_{GHG} = E_{CO_2e}^{Combustion} + E_{CO_2e}^{Direct} + E_{CO_2e}^{Indirect}$$

$$-\left(E_{CO_2}^{product} + E_{CO_2}^{CCS} + E_{CO_2}^{offset}\right)^{*}$$

*Currently not included in EC Env.

Emission monitoring methodology



Emission monitoring approaches

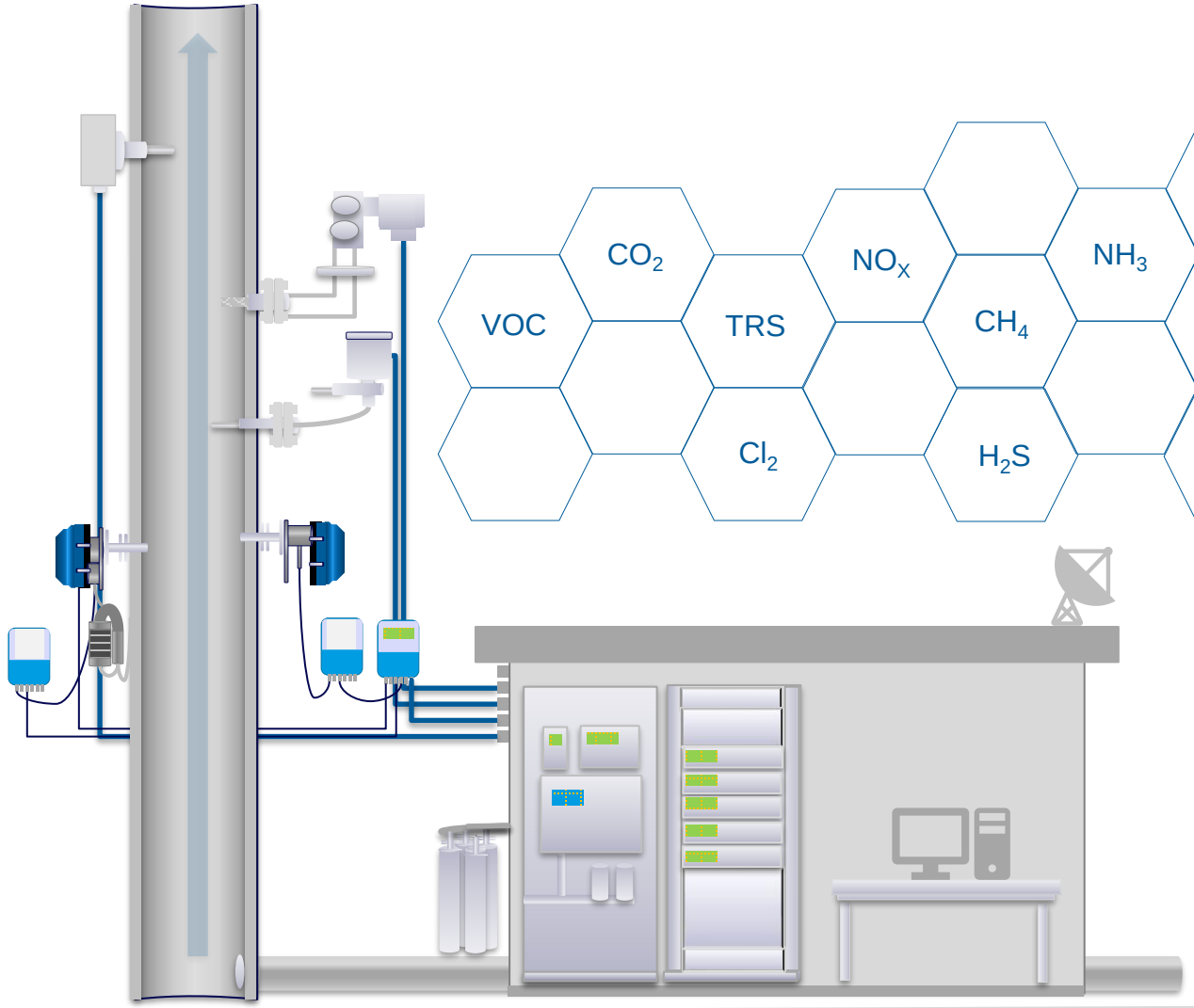
CEMS – Continuous Emission Monitoring Systems

Hardware based - from measured concentration to emissions

PEMS – Predictive Emission Monitoring Systems

Software – estimating emissions by mathematical models

Continuous Emission Monitoring System (CEMS)



- Chemiluminescence
- Pulsed Fluorescence
- NDIR / FTIR
- Flame Ionization
- Zirconium Oxide

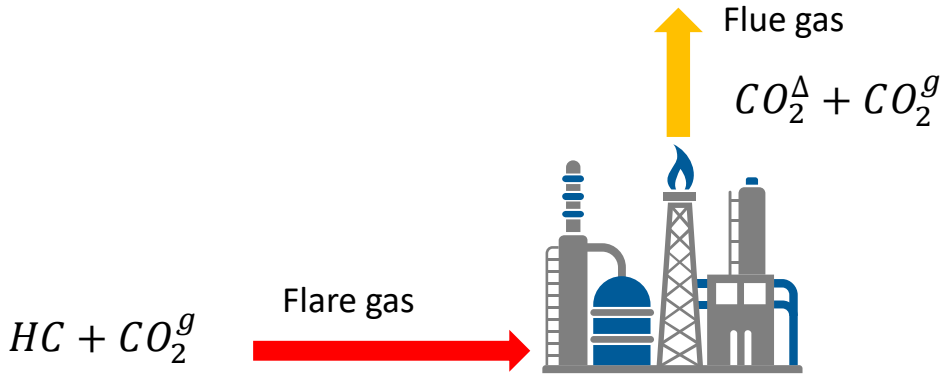
PEMS – Example parametric model

Stationary combustion – component analysis

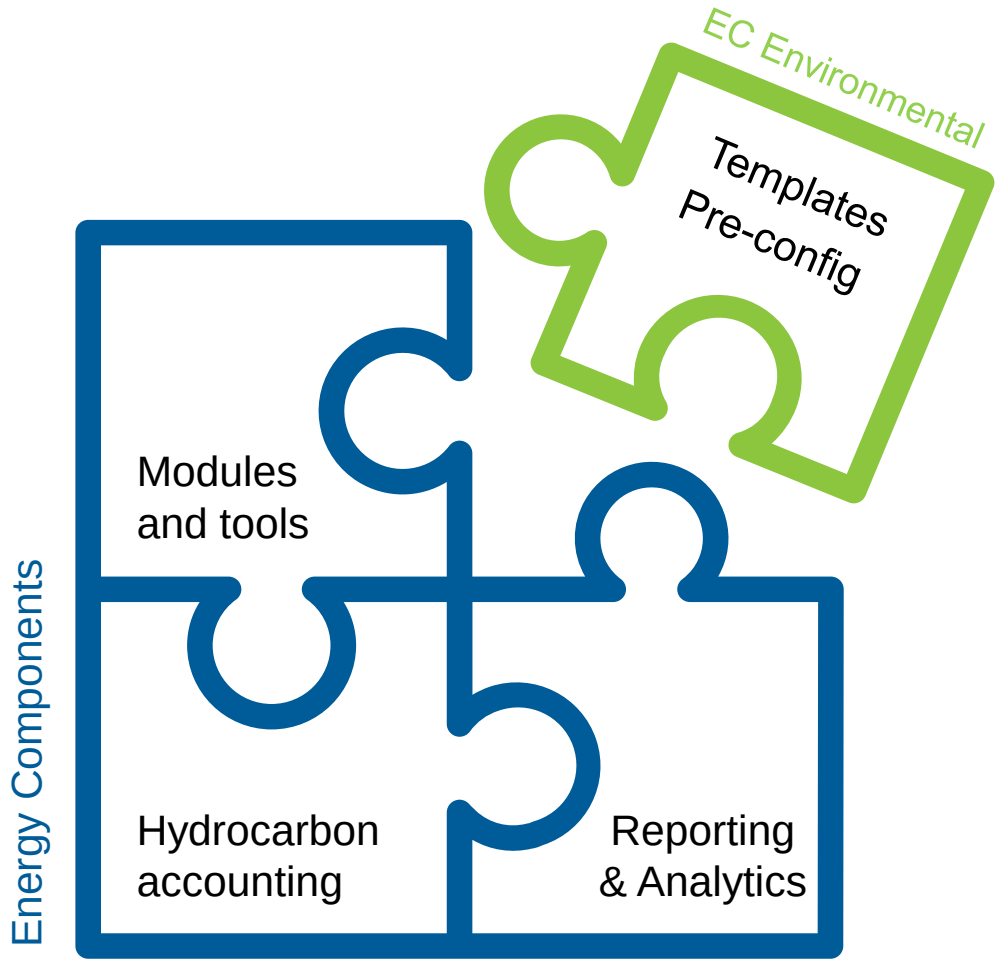
Conversion | CO_2 from hydrocarbon | Inherent CO_2

$$E_{CO_2} = V_{flare} \times \frac{1}{K_{molar\ vol}} \times MW_{CO_2} \times K_{mass} \times \left[\sum \left(\frac{mole_{HC}}{mole_g} \times \frac{n_C, fuel\ mole_C}{mole_{HC}} \times \frac{E_f \cdot mole_{CO_2,f}}{mole_{C,combusted}} \right) + \frac{n_C\ mole_{CO_2}}{mole_g} \right]$$

E&P Forum, 1994, control device performance, EPA GHGRP Subpart W5, and results from the more recent flare studies



EC Environmental plug-in enables emissions with EC



EC Hydrocarbon accounting

\+ EC Environmental (XEM)

= Emissions management with EC

EC Environmental plug-in enables emissions with EC

EC Environmental 2.2

Configuration

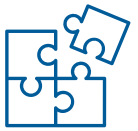
- Emission Config
- Method selection
- Unit conversion config

$f(x)$ Emission factors

Library calculations – pre-config $f(x)$

Total CO_2	CH_4	N_2O	Total GHG	nmVOC
Inert emissions	Total Carbon	CH_4 CO_2e	N_2O CO_2e	Total gas

Emission results



EC 13.1 13.2

Production / Transport

- Streams
- Production data
- Emission locations
- Component analysis
- Allocation network
- Volume distribution

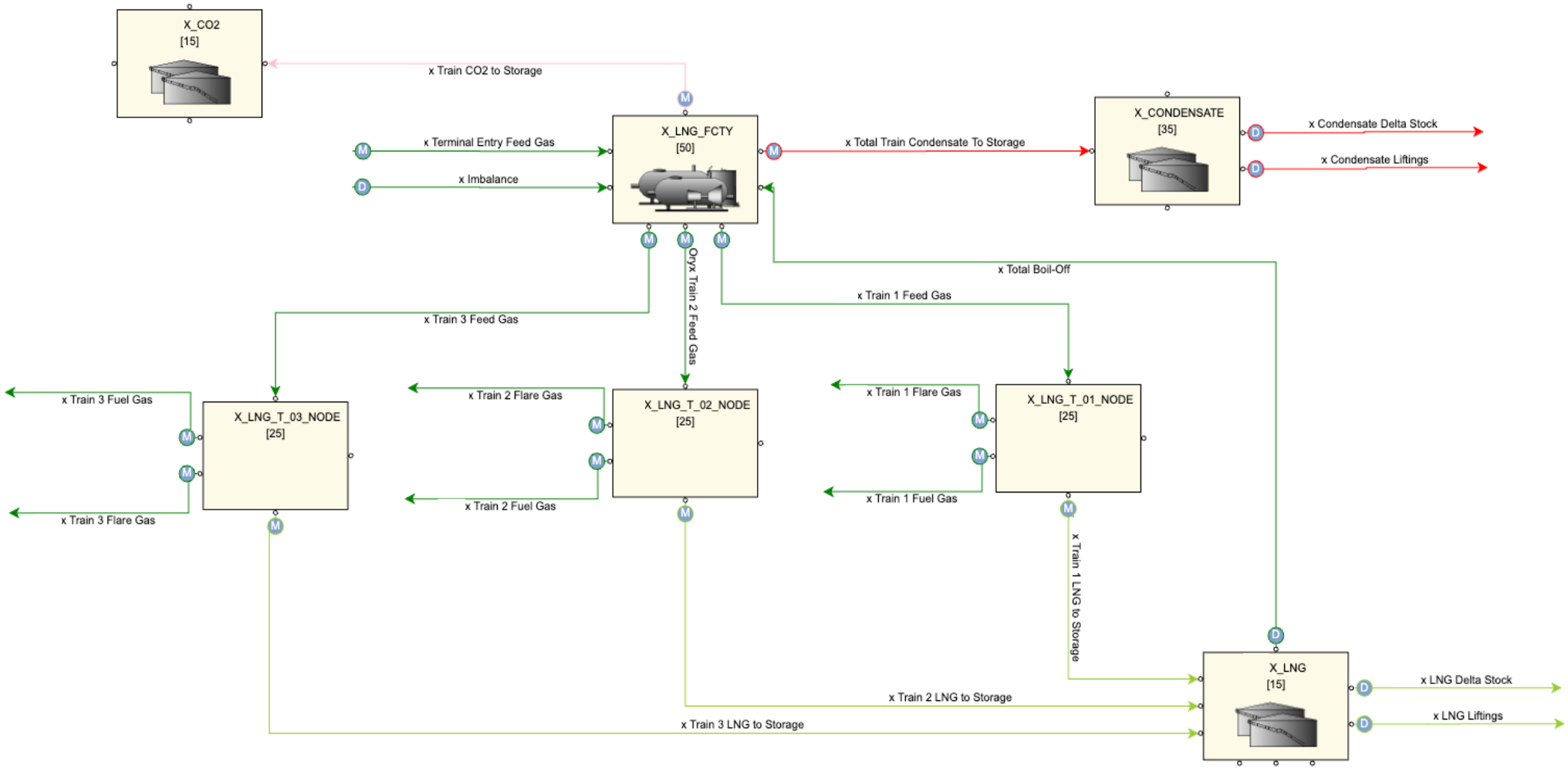
Automation

- Emission allocation
- Calculation library
- Daily allocation
- BPM / Tasks

Analytics

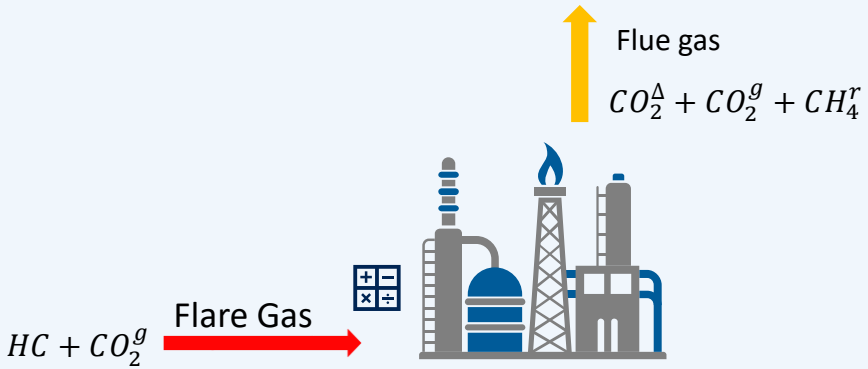
- Trends
- Compliance
- GHG Status
- Emissions status

EC hydrocarbon accounting – stream activity for emissions

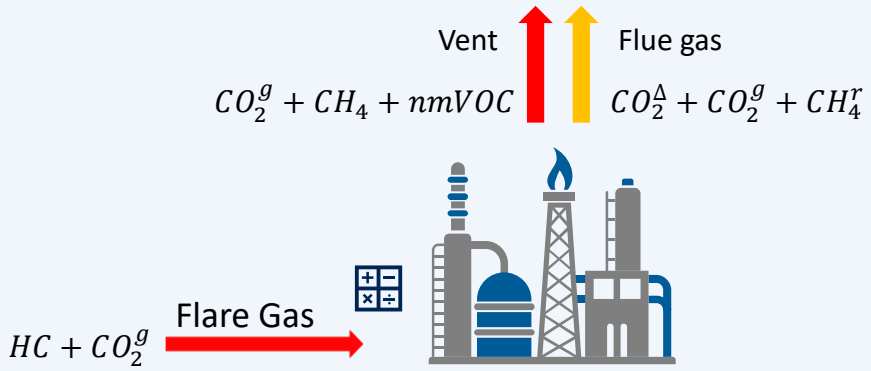


Stream examples

Flaring

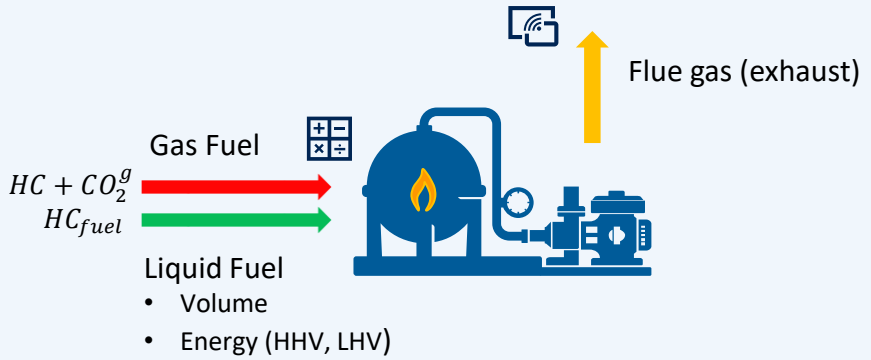


Venting and flaring

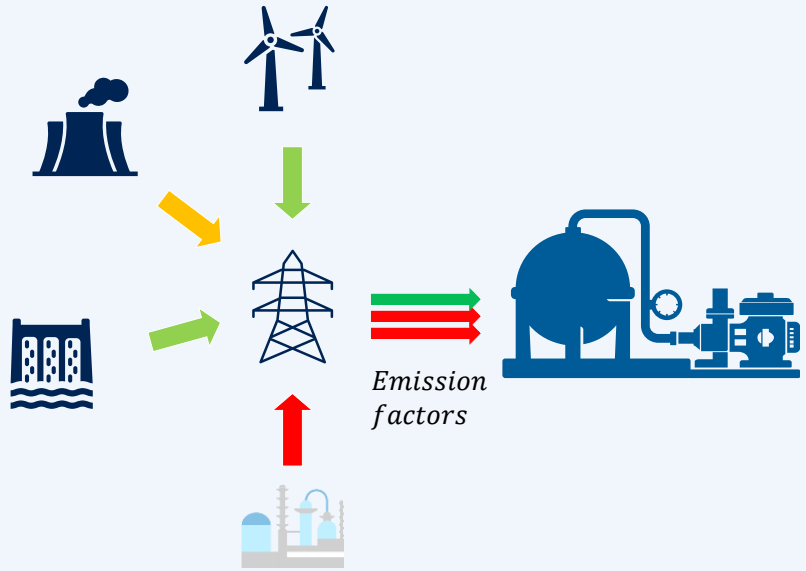


Stream examples

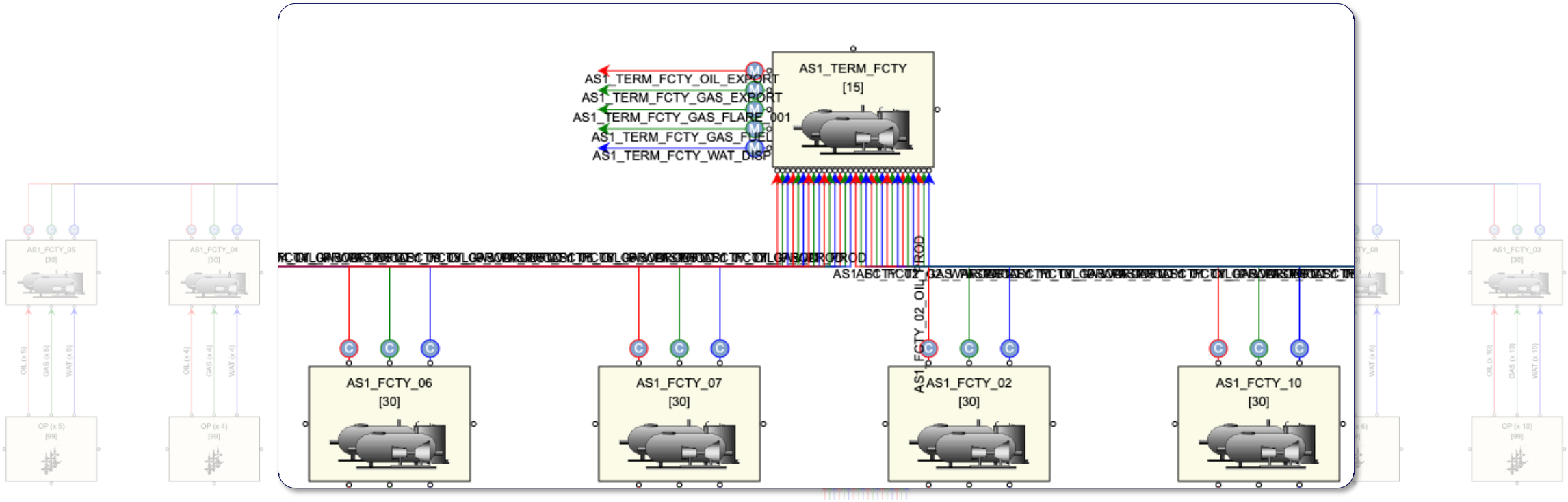
Stationary combustion – fuel or CEMS



Scope 2 emissions – Electricity mix

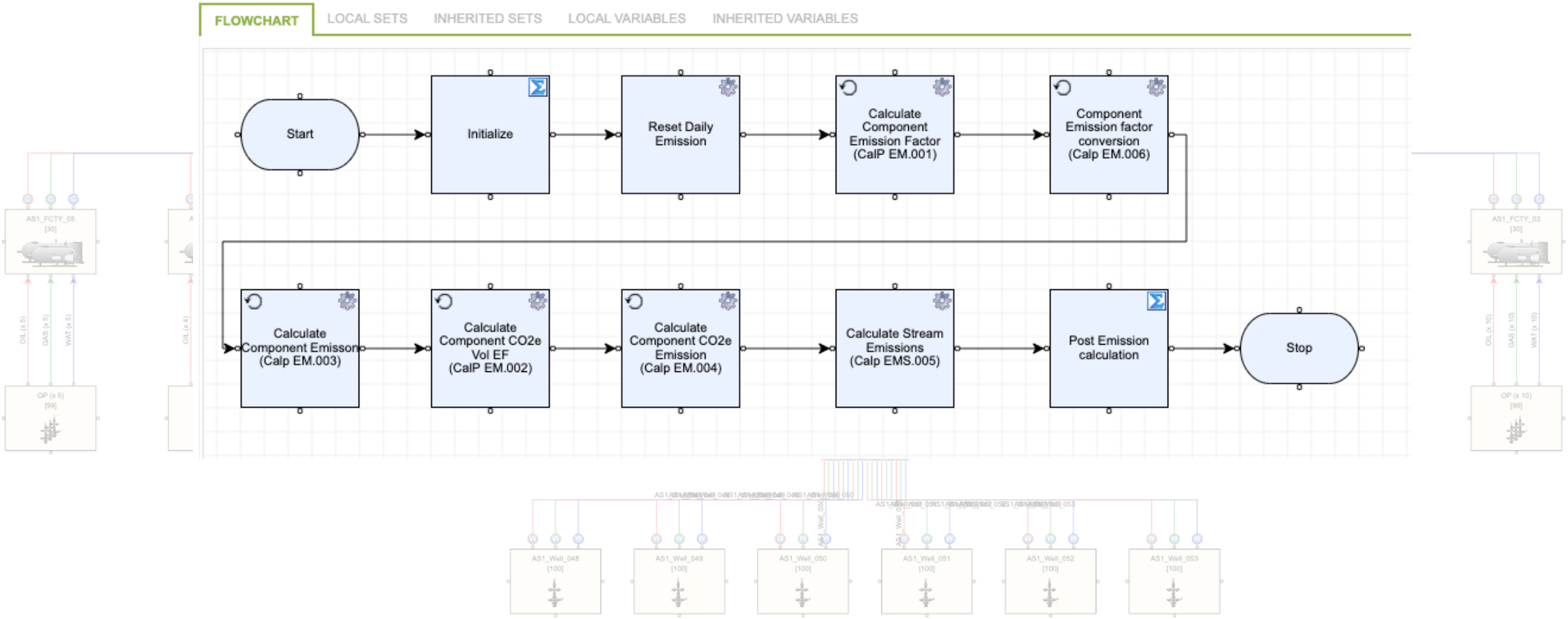


Allocations and meter data for emissions

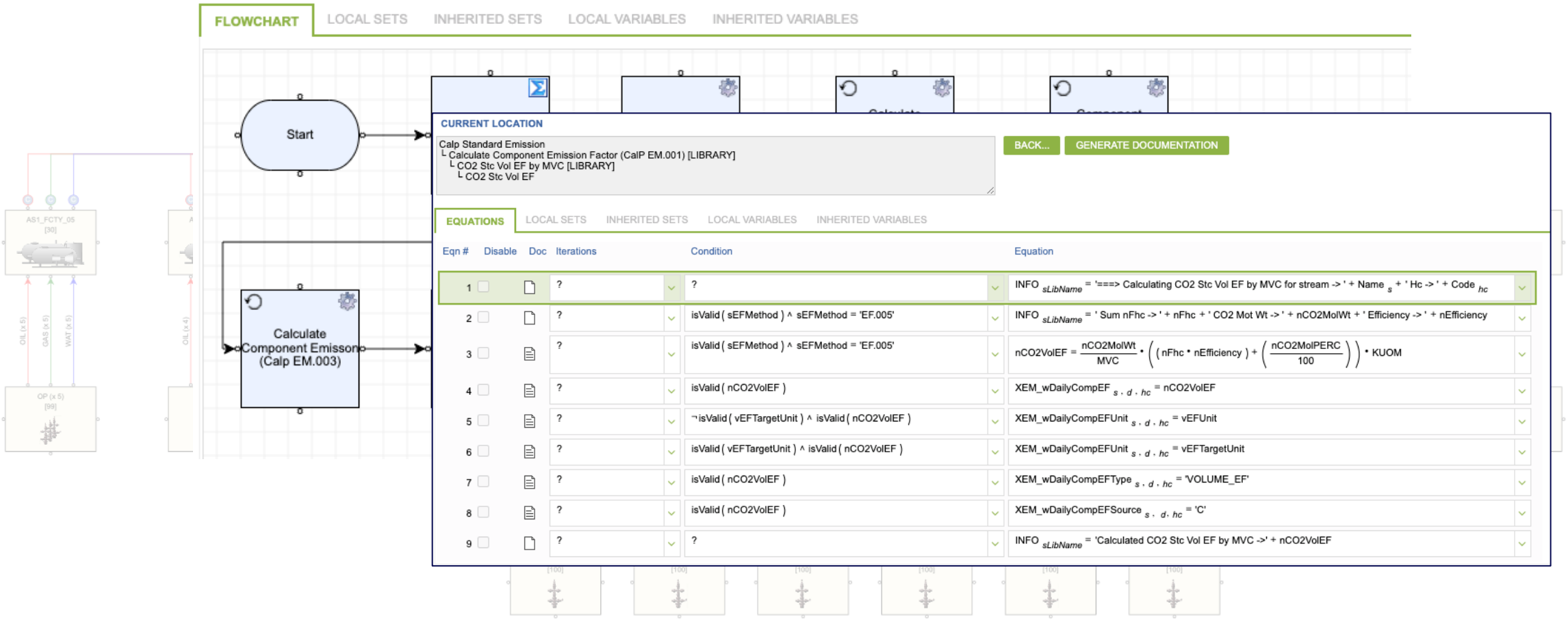


			Component Emission			CO2 Equivalent Emission		
Component	EF Source	Type	EF Value	EF Unit	Emission [kg]	EF Value	EF Unit	CO2e Emission [kg]
Carbon Dioxide	Analysis	Volume EF	232.5374	kg/Sm³	1,419,013.11	232.5374	kg/Sm³	1,419,013.11
Methane	Analysis	Volume EF	127.1480	kg/Sm³	775,895.13	3,560.1435	kg/Sm³	21,725,063.72
Nitrous Oxide	Analysis	Volume EF	23.2554	kg/Sm³	141,911.63	2,790.6520	kg/Sm³	17,029,395.48

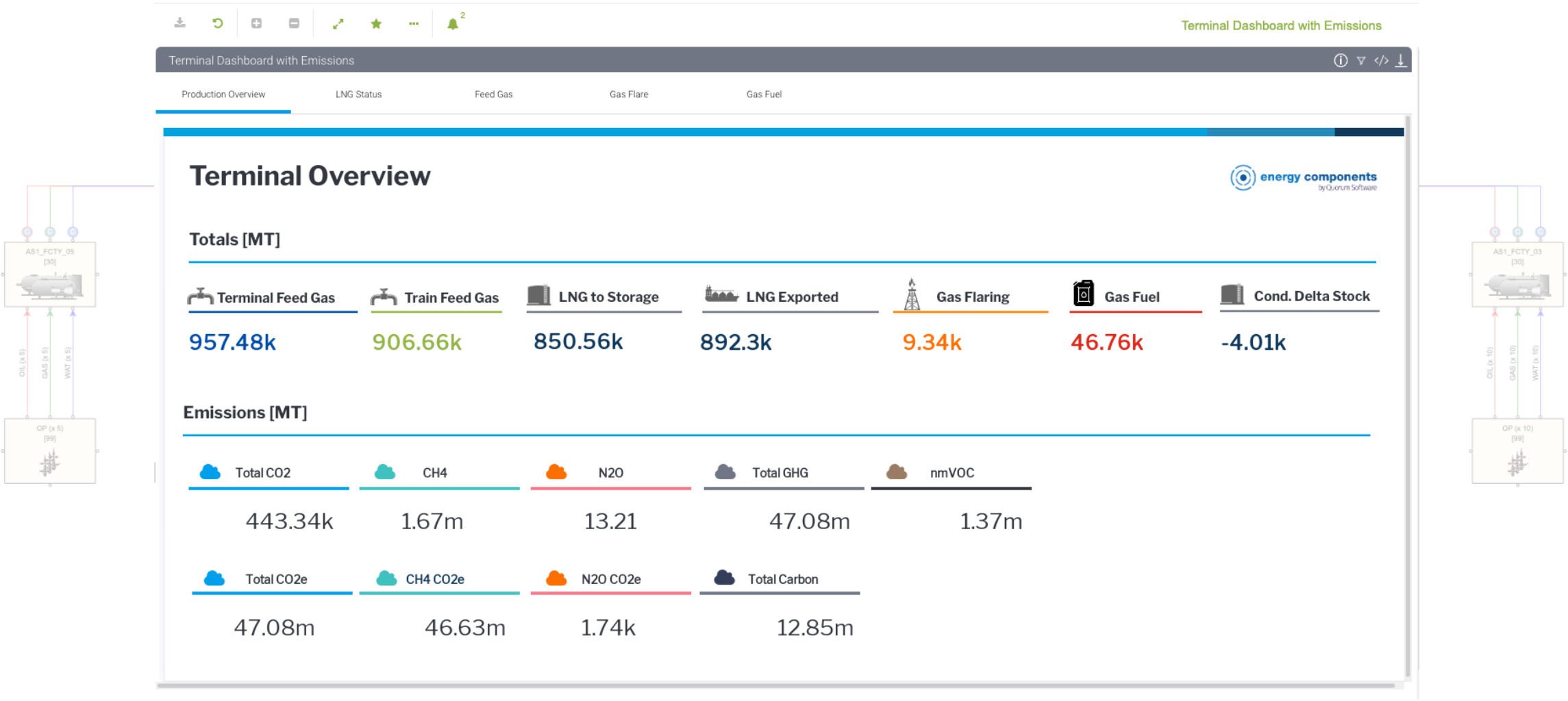
Pre-configured calculations



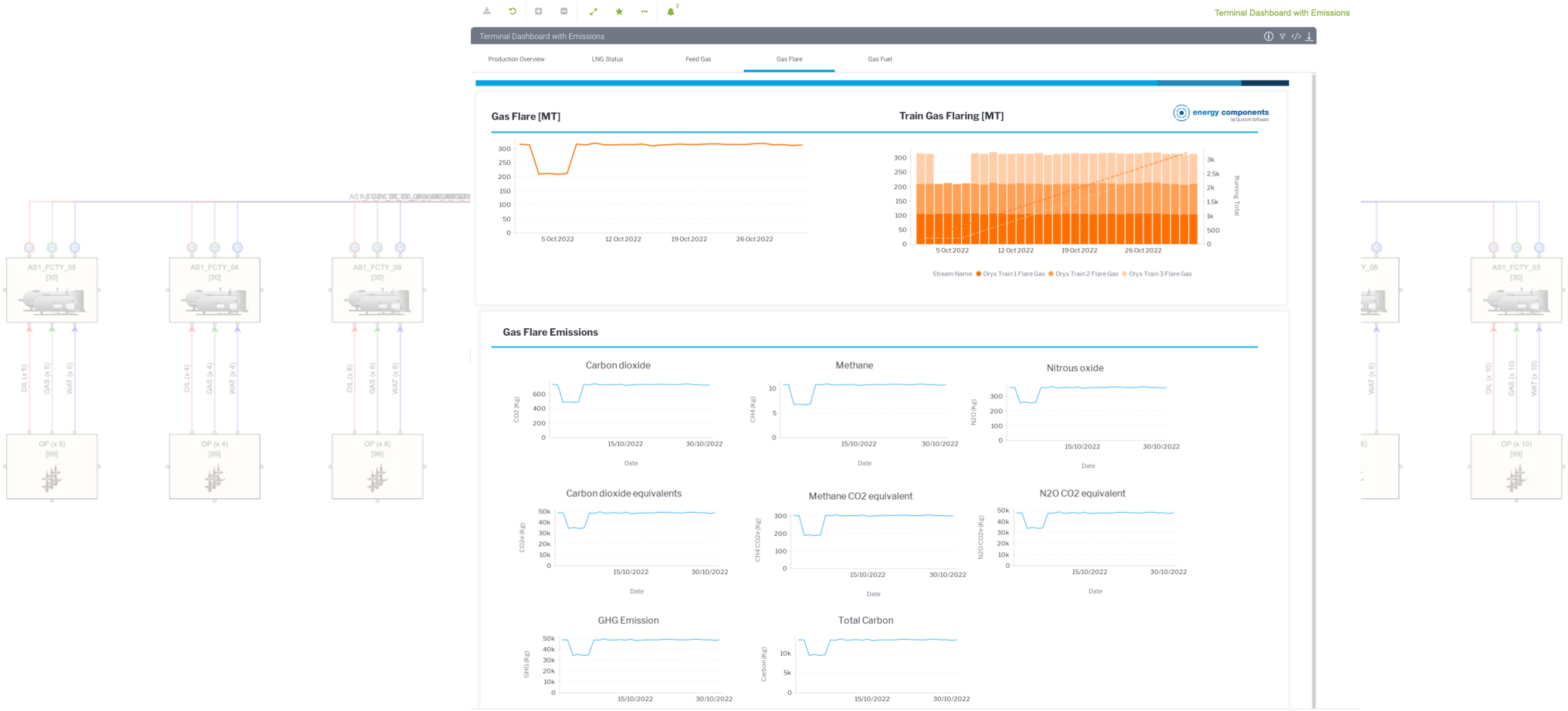
Customizable and auditable equations with EC Calculations



Example: Emission vs. hydrocarbon totals

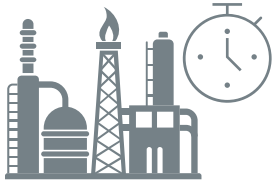


Example: emission response vs production



What’s coming in EC Environmental 3.0

Emission scenarios

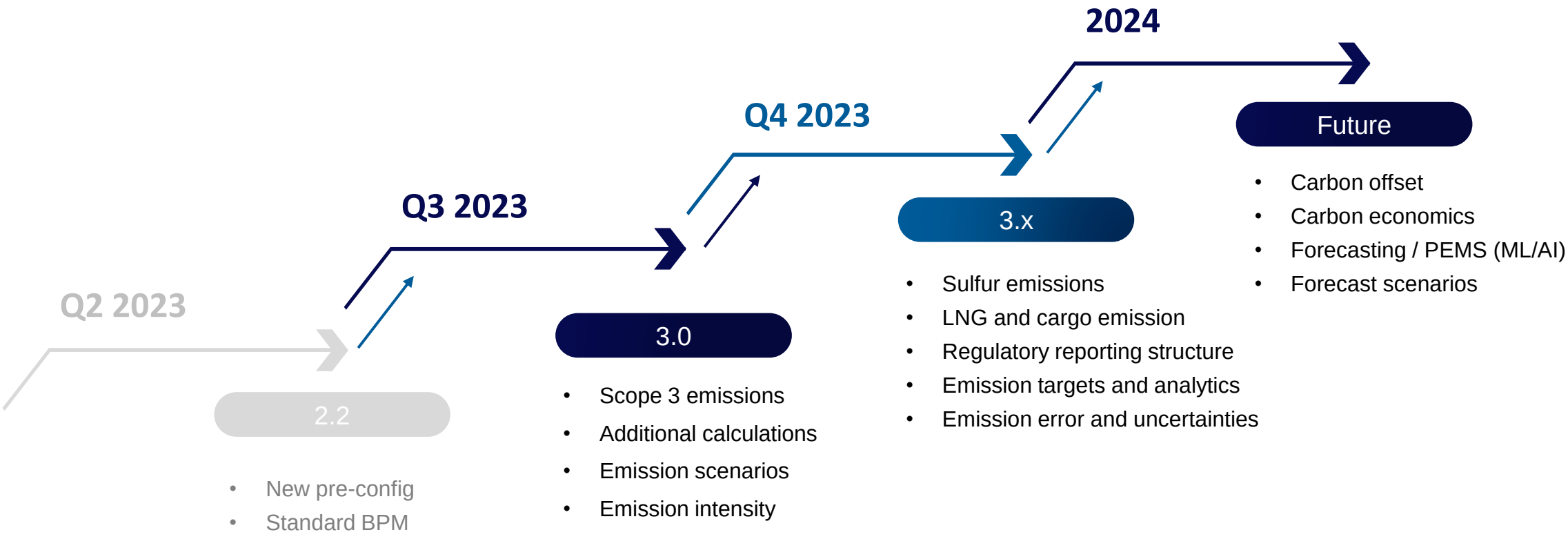


Sub-daily emissions

Scope 3 emissions

Emission intensity calculations

Roadmap 2023/24



EC Environmental: Towards net zero carbon

Focus on environmental impact drives regulatory requirements

You cannot manage what you cannot measure

Mitigation strategy and resolutions impacts operational cost & revenue

Make decisions to balance cost of mitigation and revenue

Use data and information to monitor and report emissions