Polish Digital Resilience Agenda 2040
a model of strategic preparedness
for the antinomies of digitalisation.

Scenario: Window of resources and potential

strategic area: Energy

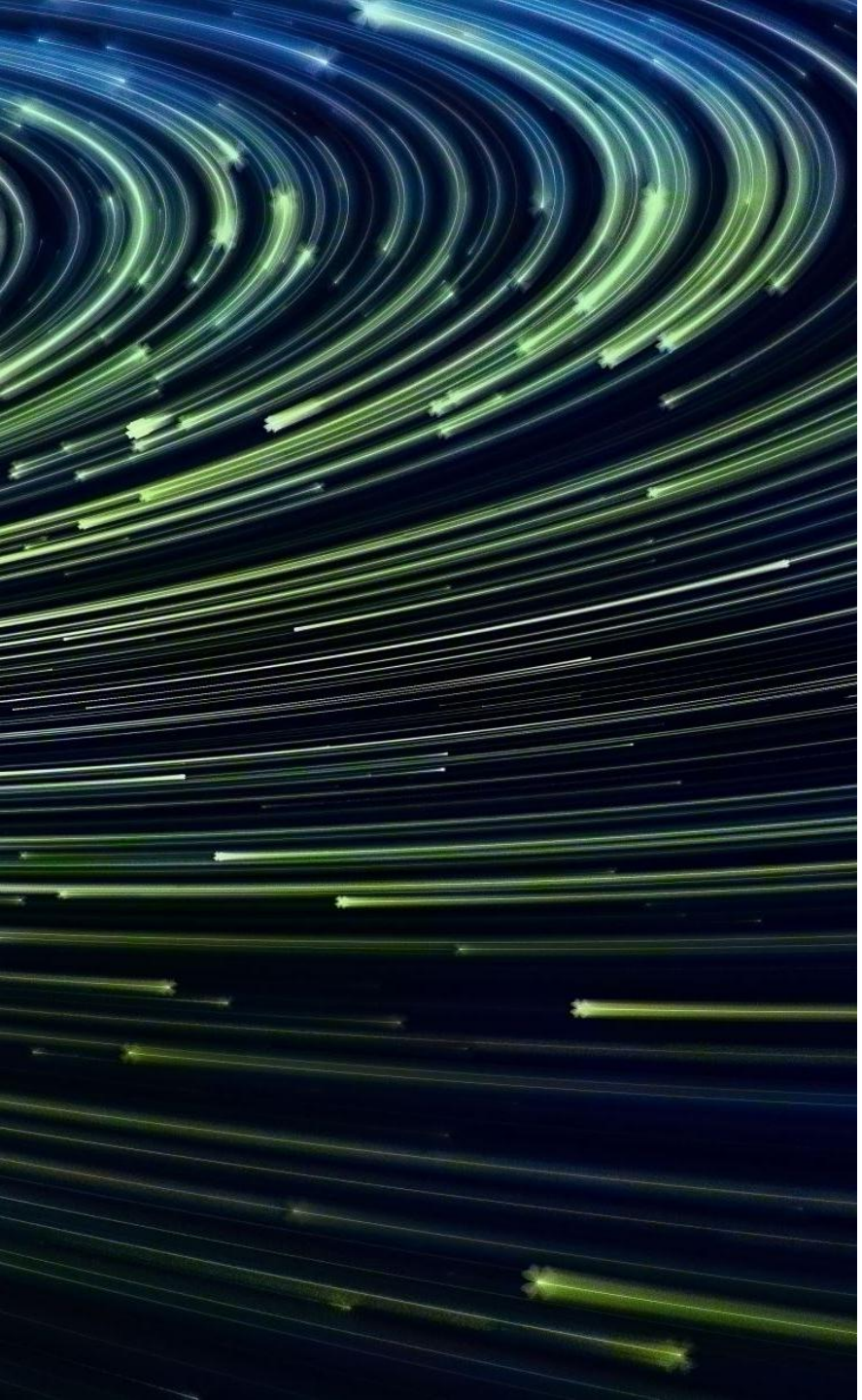
Scenario of the digital transformation of the Polish energy sector by 2040

Not an asset exchange, but a metamorphosis

A paradigm shift

Old thinking	New thinking
Replace coal with renewable energy	Build a digital, adaptive ecosystem
The network as a static infrastructure	The network as a living, self-organizing organism
Ex ante regulations	Algorithmic surveillance and technical protocols
Dependence on technology imports	Sovereignty based on your own resources

"Automation and digitalisation are not ancillary tools - they are a condition for achieving energy sovereignty."



Unique advantage: Polish geothermal potential

Geothermal potential:

The potential to supply heat to 70% of Polish households

Existing infrastructure: existing oil and gas exploration wells available for use

Digital technology boosts efficiency:

Digital Geological Twins → drilling precision +40–60%

Geothermal energy as ATES/BTES energy storage — a stabiliser for volatile renewable energy sources

Reduction in unplanned downtime: −50–70%

Reduction in operating costs: −18–25%

Installation cost: €5–15 million per unit

CPES: energy as a living organism

- *From a hierarchical network to a self-organizing biological ecosystem*
- **CPES (Cyber-Physical Energy Systems) architecture:**

- **Key abilities:**
  - **Wolfpack algorithm — a metaheuristic that searches for the optimal system configuration**
  - **Self-healing grids — automatic network reconfiguration after a failure**
  - **DSR (Demand Side Response) – data centers as virtual energy storage**
  - **Smart Contracts - P2P market without intermediaries → savings of PLN 8-12 billion per year**

Seven pillars of transformation

I. Geothermal energy as a foundation

use of existing boreholes, ATES/BTES,

II. Algorithmic oversight

replacement of ex ante regulation with technical protocols,

III. Dynamic ecosystem

real-time orchestration of sources (CPES),

IV. Algorithmic capital allocation

asset tokenisation, profitable investments,

V. Knowledge diffusion (AI-ITS)

Intelligent Tutoring Systems in response to staff shortages,

VI. Technological bridge (coal)

IoT overlays on old power stations — evolution, not revolution,

VII. On-demand production

Industry 4.0 factories as grid stabilisers.

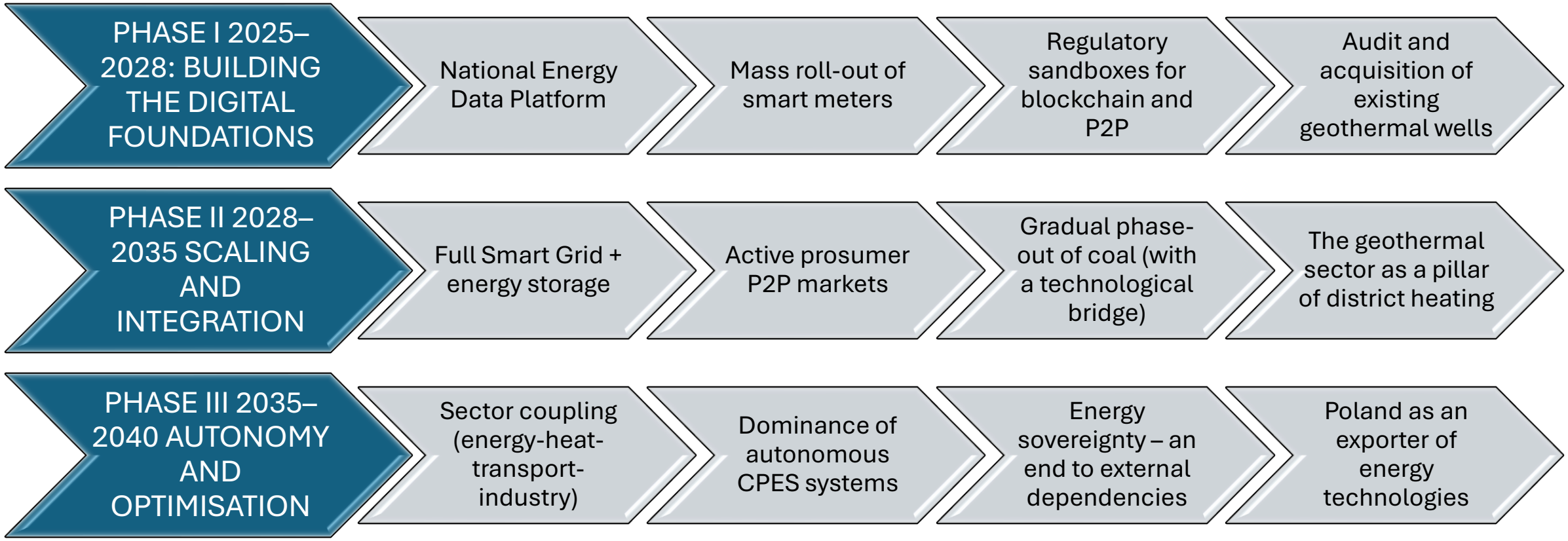
Pillar VI: "Technology Bridge" - what about coal?

"Instead of immediate, costly decommissioning — evolutionary digital modernisation"

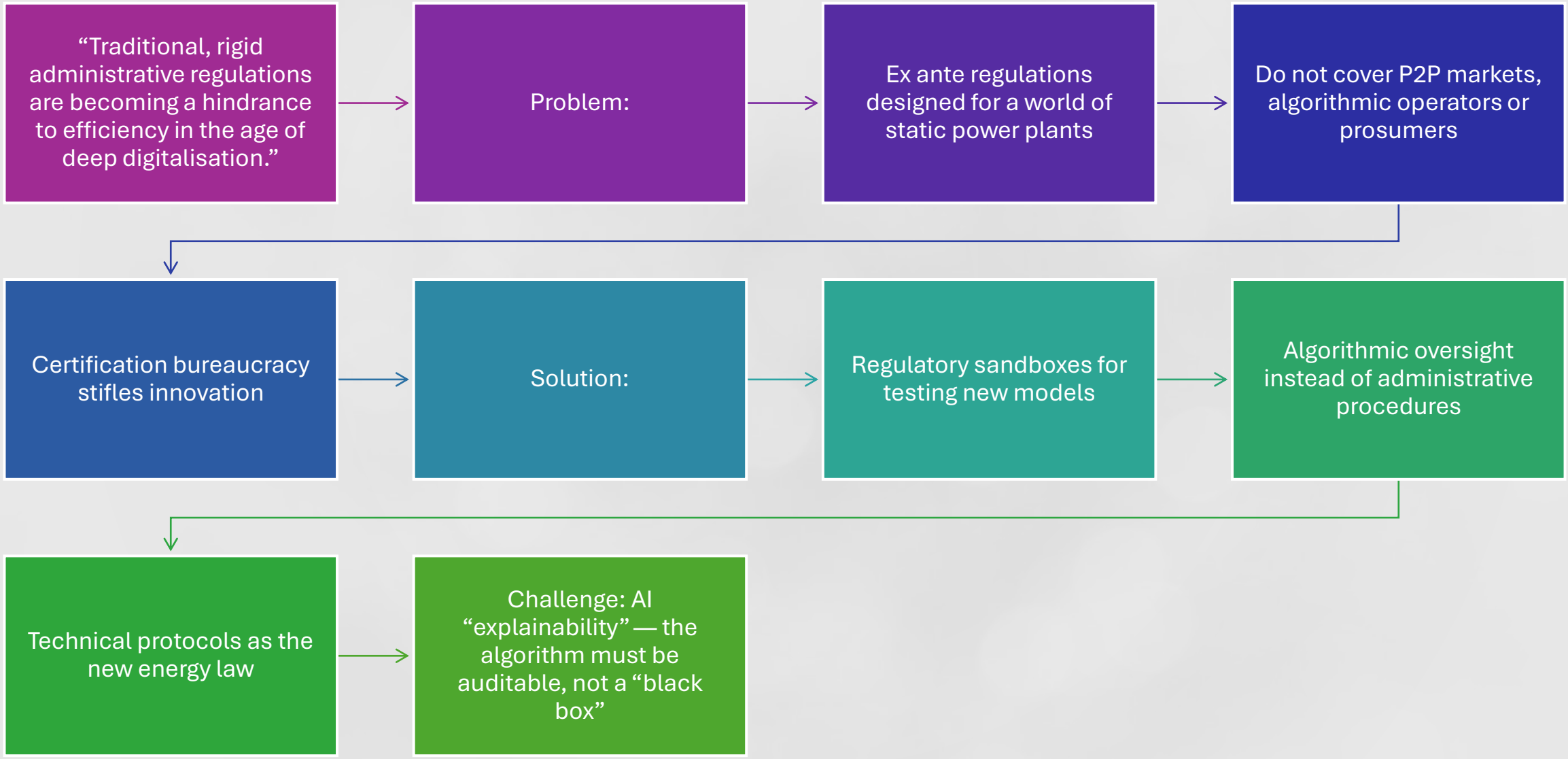
The "IoT Overlays" strategy:

- Installation of IoT sensors and big data analytics on existing coal-fired power stations
- Improved efficiency and reduced emissions without replacing the entire plant
- Coal as a stable baseload source whilst new renewable and nuclear capacity is being built
- Avoiding sudden CAPEX expenditure and the social costs of abrupt transformation
- Key principle: The energy transition must not outpace society's ability to absorb it

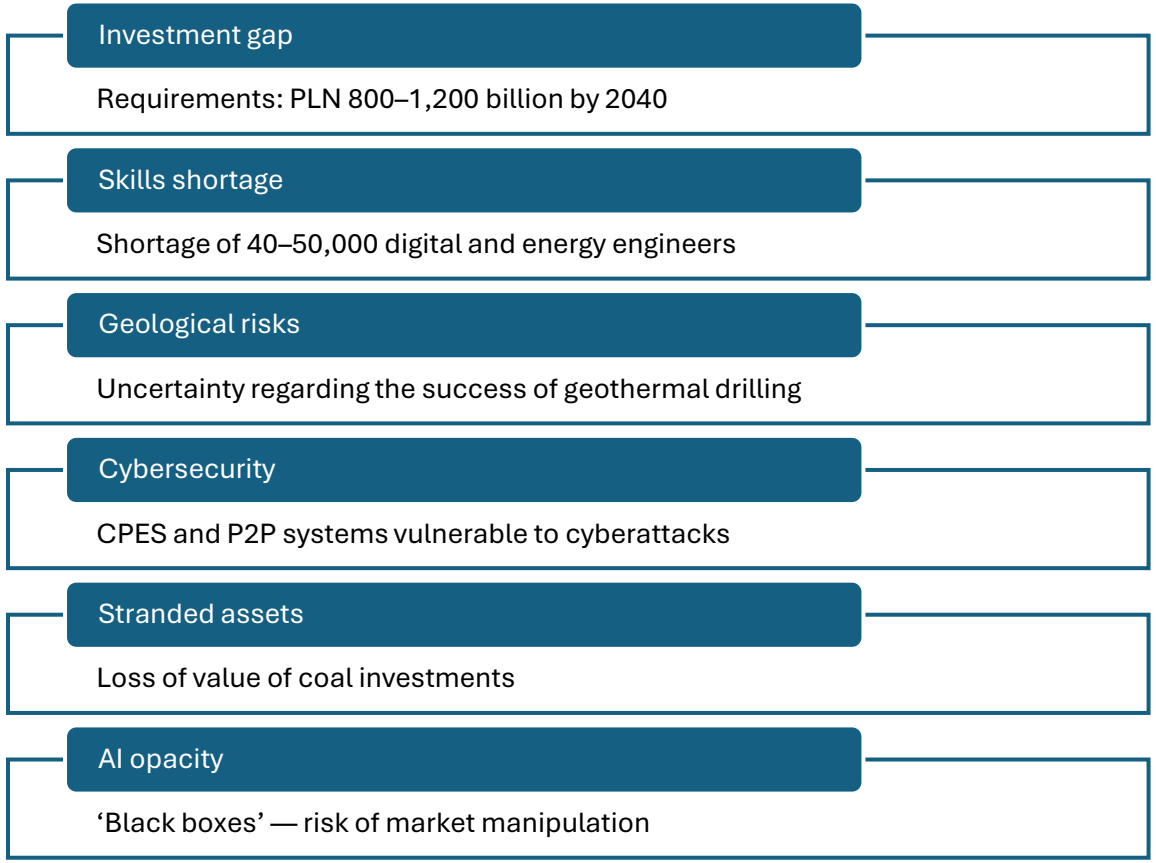
Three phases of transformation



Regulatory Paradox 2040



Risks and barriers to implementation



Response to the staff shortage:

- AI-ITS systems (Intelligent Tutoring) shortening training time by 30-50%
- Goal: creating 120,000 new jobs in the sector

Strategic recommendations

National Energy Data Platform — digital infrastructure as a priority on a par with physical infrastructure

Geothermal Acceleration Programme — geological risk guarantees, audit of existing wells, public funding

Regulatory sandboxes — a space for testing blockchain, P2P and algorithmic management

National Human Resources Programme — Data Science and energy engineering as an educational priority

IoT Overlays Strategy — digitisation of existing coal infrastructure as a transitional bridge

CPES Cybersecurity — a separate strategy for the protection of critical digital infrastructure

Tokenisation of energy assets — attracting private capital to fill the investment gap

Bottom line: a window of opportunity

"A window of resources and potentials - Poland has a unique combination of resources and historical moment. It is a matter of will and speed of decision."

Three reasons why the scenario is realistic:

- Poland has geothermal resources — a unique comparative advantage
- Existing drilling infrastructure – ready for takeover and redevelopment
- CPES and blockchain technologies are available today, not in the future

Critical condition:

- Regulatory transformation must keep pace with technological transformation
- Without sandboxes and algorithmic supervision, the digital system will be strangled by analog law

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Postscript: one-page script

This is a desirable and ambitious scenario, this time for the energy sector. Poland is entering the energy transition not as a late student imitating the West, but as a country with its own unique strategic resources, which, if managed wisely, can become the foundation of true sovereignty.

The narrative is based on a breakthrough insight: Energy modernization is a digital metamorphosis of the entire system. Poland is on the threshold of transition from a hierarchical, static power grid towards a living, self-organizing organism - a CPES (Cyber-Physical Energy Systems) system inspired by biological homeostasis. A network that "heals itself", algorithms acting like a pack of wolves looking for the optimal solution, prosumers trading energy directly via blockchain - this is not science fiction, this is technology available now.

The scenario's key finding: Poland has something other countries don't have — vast, largely unexploited geothermal potential (the ability to heat 70% of households) and a network of oil and gas exploration wells that can be taken over and converted. Geothermal is not just a source of heat – it becomes an energy store, a grid stabilizer, and an anchor of sovereignty.

The central drama, however, is the Regulatory Paradox 2040: the more digital and adaptive a system becomes, the more traditional administrative regulations suffocate it. The solution is a regulatory revolution – replacing bureaucratic ex ante procedures with algorithmic surveillance and regulatory sandboxes. Poland must change not only power plants, but also the way the law understands energy.