streamSAVE+ Dialogue Meeting #05

Streamlining Energy Savings Calculations

Data centres & savings data: from potential to action

MINUTES OF THE MEETING

Date: 26 June 2025 **Duration:** 14.00 – 15.30 CEST
Online

Summary:

This fifth dialogue meeting of streamSAVE Plus discussed energy consumption in data centres and related energy efficiency measures and savings potentials. It included insights from international reviews, and lessons learned from the German regulation on energy efficiency in data centres and how data centres are addressed in France's white certificates scheme.

- The strong and rapid growth in the demand for services provided by data centres has been partly compensated by significant energy efficiency gains until recent years. However, the recent exponential growth in the demand due to the development of AI represents a major challenge to improve energy efficiency as fast and big. Forecast thus expects large increase in electricity consumption in this sector (e.g. from 20 TWh/a in 2024 to 30 TWh/a in 2030 in Germany).
- Up to now, most energy savings came from increasing energy efficiency of servers, improving infrastructure, and moving from small data centres to large clouds and hyperscale. Further improvements are possible in these fields (e.g. liquid cooling), as well as in optimising utilisation and using more efficient software. According to the operators, the most promising energy-saving technologies include free-cooling, Direct Liquid Cooling (DLC), geo-cooling, and immersion cooling.
- DLC and immersion cooling can achieve higher energy performance (i.e. lower PUE - Power Usage Effectiveness). But free-cooling options might be more frequently used, as easier to implement.
- Substantial savings can be achieved in data centres with a potential recently estimated to about 70 TWh/year in 2030 worldwide, or 2 TWh/year in 2035 in France (both, without considering the development of AI).
- Policy measures often start with requirements to report energy consumption and energy performance indicators (cf. Article 12 of the Energy Efficiency Directive). The rapid growth of the sector makes that policy interventions become essential, as market-driven improvements are no longer fast enough to compensate the strong increase in electricity demand. The number and types of policies about data centres are thus rapidly increasing.
- Germany provides a leading example about reporting regulations, going beyond the requirements of Article 12 of the Energy Efficiency Directive. Providing information and technical support has

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been essential, as well as a progressive approach, from larger to smaller data centres, and with increasing requirements.

- Two major challenges are that the total population of data centres is unknown (addressed by estimates from the literature) and the case of co-location data centres (addressed with data-sharing agreements between operators and clients).
- Success factors include a clear legal basis (with penalties in case of non-compliance) and making the procedure as simple and transparent as possible (considering feedback from the companies).
- France's white certificates scheme provides an interesting example of market-based financial incentive that can boost energy efficiency investments in data centres, with a standardised monitoring approach.
- Standardised calculation of energy savings in data centres is possible, once assessing first how energy savings may vary according to the sites, and whether deemed savings need to be differentiated according to key parameters.
- Due to the rapid evolution of the sector, the baseline needs to be revised regularly (possibly every year).

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Introduction

- **Updates about streamSAVE Plus, by Jiří Karásek (SEVEn)**

(see also presentation file available on the streamSAVE+ platform)

Jiří gave the new Dialogue meeting attendees a brief overview of the SteamSAVE+ project. He provided an overview of the main objectives and quickly presented the 15 priority actions, for which the project develops methods to calculate energy savings:

- **10 priority actions updated from the previous streamSAVE**: Refrigeration systems; BACS (Building Automation & Control Systems); Electric vehicles; Lighting systems; Heat recovery; Motor replacement; Behavioural changes; Modal shift in freight transport; Small-scale renewable heating technologies; Tackling energy poverty
- **5 new priority actions**: Deep renovation of buildings (residential and tertiary); Data centres – IT equipment; Data centres – Cooling; Heat recovery and ventilation; Public Traffic Management

Jiří also provided an update on the new platform in development [http://streamsaveplus.eu/]. This platform enables users to test the developed methodologies and estimate the energy savings of each of the 15 Priority Actions. It also gathers the proceedings of all dialogue meetings.

- **How data centres are addressed in streamSAVE+, by Pedro Moura (ISR – Coimbra University, Portugal) and Matevž Pušnik (Jozef Stefan Institute, Slovenia)**

(see also presentation file available on the streamSAVE+ platform)

Pedro provided a brief summary of how StreamSAVE+ addresses energy efficiency in data centres. Two of the project's five newly developed priority actions are related to data centres: improving IT equipment efficiency and cooling efficiency. This emphasises the relevance of data centres in stakeholders' priorities (based on the stakeholder survey).

The scope of the actions for the IT efficiency measures is based on technological measures such as server virtualisation, the deployment of energy-efficient hardware, workload scheduling, storage tiering, and efficient network topologies. The assessment takes into account various data centre sizes and power capacities, the energy consumption of ICT equipment, the distribution of energy consumption among servers, storage, and networking, and energy savings with the various efficiency measures that are taken into account when developing methodologies to evaluate the savings.

Cooling efficiency improvements involve upgrading cooling infrastructure and are primarily concerned with improving Power Usage Effectiveness (PUE)[1]. Various cooling technologies evaluated are variable-speed units, free cooling, chilled water systems, liquid cooling, and thermal energy storage systems. The evaluation is based on PUE fluctuation, datacentre size and capacity, energy consumption, and cooling's percentage of the total ICT load. The development of both these methods is close to completion, and they will be published soon.

[1] PUE is an energy performance indicator specific to data centers, corresponding to a ratio between the energy dedicated to equipment excluding IT servers and the energy dedicated exclusively to IT servers. The lower the PUE (and the closer to 1), the higher the energy performance.

Main findings from international reviews of energy efficiency in data centres and related policies, by Fiona Brocklehurst (Ballarat Consulting, UK)

(see also presentation file available on the streamSAVE+ platform)

Fiona first reminded that everything in data centres develops very quickly. She used the growth in service demand between 2010 and 2018 as an example, pointing out the enormous increase in installed storage capacity (multiplied by 26), data centre IP traffic (x11), and data centre workloads (x6.5). Fortunately, there was also a significant increase in energy efficiency at the same time, primarily in the PUE, a decrease in the average server intensity, the average number of servers per task, and the energy consumption of storage drives. The most common energy savings are from increasing energy efficiency of servers, improving infrastructure, and moving from small 'in-house' data centres to large and outsourced clouds hyperscale. As a result of such development in this field, many large businesses now have the financial and skill resources necessary to run their operations effectively.

Fiona next showed some server consumption estimates for the USA. The trend of server electricity consumption is accelerating, and it is anticipated that AI will use the most electricity due to its exponential deployment and high energy requirements[2]. For this reason, the energy efficiency measures become even more important in future. It can be achieved through increased utilisation (large clouds), more effective software, more effective IT hardware, and more effective infrastructure. Fiona also presented the findings of a study done as part of the IEA platform on energy use in data centres, that evaluated potential energy savings, showing that substantial savings can be achieved: around 70 TWh/year in 2030 (worldwide). This potential might be even larger, when considering the development of AI. The shift to cloud, or utilisation aspect, has the potential to save significant amounts of energy. Large savings are also possible by increasing the PUE or the shutdown level. Server efficiency is quite substantial in energy saving but the potential reduces over time as systems become more efficient.

Fiona concluded her presentation by summarising the main types of policies in this field, notably reporting regulations. She reminded that it is quite challenging because there is no information on the number of DCs, their locations, or the amount of energy they use. There are some specific obligations, like those in the EU (cf. Article 12 of the Energy Efficiency Directive) and Germany (cf. next presentation below) and more general requirements in many countries, like France, Japan, and certain US states and localities. Some of the policy mechanisms that can be used to increase DC's energy efficiency are government permits, minimum energy performance standards, licenses, obligations, public sector procurement, incentives, cloud first consolidation, voluntary agreements, and labelling and certificates. The EU began with the voluntary Code of Conduct on Energy Efficiency in Data Centres in 2008. Under the EED, energy use for DCs with a capacity larger than 500kW is now to be reported.

- **Q&A**

– *Does the energy-saving potential to 2030 you showed in the figure relate to energy-saving on a global scale?*

[2] The US Department of Energy published a report in December 2024, assessing that electricity demand from data centres in the US could triple by 2028: https://www.energy.gov/articles/doe-releases-new-report-evaluating-increase-electricity-demand-data-centers

Indeed, that is the worldwide energy savings.

— *When you reviewed the policies and reporting schemes, did you see any trends, such as more countries developing policies in this field? Or more types of policies implemented?*

Most of the policies are very recent. There are a few exceptions, such as UK and Netherlands obligations that are part of larger policies. Setting requirements specifically to data centres is relatively recent. However, such regulations are becoming increasingly important.

— *As most policies in this field are recent, does it mean that the energy efficiency improvements over 2010-2018 were mostly market-driven, for example due to the competition between data centre operators?*

Yes, it is partly that, but it also responds to the increasing cost of electricity. Thus, it is a market-driven incentive. Image is also a driver, to show companies' environmental commitments and to meet preferences of their customers. However, regulations can ensure that savings occur more quickly than they would if driven alone by the market.

— *You have shown the energy consumption of various scenarios about AI developments - AI 2, AI4, AI8 - could you perhaps comment on the differences?*

You can see the details in the following study: Shehabi, A., Smith, S.J., Hubbard, A., Newkirk, A., Lei, N., Siddik, M.A.B., Holecek, B., Koomey, J., Masanet, E., Sartor, D. 2024. [2024 United States Data Center Energy Usage Report]. Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-2001637

— *Is this improvement due to this sector's fast growth? What proportion of DCs in the EU are actually subject to the EED's reporting requirement?*

That is difficult to quantify. As I showed, there are some assumptions that are valid, but as the field develops rapidly, so does the number. There is a lot of uncertainty in analysis, primarily due to the advancement of AI. As a result, we obviously need a comprehensive understanding of this, and regulatory pressure may help with that.

Regulating energy efficiency in data centres: experience from Germany, by Christopher Niederelz (BAFA - Federal Energy Efficiency Center)

(see also presentation file available on the streamSAVE+ platform; this presentation complements and updates a previous presentation made at the Concerted Action EED)

Christopher began by discussing the current state in Germany. After the United States, Germany has the second-highest number of data centres. It currently has about 3,000 large DCs that are over 40kW, and the trend continues to rise, mostly as a result of the development of cloud storage and AI. The overall energy consumption of data centres in Germany is expected to increase from 20 TWh/a in 2024 to 30 TWh/a in 2030.

The Energy Efficiency Act (EnEfG) adopted in November 2023, which outlines energy savings across various sectors, was Germany's first legislative framework with provisions specific to data centres. It requires reporting by data centres into the national registry and integrates provisions on RES and energy management systems. It regulates energy efficiency DCs in with requirements that go beyond the ones of Article 12 of the EED, for example in terms of data points. It has set efficiency standards (such as PUE or waste heat utilisation), with requirements progressively increasing according to a clear timeline, for both newly constructed DCs and existing ones (with lower requirements for DCs in operation before 2026, but promoting continuous improvements). DCs' energy supply should come 100% from RES by 2027.

The minimum reporting requirements include basic data, general specifications and energy/performance data such as energy consumption, renewable energy use, amount and temperature of waste heat, PUE value, non-redundant connected load, etc. The National Registry for DCs (RZReg), which requires DC operators to report these particular data points, is designed to use all of this data. The registry has been operational since June 2024, and in Q3 of 2025, the evaluated data will be made publicly available. Compared to Article 12 EED, data points from smaller DCs (less than 300kW) will also be included in the national registry.

Christopher concluded his talk by outlining the main difficulties faced when developing the national dataset. Due to the large number of unknown characteristics, creating the dataset itself was one of the most difficult tasks. The assessment of the status quo thus included the best estimations available. The administration office set up websites, technical guidelines, workshops, and a hotline to assist operators report the data points in a transparent and accurate manner. Providing information and technical support has been essential in the implementation of the regulation.

The second largest challenge is completing data from co-location DCs, which make up around half of all DCs in Germany. There are practical or contractual challenges (such as non-closure agreements). The EnEfG's legal requirements and data sharing advice have helped to overcome these.

- **Q&A**

— *What is the primary reason for making data available to the public? to establish a benchmark, have a transparent market, assess energy savings potentials?*

Mainly the transparent market point of view. However, we are unable to publish certain types of data. We are now conducting analysis to make sure that private and critical data are not exposed. The obligation to report and the obligation to publish are two different things, and we must distinguish them. The data that will be sent for additional analysis and those that will be publicly available are presented in the EnEfG annex.

— *Some of the biggest data centres in other countries are refusing to disclose their data to the public. How would you respond to this?*

The EnEfG legal duty is our very specialised enforcement mechanism in the last instance. However, we ask the operators well in advance and work to make the procedure as simple and transparent as possible (e.g., a straightforward reporting method, guidance, etc.). Enforcement has not yet been required, and some data are still being processed. The obligation is currently being notified to operators. However, if necessary, the reporting will eventually be required by law, and the EnEfG has established fines for those who do not comply.

— *Who is in charge of managing the DC national registry? Is it the Energy Agency or the Ministry? And who verifies the accuracy of the information provided?*

The Federal Ministry for Economic Affairs is in charge, and the Ministry's enforcement agency (BAFA) oversees its implementation. But BAFA is not examining or correcting the data. Only checks who reported, asks for clarification, and reminds operators of their responsibility. The operators are accountable for reporting the data. And if BAFA believes the data is unreliable, it requests a revision. This approach provides accuracy to data points.

— *Is it clear to DCs what they should report?*

We have the registration site and the reporting platform. The technical support includes an online tutorial, a technical report and guidelines on how to report as well as what data points to report. For the time being, the feedback has been mostly positive.

French experience with energy savings in data centres, by Nathan Chiantaretto (Max Dubois Consultant)

- **Potential for energy savings in data centres in France**

(see also presentation file available on the streamSAVE+ platform)

Nathan presented the findings of a national study on energy efficiency in data centres dating October 2024. The study audited 50 data centres spread across 162 sites and consulted 74 future sites planned to be built within the next five years. The DCs are expected to account for 4.76% of France's electricity consumption in 2030 (vs. 2.3% in 2020). Nathan also confirmed that this is a rapidly growing area in France, due primarily to the development of AI. The majority of data centres are located in Paris, while the average PUE in France is 1.5. The power distribution is very concentrated. 28% of the operators answering the survey stated that their upcoming projects include data centres with an IT density greater than 30 kW/m^2. (while the current average density is 3.1 kW/m^2).

France's white certificates scheme (CEE) can be used to finance energy-saving measures, including energy efficiency improvements in data centres. During the study, it was observed that more than half of surveyed DC operators had no or limited knowledge of the CEE scheme. According to the operators, the most promising energy-saving technologies include free-cooling, Direct Liquid Cooling (DLC), geo-cooling, and immersion cooling. Nathan went into detail about several of the technologies, including DLC, immersion cooling, hybrid free cooling, monitoring, and heat recovery.

At the moment, the majority of ICT rooms are cooled by air. DLC is a cooling system made up of chilled water loops that circle around the servers. The average PUE is 1.15. This is a significant gain in energy savings. It is anticipated that by 2035, 7.4% of all IT capacity will have DCL, with an annual energy savings potential of 353 GWh/a.

The idea behind immersion cooling is that the servers will be immersed in liquid. The primary benefit is that it is easy to maintain the temperature. The average PUE is 1.1, and immersion cooling is expected to be installed on 8.1% of IT power (i.e. 203 MW) by 2035, with estimated energy savings of 0.5 TWh/year in 2035.

Free cooling is a widely utilised technology. It is a very efficient air-based cooling system that is typically limited to small data centres. The climate zone has a significant impact on the performance of the hybrid air-to-water cooling system. The average PUE is 1.35. However, this form of technology is widely accepted by operators (as easier to implement than DLC or immersion cooling). It is anticipated that 17.9% of total IT power will be equipped with hybrid-free cooling by 2035, saving 240 GWh per year.

Nathan noted the importance of the infrastructure monitoring. The study estimated that monitoring might result in an additional 5% savings above the expected savings, delivering 102 GWh/y in 2035.

One of the most significant options for energy savings is heat recovery. The main advantage is in the indirect savings, as 1kW of IT generates 1kW of heat that may be reused. Unfortunately, it is currently underused in France. When all of the opportunities for saving technologies are combined, the potential is expected to be 471 GWh/year by 2035, which is 4% of industrial energy savings.

Overall, the savings potential could reach almost 2 TWh/year in 2035.

- **Q&A**

— *What is the indicative CEE pricing for estimates you showed?*

The average price of white certificates in France is currently approximately 7 euros per MWh cumac (CEE unit, cumac = lifetime-cumulated and discounted, with a discount rate of 4%/year). For example, in cooling data centres it accounts for 10-25% of the CAPEX of an energy-efficient solution. Thus, it is significant financial incentive that encourages operators to invest in energy efficiency solutions.

— *You showed potential savings of 2TWh/year for 2035. How does it compare with the expected increasing electricity consumption of data centres?*

This potential would represent about 8.4% of overall data centre consumption. As the sector grows, data centres may consume an increasing amount of energy. The CEE purpose is to enable data centres to become as energy efficient as possible, as for other sectors.

- **Example of a new standardized calculation method about free cooling in data centres**

(see also presentation file available on the streamSAVE+ platform)

In his second presentation, Nathan showed an example of standardized calculation method for the case of free cooling (hybrid air-water cooling). The first step is to prove the relevance of the action type in the context of the CEE scheme, i.e. whether the energy savings potential is significant. Data was gathered through an audit of 50 data centres. This was followed by a review of the legal and regulatory framework, to confirm that incentivising this action type with the CEE scheme is additional. The potential deposit for energy savings was then calculated. The use of free cooling solutions was considered for both, retrofitting unequipped existing DCs and new DC to meet growing demand. Then the simulation of various determining parameters, including climate zone, chilled water outlet temperature range, circulation loop, and compressor electric power was carried out, to assess how energy savings may vary according to the sites, and whether deemed savings need to be differentiated according to key parameters.

A standardised calculation method was developed based on all of the simulation results. This formula enables operators to calculate their savings easily. It has been validated by ADEME and ATEE, and then submitted to the ministry that takes the final decision. It should be published soon. The estimated potential for this standardised action (free cooling) is an annual energy savings of 0.38 TWh/year, resulting in a cumulative energy savings of 1.9 TWh by 2030. DC operators that would invest in free cooling solutions would achieve a 13 to 18% reduction in CAPEX. As a result, this clearly shows that the CEE scheme can provides incentives for energy efficiency in data centres.

- **Q&A**

— *Given the rapid evolution of technology, how do you determine the baseline in factsheets?*

We used 2024 as the baseline year. However, the reference data will be updated annually. The projections will also be improved to integrate evolving AI and more efficient measures. So it is critical to monitor the evolution and update the data sheets.

— *When will these types of calculations be available?*

We are at different stages of development with various types of technologies. For example, the data sheet for free-cooling is ready and being revised by the ministry (DGEC). It should be published and become applicable this year. Also, DLC is quite significant in France, thus it is expected to be released shortly. We are also working on another computation methods at the moment.

— *How do you calculate investment costs?*

We collaborate with many providers on solutions, and they may advise us on data. We also work with operators to collect data. Then we evaluated the collected data to determine whether they were representative of all DCs.

Further readings

Acton, M., Booth, J., Paci, D. (2025). 2025 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency. Joint Research Centre report JRC141521.

Brocklehurst, F. (2024). Public Data on Data Centre Energy Use. Report for the 4E TCP (Technology Collaboration Programme on Energy Efficient End-Use Equipment) – EDNA (Efficient, Demand Flexible Networked Appliances Platform).

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Brocklehurst, F (2022). International review of energy efficiency in Data Centres. Report for IEA Energy in Buildings and Community TCP Building Energy Codes Working Group.

Hoberg, N. (2024). Implementing the EED: Data centers and the German Energy Efficiency Act. Presentation at the Concerted Action EED.

Kamiya, G., Coroamă, V.C. (2025). Data Centre Energy Use: Critical Review of Models and Results. Report for the 4E TCP (Technology Collaboration Programme on Energy Efficient End-Use Equipment) – EDNA (Efficient, Demand Flexible Networked Appliances Platform).

Kamiya, G., Bertoldi, P. (2024). Energy Consumption in Data Centres and Broadband Communication Networks in the EU. Joint Research Centre report JRC135926

MDC (2024). L'efficience énergétique dans les datacenters [Energy Efficiency in Data Centres]. Extract of the report by Max Dubois Consultant for ADEME, ATEE and France Datacenter.

Montevecchi, F., Stickler, T., Hintemann, R., Hinterholzer, S. (2020). Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market. Final Study Report by Austria's Environment Agency and Borderstep Institute for the European Commission.

Yilmaz, C. (2023). Achieving Sustainable Digitalization: Strategies for Energy Savings in Data Centres. Presentation at the final dialogue meeting of streamSAVE.

Information and links on energy performance of data centres on the European Commission's website: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en#energy-performance-of-data-centres

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