Assured Machine Learning and Cyber Deployment

John Dirkman, P.E.
Vice President, Product Management
jdirkman@resource-innovations.com

resource innovations

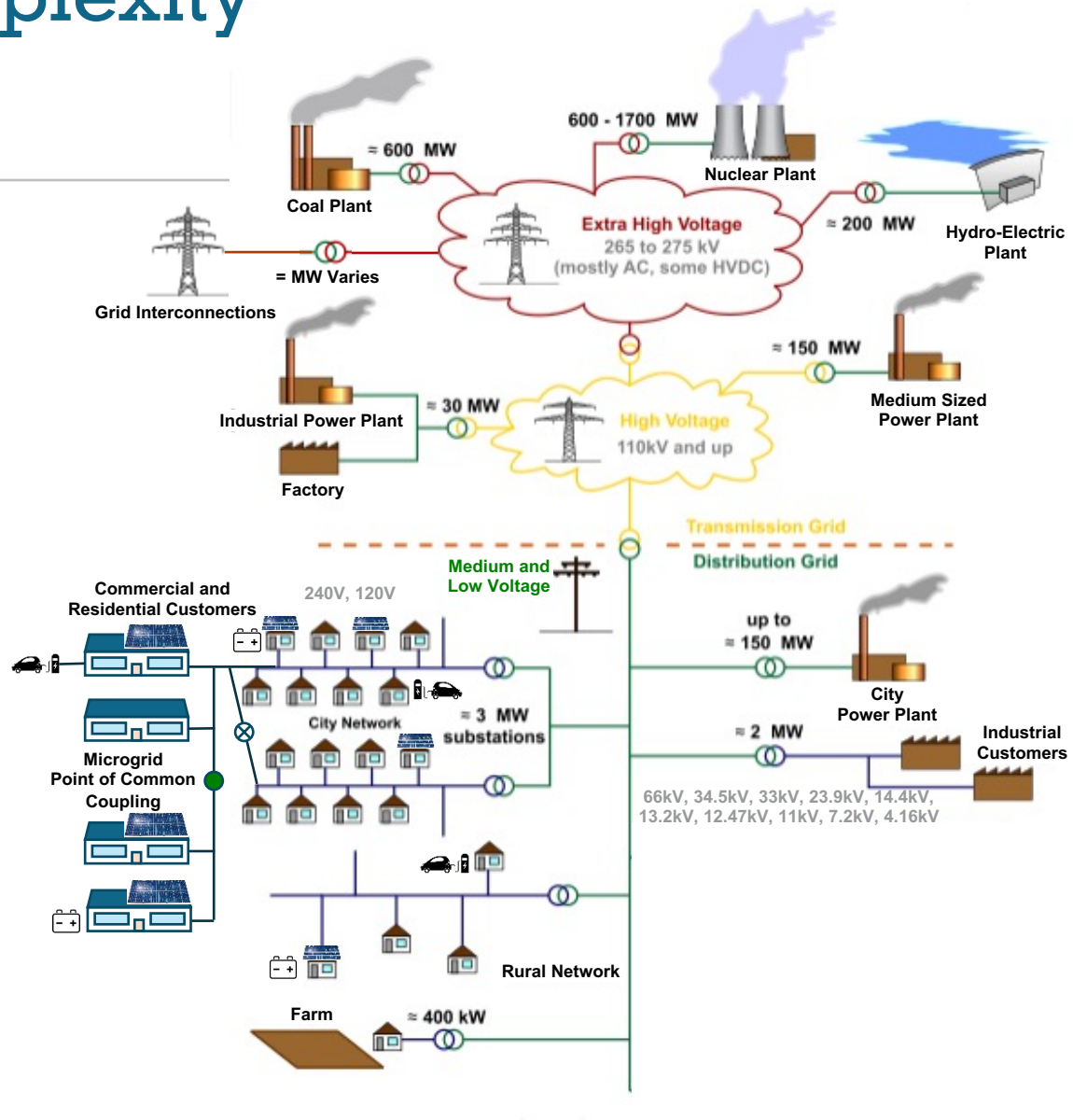
Electric Grid Organization Complexity and RI Grid Software Solutions

Customers Served

- Electric Transmission and Distribution Utilities
- Independent System Operators
- Energy Traders
- Grid Control System Suppliers (GE, Hitachi Energy, Toshiba, Smarter Grid Solutions)
- Department of Energy via Arizona State University and other partners

RI Grid software for planning, operational, and financial analytics

- Utilities must always balance supply (generation) and demand (load), or risk voltage and frequency problems which can lead to brownouts and blackouts.
- Variable renewable generation in transmission and distribution contributes to potential unbalance between supply and demand.
- Utilities have less control over the modern grid.



https://en.wikipedia.org/wiki/Electric_power_distribution

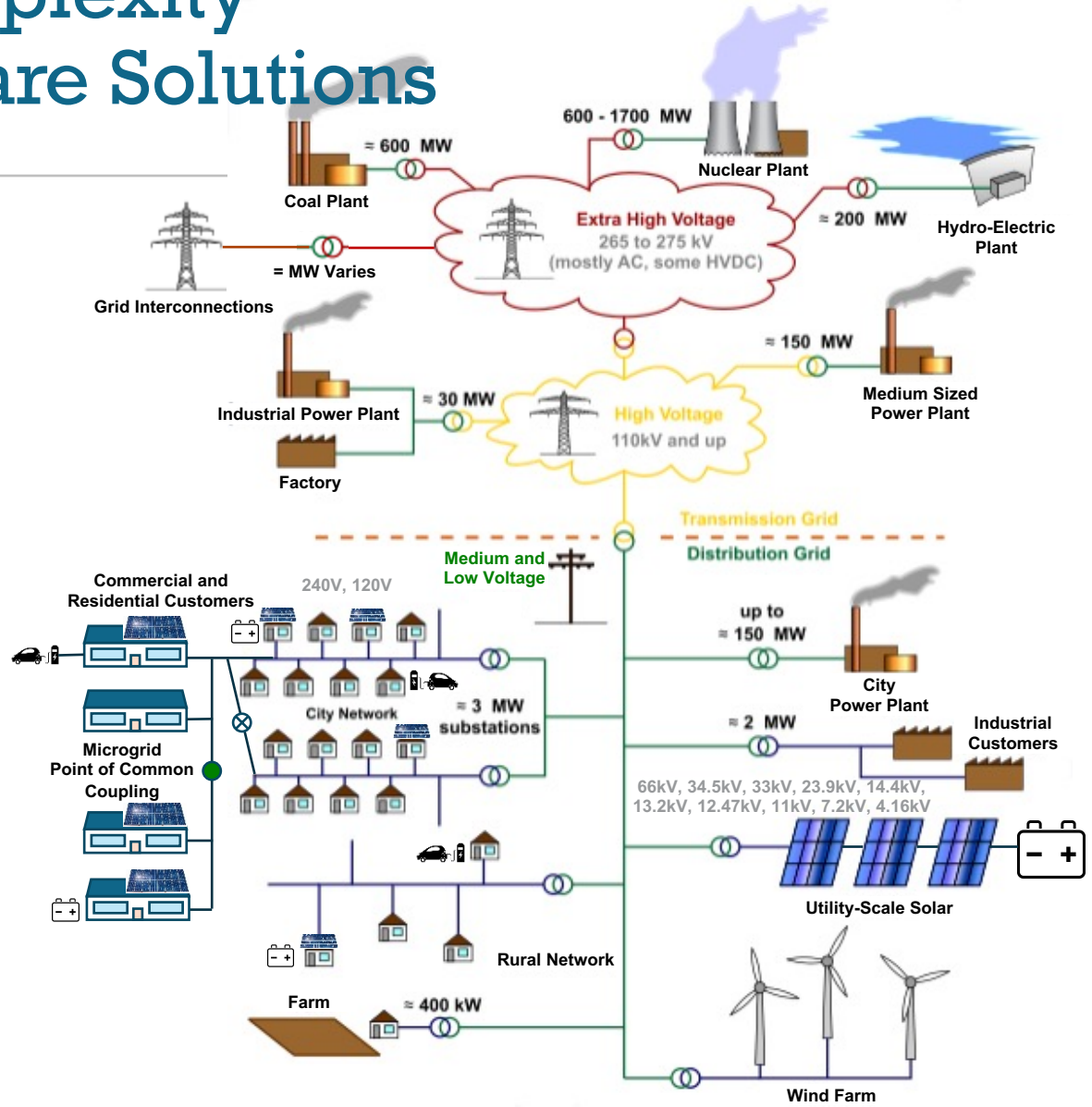
Electric Grid Organization Complexity and RI Transmission Grid Software Solutions

Transmission Energy Analytics Software

Grid360 Engines: T&D grid planning, operations and analytics

Day-Ahead Reactive Planning (DARP): Forecast and optimally dispatch grid resources to mitigate renewable variability, powered by the Grid360 Engines

Grid360 External Network Modeling (Modelex): Simplifies and consolidates transmission network models to improve analytical performance

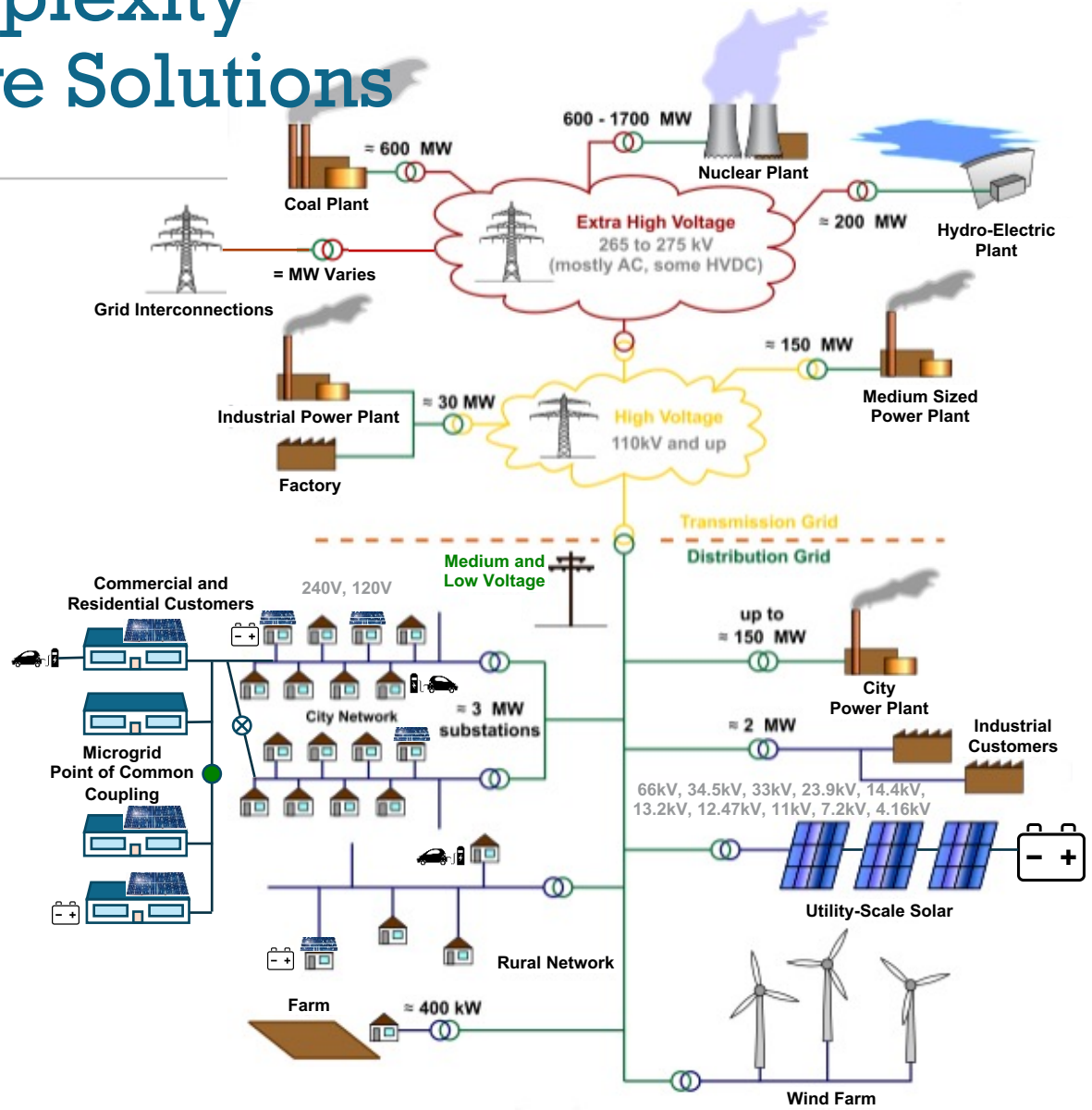


https://en.wikipedia.org/wiki/Electric_power_distribution

Electric Grid Organization Complexity and RI Distribution Grid Software Solutions

Distribution Energy Analytics Software

Grid360 Distribution Analytics: Advanced visualization, analytics, and planning applications, enabling demand response, distributed energy resources (solar and wind generation), electric vehicles, cybersecurity, and smart meter analysis and optimization, powered by the Grid360 Engines



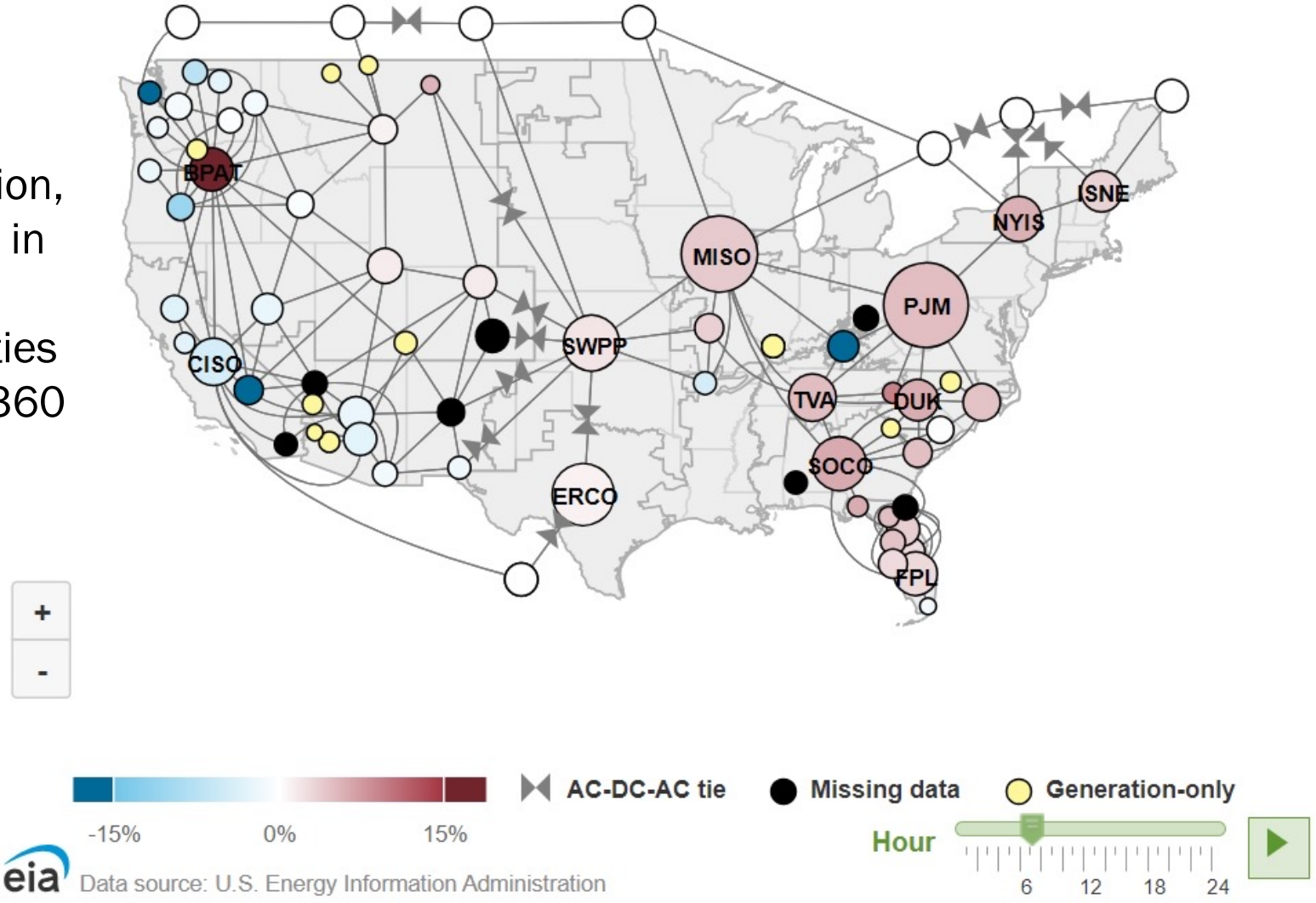
https://en.wikipedia.org/wiki/Electric_power_distribution

Electric Grid Organization Complexity and RI Financial Grid Software Solutions

Transmission Financial Analytics Software

iHedge: Energy market financial simulation, analysis, and engagement; used at ISOs in North America and New Zealand for congestion hedging by load serving entities and power traders, powered by the Grid360 Engines

$3B
Annual FTR Value Managed by iHedge Software



https://www.eia.gov/electricity/gridmonitor/dashboard/electric_overview/US48/US48

Tech to Market Approach and Industry Advisory Board

Technical approach

Six primary markets: (1) Energy Management Systems (EMS), (2) Distribution Management Systems (DMS), (3) Supervisory Control and Data Acquisition (SCADA), (4) Programmable Logic Controller (PLC), (5) Industrial Control Systems (ICS)/Cyber-Physical Systems (CPS), and (6) IoT devices

Integration/add on of new technology without need for wholesale replacement of systems/devices

Commercialization approach

Development of engines is preferred

Market segments

EMS/DMS/SCADA: IOU T&D utilities, municipal utilities and cooperatives in North America, T&D utilities in rest of the world

PLC/ICS/CPS/IoT: many potential applications

Key commercial partners, customers/advisors

Input from Industry Advisory Board (IAB)

IAB composed of utility personnel, vendors, system integrators, and academics

IAB provides feedback/validation of our proposed approach and market strategy

IAB also helps identify early adopters

Market via eco-system of utilities, vendors, and system integrators

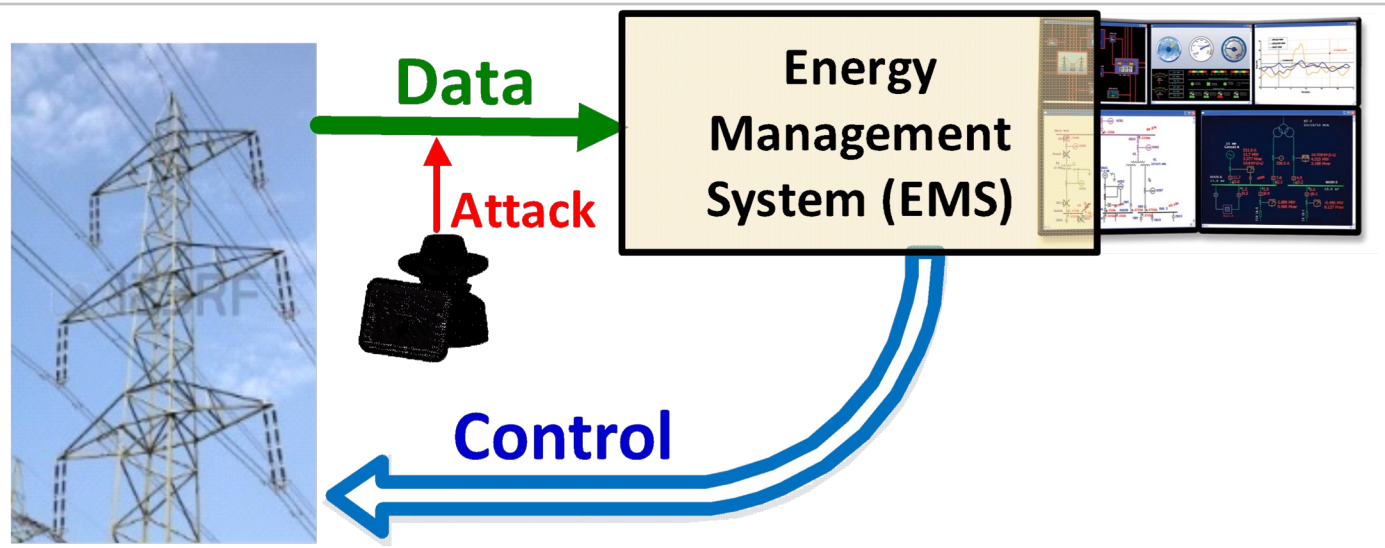
Executed successfully for DOE ARPA-E Sensor Enabled Modeling of Future Distribution Systems with DER and other projects

Additional commercial activities

Promotion of technology and preliminary outreach to potential customers

Publication of results obtained during project - journals, white papers, conferences, etc.

Generating and Detecting Mimicking Attacks Tasks 5 and 8



Knowing system configuration, attacker can maliciously change a subset of measurements with counterfeit data before they reach the EMS

Requires attacker to have access to measurement devices or data concentrators

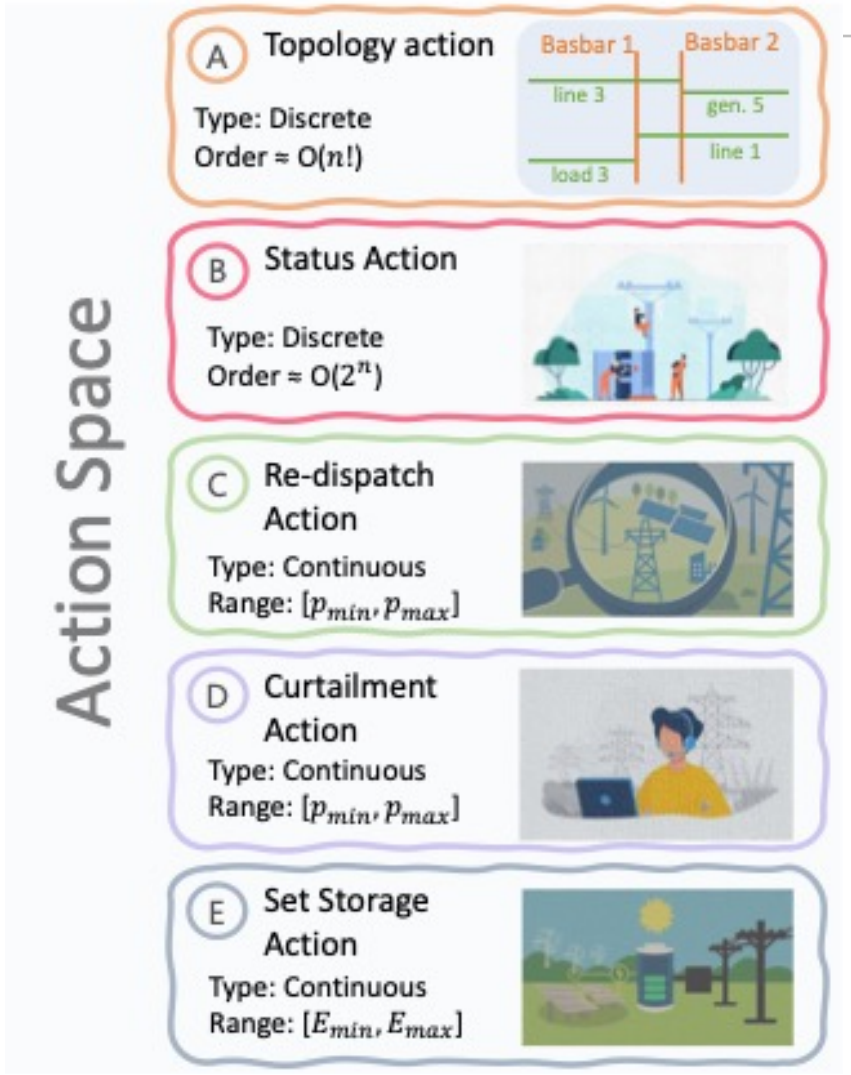
Can be unobservable and result in physical / economic consequences

Generating and Detecting Mimicking Attacks Tasks 5 and 8

- SVR load predictor to accurately predict loads
- SVM attack detector to identify attacks with high accuracy
- Predicted loads are used to mitigate attacks when they are detected

- SVR load predictor and SVM attack detector as separate engines to be applied to EMS and ADMS products

Large Power Grids: Action Space for RL Task 16



Discrete actions:

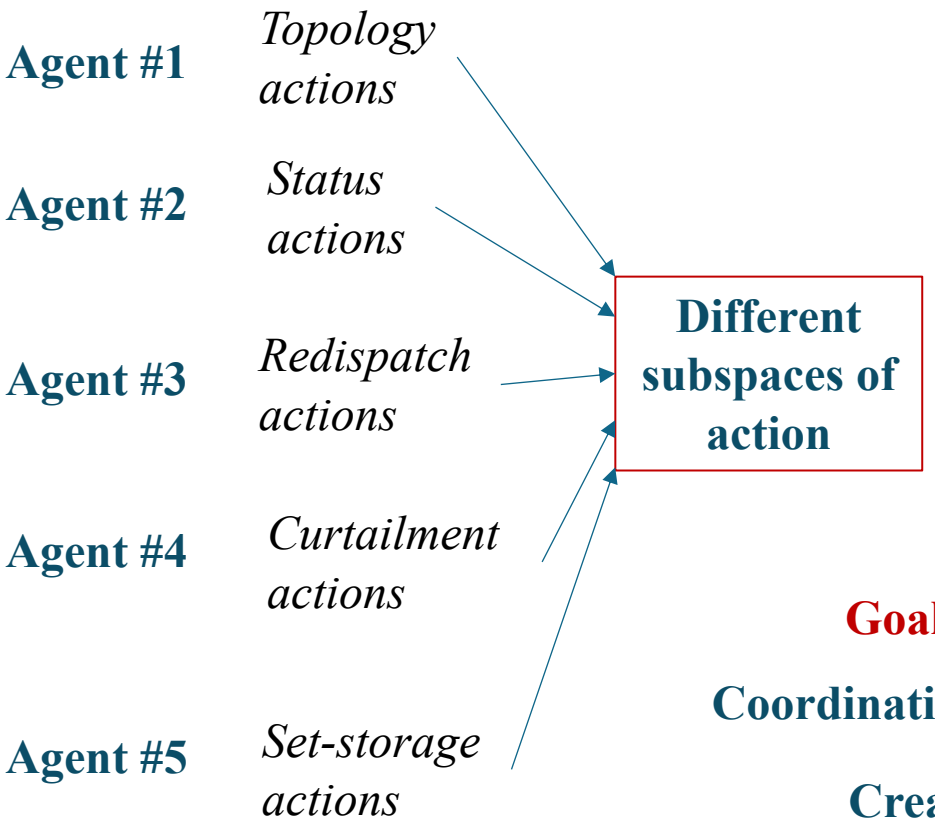
- *Topology actions*: changing the topology of certain substations
- *Status actions*: transmission or power line switching

Continuous actions:

- *Redispatch actions*: changing the operating schedule of power plants
- *Curtailment actions*: limiting the production of renewable generators
- *Set-storage actions*: changing the role of some storage units from loads to generators or vice versa

Example: IEEE 118-Bus system: about 12 million possible actions

Large Power Grids: Action Space for RL Task 16



Grid under attack

RL Environment

Goal: maximizing reward for grid survival

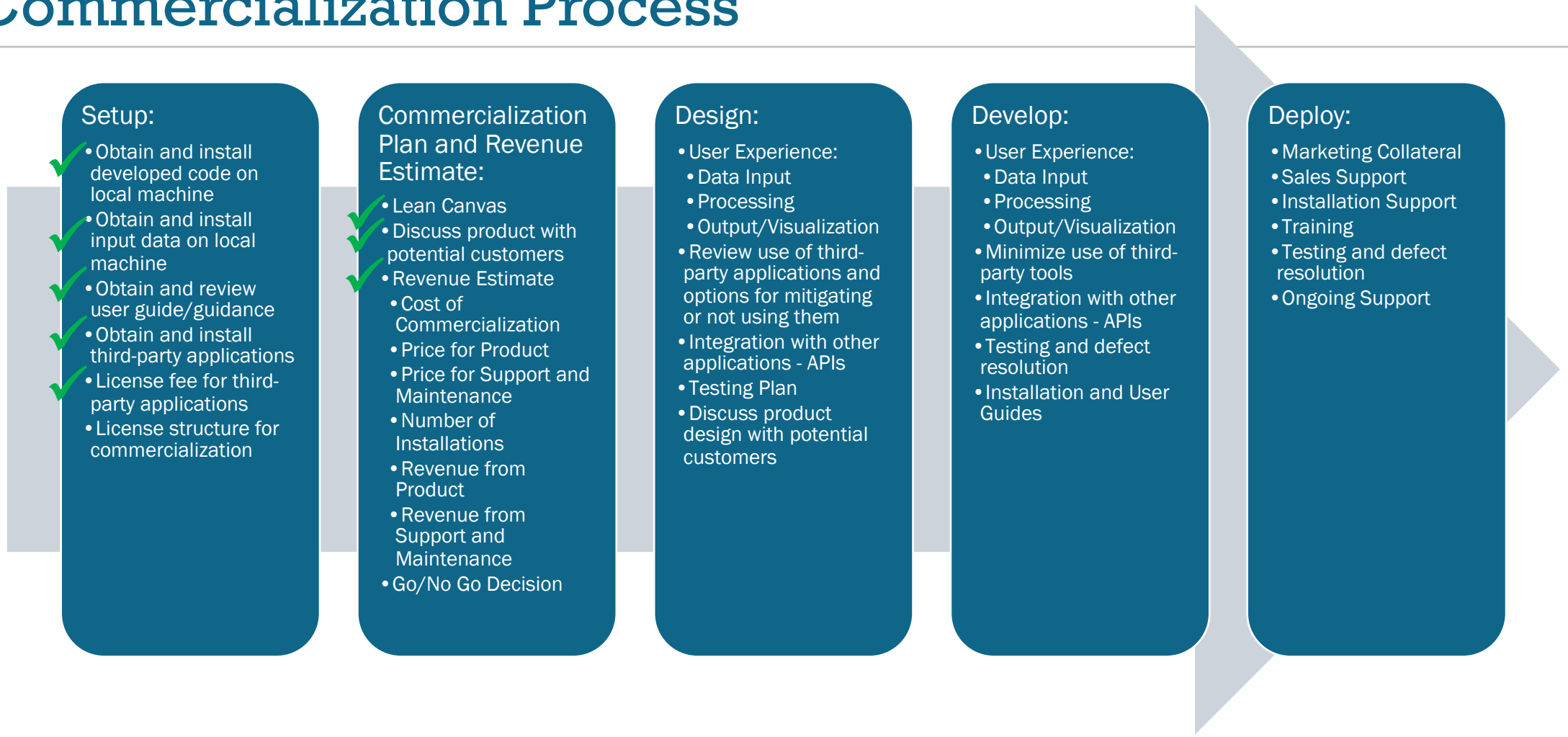
Coordination: Temporal Graph Convolutional Network

Create engine from developed TGCN code

Commercialization Efforts – Coding and Testing

- Ongoing team meetings with ASU and RI
- Discussions on data, testing, and code changes
- Methods for streamlining code
- Testing of algorithms under various industry level simulations
- Methods for visualization in Grid360

Commercialization Process



The Lean Canvas

Designed for:	*Designed by:*	*Date:*	*Version:*
Load Prediction, Redistribution Attack Detection and Mitigation	John Dirkman	9 March 2023	1.0

Problem

Utilities lack software to predict and detect attacks intended to redistribute load measurement data.

Solution

Develop software to predict and detect attacks intended to redistribute load measurement data that can work with existing SCADA systems.

Unique Value Prop.

There is currently no commercially available software to predict, detect, and prevent attacks on loads.

Unfair Advantage

1. ASU domain knowledge and research.
2. Easier path to commercialization using Grid360 engines framework
3. Established sales and delivery channels.

Customer Segments

Electric Distribution Utility Companies Worldwide

Existing Alternatives

While there have been technical papers published on this topic, no known commercial software currently provides this capability.

Key Metrics

Customer contacts, RFP's received, contracts closed.

High-Level Concept

Use support vector regression (SVR) for enhanced load prediction, then combine with a support vector machine (SVM) classifier to classify incoming load estimate as either normative or attacked.

Channels

1. Direct to utilities
2. Via business partners: GE, Hitachi/ABB
3. Via SI's: Infosys, Accenture, Capgemini, Deloitte, Guidehouse, HCL

Early Adopters

Existing RI and business partner clients

Cost Structure

List your fixed and variable costs:

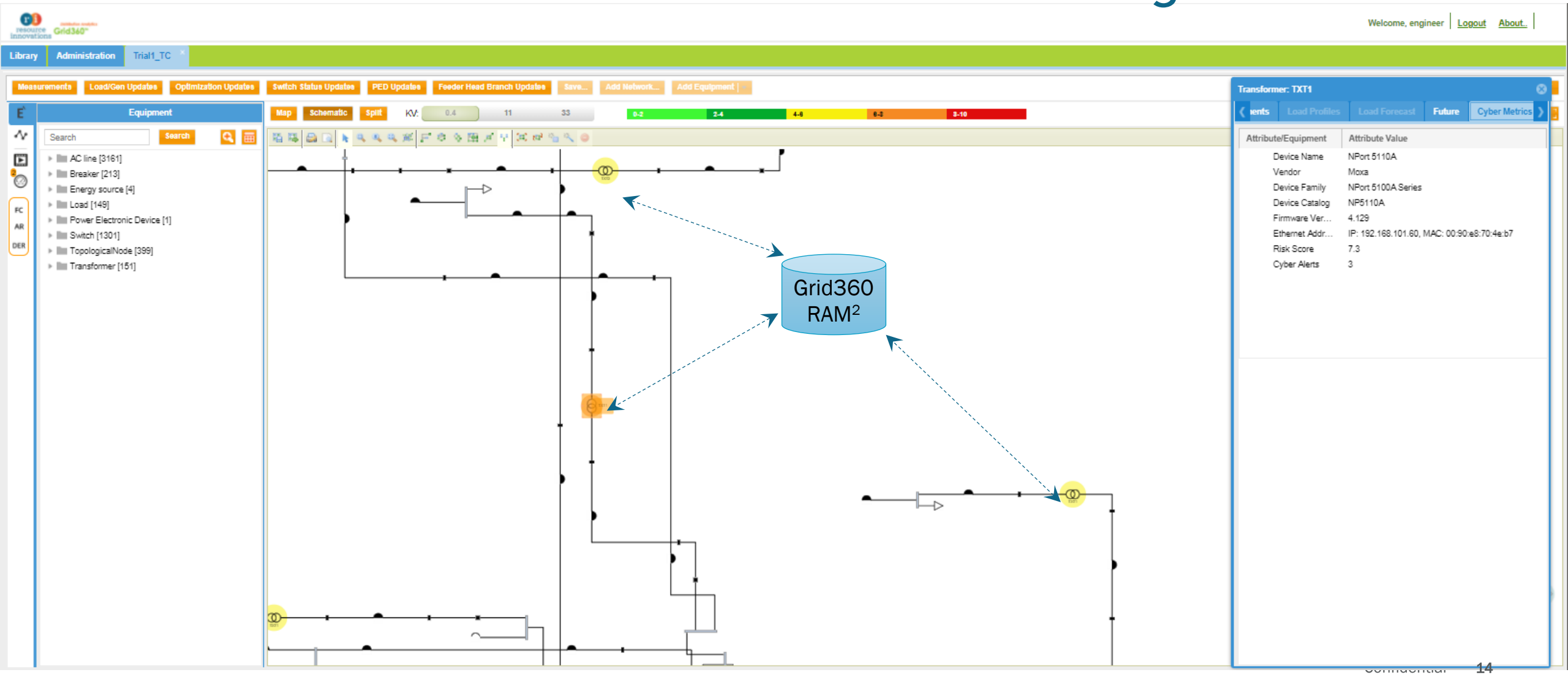
- Business development costs
- Software development and testing costs
- Sales engineering costs
- Project implementation costs

Revenue Streams

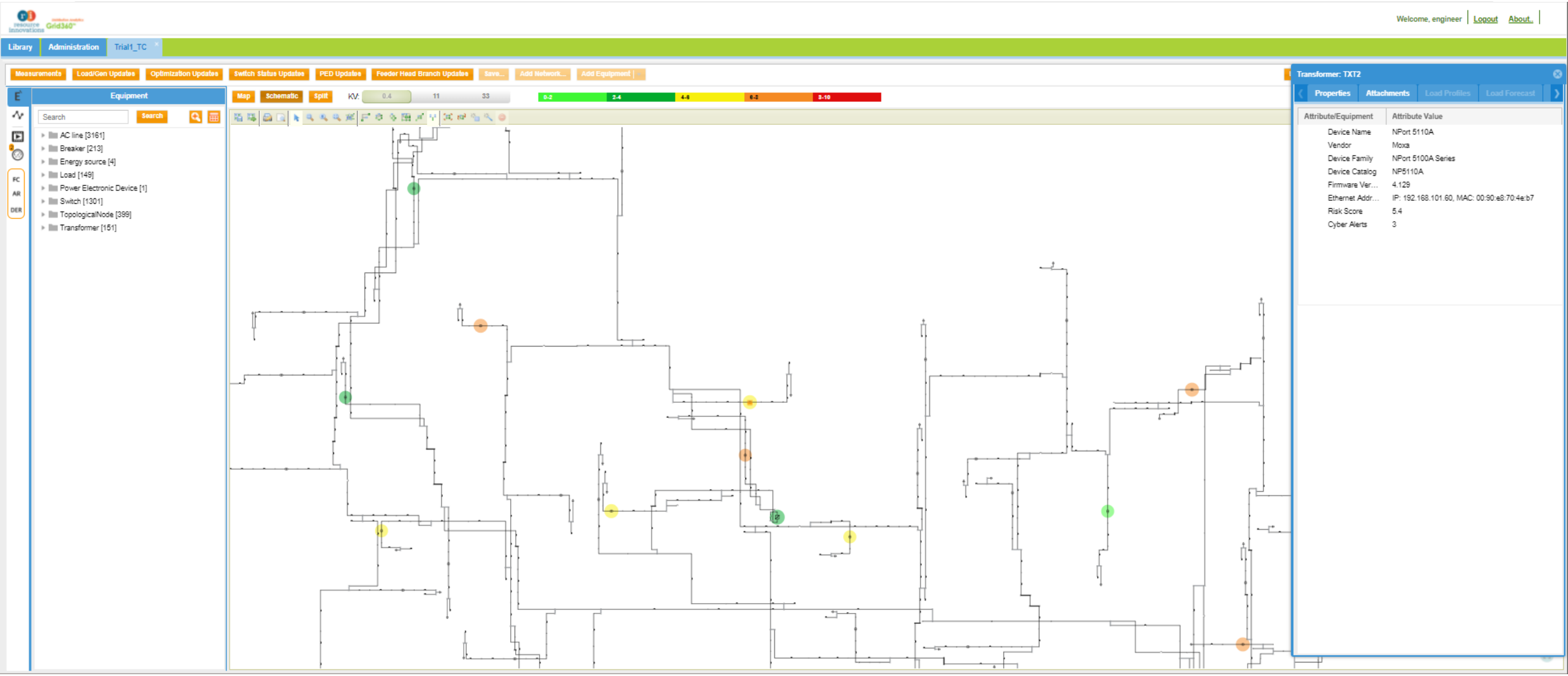
List your sources of revenue:

- Software licenses: one-time/perpetual or annual/subscription/SaaS
- Implementation/integration
- Ongoing support and maintenance

Threat Assessment Risk Score – OTORIO Integration

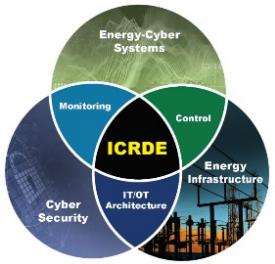


Threat Assessment Heat Map – OTORIO Integration




THANK YOU!
John Dirkman, P.E.
Vice President, Product Management
jdirkman@resource-innovations.com
resource
innovations

DOE ARPA-E and BIRD ICRDE Grant Projects



Sensor-enabled Modeling of Future Distribution Systems with Distributed Energy Resources

Partners include Arizona State University, Arizona Public Service, Resource Innovations

- Development of accurate, sensor-driven mathematical models of APS distribution feeders, loads, and dispatchable resource assets
- Development of monitoring and control algorithms for optimal scheduling of DERs
- Technology to Market strategy via Industry Advisory Board

Stochastic Optimal Power Flow for Real-time Management of Distributed Renewable Generation and Demand Response

Partners include Arizona State University, Resource Innovations, Sandia National Labs, PJM, MISO, NREL

- Prototype software for stochastic Security Constrained Economic Dispatch (SCED)/ Stochastic Look-Ahead Commitment (SLAC), scalable for large systems with high percentage of renewable generation (stochastic resources)
- Forecast algorithms for bulk and distributed wind and solar generation
- Classification and aggregate modelling of DR

Comprehensive Cybersecurity Technology for Critical Power Infrastructure AI-based Centralized Defense and Edge Resilience

Many partners, utilities include Arava Power, Duquesne Light Company, Arizona Public Service, Delek US

- Support research, development, testing, and commercialization of software to harden utility EMS, DMS, and SCADA against cyberattacks