Getting to Net-Zero: The Role of AI&ML

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AI&ML's Role In The Energy Transition

- Pivotal tool, but not the only one

- Already playing a huge role

- Cross-sector decarbonization applications
  - Transportation
  - Electric Grid
  - Buildings
  - Industry

- AI and Digitalization positive feedback loop

- Caution required

Clean Energy Integration

Decarbonization Roadmapping and Impact Analysis

Energy Efficiency

Energy Equity, Environmental Justice

Forecasting and System Planning

Grid Reliability and Resilience

Challenges and Current Gaps in AI for Net Zero

- Existing data infrastructure
  - Insufficient real-world data
  - Data quality and availability

- Robustness
  - Handling "unseen" events

- Trustworthy AI
  - Often "black-box" models
  - Lack interpretability and explainability

- Bias, fairness, privacy

- Security
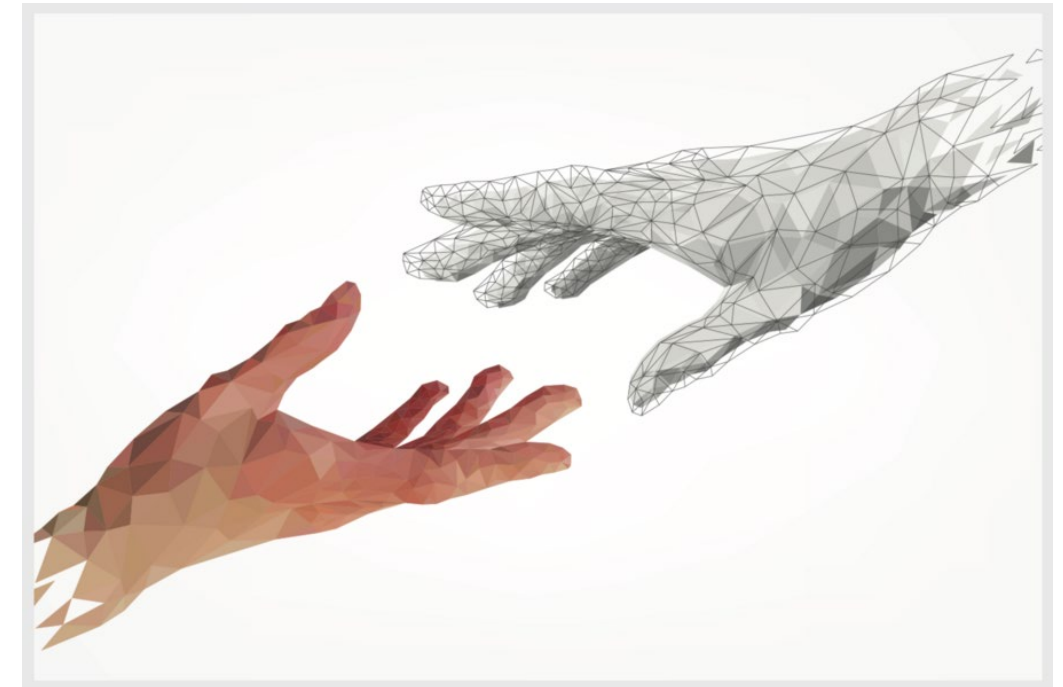
Research, Development, and Demonstration to the Rescue

- State-of-the-art today not good enough, yet

- Research & Development
  - Developing "grid of the future"
  - Model transparency
    - ✓ Physics-informed methods, others
  - Model improvements

- Demonstration
  - At the Labs and in industry
  - Demonstrate value proposition
  - Builds trust in new methods
  - Highlights gaps
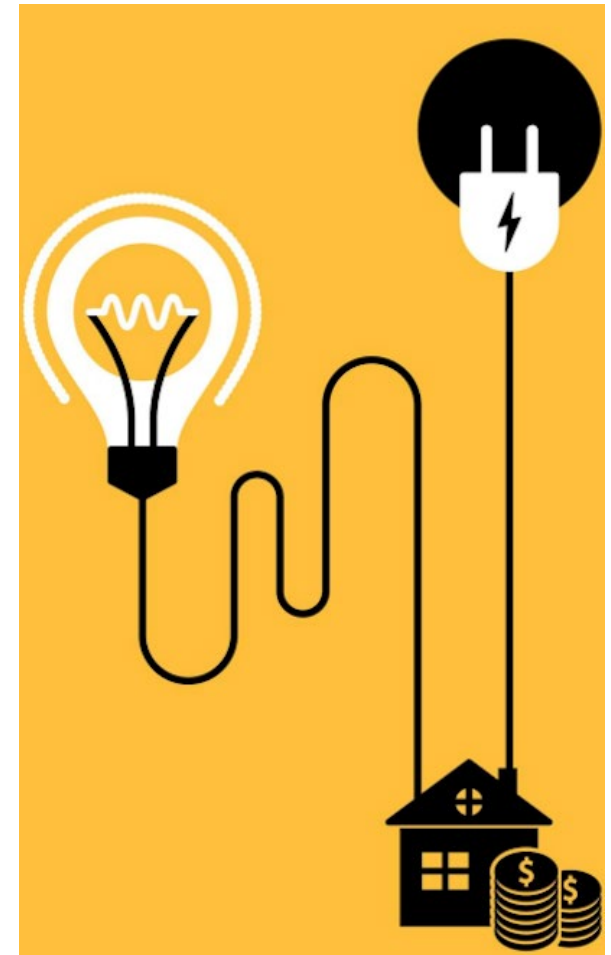 - Best practice development
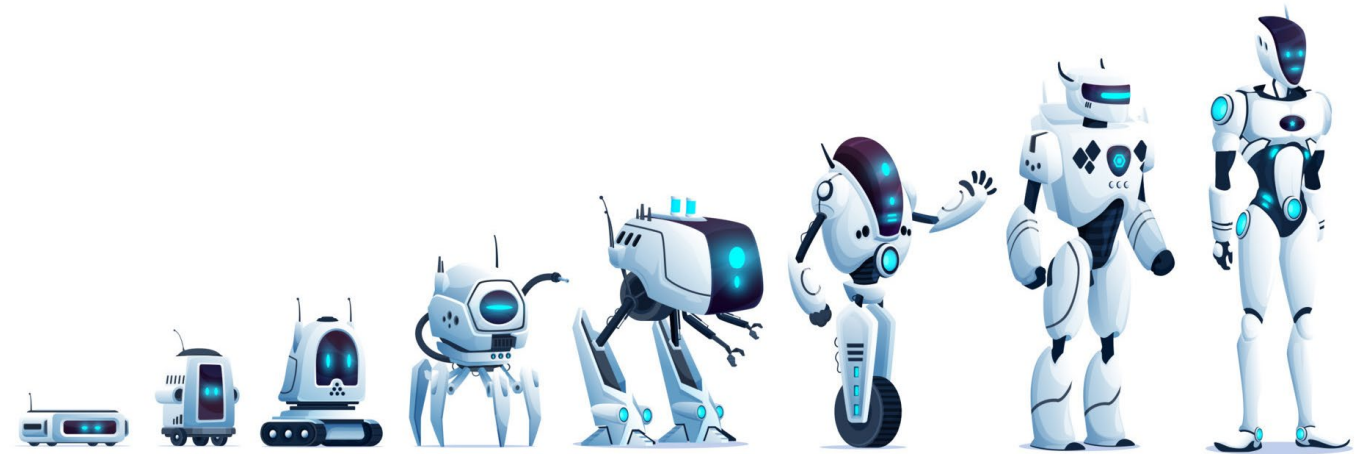
Net Zero Deployment Strategies Using AI&ML

- Demand side – energy efficiency and optimization
  - Energy forecasting
  - Fault detection and diagnosis (FDD)
  - Advanced control for DERs

- Supply side – Smart Grid: grid management and operations
  - Renewable energy integration
  - Energy storage optimization
  - Resilience and long-term planning

- Transportation
  - Electric vehicle charging and infrastructure optimization
  - Traffic management

- Earth systems and energy interactions
  - Non-stationary climate modeling and impacts

- Compliance tracking – Scope 3 challenges

AI Enabling an Affordable Net-Zero Future

- Root-cause analysis of past events
  - Renewable energy curtailment
  - Price volatility

- Minimize required build-out
  - Improved planning
  - Maximize utilization
  - Increase efficiency

- Increase resilience
  - FDD
  - Extreme event response

- Ensure the burden is equitably shared
  - Equity impacts assessment, policy design

Thank you