WSTAR-Wasa Zero Emission Data Center

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Outline

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WSTAR – Wasa Zero Emission Data Centre

- Wasa Zero Emission Data Center (WSTAR) is an infrastructure enabling the research on future climate-neutral data centers.

- Project facts
    - Total budget: 1.9 MEUR.
    - Funded by the Academy of Finland.
    - Time schedule: 1.1.2023 – 31.12.2025.
    - Project partners: University of Vaasa, Åbo Akademi University, Novia University of Applied Sciences, VAMK University of Applied Sciences.

- Official website

WSTAR – Wasa Zero Emission Data Centre

- As a part of the Technobothnia research infrastructure in Vaasa, the energy capital in Finland, it provides direct and near contacts to the energy industry.

- The project has received funding from the European Union – NextGenerationEU instrument and is funded by the Academy of Finland under grant number No 353562 (353563, 353590, 353606).

Data Center

- A facility that houses critical infrastructure and equipment to store, manage, and process data.

- It consists of several key components, each of which plays a specific role in ensuring the data center operates efficiently, securely, and reliably.

Data Center Components

1. Computing Hardware:

   - Servers: Servers are the backbone of the data center, providing computing power to run applications, process data, and host websites. They are typically housed in racks and can be specialized for different tasks (e.g., web servers, database servers).

   - Storage Systems: These are used to store and manage data. Types of storage include:

     - Hard Disk Drives (HDDs) and Solid State Drives (SSDs) for high-speed access to data.
     - Storage Area Networks (SANs) and Network-Attached Storage (NAS) for large-scale data storage.

Data Center Components

2. Networking Equipment

- Routers, switches, and firewalls manage the flow of data between servers, storage, and external networks. They ensure efficient data transfer and security.

- Load balancers distribute network traffic evenly across multiple servers to ensure reliability and performance.

3. Power Infrastructure

- Data centers require robust power systems, including uninterruptible power supplies (UPS) and backup generators, to ensure continuous operation even during power outages.

- Power distribution units (PDUs) distribute electricity to the various equipment in the data center.

Data Center Components

4. Cooling Systems
   - Data centers generate a lot of heat, so advanced cooling systems are essential. These include air conditioning units, chillers, fans, and liquid cooling technologies to maintain optimal operating temperatures.

5. Cabling
   - Fiber optic and Ethernet cables connect servers, storage, and networking devices. Proper cabling management is important for efficiency and scalability.

6. Security Systems
   - Physical security includes access control systems, surveillance cameras, and biometric scanners to restrict unauthorized access.
   - Cybersecurity systems involve firewalls, encryption, and other software to protect data from online threats.

Data Center Components

7. ## Data Center Management Software

   - Software platforms manage the hardware, power consumption, cooling, and overall performance of the data center, providing real-time monitoring and control.

8. ## Environmental Control Systems

   - Sensors and monitoring devices help track humidity, temperature, and air quality, ensuring that conditions remain stable for optimal equipment performance.

9. ## Redundancy and Failover Systems

   - To ensure high availability, data centers have redundancy for power, networking, storage, and cooling systems. Failover systems kick in if any primary system fails.

Data Center Components

10. Fire Suppression Systems

- Specialized fire detection and suppression systems such as gas-based fire suppression or water mist systems (very fine water droplets) to protect the data center from potential fires without damaging sensitive equipment.

Energy consumption of Data Centers

- Data centers are significant consumers of energy and contributors to global carbon emissions due to their large-scale use of computing power, storage, and cooling systems.

Energy consumption of Data Centers

- **Global Energy Use**: Data centers worldwide are estimated to consume around 200 to 250 terawatt-hours (TWh) of electricity per year, which accounts for roughly 1% to 2% of global electricity consumption.

    - This is comparable to the energy usage of some medium-sized countries, like Argentina or Australia.

- **Growth in Energy Demand**: With the increasing demand for data services (such as cloud computing, artificial intelligence, and streaming services), energy consumption by data centers is expected to grow significantly in the coming years. By 2030, data center energy usage could exceed 8% of global electricity demand if efficiency measures aren't adopted.

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Energy consumption of Data Centers

- Energy Use Breakdown:
  - Servers and storage: Around 50% of energy usage.
  - Cooling systems: Approximately 30% to 40%.
  - Networking equipment and other infrastructure: The remaining 10% to 20%.

Carbon Emissions from Data Centers:

- **Global Carbon Emissions**: Data centers are responsible for an estimated 2% to 3% of global greenhouse gas emissions. This is comparable to the carbon footprint of the entire aviation industry.

- If not addressed, the emissions from data centers are projected to rise dramatically, especially with the growth of cloud computing, artificial intelligence, and the Internet of Things (IoT).

- Emissions Per Data Center: The carbon emissions of a data center depend on its location, energy efficiency, and the carbon intensity of the electricity grid it uses. For example:
    - A large hyperscale data center (used by major companies like Google, Amazon, and Microsoft) can emit tens of thousands of metric tons of CO_2 annually if powered by fossil fuels.
    - The emissions vary widely depending on whether the data center uses renewable energy or relies on conventional electricity grids powered by coal, gas, or oil.

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Energy Consumption and Emissions

- **Power Usage Effectiveness (PUE):**
  - **PUE is a common metric to measure data center energy efficiency, with an ideal value being 1.0.** This means that all the energy is being used by computing equipment, with none wasted on cooling or other infrastructure.
  - **Most data centers have a PUE between 1.2 and 1.8.** A PUE of 1.5 means that for every 1 kWh used for computing, 0.5 kWh is used for cooling and overhead.

- **Cooling Systems:** Cooling is one of the largest contributors to energy use in a data center. In **traditional data centers**, about **30-40% of total energy is spent on cooling**, especially in **regions with warmer climates**.

- **Renewable vs. Non-Renewable Energy:**
  - Data centers **powered by renewable energy (solar, wind, hydropower)** have a **significantly lower carbon footprint**. Some companies, like Google and Microsoft, are **transitioning to 100% renewable energy** for their data centers.
  - Data centers relying **on fossil fuels** contribute **much higher emissions** due to the **carbon intensity** of their electricity supply.

Energy and Emissions Projections

- Future Growth: As the demand for digital services continues to rise, energy consumption by data centers could increase significantly. If no energy efficiency or renewable energy measures are implemented, data centers could account for 8% or more of global energy consumption by 2030.

- Sustainability Initiatives: Many tech giants like Amazon, Google, and Microsoft have committed to carbon neutrality or net-zero emissions by using renewable energy, improving energy efficiency, and investing in carbon offsets. These efforts are vital for controlling the environmental impact of future data centers.

Energy Consumption by Hyperscale Data Centers

- **Energy Use**: A typical hyperscale data center (operated by companies like Amazon Web Services, Microsoft Azure, or Google Cloud) can consume between 20 to 50 megawatts (MW) of power, enough to power around 16,000 to 40,000 homes in the U.S.

- **Data Growth Impact**: These data centers can handle vast amounts of data and traffic, leading to higher energy demand.

Key Considerations

- **Data Explosion**: The growth in data usage, cloud services, and artificial intelligence (AI) requires substantial computational resources, leading to higher energy consumption.

- **Efficiency Improvements:** Innovations like liquid cooling, AI-optimized power usage, and renewable energy integration are helping reduce both energy use and emissions.

- **Renewable Energy Transition:** Many companies are transitioning to using 100% renewable energy in their data centers, which significantly cuts emissions.

Zero-emission Data Centers

Zero-emission data centers are crucial for several environmental, economic, and technological reasons:

1. Environmental Impact:

   - Reduction in Carbon Emissions: Data centers consume vast amounts of energy to power and cool their servers, contributing significantly to global greenhouse gas emissions. Moving to zero-emission models (through renewable energy like solar, wind, or geothermal) helps mitigate climate change by reducing their carbon footprint.

   - Combatting Global Warming: Data centers are responsible for approximately 2% of global carbon emissions, roughly equivalent to the aviation industry. Transitioning to zero-emission models can help slow down global warming.

   - Energy Efficiency: Sustainable energy solutions like using low-power cooling systems and energy-efficient hardware reduce overall energy demand.

Zero-emission Data Centers

2. Meeting Energy Demand Growth:

    ▪ Increasing Data Usage: With the rapid rise in data usage, cloud services, AI, and the Internet of Things (IoT), the demand for data processing and storage continues to grow. Zero-emission data centers ensure that this growth doesn't come at the cost of the environment.

    ▪ Sustainability in Technological Progress: As more industries move online and digital infrastructures expand, keeping energy demands sustainable becomes crucial for a growing, connected global economy.

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Zero-emission Data Centers

3. Regulatory Compliance:

- Government Policies: Many countries are implementing stricter environmental regulations and carbon emission targets. Zero-emission data centers can help companies comply with these regulations and avoid penalties.

- Net-Zero Goals: Countries and corporations are adopting net-zero carbon emission goals by mid-century. Green data centers play a vital role in achieving these targets.

Zero-emission Data Centers

4. Economical Benefits:

- Cost Savings in the Long Run: Although the initial investment in renewable energy infrastructure can be high, zero-emission data centers lower operating costs over time by utilizing free, renewable energy. Reduced energy consumption and reliance on fossil fuels can lead to significant savings.

- Energy Independence: Data centers that generate their own energy through renewable sources can reduce dependency on external electricity suppliers, ensuring stable and predictable energy costs.

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Zero-emission Data Centers

5. Corporate Social Responsibility (CSR) and Branding:

   - Consumer Expectations: Many consumers and businesses prioritize environmental responsibility. Companies that use zero-emission data centers can enhance their brand image and attract eco-conscious customers.

   - Stakeholder Demands: Investors and stakeholders are increasingly pushing companies to adopt sustainable practices. Zero-emission data centers demonstrate a commitment to sustainability, which can be a competitive advantage.

Zero-emission Data Centers

6. Technological Leadership and Innovation:

   - Innovation in Sustainability: Pioneering zero-emission data centers raise innovation in areas such as energy storage, efficient cooling systems, and AI-powered energy management, which can benefit not only data centers but also other industries.

   - Adoption of Circular Economy Principles: By using sustainable building materials, reusing waste heat, and minimizing water usage, zero-emission data centers can contribute to a more circular economy.

Thanks for your attention ☺