# Input for Discussion: Roundtable Sustainability and Digitalization

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## Introduction

This is a position paper as input to the Round Table "Sustainability and Digitalization" - *Commissie DiZa (Digitale Zaken)*.

My expertise is specific to software, software engineering, and both the direct energy footprint of software and the indirect role that software plays for sustainability goals. The positions below should be considered with this focus.

## Discussion Topics

1. **The "Twin Transition" demands for a much larger scoping of the sustainability ambition of the Netherlands.** The so-called *twin transition* witnesses the combination of the energy transition (from brown to green energy resources) and the digital transformation of all sectors of our society - both at a global scale. It is not possible anymore to look at one or the other individually, because they are intertwined and inter-dependent.
   If we look at the Netherlands in particular, we can observe interesting and worrisome phenomena: (a) the **datacenter industry** claims an urgency to grow further, with a negative impact on farming (hence food), natural resources (hence planetary balance), and a claim on a big chunk of available renewable energy resources to fulfil their electricity needs (hence green energy needed by households and other sectors); (b) the Netherlands (so-called the "startup country") is in an excellent position to finally create **true competition for the Silicon Valley and Asiatic digital giants**.

   **Proposition:** The past and current generations of innovative companies may still include Philips and ASML, but we are outstanding in many fields, *e.g.,* artificial intelligence[1], sustainability-aware software engineering, software-defined infrastructures. We should invest in a truly disruptive innovation emerging from SMEs and startups in the software industry with such ambition. This investment, however, requires electricity and a targeted vision. This may include unprecedented opportunities for innovative sector-specific software/services/platforms for digital micro-communities and digital commons

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[1]A market analysis report posits that the global AI market size was valued at USD 136.55 billion in 2022 and is projected to expand at a compound annual growth rate of 37.3% from 2023 to 2030 (source: `https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-market`)

(*e.g.,* software tackling sustainability of work-life balance or safety in local communities; local energy prosumption cutting the need for using the central grid; food[2] sharing).

**Some Figures 1**

The energy needed to power **global data centers** and data transmission networks would be enough to power France, which has about 68 million people. The Track Clean Energy Progress (TCEP) [a] report of 2023 indicates that data centers and data transmission networks contribute, respectively, to the 1-1.5% of the global energy demand [1]. Despite evidence that technological improvements helped mitigating their energy demand in the past years, the request for data centers resources and network traffic is increasing. Data centers and networks are called to handle huge volumes of data created and consumed every day. According to Statista[b], almost 327.77 billion terabytes of data are generated and consumed globally each day. The growth in the use of data-intensive software, such as AI and scientific applications, exacerbates the issue [4].

A recent analysis of the growing **energy footprint of AI software** [3] reads as: (1) In recent years, data center energy consumption has accounted for a relatively stable 1-1.5% of global electricity use (excluding cryptocurrency mining), but between 2010 and 2018 global data center electricity consumption may have increase "only" 6%[c]. (2) It is probably too optimistic to expect that improvements in hardware and software efficiencies will fully offset any long-term changes in the exponential growth of AI-related electricity consumption. These advancements can trigger a rebound effect whereby increasing efficiency leads to increased demand for AI, escalating rather than reducing total resource use. The AI enthusiasm of 2022 and 2023 could be part of such a rebound effect. (3) As an example, the estimated energy consumption per online request for various AI-powered systems compared to a standard Google search has increase by 900%To make a comparison, **an average US household** consumes per year about 10,000 kWh[d]. If we look at **a ChatGPT request**, it currently consumes 17,000 times higher than the daily consumption of the average household [5] (*i.e.,* equivalent to about **1.7 households**); with a projection **by 2029 to grow to about 40,000 households** [2].

[a] The Track Clean Energy Progress is a report published by the International Energy Agency (IEA) that evaluates the latest progresses regarding the transition to clean energy sources

[b] `https://www.statista.com/statistics/871513/worldwide-data-created`

[c] Digiconomist, Almere, the Netherlands

[d] `https://shrinkthatfootprint.com/average-household-electricity-consumption`

2. **The Datacenter Industry must (and can) decrease their energy footprint significantly.** Our society depends on the datacenter industry. Its carbon footprint is improving thanks to (1) hardware technology innovation, and (2) an increasing adoption of renewable energy resources[3]. However, no significant investment/effort has been put in optimizing the energy consumption of the datacenter services.

   It is obvious how much our society is dependent on cloud based services, these including software services (*e.g.,* DigiD, Belastingdienst), software management and data management.

   **Proposition:** Given the undergoing *twin transition*, it is imperative to demand from data centers significant effort to optimize their software (all tiers, including IaaS, PaaS, SaaS, and AaaS) and their data

[2] Food waste has reached 30% globally, hence calling for a fundamental behavior change.

[3] Google Sustainability `https://sustainability.google`

management procedures covering the whole data lifecycle (from storage, to data processing and data cleaning).
This need is becoming now evident to the general public, too, with the massive adoption of AI technologies and Large Language Models which require unprecedented use of electricity for data collection, data storage, data traffic, and processing power for their construction and usage [3]. Other well-known examples include the use of cryptocurrencies, blockchains, and high performance computing applications like in biology and medicine.

**Some Figures 2**

Good practices and tactics for software optimization (in the cloud and beyond the cloud) do exist[a]. Preliminary measured optimizations are extremely promising. For example: cloud-to edge migration (96% energy decrease), workload smart scheduling (-6%), putting applications to sleep (-8%), energy-efficient queries (-25%).
The software can be designed for *digital sufficiency*, *i.e.,* to support processes that address sustainability goals[b]. Software can also be designed to address (or hinder) such sustainability goals[c].
Software for the digital workforce should consider sustainability, too, *e.g.,* to support flexible work[d].

[a] Digital Sustainability Center, Archive of Awesome and Dark Tactics, at: `https://s2group.cs.vu.nl/AwesomeAndDarkTactics/catalog`

[b] Madon, M., & Lago, P. (2023). "We are always on, is that really necessary?" Exploring the Path to Digital Sufficiency in Flexible Work. International Conference on ICT for Sustainability.

[c] Toczé, K., Madon, M., Garcia, M., Lago, P. (2022). The dark side of cloud and edge computing: An exploratory study. Eighth Workshop on Computing within Limits 2022, Virtual. `https://doi.org/10.21428/bf6fb269.9422c084`.

[d] Nationale Coalitie Duurzame Digitalisering, Op weg naar een emissieloze online thuiswerkplek (2023). `https://coalitieduurzamedigitalisering.nl/wp-content/uploads/Handleiding-Emissieloze-Online-Thuiswerkplek-2023.pdf`

3. **Sustainability reporting should be compulsory for all types and sizes of organizations.** For the adoption of the Corporate Sustainability Reporting Directive (CSRD) to be truly impactful (with positive effects), the Netherlands should invest in the following must-have's:
(a) Demand that **all software be designed and developed for energy efficiency**. The whole society in all industrial tiers exploits and is dependent on software, from public sector services to the citizens, to fundamental sectors like banking, healthcare, education and democracy, and other sectors like farming, manufacturing, and transportation.
(b) Demand that **sustainability reporting be provided by all organizations**, independently from sector or size. This is already happening, given that large organizations need data from their suppliers and/or customers. Recent news pointed to the fact that in the Netherlands only 25% of the organizations know about the reporting demands and even less are ready. However, if everybody is *officially* asked to report, awareness and investments will come from the whole value chain. This will also lead to more significant reported figures.
(c) Demand for **truly significant standardization**. Standardization-involved organizations like NEN, SDIA and GSF, should be asked to provide measures and key performance indicators that facilitate a true and significant indication of the extent of the transition toward sustainability-aware digitalization. This means that, *e.g.,* software and software applications must be measured in terms of their direct

impact (*i.e.,* energy footprint) and indirect impact (*i.e.,* sustainability contribution of their supported processes and services to the target user). In addition, such measures and KPIs should be standard, *i.e.,* calculated in the same way so that comparisons are possible and truly informative (instead of misused and insignificant).

**Some Figures 3**

According to the European Commission[a], "The EU legislation for **energy labels and ecodesign** has been estimated to bring energy **savings of approximately 230 million tonnes of oil equivalent (Mtoe) by 2030**. For consumers, this means an average saving of up to €285 per year on their household energy bills. Moreover, energy efficiency measures will create **€66 billion in extra revenue for European companies**." Now that software has become a commodity (like washing machines and laptops) we need labels for software products and apps, too, to empower all stakeholders, from public and private sector and individuals, to make the right choices.
The only standard explicitly addressing the **energy consumption of software**, is the Blue Angel[b]. Quoting: "By purchasing software that has been awarded the Blue Angel, consumers and public procurers can be sure that the software uses hardware resources in a particularly efficient manner and saves energy."

[a] About Energy Labels and Ecodesign, online at `http://tiny.cc/1nfjxz`
[b] Blue Angel Ecolabel `https://www.blauer-engel.de/en/productworld/resources-and-energy-efficient-software-products`

4. The Netherlands needs to equip everybody, from professionals to the general public, with **sustainability-related competencies and skills** regarding digitalization in general and software in particular. Moreover, the government should make sure that **truly useful** competencies are being provided by organizations (like universities) and companies (like consultancies) so to avoid misuse, waste of investment, and ultimately to equip organisations with the sustainability tools they need for a fast and stable impact.

**Some Figures 4**

The need for ICT-related sustainability skills and competencies in industry is a fact, as well as the opportunities to fulfil them[a]. Education and Training programs providing significant and impactful competencies and skills need to be developed further [b].

[a] Heldal, R., *et al.* (2024). Sustainability competencies and skills in software engineering: An industry perspective. The Journal of Systems and Software, 211, 111978. Open access at `https://doi.org/10.1016/j.jss.2024.111978`
[b] Peters, A.-K., *et al.* (2024). Sustainability in Computing Education: A Systematic Literature Review. ACM Trans. Comput. Educ., 24(1), 1–53. Open access at `https://dl.acm.org/doi/full/10.1145/3639060`

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