INL/CON-24-78128-Revision-0



# Cybersecurity Considerations for Emerging Energy Technologies

May 2024

Megan Jordan Culler

Changing the World's Energy Future


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**May 2024**

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**Megan Culler**
Infrastructure Security

# Cybersecurity Considerations for Emerging Energy Technologies

## SEIA's Security and Reliability Forum

Battelle Energy Alliance manages INL for the
U.S. Department of Energy's Office of Nuclear Energy

Idaho National Laboratory

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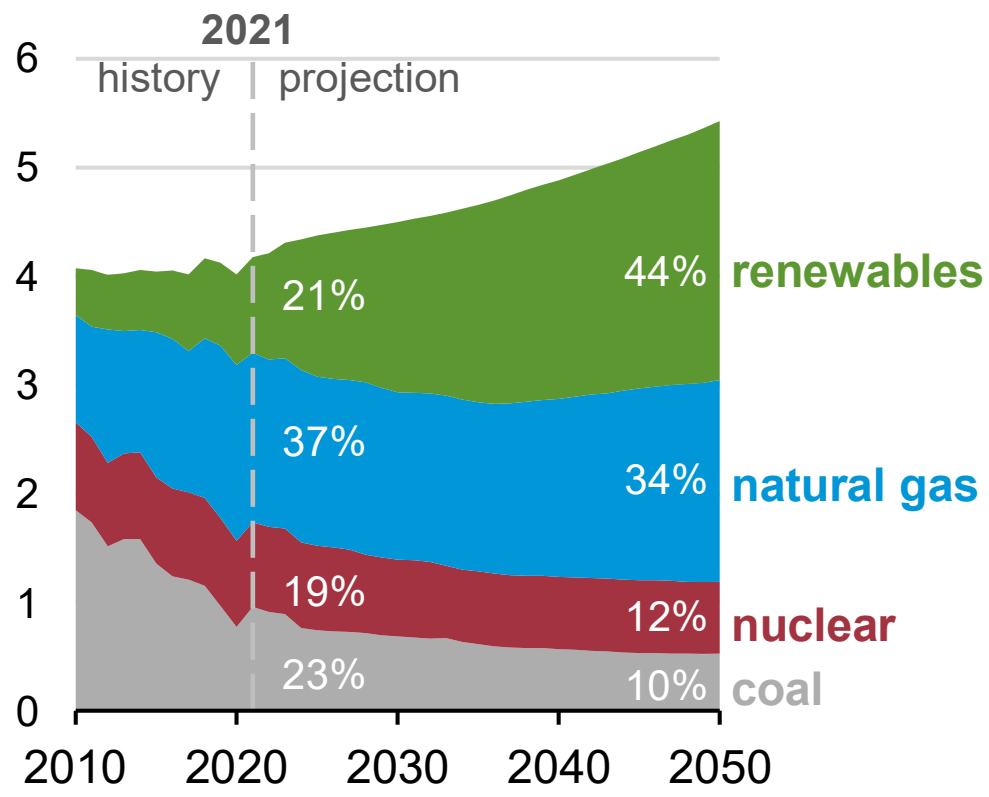
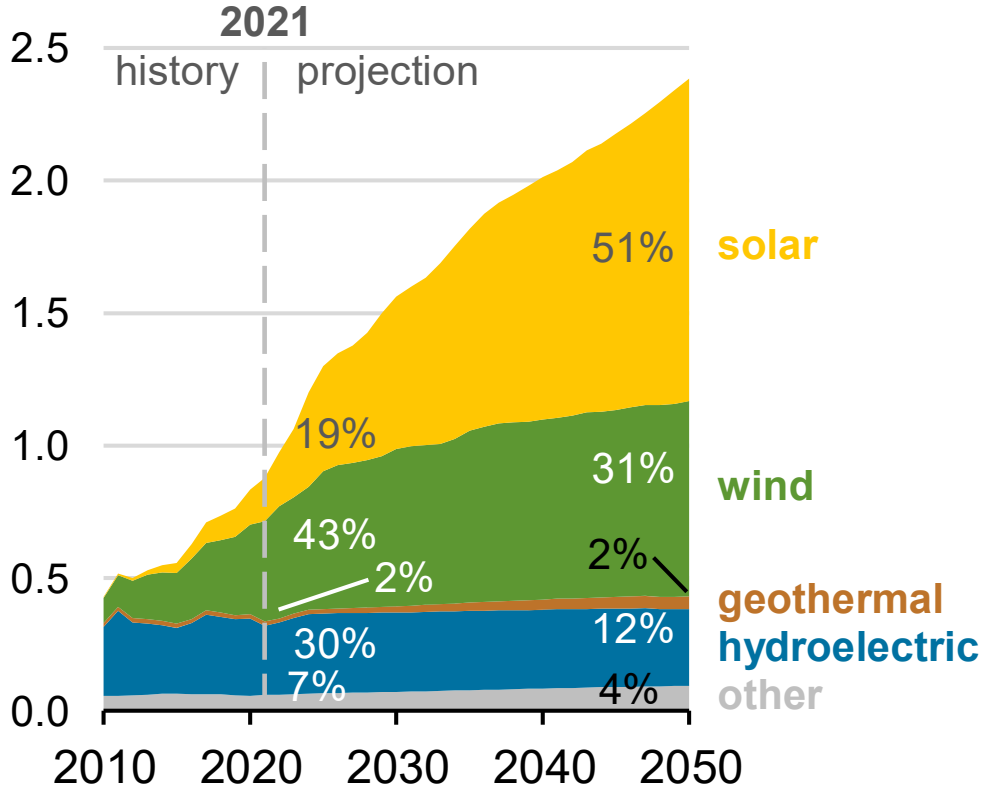
# 2020 to 2050 Capacity and Energy Production in the U.S.

**U.S. electricity generation**
**AEO2022 Reference case**
trillion kilowatthours

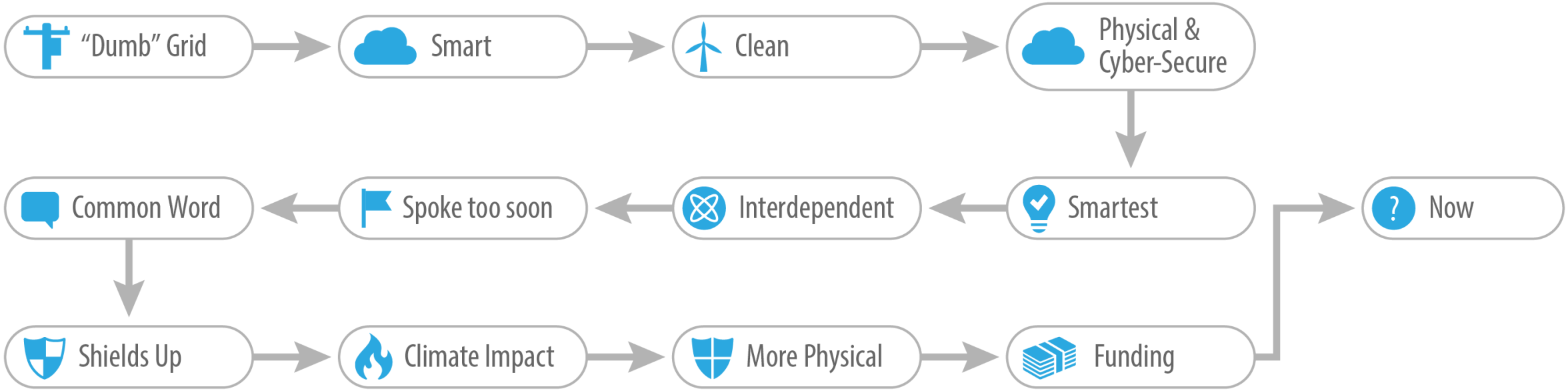



**U.S. renewable electricity generation**
**including end use**
trillion kilowatthours




https://www.eia.gov/todayinenergy/detail.php?id=51698

# Energy Delivery Digital Transformation:
*Where are we Going?*



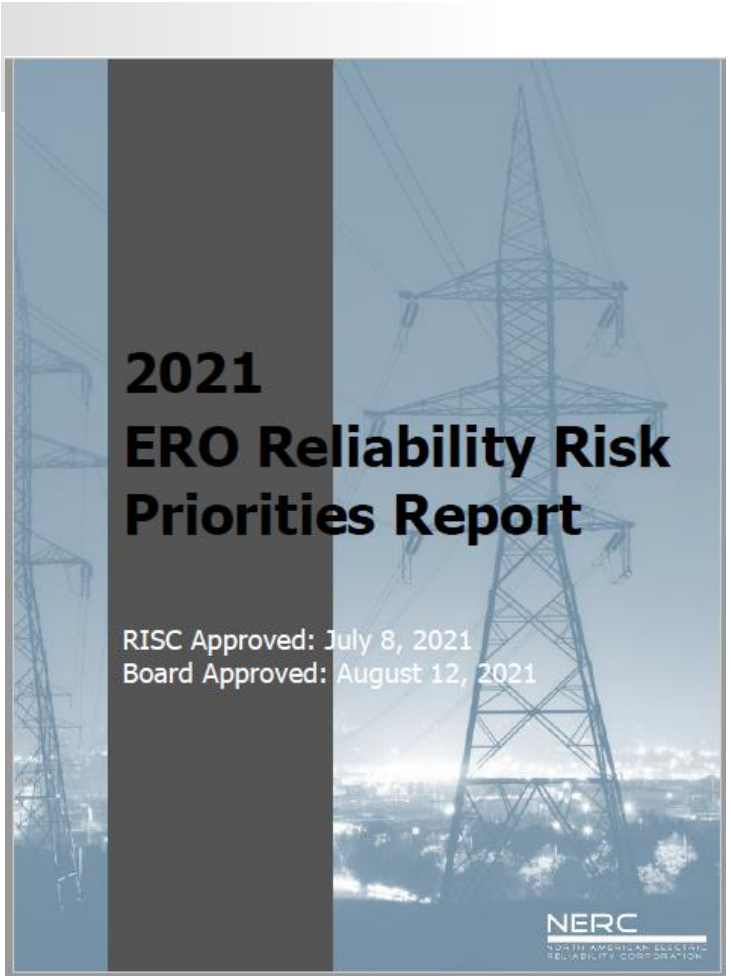
# Future of IBR

| Changes in IBR | | Impact to cybersecurity |
|---|---|---|
| • Growth of stakeholders | → | • Increase in attack surface |
| • Growth of endpoints | → | • Increase in attack surface, vulnerabilities |
| • Electrification of loads | → | • Increase in potential impact |
| • Aggregation of DER | → | • Increase in potential impact |
| • Increasing regulation | → | • Standards more widespread |
| • Digitization of monitoring | → | • Explosion of data to process and store |
| • Digitization of control | → | • Need for resilience of critical functionality |
| • Distribution of control | → | • Management of roles and privileges |
| • Smarter inverters | → | • Increase in attack surface |

# Risk for the Grid

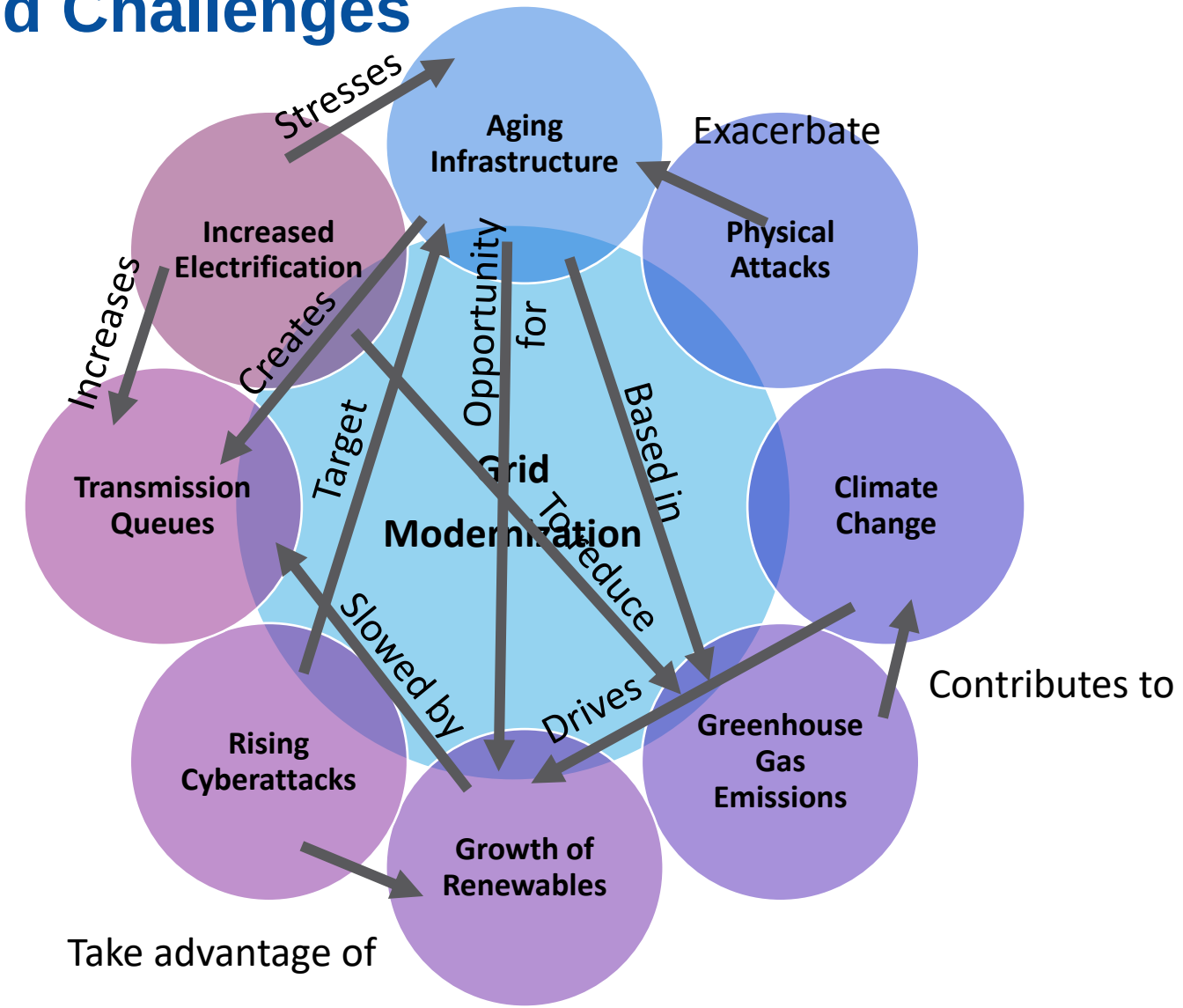
## Changing Resource Mix and Cybersecurity are the highest Ranked Risks

*NERC Reliability - Risk*

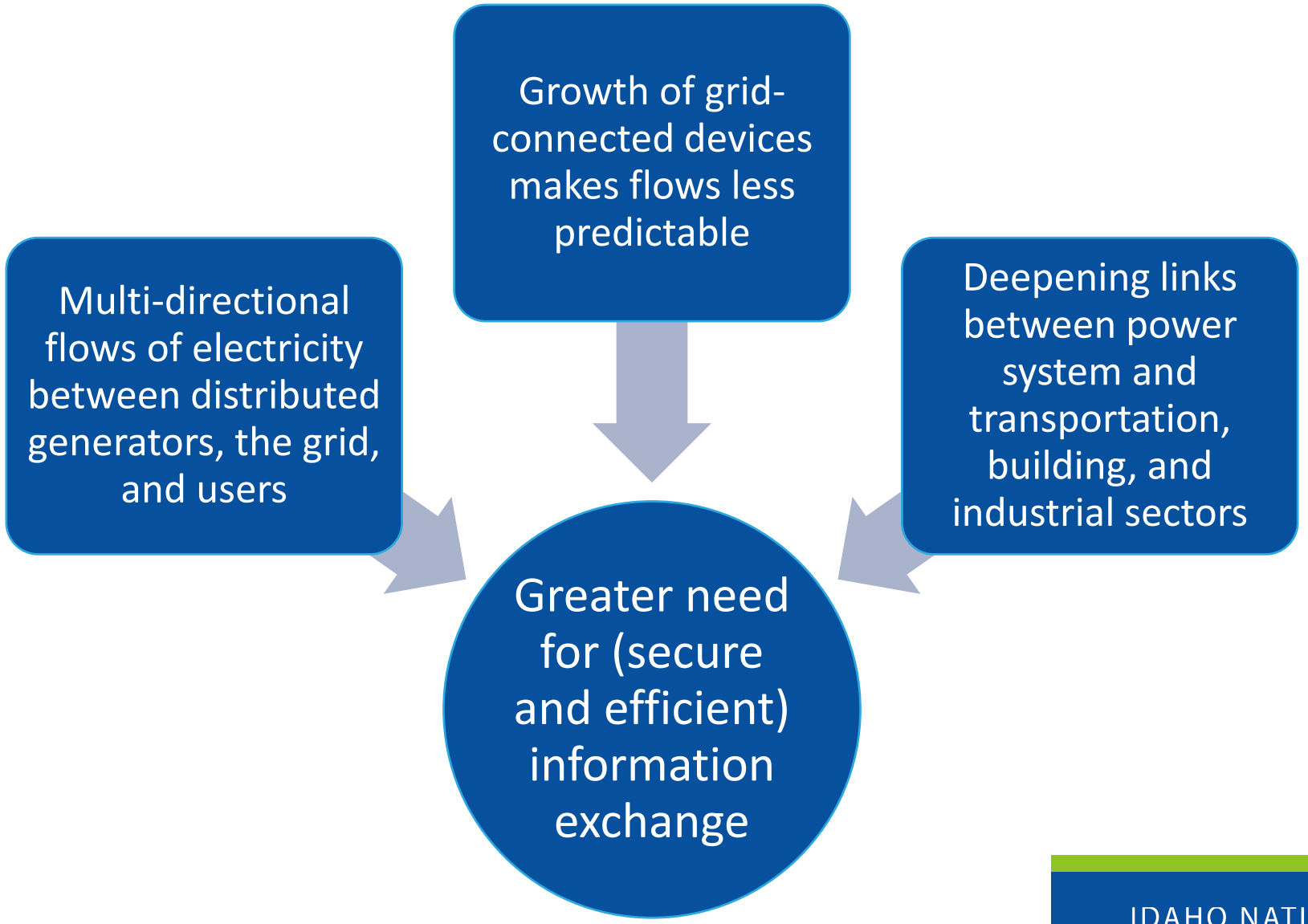




# Interconnected Challenges

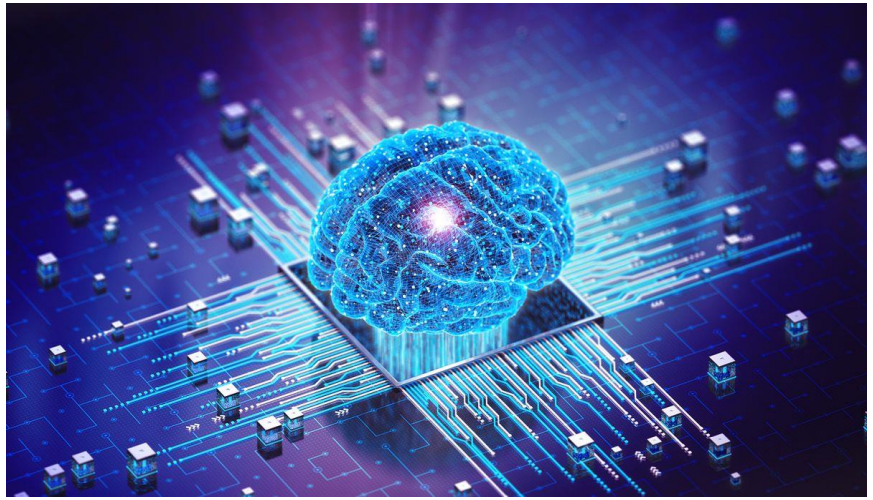


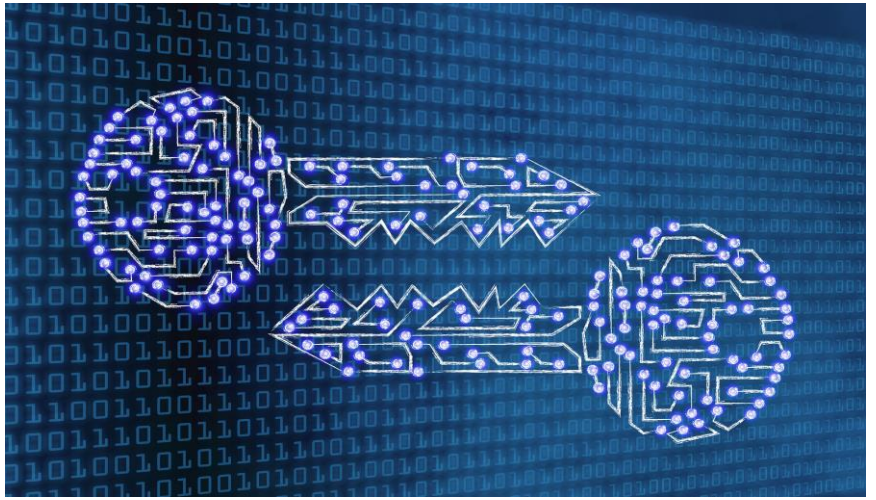
# Drivers of Technology Changes



# Emerging Technologies for the Energy Landscape

Artificial Intelligence





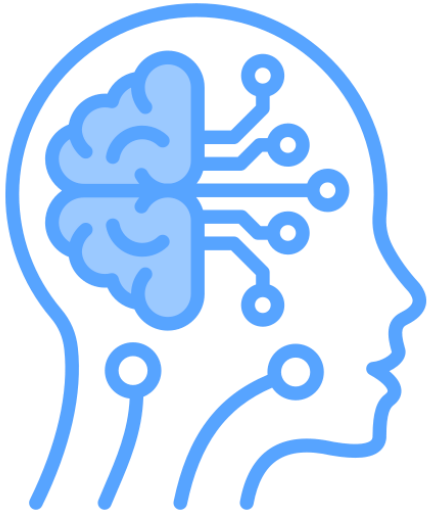
Post-Quantum Cryptography

Zero-Trust Architectures


Cloud Computing

# Artificial Intelligence

Artificial Intelligence



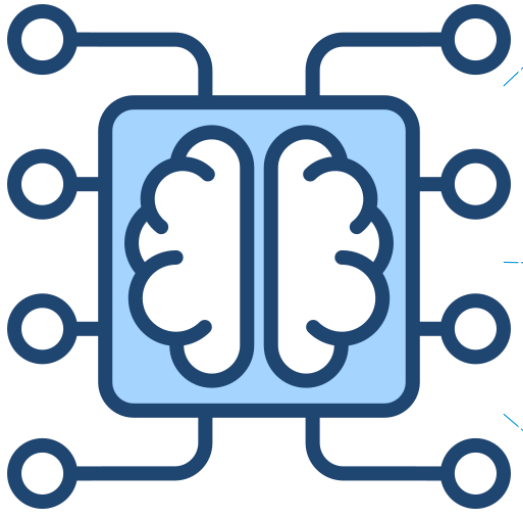
What is it

Applications

Cyber Considerations

# Artificial Intelligence

~~Artificial Intelligence~~
Machine Learning



**What is it**

- ML is a subset of AI
- ML extracts knowledge from data and learns autonomously
- AI mimics human decision making
- All rely on large datasets

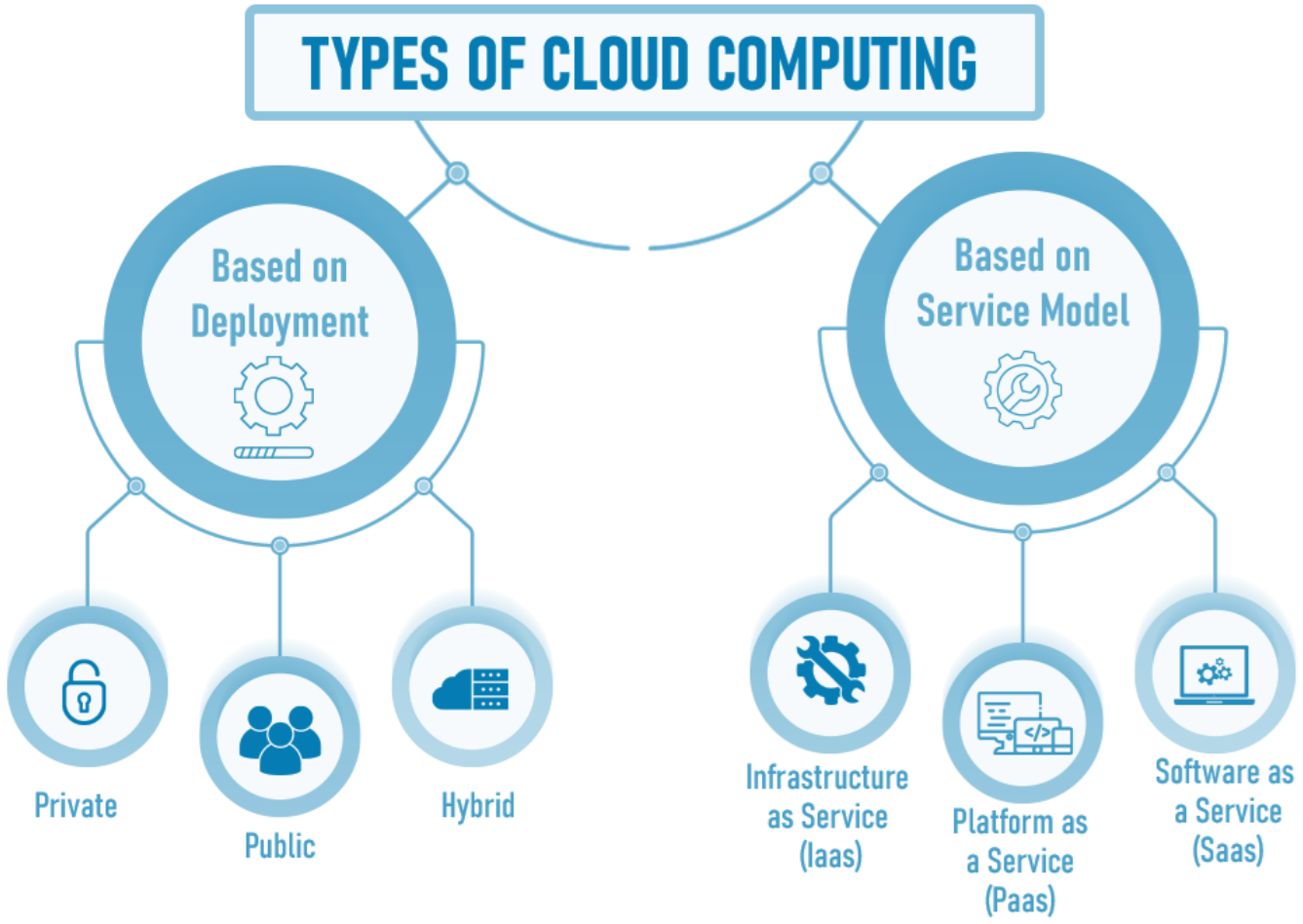
**Applications**

- Improve predictions of supply and demand
- Predictive maintenance
- Facilitate demand response
- Manage and control grids

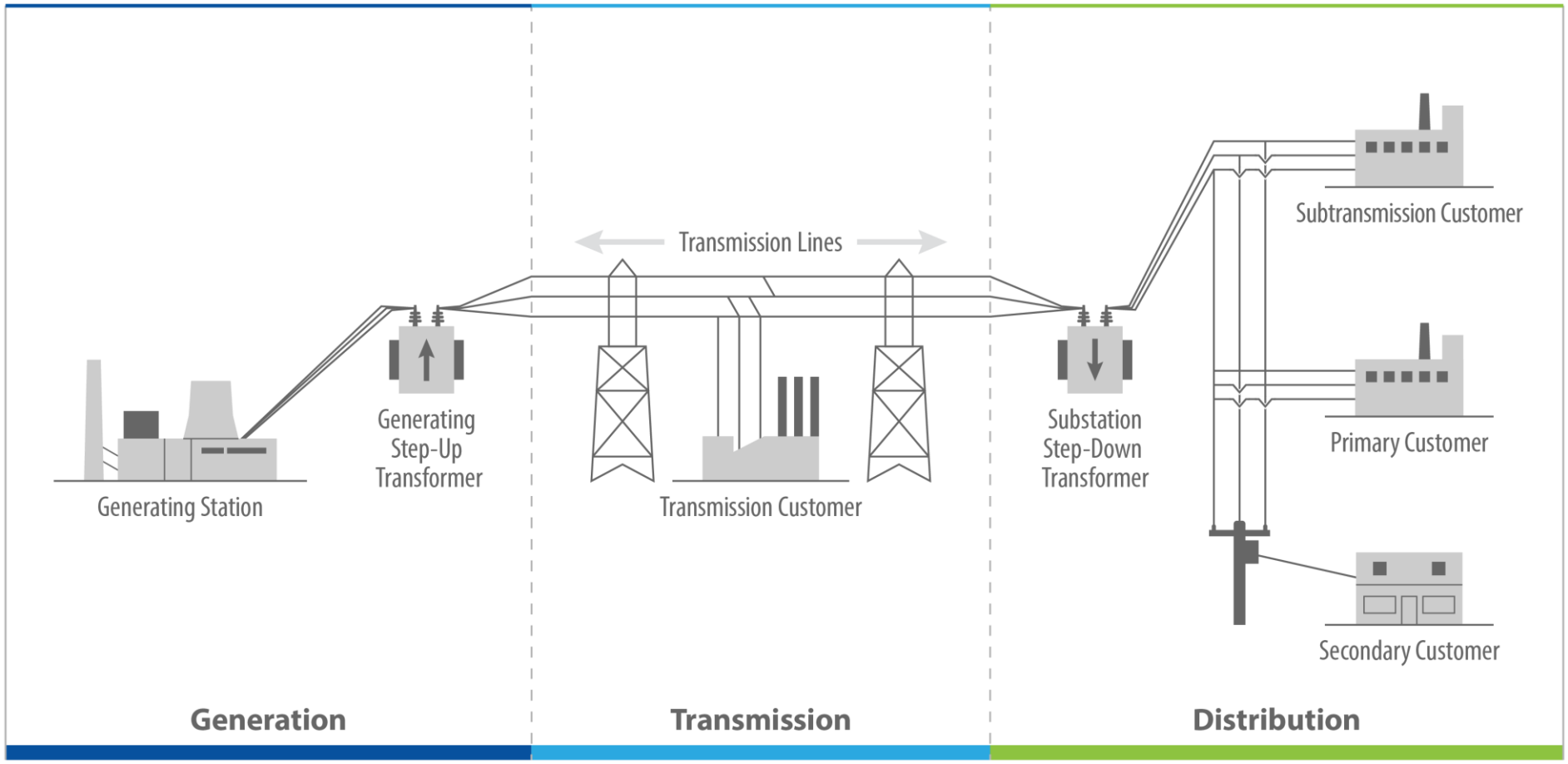
**Cyber Considerations**

- Data security
- Influence of biases or errors
- Miscorrelations due to insufficient training, data, or coding mistake
- Adversarial ML

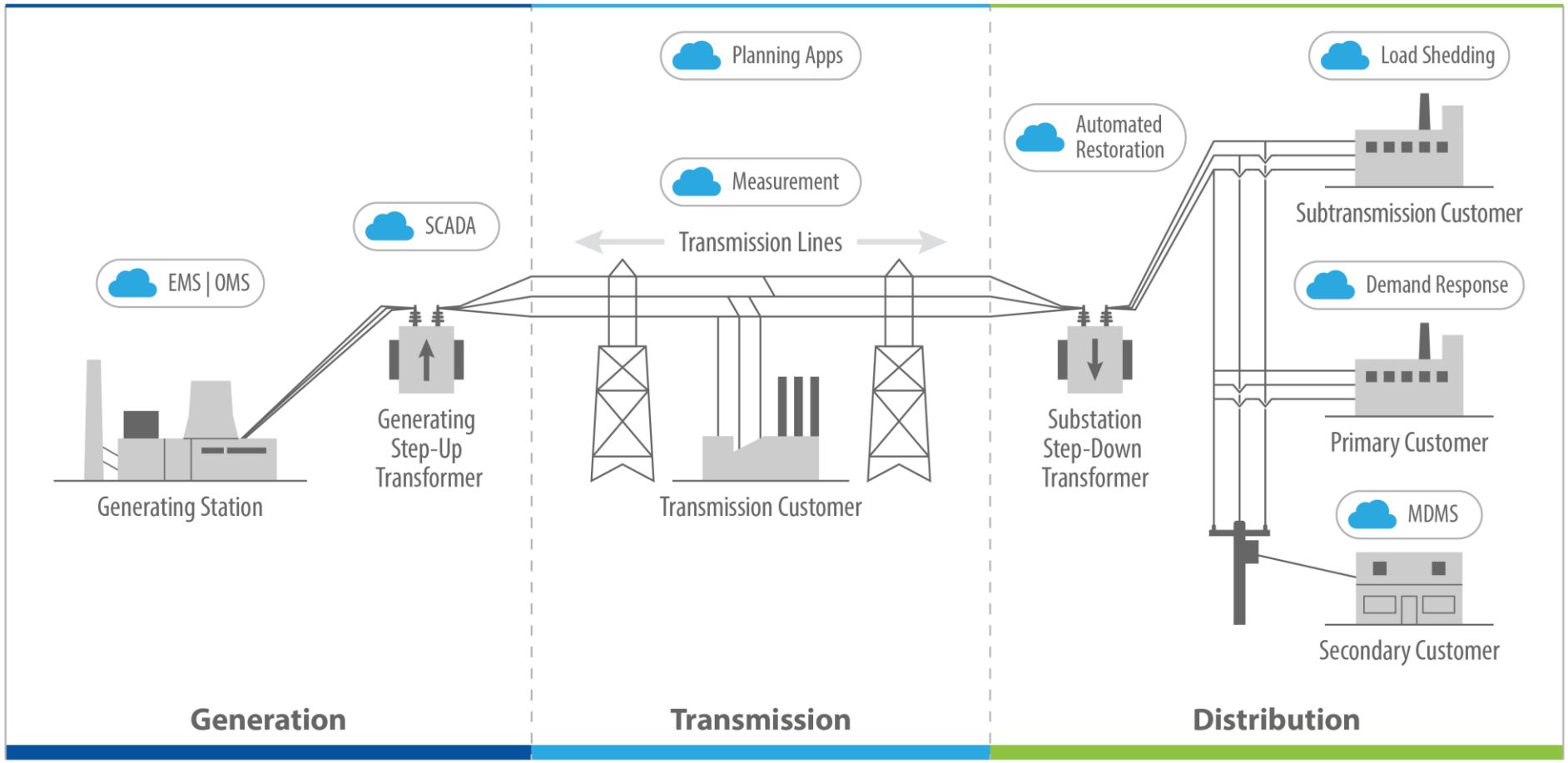
# Cloud Computing



# Cloud is Everywhere



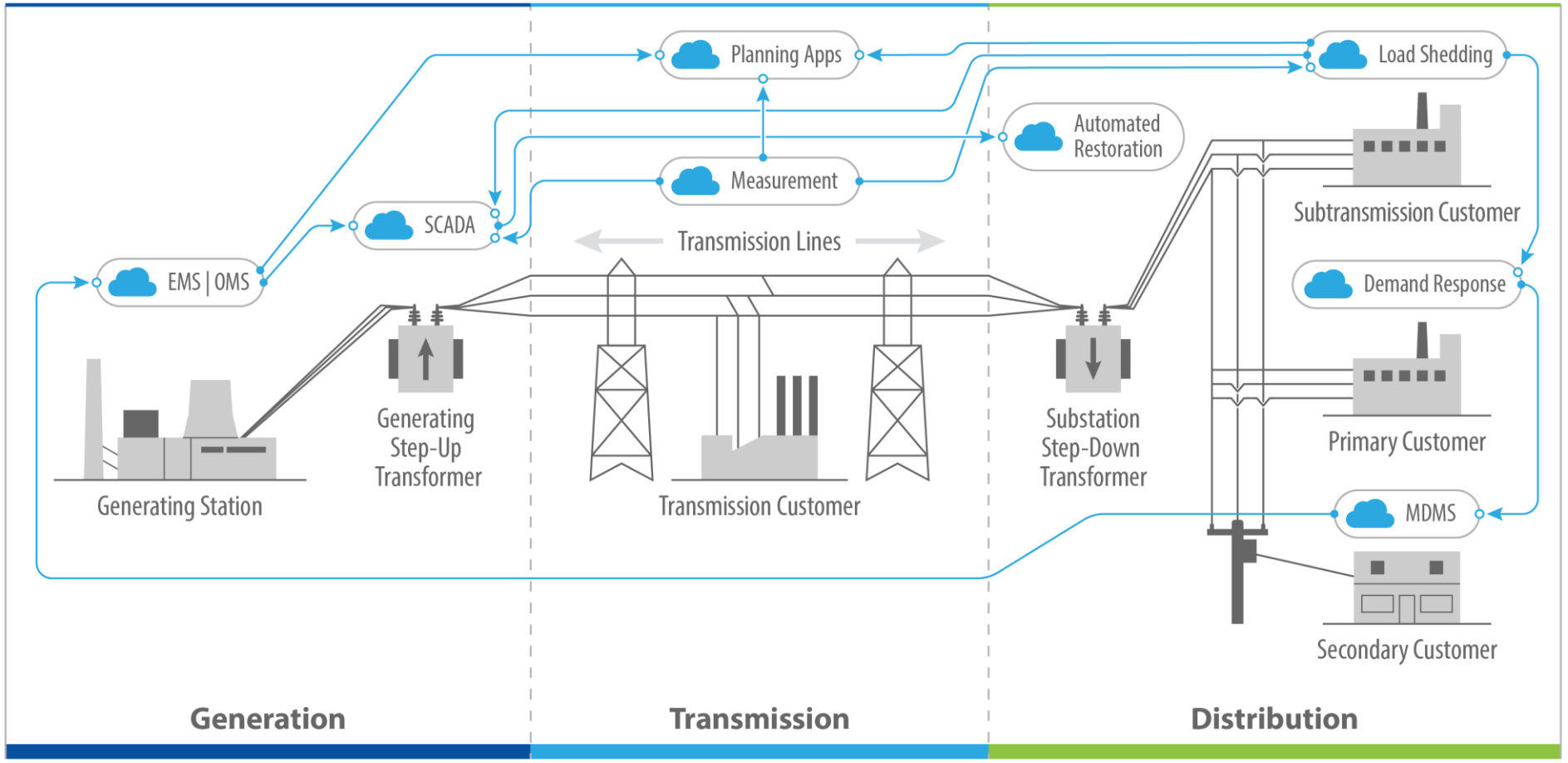
# Cloud is Everywhere




## Applications

- Analyze sensors that collect vast amounts of data
- Digital twins
- Supply chain management
- Access to third-party services

# Interconnected Interdependent Cloud is Everywhere




## Cybersecurity Considerations

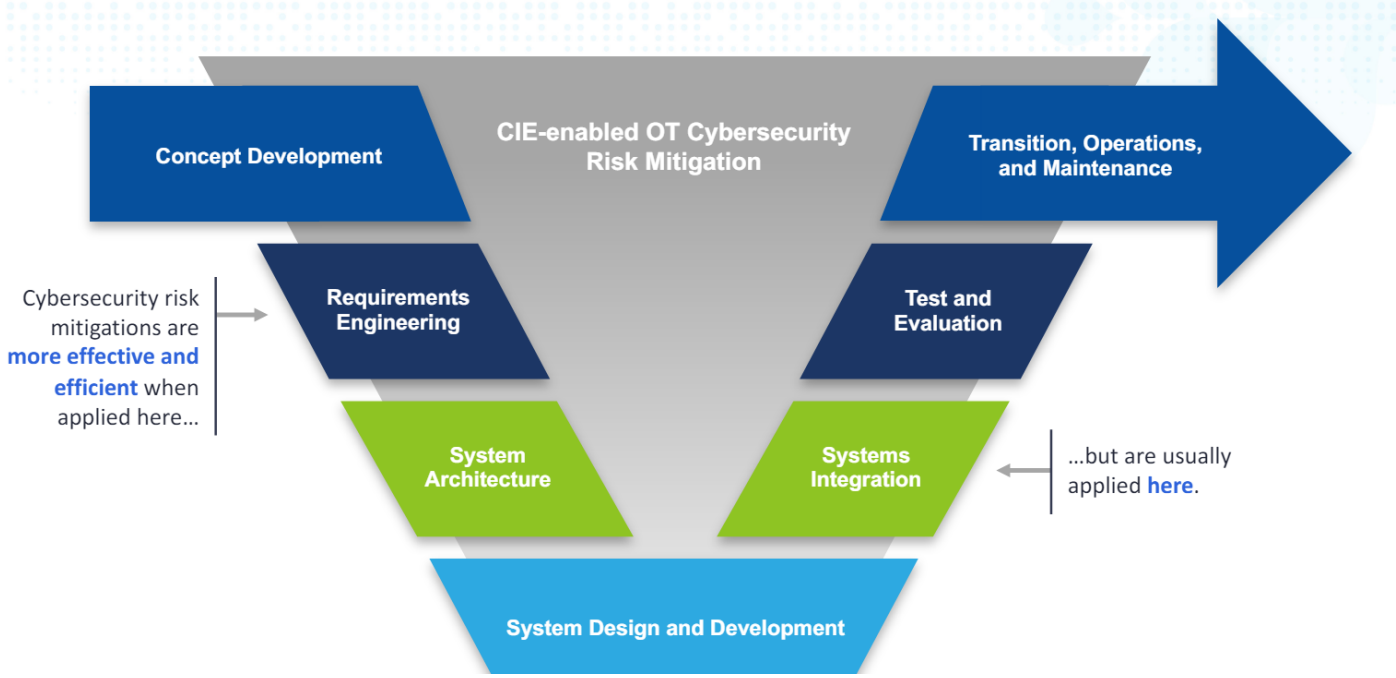
- Where is your data and who has access to it?
- What critical functions are in the cloud?
- Potential consequences if the system fails
- Cloud computing supply chain

# INL's Solution: Cirrus

- A **consequence-driven decision support framework** for entities to assess their grid modernization deployment strategy in the cloud
- Test against use cases and partner users **enabling adequate assessment** of deployment plans.

# INL's Solution Pt. 2: Cyber-Informed Engineering

- Uses design **decisions and engineering controls** to eliminate or mitigate avenues for cyber-enabled attack.
- Offers the **opportunity to use engineering to eliminate specific harmful consequences** throughout the design and operation lifecycle, rather than add cybersecurity controls after the fact.



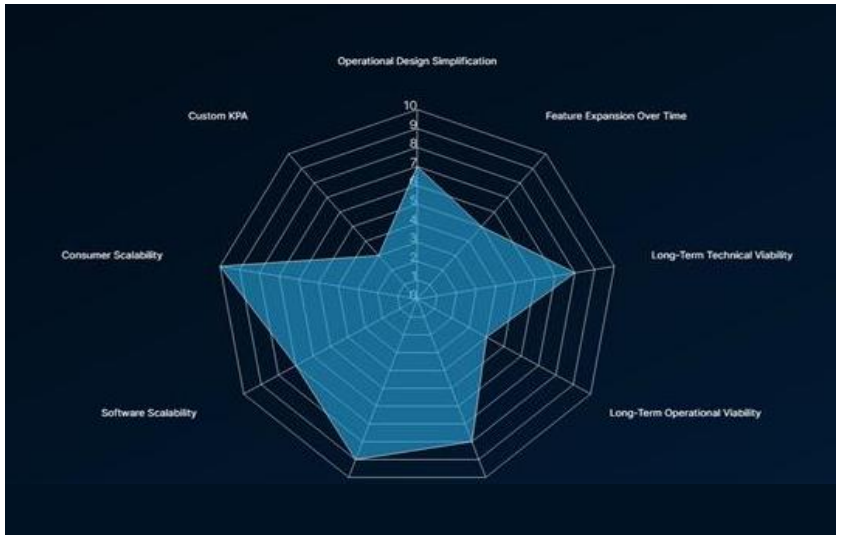

- Focuses on **engineers and technicians**, and provides a framework for cybersecurity education, awareness, and accountability.
- Aims to engender a **culture of security** aligned with the existing industry safety culture.

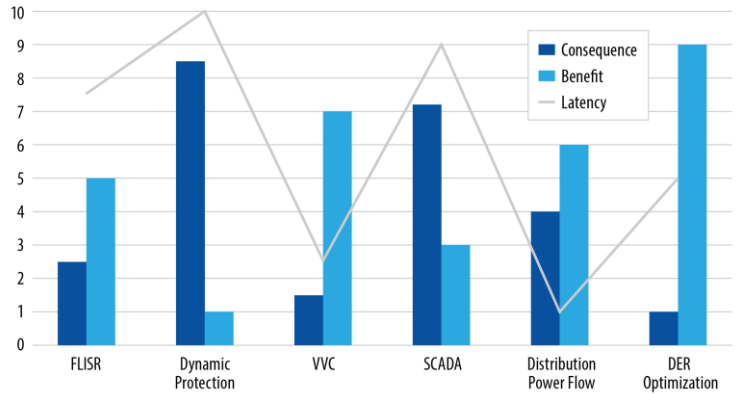
# **Output:** *So You Did the Framework, What Do You Get at the End?*

**Cloud Solution Utilities: your use case**

- **Infrastructure Evaluation:** audit existing systems for seamless cloud integration
- **Benefits:** (e.g., efficiency, scalability)
- **Risk Areas and Consequences:** (e.g., cyber threats, data breaches)
- **RFP Guideline**

- **Key Guidelines for Cloud Integration:** (e.g., infrastructure evaluation, regulatory compliance, workforce capability, etc.)
- **Cost-benefit Analysis:** analyze costs for justifying cloud migration investment
- **Workforce Capability:** equip your workforce for a smooth cloud transition
- **Path Forward:** strategize your path with informed decision-making



# Cloud Application: Present and Future

**Today:**

- Consider **interdependent consequences and benefits** of a cloud deployment for electric grid controls and applications
- Develop understanding of framing cloud applications.

**Tomorrow:**

- **Apply lessons** learned and driven cyber-informed frameworks.

**Future:**

- **Evaluate trends** in cloud deployment in infrastructure.

Learn more or get involved: emma.stewart@inl.gov.

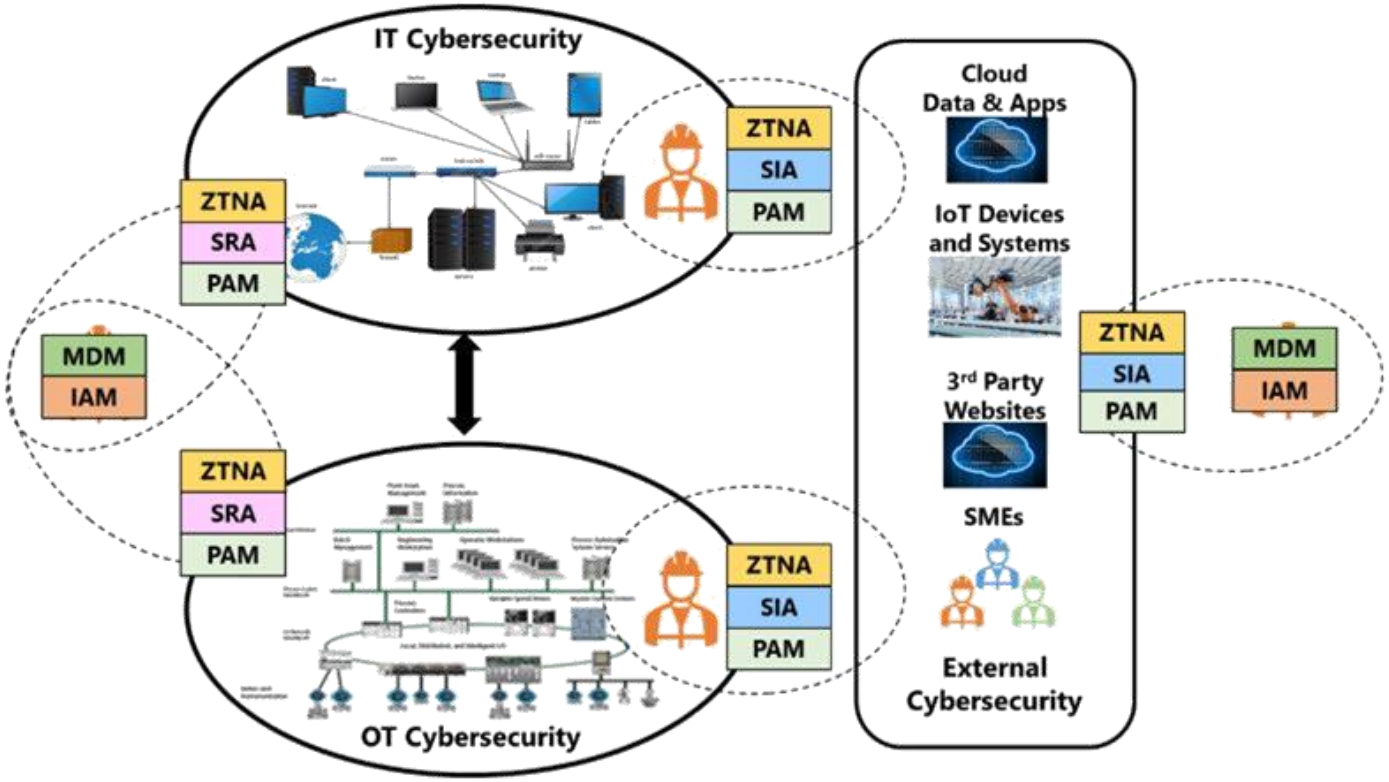
# Zero-Trust Architectures

***Trust but verify***

- **Why**
  - OT networks are an attractive target
  - 3rd party access increasingly common
  - Shared accounts among users make monitoring difficult
  - VPNs and other network architecture components have known vulnerabilities
- **What**
  - Move from static, network-based perimeters to focus on assets, users, and resources
  - Authentication and authorization (both subject and device) performed for each new session

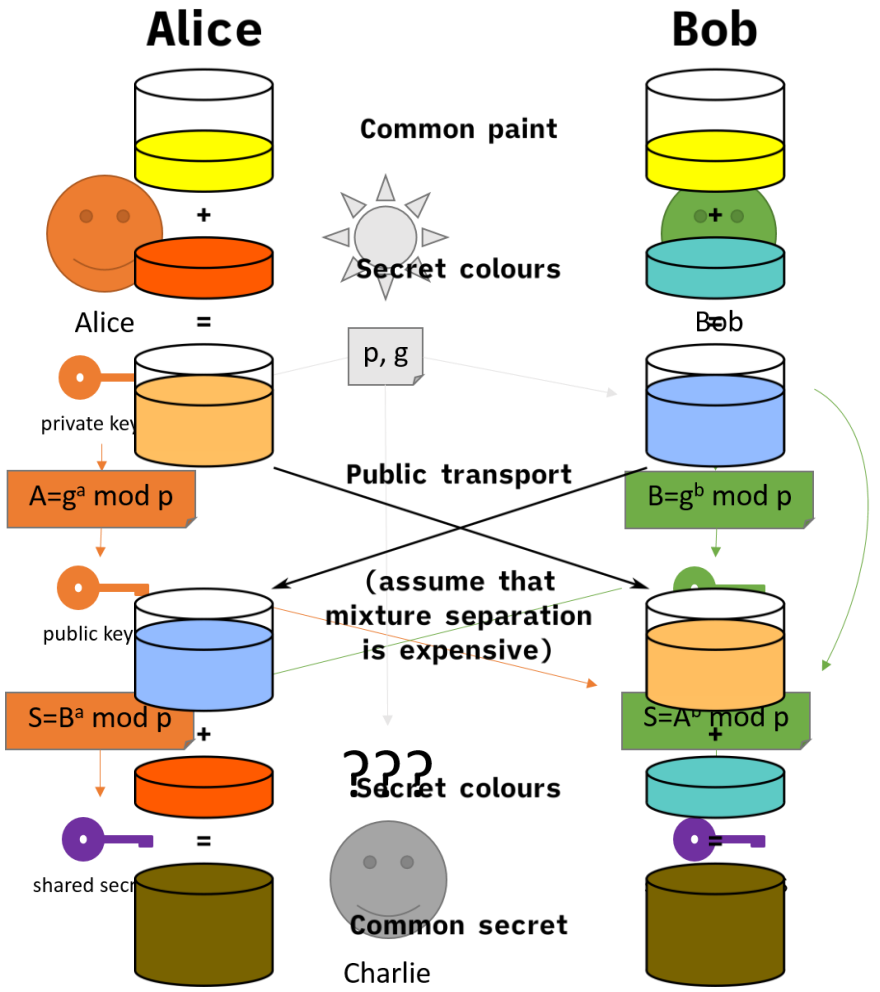
# Zero-Trust Architectures

- **Applications**
  - BYOD policies for grid-edge devices
  - Third-party vendor access
  - Generic and shared user accounts
- **Challenges**
  - Can be difficult to get full visibility in OT networks
  - Many OT assets have longer lifetimes than IT assets
  - Security must not impede critical functionality
  - Wholesale changes unlikely to work within organizational cultures



# Post Quantum Cryptography

- **Why?**
  - Existing algorithms are not unbreakable, they just take a long time to brute force
  - Quantum computing can break traditional encryption much faster
- **Applications**
  - Small, lab scale quantum computers have been built
  - NIST announced first four quantum-resistant algorithms in 2022
  - Three algorithms expected to be ready for use in 2024
- **Risks**
  - Early stages of research




**Public key exchange**
**Diffie-Hellman algorithm**

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