مجموعة **سلامة** الفكرية للسياسات والأعمال

SALAMA Policy & Business Intellectual Group

The AI Energy Paradox:

Advance Sustainability vs. Climate Footprint.

Leading Regional Cases from KSA & UAE.

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Artificial Intelligence (AI) is the transformative force capable of solving the world's most pressing challenges, particularly in the realm of sustainability. By optimizing energy use, reducing waste, and enhancing climate predictions, AI is proving to be a powerful ally in combating environmental crises. However, the energy-intensive nature of AI systems itself raises a crucial question: can we achieve the sustainability gains promised by AI without exacerbating its own energy footprint? This paradox demands a closer look at both the contributions of AI to sustainability and the challenges posed by its energy consumption.

The rise of AI is intrinsically linked to the global push for digital transformation. Across industries, businesses and governments are leveraging AI-driven technologies to create smarter systems, optimize resources, and improve decision-making processes. For instance, AI algorithms are helping utility companies predict energy demand more accurately, reducing waste and facilitating better integration of renewable energy sources.

Yet, the enthusiasm for AI adoption must be tempered with an understanding of its environmental cost. The energy consumption required to train and deploy advanced AI systems is staggering, with large-scale models demanding the computational power of thousands of processors. As AI systems become more complex and pervasive, their environmental footprint grows, prompting a critical need for innovation in energy efficiency and sustainability practices.

The AI sustainability paradox underscores the complexity of leveraging technology to address global challenges. While AI holds immense promise for combating climate change, its energy demands cannot be ignored. The question is not whether AI can save the world, but whether we can save the world with AI. The answer lies in our ability to balance innovation with responsibility.

KSA: Strategic Focus on AI Data Centers and Green Energy

The Kingdom of Saudi Arabia's ambition to create a $100 billion AI powerhouse is exemplified by the work of the Saudi Company for Artificial Intelligence (SCAI), established under the Public Investment Fund (PIF) in 2021. SCAI's mission is to drive innovation across critical sectors by developing AI-powered data centers that are seamlessly integrated with renewable energy solutions, ensuring both technological progress and environmental responsibility.

SCAI is at the forefront of developing advanced data center infrastructure to meet the computational demands of AI applications. In partnership with global technology leaders like Google Cloud and Microsoft, these data centers are designed to optimize energy use through AI-powered cooling systems and predictive algorithms. These innovations reduce energy consumption while maintaining peak performance, positioning Saudi Arabia as a leader in energy-efficient AI technologies.

To support its energy-intensive AI infrastructure, SCAI is leveraging Saudi Arabia's vast investments in renewable energy. Projects like the Sudair Solar PV Plant, which has a capacity of 1.5 GW, provide clean and uninterrupted energy to power data centers. Additionally, advanced battery storage systems ensure a steady supply of electricity, enabling continuous AI operations without reliance on fossil fuels.

SCAI's initiatives align with Saudi Arabia's Vision 2030, which prioritizes economic diversification and environmental stewardship. By coupling AI advancements with renewable energy strategies, the kingdom is creating a resilient ecosystem that supports growth, innovation, and global collaboration. These projects demonstrate how strategic investments in AI and green energy can drive transformative change on a global scale.

UAE: Mubadala’s Landmark Renewable Energy and AI Initiative

During his address at the World Economic Forum, Davos 2025, H.E. Khaldoon Al Mubarak, Managing Director and Group Chief Executive Officer of Mubadala, the UAE sovereign investor managing a diverse portfolio of assets in the UAE and abroa d of USD 302 BN assets under management, unveiled a groundbreaking project in the UAE - a $6 billion solar energy initiative. The project involves the construction of the largest gigawatt-scale solar panel energy facility in the region. The facility will deploy 5.2 GW of solar panels across 90 square kilometers and integrate 19 gigawatts of battery storage, enabling it to produce 1 gigawatt of uninterrupted base load solar power. This transformative initiative aligns with the UAE's Net Zero by 2050 objectives and underscores the nation's leadership in renewable energy innovation.

What makes this project even more significant is its synergy with the UAE’s growing investments in AI enablement and data center capacity. By coupling sustainable energy solutions with advanced AI technologies, the UAE is creating a foundation for energy-efficient computational infrastructure. This dual focus not only supports local growth but also positions the UAE as a global leader in renewable energy-powered AI advancements.

The project highlights a pivotal shift toward AI-driven sustainability, with energy-intensive industries like data centers relying on renewable power to mitigate environmental impact. By integrating solar energy with AI and compute capacity, the UAE exemplifies how nations can address the global energy dilemma while fostering innovation and growth.

The Promise of AI for Sustainability

AI's potential to address climate change is immense. Here are a few examples of how AI is already making a difference:

- **Energy Optimization:** AI-powered smart grids can balance energy supply and demand in real-time, reducing waste and integrating renewable energy sources more effectively. For instance, Google's DeepMind reduced the energy used for cooling its data centers by 40% through AI-driven optimization.

- **Climate Modeling:** AI can process vast amounts of climate data to improve the accuracy of weather forecasts and long-term climate predictions. This helps policymakers and businesses make informed decisions about resource allocation and disaster preparedness.

- **Precision Agriculture:** AI enables farmers to optimize water usage, reduce pesticide application, and increase crop yields. According to the World Economic Forum, AI-driven precision agriculture could reduce global greenhouse gas emissions by 1-2%.

- **Carbon Capture and Storage:** AI is being used to design more efficient carbon capture technologies, which are critical for achieving net-zero emissions. For example, researchers at MIT used AI to identify a new material that could significantly improve carbon capture efficiency.

In addition, AI's versatility enables it to support numerous United Nations Sustainable Development Goals (SDGs):

- **Healthcare (SDG 3):** AI enhances diagnostic accuracy through advanced imaging analysis and predictive analytics, leading to improved patient outcomes. Algorithms capable of detecting diseases early facilitate timely and potentially life-saving interventions. For instance, Google Health's AI-powered tools for breast cancer detection have achieved an accuracy rate comparable to expert radiologists, reducing diagnostic errors and improving early detection rates.

- **Education (SDG 4):** Personalized learning platforms powered by AI cater to individual student needs, promoting inclusive and equitable education. Systems like IBM's Watson Education adapt to diverse learning styles and provide teachers with actionable insights to improve learning outcomes. UNESCO's partnerships with AI initiatives also aim to expand education access in underprivileged regions.

- **Climate (SDG 13):** AI models predict climate patterns, aiding in disaster preparedness and resource management. By analyzing vast datasets, AI supports efforts to mitigate and adapt to climate change impacts. Microsoft's AI for Earth program has funded over 700 projects globally, tackling issues like deforestation and water conservation through AI-driven insights.

These applications underscore AI's potential to drive significant progress toward achieving global sustainability goals, offering hope for a more efficient and equitable future.

The Energy Cost of AI

While AI offers transformative solutions, its energy footprint is substantial. Training and running AI models, particularly large-scale deep learning systems, require enormous computational power. Here are some key statistics that highlight the energy demands of AI:

- **Training Large Models:** Training a single large AI model, such as OpenAI's GPT-3, can consume up to 1,287 megawatt-hours (MWh) of electricity, equivalent to the annual energy consumption of 120 average U.S. households. This process also emits approximately 626 metric tons of CO_2, comparable to the lifetime emissions of 5 cars or equivalent to the carbon footprint of multiple transatlantic flights.

- **Data Center Energy Use:** Data centers, which power AI systems, account for about 2% of global electricity consumption for approximately 460 terawatt-hours (TWh) of electricity annually. By 2028, global data center electricity consumption is expected to more than double, reaching 857 TWh, with a compound annual growth rate of 19.5% from 2023 to 2028. In the US alone, projections indicate that. data centers will consume approximately 292 TWh of electricity by 2026, representing about 6.5% of total U.S. power demand.

- **Inference Costs:** While training AI models is energy-intensive, the ongoing energy use for inference (running the models) is also significant. For example, deploying GPT-3 for widespread use could require thousands of GPUs running 24/7, consuming energy on par with small cities.

- **E-Waste and Hardware:** The hardware required for AI, such as GPUs and TPUs, has a significant environmental impact. The production of these components involves

mining rare earth metals, which generates 1.4 tons of radioactive waste and 200 cubic meters of acidic wastewater per kilogram of material. Manufacturing a single NVIDIA A100 GPU emits around 1,000 kilograms of CO_2. The rapid pace of AI advancements leads to frequent hardware upgrades, creating massive e-waste. In 2019, the world generated 53.6 million metric tons of e-waste (with only 17.4% of e-waste recycled), projected to hit 74.7 million metric tons by 2030.

- **Cooling Costs:** Data centers running AI systems require extensive cooling to prevent overheating, which adds to their energy consumption. Cooling can account for up to 40% of a data center's total energy use. For example, a large data center can consume 20-50 megawatts (MW) of power, with a significant portion dedicated to cooling systems. This energy demand is equivalent to powering 20,000-50,000 homes in USA.

The Paradox: Balancing Benefits and Costs

The central question is whether the benefits of AI in combating climate change outweigh its energy costs. To address this dilemma, the focus must shift towards developing energy-efficient AI systems and adopting sustainable practices within the tech ecosystem. Innovations such as green data centers powered by renewable energy, more efficient algorithms, and hardware optimization are already making strides in this direction. Additionally, industry leaders and policymakers must work collaboratively to establish regulations and incentives that prioritize energy-efficient AI development, ensuring that technological progress does not come at the expense of environmental health. Key factors for consideration:

Renewable Energy Integration: If AI systems are powered by renewable energy, their environmental impact can be significantly reduced. Companies like Google, Microsoft and Amazon are already committing to 100% renewable energy for their data centers to become carbon-negative by 2030. Companies are as well investing in microgrids and on-site renewable energy generation to ensure a stable power supply by deploying solar-powered microgrids at some of its data centers, reducing reliance on the main grid. However, building renewable energy infrastructure, such as solar farms and wind turbines, requires significant upfront investment. For example, constructing a 100 MW solar farm can cost 100-150 million USD, depending on location and technology. Another important aspect to use AI driving efficiency in energy use across industries, potentially offsetting its own carbon footprint. For example, AI-optimized logistics and supply chains could reduce global emissions by up to 10%. AI-powered energy management systems can reduce energy waste by 10-20% in power grids. Also, AI-optimized logistics and route planning could reduce global transportation emissions by up to 10%, equivalent to more than 1.5 gigatons of CO_2 annually

Innovation in AI Design: Researchers are developing more energy-efficient AI algorithms and hardware. Techniques like model pruning, quantization, and federated learning can reduce the computational load of AI systems by up to 90% less energy without sacrificing performance. On the hardware manufacturing front, companies like NVIDIA, Google, and Intel are developing specialized hardware, such as Tensor Processing Units (TPUs) and Graphics Processing Units (GPUs), optimized for AI workloads. These chips are designed to perform AI tasks more efficiently, reducing energy consumption by up to 10x compared to general-purpose processors. Another important aspect is to consider Edge Computing. By processing data closer to the source (e.g., on IoT devices), edge computing reduces the need for energy-intensive data transmission to centralized servers. This approach can lower energy use by **20-30%** for AI applications like real-time video analysis.

Policy and Regulation: Governments, policy makers and industry leaders must establish guidelines to ensure sustainable AI development. This includes setting energy efficiency standards for data centers, incentivizing green AI research, and promoting transparency in AI's environmental impact. Strong policy frameworks are essential to ensure AI's sustainability. For example, The European Union AI Act, includes provisions for energy efficiency and environmental impact, such as Transparency Requirements, Sustainability Standards, Lifecycle Assessment. The EU estimates that these measures could reduce the carbon footprint of AI systems in Europe by up to 20% by 2030. In the United States, the Department of Energy (DOE) has launched the Energy-Efficient AI Initiative to promote sustainable AI development. Key components include: funding for research, public-private partnerships, and benchmarking tools. The DOE estimates that these efforts could reduce the energy consumption of AI systems in the U.S. by 30% by 2030.

Charting a Sustainable Future for AI

To ensure AI's contributions to sustainability are not undermined by its energy footprint, stakeholders across the ecosystem must take collective action. Researchers should focus on creating algorithms and hardware optimized for energy efficiency. Businesses should adopt sustainable AI deployment strategies, such as leveraging renewable energy-powered data centers and recycling old hardware. Governments and policy makers play a pivotal role in this transition by enacting policies and providing infrastructure support for green technology. Furthermore, transparency in reporting AI's energy usage and its environmental impact is critical for accountability and improvement.

A multi-pronged approach shall consider:

- **Invest in Green AI:** Prioritize research into energy-efficient AI models and hardware. Governments and private sectors should fund initiatives that focus on reducing the carbon footprint of AI systems.

- **Adopt Renewable Energy:** Transitioning AI infrastructure to renewable energy sources is critical. Tech companies must lead by example, committing to carbon-neutral or carbon-negative operations.

- **Promote Responsible AI Use:** Encourage the development of AI applications that directly address sustainability challenges, such as climate modeling, energy optimization, and circular economy solutions.

- **Measure and Report:** Establish standardized metrics for measuring the environmental impact of AI systems. Transparency will drive accountability and innovation.
- **Public Awareness:** Educate stakeholders about the energy costs of AI and the importance of sustainable practices. This will foster a culture of responsibility among developers, businesses, and consumers.

AI's dual role as both a driver of sustainability and a significant energy consumer presents a complex challenge that requires innovative solutions and collaborative efforts. By investing in energy-efficient technologies, fostering partnerships, and implementing forward-thinking policies, we can ensure AI remains a powerful force for good.

Looking forward, emerging technologies like quantum computing hold the promise of radically reducing the energy footprint of AI systems. Additionally, developing standardized global frameworks for energy reporting and sustainability in AI deployment will be critical to maintaining transparency and accountability.

Public-private collaborations must also scale efforts to create energy-efficient infrastructures, particularly in developing nations where energy resources are limited. Moreover, expanding public awareness about the environmental impact of AI and fostering education around sustainable practices will be instrumental in creating a culture of responsibility

The key lies in striking the right balance between advancing innovation and managing its impact, enabling AI to truly deliver on its promise of a sustainable future. With collective efforts, we can harness AI's transformative potential while safeguarding the planet for generations to come.

GEORGE SALAMA

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With more than 20 years of experience, George Salama, the “Salama - Policy & Business Intellectual Group” Executive President, is a seasoned international technology advisor, and a diplomat at heart.

Twitter’s Regional Director - Public Policy from 2016 to 2022, where he reinforced Twitter's presence in the MENA region and beyond, led strategic engagement with leaders, governments, policy makers, regulators, law enforcement, civil society and media. George enabled significant policy reforms that served the business evolution and sustainability.

Before joining Twitter, George was the head of Public Policy for SAMENA Telecom Council, an ICT Industry Council based in the UAE, where he was in responsible of setting up, executing the council’s policy plan and business strategies and shaping the ICT industry growth.

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