Europe's Digital Future

The Intersection of Nuclear Energy and AI Governance

Exploring the Convergence of Critical Technologies

Report Date: 14.10.2025

PRESENTED BY

Kristian Vigenin,

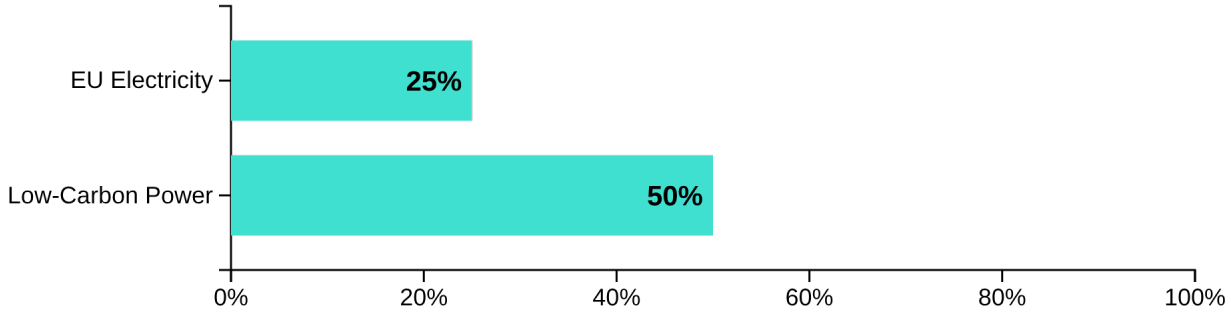
Member of the European parliament

Nuclear Energy in Europe's Energy Structure

25%
of EU electricity

50%+
of low-carbon power

Nuclear Energy's Contribution



Bulgaria Case Study

0% 100%

Kozloduy Nuclear Power Plant provides approximately **1/3** of Bulgaria's electricity.

Strategic importance for energy security

Nuclear energy provides stable baseload power without CO_2 emissions

Responsible Nuclear Energy Utilization

Nuclear energy is strategically important for European energy security and decarbonization goals, yet faces significant challenges that must be addressed.

Strict Safety Standards

Implementing robust safety protocols and adhering to the highest regulatory requirements to ensure plant safety and public protection.

Open Public Dialogue

Fostering transparent communication with stakeholders and citizens about nuclear energy benefits, risks, and waste management.

Continuous Innovation

Investing in advanced technologies like small modular reactors and improved waste management to address current limitations.

European Energy Sovereignty

Reducing dependency on imported fuels and maintaining strategic control over energy systems and technologies.

> "This is not a contradiction, but the essence of good governance. Responsible nuclear energy use requires balancing technical excellence with public acceptance and environmental protection."

AI Applications in Nuclear Energy Systems

Sensors | Operation | Fuel Cycle | Waste

Safety Optimization

- ML models analyze sensor data to detect anomalies before human operators notice
- Reduces unplanned outages and improves safety margins
- Enables predictive maintenance for critical components

Design & Efficiency

- AI-driven simulation tools accelerate reactor design
- Optimizes fuel cycle, enabling more efficient operation
- Enables safer, more efficient next-gen reactors including SMRs

Waste Management

- AI supports radiation monitoring and robotic inspection
- Enables precise mapping of storage facilities
- Minimizes personnel exposure and environmental risks

If properly governed, AI has the potential to make nuclear energy cleaner, safer, and more cost-effective.

New Risks in Safety-Critical AI Systems

Opacity & Explainability

AI systems, especially large models and complex integrations, produce recommendations that human operators struggle to explain.

In nuclear environments, **opaque recommendations are dangerous**

Adversarial Attacks & Threats

AI systems can become vehicles for attacks or errors, increasing the attack surface of critical infrastructure.

Automation expands vulnerability of key infrastructure

Governance Gaps

Existing nuclear safety regulations, network security directives, and AI legislation may not perfectly align.

We cannot wait for incidents to discover these gaps

Human-AI Interaction

AI and human collaboration requires clear explainability

Call to Action

These risks are interconnected and require immediate attention. Safety-critical AI systems must be designed with human oversight and explainability in mind.

Protection of personnel, not just systems

AI's Growing Energy Demand

Substantial Energy Footprint

AI's energy consumption includes data centers, semiconductors, networks, and cooling systems.

- Training a large AI model can consume as much electricity as thousands of European households in a year

Energy Growth Projection

By 2030, global electricity demand for data centers and AI systems could:

2x
potentially double

3x
possibly triple

Global AI energy consumption could soon match a medium-sized European country

Nuclear Energy as a Partner for Digital Transformation

Nuclear energy complements renewable sources

Stable 24/7 Power

- Uninterruptible during sun down or wind calm
- Low-carbon foundation for AI infrastructure

Data Centers

- SMRs for industrial clusters
- Advanced cooling systems

AI Systems

- Power for drug design
- Grid management

"Our digital future depends on energy transformation"

Ethical Boundaries and Risk Management

Over-automation Risks

- When decision-making power is delegated to algorithms, human responsibility becomes blurred
- Who is responsible when AI systems fail in safety-critical environments?
- Legal frameworks must evolve to address algorithmic decision-making in high-stakes environments

Cybersecurity Dimensions

- IAEA has warned of growing cyber threats to nuclear facilities
- AI tools can both provide protection and be weaponized by attackers
- We are entering an "algorithm security" era with enhanced capabilities for both defenders and attackers

Social Dimensions

- Energy sector workers (engineers, operators, maintenance personnel) must not be left behind
- Workers are living guardians of safety culture and must be protected
- No genuine progress without justice; technology serves people, not the other way around

Balancing innovation with control is essential for responsible AI and nuclear energy integration

Call to Action

Key Investments for a Sustainable Future

Public Research
Invest in independent research to ensure safety and innovation

Unified Standards
Create harmonized safety and security standards across borders

Robust Cybersecurity
Protect critical infrastructure from evolving digital threats

Worker Participation
Ensure energy industry workers have a voice in AI implementation

Parliamentary Oversight
Maintain democratic control over nuclear and AI governance

Vision for Europe

"A sustainable future requires balancing innovation with safety, protecting workers while embracing digital transformation, and ensuring that our energy choices serve the public interest."

Path Forward

- Integrate AI to enhance safety and efficiency
- Balance renewable energy with stable baseload
- Prioritize public interest in technology deployment