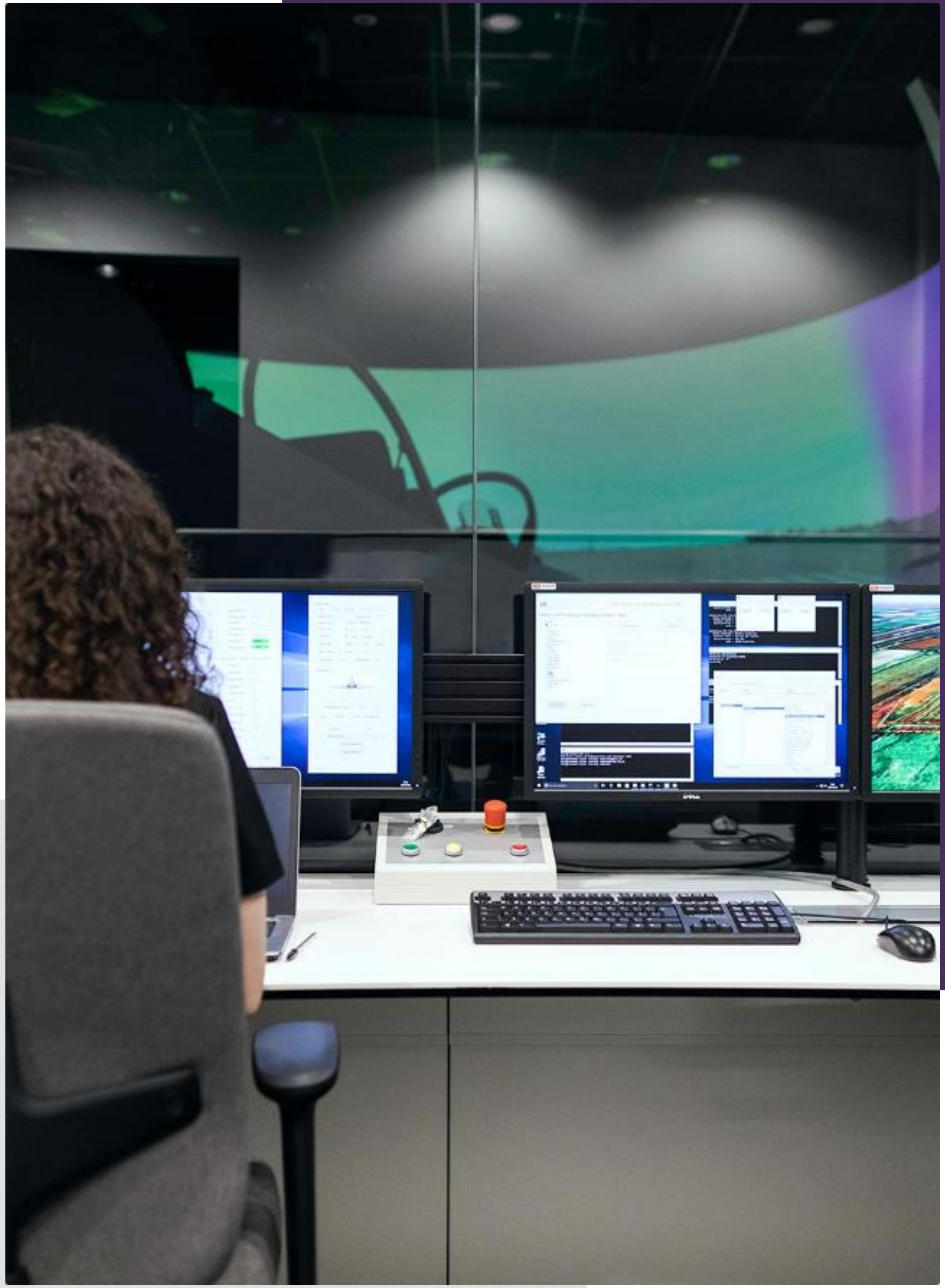
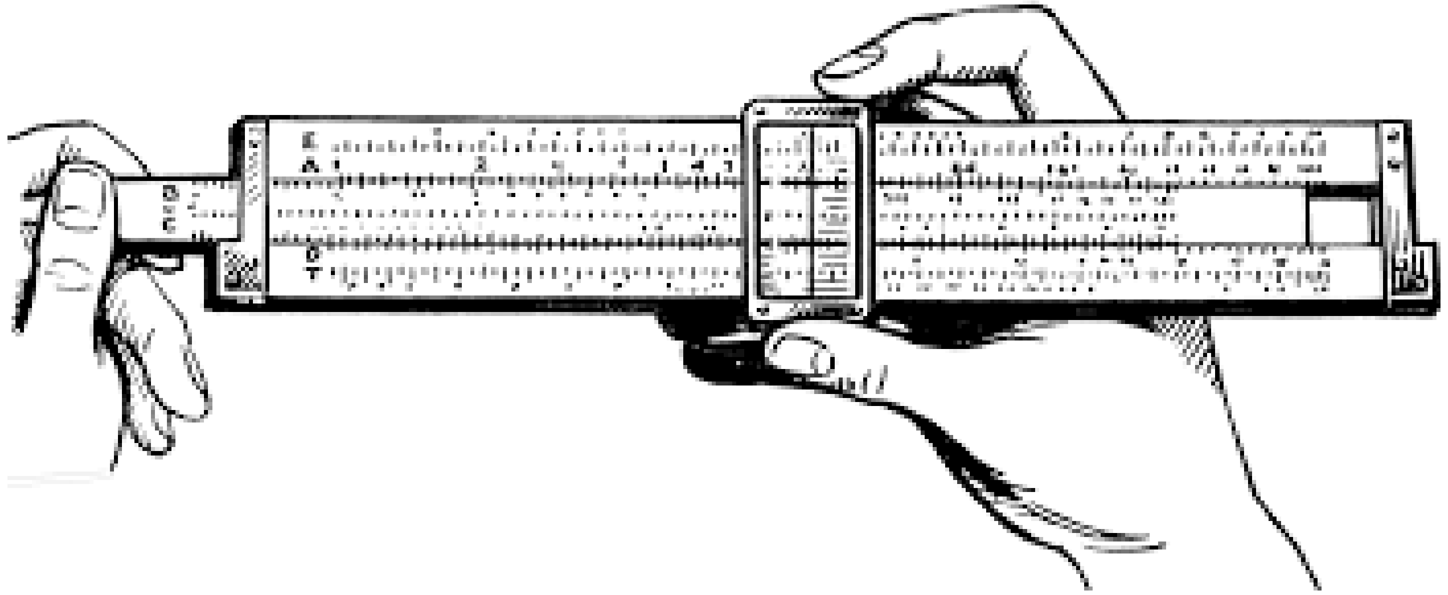
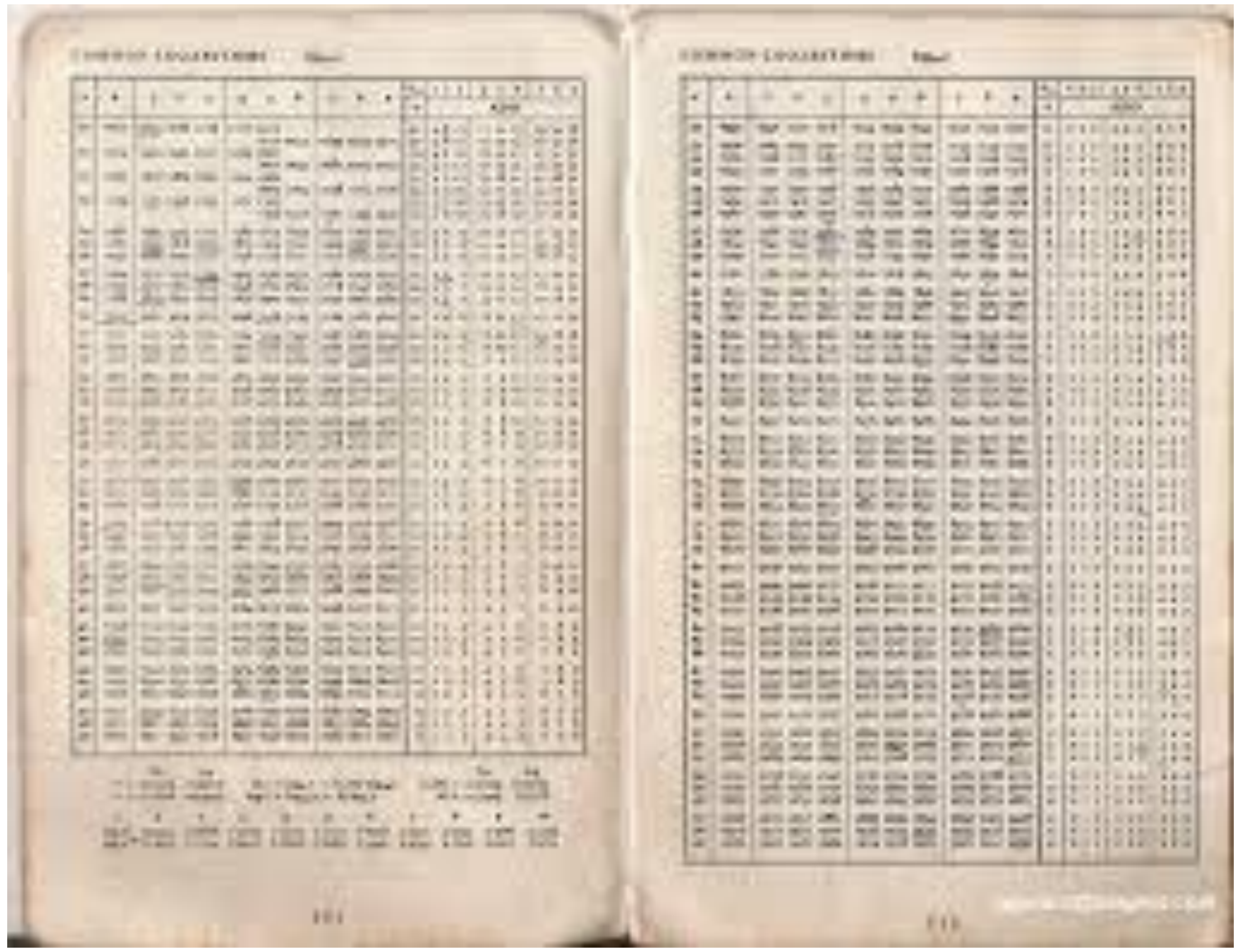


AI and the Future of Energy: Driving Efficiency, Safety, and Sustainability

Seye Solabomi

Once upon a time…





Analytics – Prediction - Automation

Real-time analytics monitor smart meters, sensors, and IoT to optimize production and consumption

Predictive adjustments use advanced algorithms to identify inefficiencies and suggest actions

AI-driven automation streamlines processes, improves asset utilization, and cuts operational costs

Enhances **demand forecasting** to meet regulatory targets and customer expectations

Supports **sustainability** by reducing waste across production and consumption

AI Advancing Safety in Energy Systems

Predictive analytics anticipate equipment failures and hazardous conditions before incidents

Intelligent monitoring analyzes sensor data to detect anomalies for proactive maintenance

Machine learning risk models inform emergency planning and reduce downtime

Reduces downtime and **protects workers and infrastructure** in hazardous energy environments

Supports rapid response through automated alerts while preserving human oversight

Safety & Inspection

AI Supporting Sustainability Goals in Energy

Renewables integration — AI forecasts weather and demand to maximize solar and wind utilization

Emissions reduction — AI optimizes dispatch and storage to cut carbon output

Resource management — AI monitors assets and schedules maintenance to reduce waste

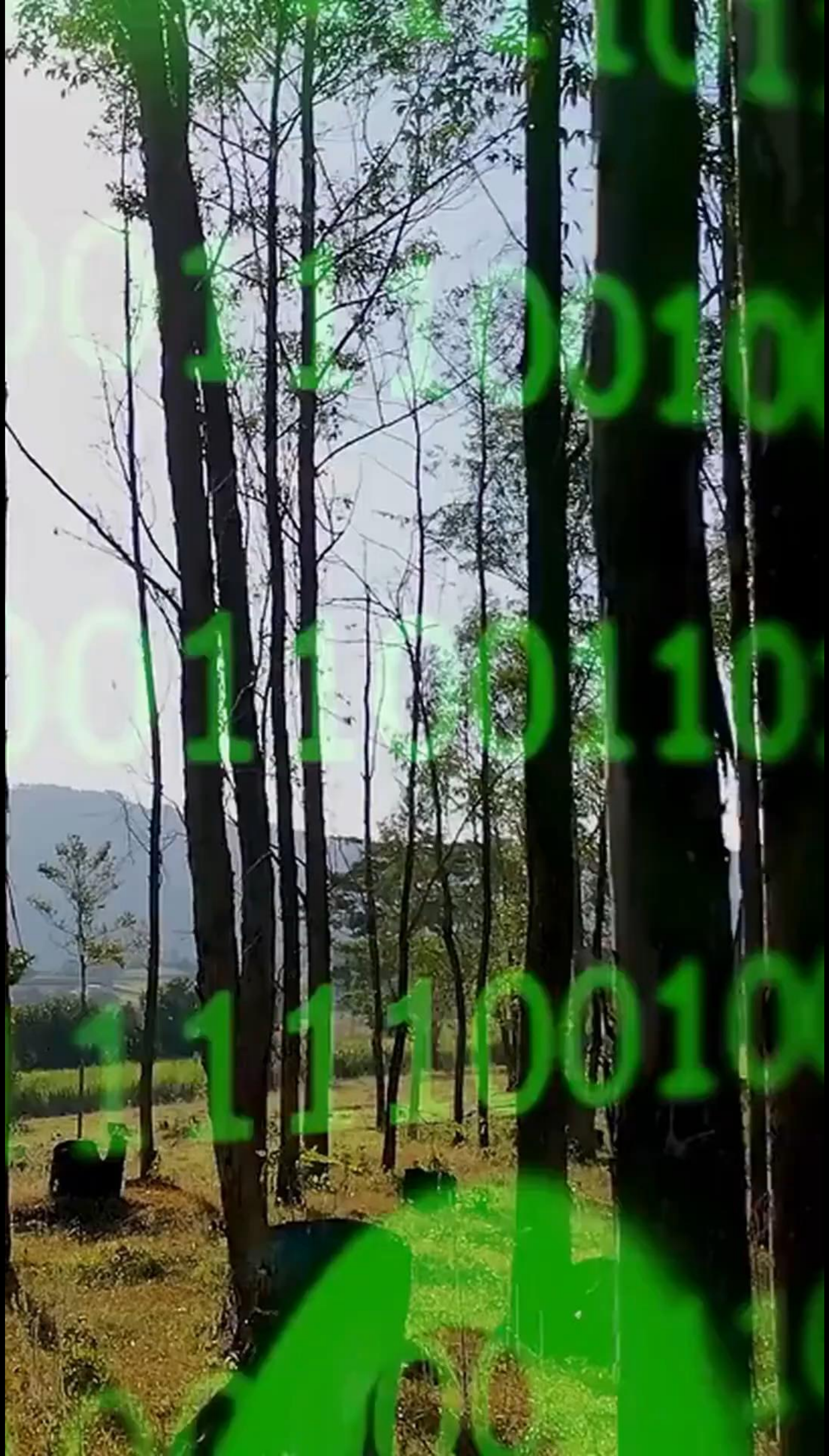
Smart grids — Dynamic balancing of supply and demand via AI-enabled controls

Compliance & reporting — AI helps meet environmental regulations and sustainability targets

Marketing opportunity — Use AI insights to craft sustainability messaging and customer segmentation

Summary — AI enables efficient use of renewables, lowers carbon, and supports corporate sustainability

AI Energy
Optimization



AI-Enabled Predictive Maintenance & Asset Management

- **Reduced downtime** by forecasting equipment degradation from historical and real-time data
- **Lower maintenance costs** through targeted interventions and fewer unexpected failures
- **Prioritized repairs** based on risk and performance metrics to maximize asset uptime
- **Improved lifecycle management** and capital allocation strategies driven by AI insights
- **Real-time monitoring** integrated with historical analytics for continuous optimization
- Summary: **AI reduces failures, cuts costs, and directs capital where it delivers most value**

AI’s Role in Grid Optimization & Demand Response

Real-time balancing, consumer incentives, and smarter integration of distributed resources

Enable **real-time balancing** of electricity supply and demand with predictive algorithms

Power **Demand Response** programs by incentivizing consumer adjustments during peak periods

Integrate **distributed energy resources** (solar, storage, EVs) for improved reliability

Reduce **energy losses** and grid strain through adaptive control and load shifting

Support operators with automated recommendations while keeping **human intervention** options

Enhance **reliability** via fault detection, predictive maintenance, and grid resilience

Opportunity for **marketers**: promote time-of-use offers and AI-enabled energy services

Summary: AI enables dynamic grid management, demand response, DER integration, and loss reduction

Opportunities of AI in Energy Marketing and Customer Engagement

Use AI to personalize offers, optimize pricing, and improve customer experience at scale

- Predictive analytics for demand forecasting and tailored offers
- Customer segmentation using behavioral and usage data
- Personalized engagement via targeted campaigns and realtime messaging
- Automated pricing platforms that optimize tariffs and promotions
- Promote energy efficiency programs with AI-driven recommendations
- Chatbots & real-time communication to enhance customer experience
- Adapt to changing consumer behavior and regulation efficiently

AI enables personalization, efficiency, and scalable engagement

Challenges in Integrating AI into Energy Operations

Key obstacles and practical actions to enable safe, transparent, and adoptable AI

1. Data quality & integration — inconsistent sources, legacy systems; centralize data lakes, enforce standards, continuous validation
2. Interoperability — complex system interfaces; adopt open APIs, modular architectures, vendor-neutral standards
3. Workforce skill gaps — limited AI literacy; invest in cross-functional training, role-based upskilling, mentorship programs
4. Change management & adoption — resistance to new workflows; involve users early, pilot fast, measure adoption KPIs
5. Ethics, bias & transparency — fairness and explainability required; embed bias checks, model explainability, audit trails
6. Governance & failsafes — need human-in-the-loop and clear policy; define governance, emergency overrides, and professional oversight
7. Cross-functional collaboration — align IT, operations, safety, and compliance; establish steering committees and shared KPIs
8. Ongoing training & lifecycle management — models degrade; implement continuous learning, monitoring, and retraining plans
9. Summary: strategic planning + standards + people-first change = practical path to safe AI adoption

AI Governance & Ethical Standards for Energy

Policies, transparency, and accountability to protect people and critical infrastructure

Responsible development to mitigate unintended biases, privacy breaches, and operational failures

Establish clear policies, transparency standards, and accountability mechanisms

Align AI strategies with regulatory compliance and ethical frameworks

Implement failsafe systems that allow human intervention in operations

Involve energy professionals in crafting AI policy to safeguard critical infrastructure

Build stakeholder trust through accountability, audit trails, and transparent reporting

Ensuring Failsafe Systems and Human Oversight in AI Deployments

- Manual override capability for immediate human intervention to stop or redirect AI actions
- Continuous monitoring: real-time telemetry, anomaly detection, and alerting for energy systems
- Transparent reporting: clear logs, audit trails, and explainable outputs for post-incident review
- Human validation of AI outputs: expert review for complex scenarios and edge cases
- Resilience planning: redundant controls, graceful degradation, and failover procedures
- Embed clear escalation paths and roles so energy professionals can craft policy and respond effectively
- Maintain continuous training and drills to keep humans fluent in system limits and overrides
- Summary: Combine technical failsafes + human oversight to manage AI risk in energy operations

Energy Professionals Shaping AI Policy

1. Domain knowledge ensures policies reflect operational realities, safety constraints, and context-specific risks
2. Safety-first design: embed failsafe requirements and human intervention points in AI systems
3. Ethics & compliance: translate ethical imperatives into actionable operational rules
4. Practical governance: co-create audit trails, testing protocols, and deployment standards
5. Stakeholder buy-in: collaborative process increases acceptance and improves adherence
6. Strategic alignment: align AI use with business objectives and societal sustainability goals
7. Summary: Involve energy professionals to ensure practical, safe, ethical, and accepted AI policy

Existing AI Deployments

Refining and Process Optimization

- Shell

Shell uses AI for refinery process optimization, leveraging machine learning to analyze sensor data and improve throughput, energy efficiency, and emissions control. Their collaboration with C3.ai has enabled predictive analytics across refining operations.

- BP

BP applies AI in its refining operations to predict equipment failures and optimize maintenance schedules. This reduces downtime and enhances safety. Their use of digital twins and AI models helps simulate refinery conditions and improve decision-making.

- Chevron

Chevron integrates AI into its downstream operations for real-time monitoring and predictive maintenance. AI models analyze vibration and temperature data from pumps and compressors to anticipate failures before they occur.

- TotalEnergies

In 2022, TotalEnergies partnered with Fieldbox to deploy an AI system that predicts pump failures in downstream facilities. This predictive maintenance tool helps reduce unplanned downtime and maintenance costs. TotalEnergies established also established a Digital Factory in 2020, housing over 300 AI and digital experts. This hub develops AI models to optimize refining operations, reduce emissions, and improve energy efficiency across its industrial sites.

Customer Analytics and Retail Optimization

- Iberdrola

Iberdrola uses AI to enhance customer experience in its energy retail business. Through its Aldeatejada innovation center, it applies machine learning to forecast demand and personalize energy plans for consumers.

- Schneider Electric

Schneider Electric deploys AI in smart building systems that adjust HVAC and lighting based on occupancy and weather patterns. These systems are part of their downstream energy efficiency solutions for commercial clients.

Demand Forecasting and Trading

- Shell and BP

Both companies use AI for electricity trading algorithms that analyze market trends, demand forecasts, and regional load shifts to optimize bidding strategies.

Predictive Maintenance and Asset Management

- NextEra Energy

NextEra uses AI-powered drones for infrastructure inspections in its downstream operations. These drones capture thermal images and detect anomalies in pipelines and storage facilities, enabling faster repairs and reducing outages.

- National Grid

While primarily a transmission company, National Grid's downstream applications include AI-driven monitoring of underground utilities. This helps avoid costly excavation errors and improves service reliability.

Energy Trading and Forecasting

- Predictive Layer Acquisition

In 2023, TotalEnergies acquired Predictive Layer, a company specializing in machine learning for energy trading. This strengthened its ability to forecast energy prices and optimize trading strategies in downstream markets.

- Cerebras CS-2 Supercomputer

To support its AI ambitions, TotalEnergies invested in the Cerebras CS-2, a high-performance AI computer used to train models for energy forecasting and trading optimization.

Customer-Facing and Retail Applications

- Microsoft Copilot for Employee Productivity

In 2024, TotalEnergies became one of the first energy companies to adopt Microsoft's generative AI assistant (Copilot) to enhance employee productivity in customer service and retail operations.

- AI for Energy Management Services

The company uses AI to help customers manage their energy consumption more efficiently, offering personalized services and usage forecasts through digital platforms.

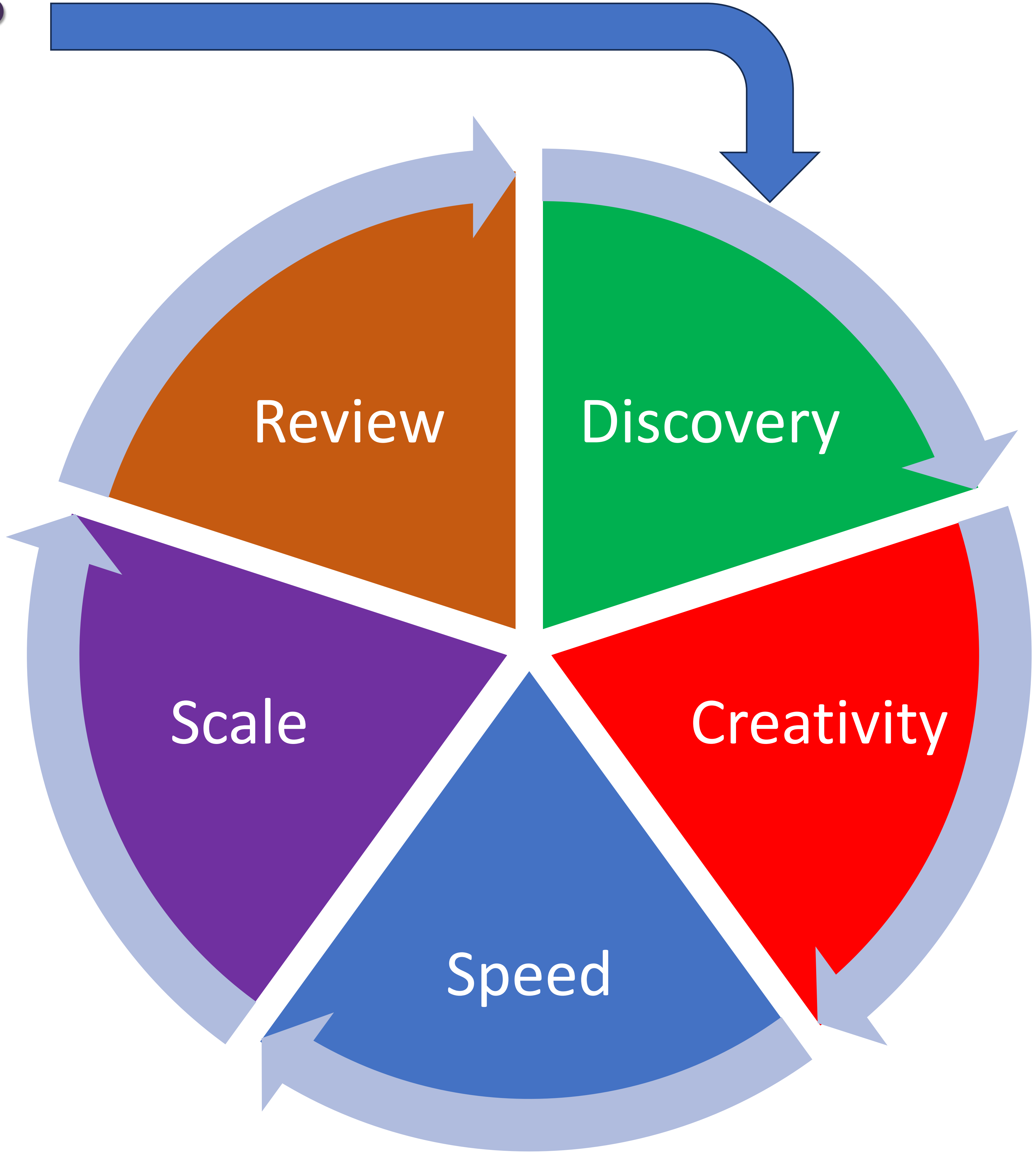
Strategic AI Ecosystem

- Mistral AI Joint Innovation Lab

In 2025, TotalEnergies partnered with Mistral AI to co-develop next-generation generative AI tools. These tools support over 1,000 researchers working on low-carbon energy solutions, including downstream applications like biofuels and synthetic fuels.

Sources: TotalEnergies – AI, Expediting the Energy Transition, EnkiAI – TotalEnergies AI Initiatives for 2025, Klover.ai – TotalEnergies' AI Strategy , Digital Adoption – 12 Examples of AI in Energy, Energy Digital – Top 10 AI Applications in Energy, Appinventiv – AI in Oil and Gas

Where to Start?



Next Steps

Recommended Reading: Industry Whitepapers, Standards Organizations' Guidelines, Emerging AI Ethics Frameworks For Energy Systems

Next Steps: Consult Sector-specific Standards And Ethics Frameworks When Developing AI Policies And Failsafe Requirements

"The secret of change is to focus all of your energy, not on fighting the old, but on building the new," - Socrates