Energy performance and savings in data centres

The streamSAVE+ methodology about savings calculation for cooling of data centres

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Context and Objectives

A transparent, scalable methodology to quantify energy savings in data centres using PUE (Power Usage Effectiveness) as the primary proxy. Designed specifically for Article 8 of the Energy Efficiency Directive (2023/1791).

Key Insight

PUE captures the ratio between the total facility energy consumption and the energy used by IT equipment, making it a comprehensive indicator of infrastructure performance.

Regulatory Alignment

Directly supports EED compliance and corporate sustainability reporting.

Operational Stability

Measures infrastructure improvements without altering the fixed IT processing load.

Applicability

Ideal for retrofits and scenarios where sub-metering is incomplete or inconsistent.

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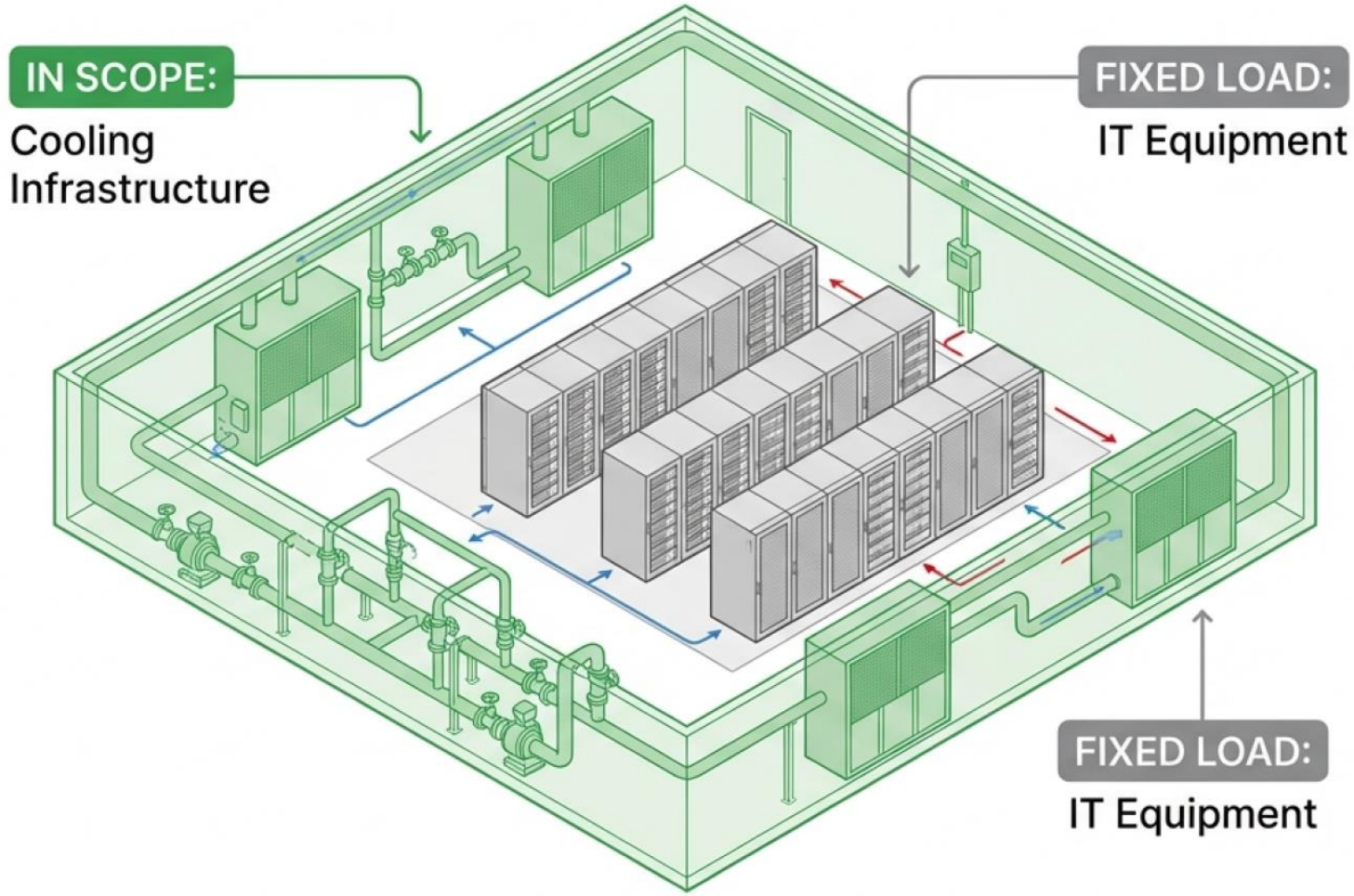
Scope of the Methodology



Applicability Criteria

- Valid for: Retrofits, Upgrades, Modernisation
- Valid for: Operational Optimisation (Airflow, Setpoints)
- Excluded: New builds without validated baselines
- Excluded: Expansions altering IT load profiles

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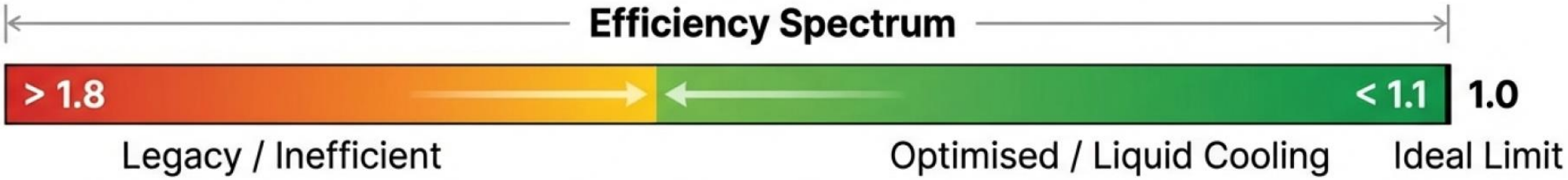
The Core Metric: Power Usage Effectivness

$$PUE = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}} = \frac{(\text{Cooling} + \text{Power} + \text{Lighting} + \text{IT})}{(\text{Servers} + \text{Storage} + \text{Network})}$$



Metric standardised under ISO/IEC 30134-2:2016 and EN 50600-4-2:2016.

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Addressed Efficiency Interventions

CRAC/CRAH Upgrades

Variable-speed fans and integrated controls replacing legacy units.

Chilled Water Systems

Transition from air-based to centralized chilled water loops.

Free Cooling

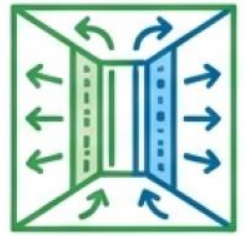
Air-side or water-side economisers utilizing ambient conditions.

Direct-to-Chip Liquid

Targeting high-density CPUs/GPUs for superior thermal transfer.

Immersion Cooling

Submerging hardware in dielectric fluid; enables silent operation.



Optimisation

Airflow containment (Hot/Cold aisle) and smart control integration.

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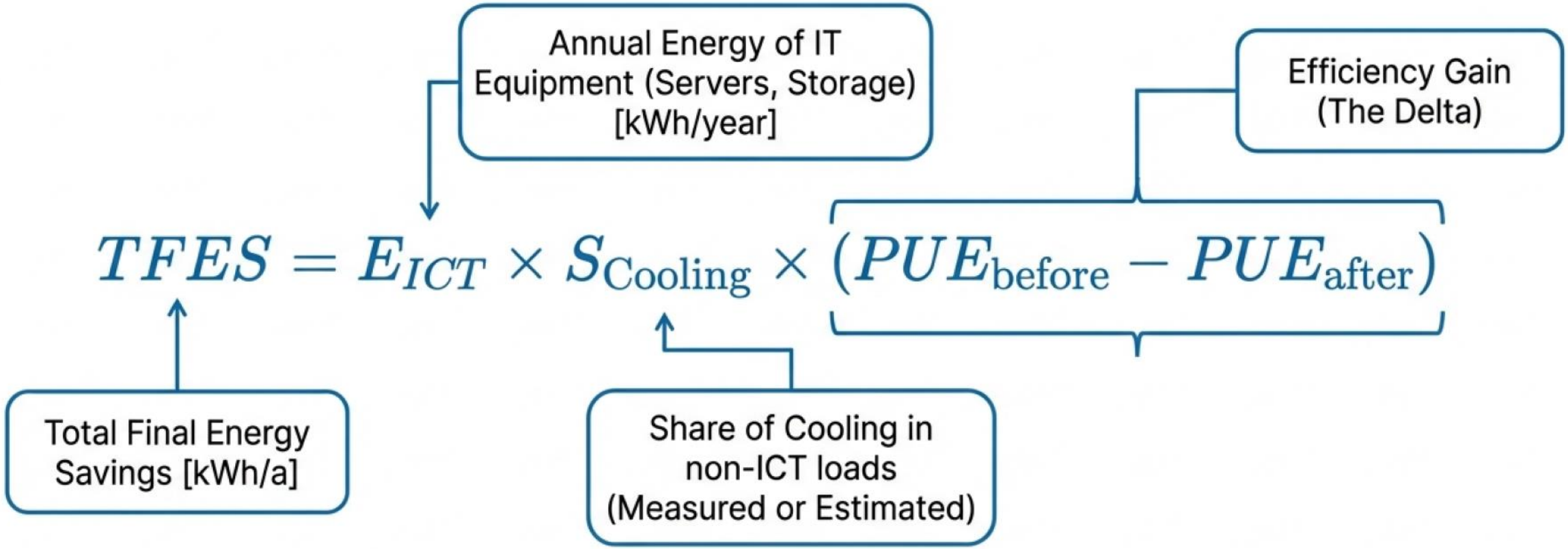
Calculation of Final Energy Savings



Note: Calculation assumes additionality (measure would not have occurred without support).

Indicative Values

Technology	Baseline PUE	Improved PUE
Upgrade CRAC/CRAH units to variable-speed systems	> 1.8	1.5 – 1.6
Transition to chilled water system with air-side economizers	> 1.6	1.3 – 1.5
Implement free cooling (air-side, water-side, TES etc.)	1.6 – 1.8	1.2 – 1.4
Deploy liquid cooling (direct-to-chip or immersion)	1.6 – 1.8	1.02 – 1.1
Optimize two-phase/passive cooling (e.g., thermosiphon loops)	1.5 – 1.7	1.1 – 1.3
Integrate thermal energy storage (TES) for peak shaving and free cooling	1.6 – 1.8	1.2 – 1.4

$S_{Cooling}$: Share of cooling in non-ICT loads

Facility Size	Cooling Share
Very Small (100-500 kW)	75-80% Cooling Share — High Overhead
Small (500-1,000 kW)	65-70% Cooling Share
Medium (1-2 MW)	50-55% Cooling Share
Large (2-10 MW)	44-48%
Very Large (>10 MW)	32-40% — Economies of Scale

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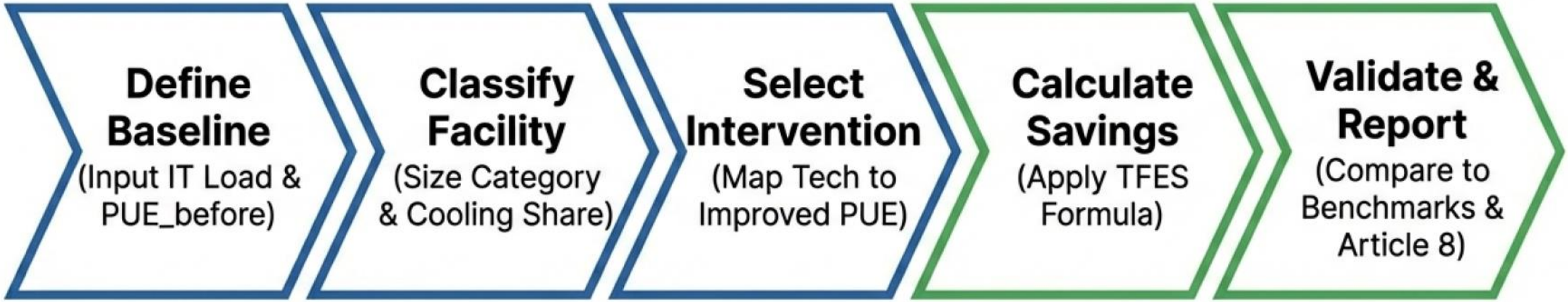
Implementation Checklist

Technology	Baseline PUE	Improved PUE
Upgrade CRAC/CRAH	> 1.8	1.5 – 1.6
Integrate thermal energy storage (TES) for peak shaving and free cooling	1.6 – 1.8	1.2 – 1.4



Very Large (>10 MW)	32-40%	Economies of Scale

Data Sources for Indicative Values

This methodology relies on empirically validated parameters from recent EU and international research.

- **EU Code of Conduct for Data Centres (2023/2024)** – Best Practice Guidelines
- **Scientific Literature** – Zhou et al. (2024), Zhang et al. (2022) on cooling technologies
- **Industry Studies** – Schneider Electric (Bunger et al., 2019) for CapEx analysis
- **Regulatory Framework** – Commission Delegated Regulation (EU) 2024/1364

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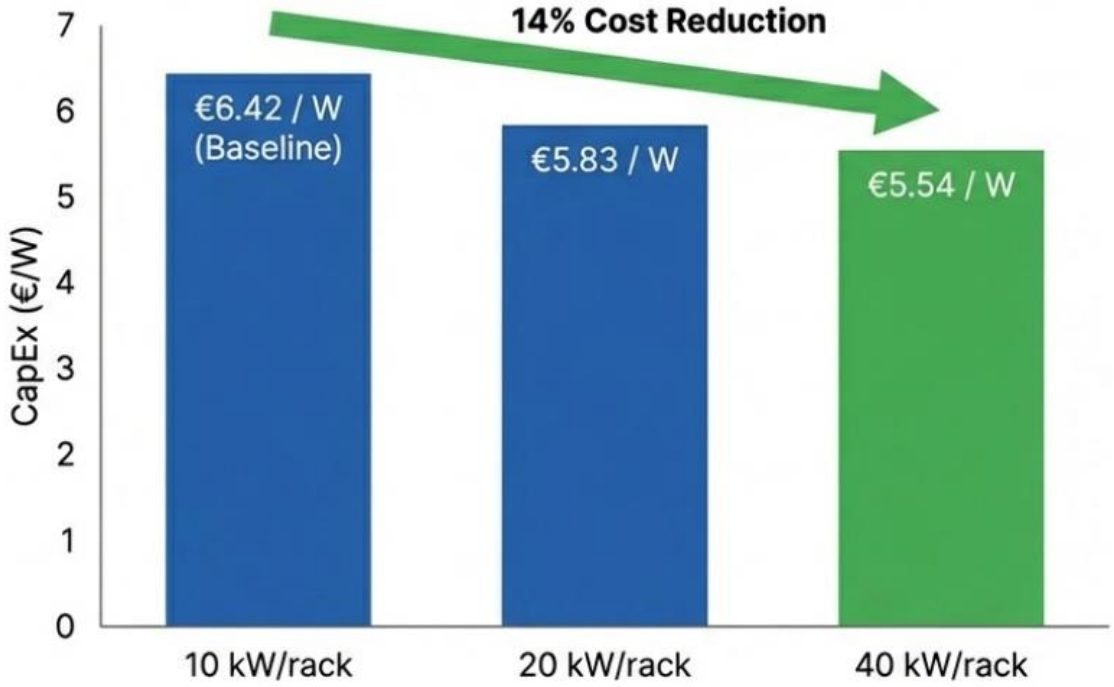
Overview of Costs Related to the Action

The Density Advantage

Liquid Cooling CapEx per Watt as Density Increases



Reasoning:

Higher density reduces the number of racks required for the same computing power, creating savings in:

- Floor Space
- Containment Structures
- Physical Racks

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Impact on Energy Consumption and CO_2

$$EPEC = FEC_{Baseline} \cdot f_{PE,electricity} - FEC_{Action} \cdot f_{PE,electircity}$$

EPEC	Effect on primary energy consumption [kWh/a]
FEC	Annual final energy consumption [kWh/a]
fPE,electricity	Factor to convert final to primary energy savings for electricity [dmnl]
Baseline	Index for the baseline situation of the action
Action	Index for the situation after the implementation of the action

$$GHGSAV = TFES \cdot f_{GHG,electricity} * 10^{-6}$$

GHGSAV	Greenhouse gas savings [t CO2e p.a.]
FEC	Annual final energy consumption [kWh/a]
fGHG,electricity	Emission factor for electricity [g CO_2/kWh]

A framework for sustainable growth

- **Standardised:** A harmonised approach for National Authorities and Auditors.
- **Flexible:** Agnostic to server types, suitable for Edge to Hyperscale.
- **Compliant:** Fully aligned with the EU Energy Efficiency Directive (EED).

Optimising cooling is the most direct path to decarbonising digital infrastructure.

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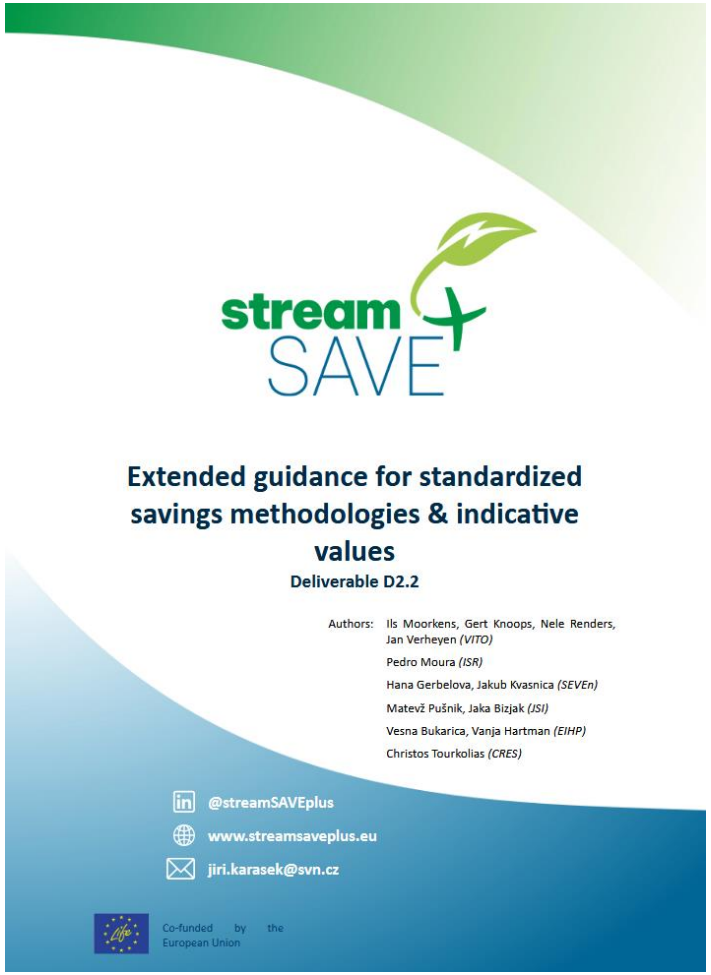
A framework for sustainable growth



You can find more information in Chapter 4 of deliverable D2.2

https://streamsaveplus.eu/storage/app/media/uploaded-files/d22-extended-guidance-for-standardized-savings-methodologies-indicative-values.pdf

Thank you for your attention!

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Project partners

Thank You

Get in touch for more information!

Project coordinator – Jiří Karásek, SEVEn

All project reports will be available for download on the streamSAVE+ website **https://streamsaveplus.eu/**

And the platform

https://streamsaveplus.eu/priority-actions

Email the project at **jiri.karasek@svn.cz**

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