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AIST-FREA スペシャルセッション

GRAND RENEWABLE ENERGY 2018

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IEC 61850 Standardization and Cybersecurity Aspects

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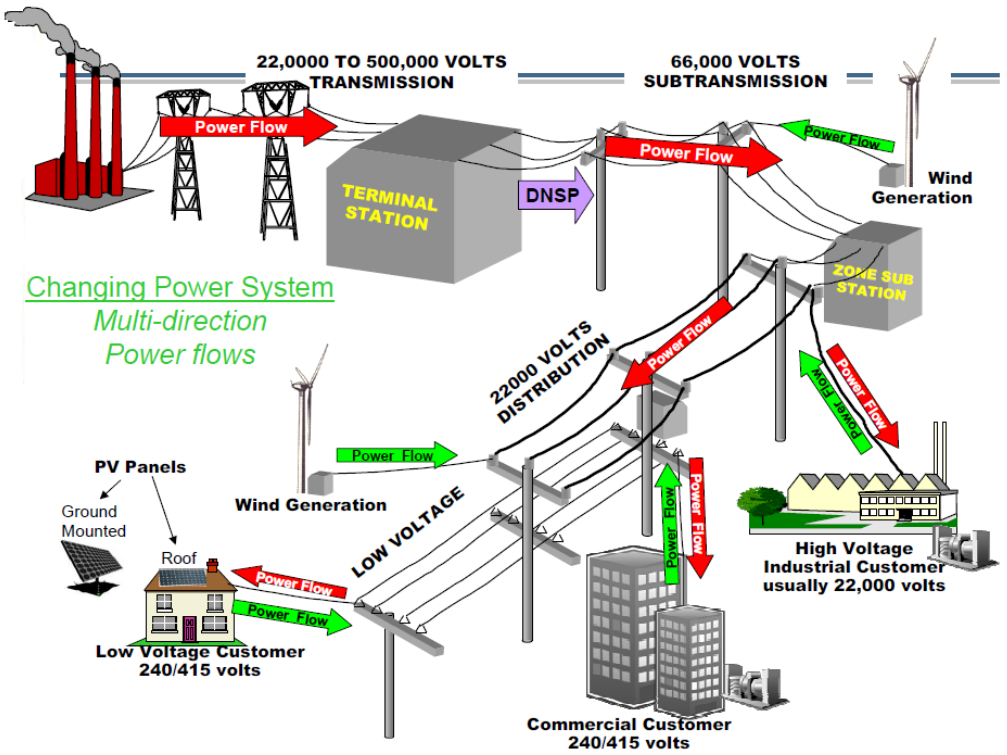
  - Motivation
  - IEC 61850 Standard and Models
  - Cybersecurity Issues
- Futurework

Challenges in Active Networks

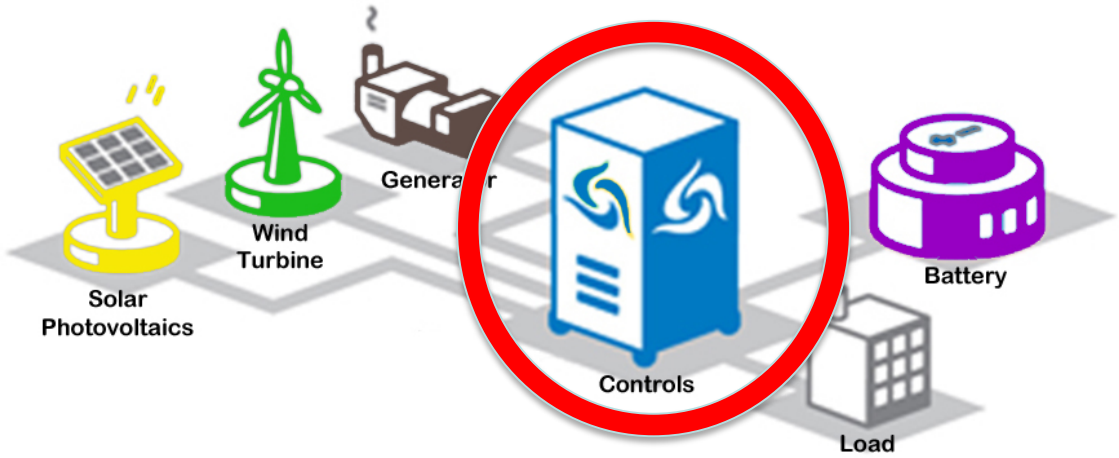
- Power flow is no more uni-directional
- Power generation at all levels
- Changed structure



Figures are courtesy of Joe Thomas, Citipower, Australia

Smart/Micro-Grids

- Active monitoring is required
- Communication and Control is the key!
  - Micro-Generators
  - Storage
  - Loads
  - Protection Devices



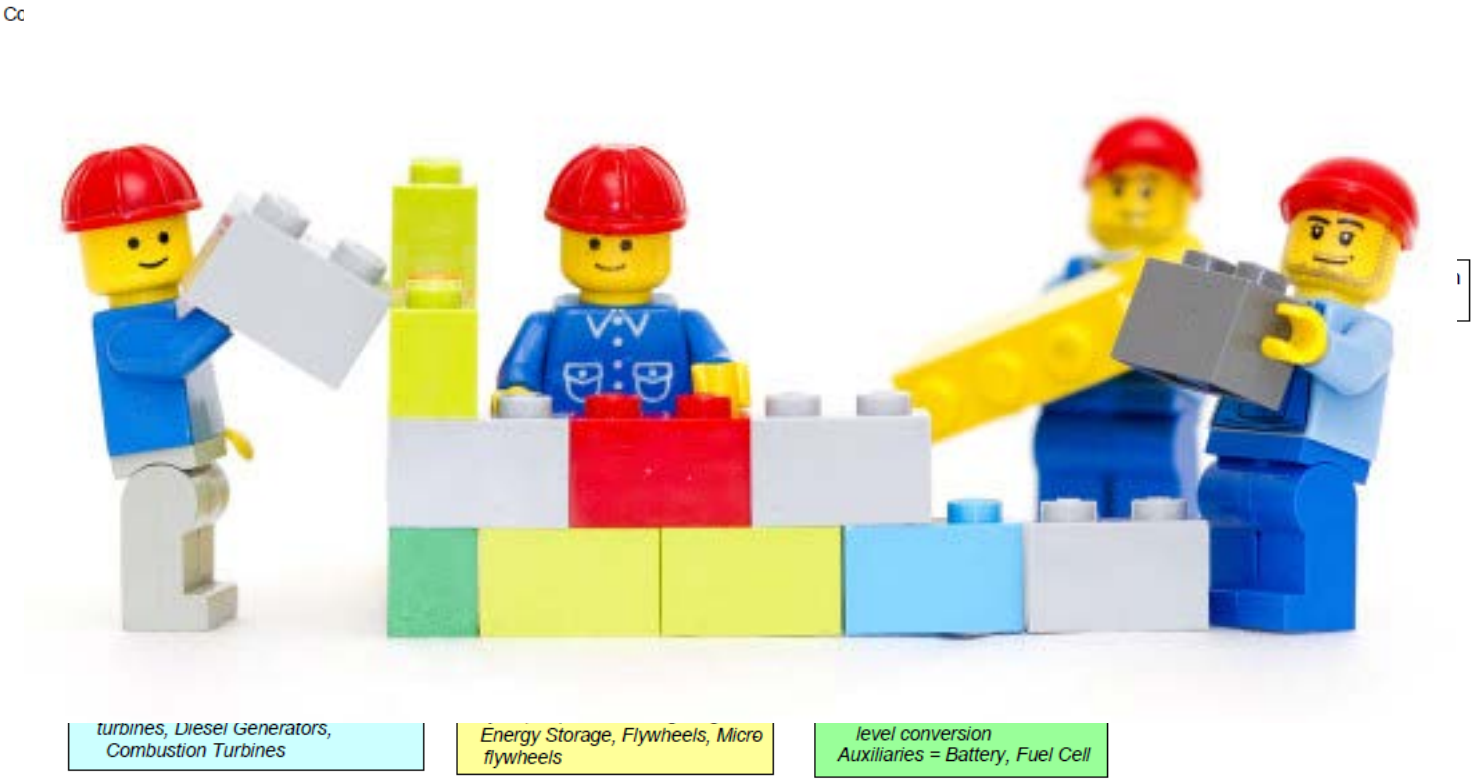
Substation Communication Standard IEC 61850

- Communication Barriers
  - Different languages
  - Miscommunication
- Standard Communication
  - Across all equipment
  - And vendors
- Generated Interest
  - Extensions are made

  e.g. for Distributed Generation.
  - > IEC 61850-7-420

Explaining IEC 61850-7-420 Modeling

- Template for DER systems
- Different Logical Nodes (LNs) for different tasks
- Different DER systems may use different LNs



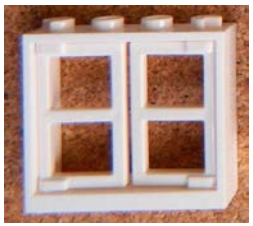
Explaining IEC 61850-7-420 Modeling

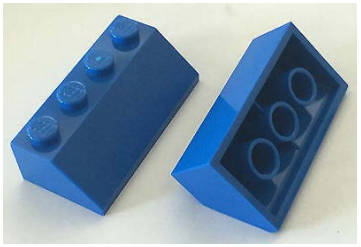
- House
- Standard Parts
  - Roof, bricks, grass
  - Windows (flap, non-flap)

Explaining IEC 61850-7-420 Modeling

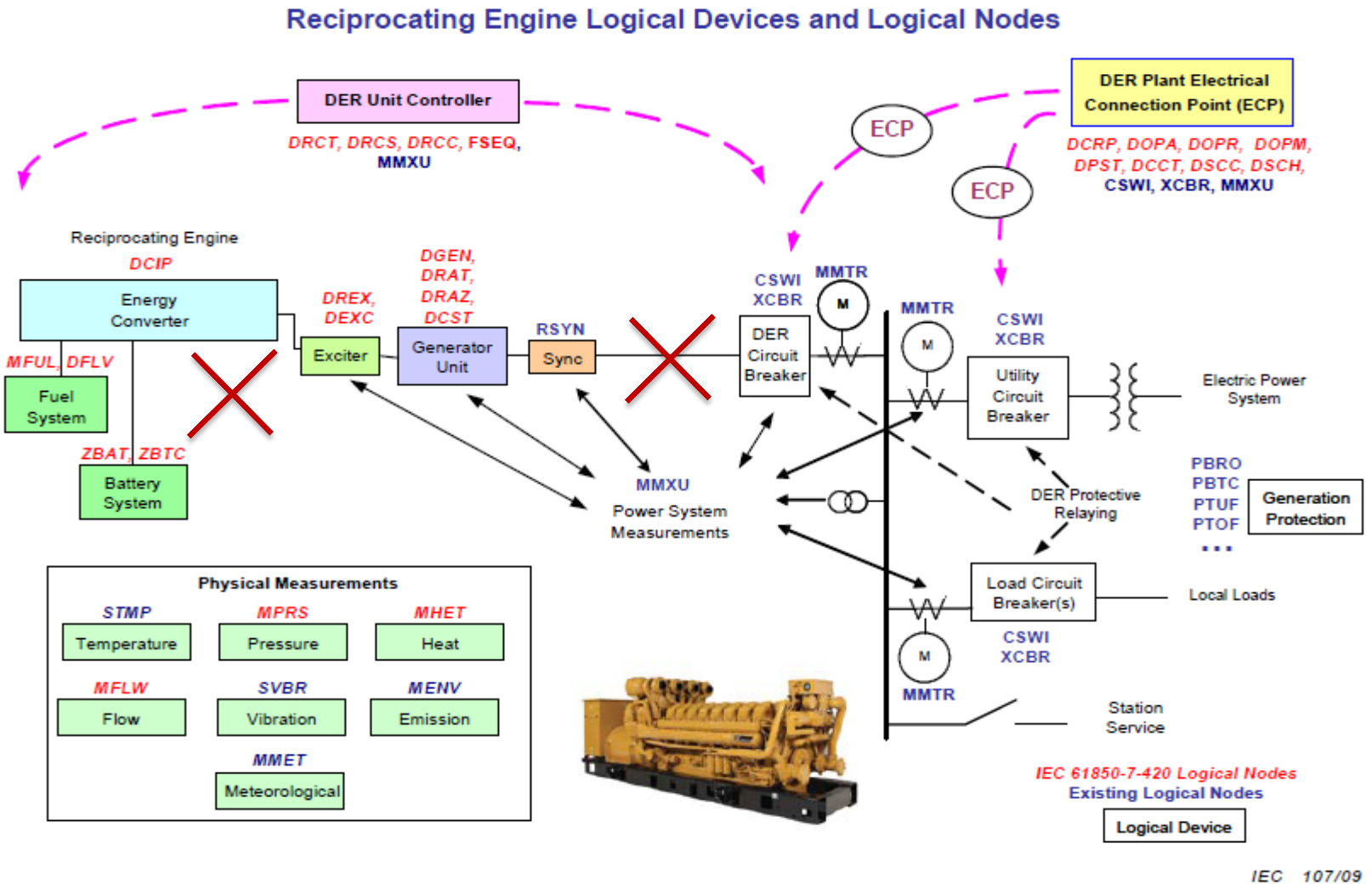
- Doors
  - Entrance doors (door knob)
  - Garage door (optional)
- Lights, Chimneys (different colors)

Explaining IEC 61850-7-420 Modeling

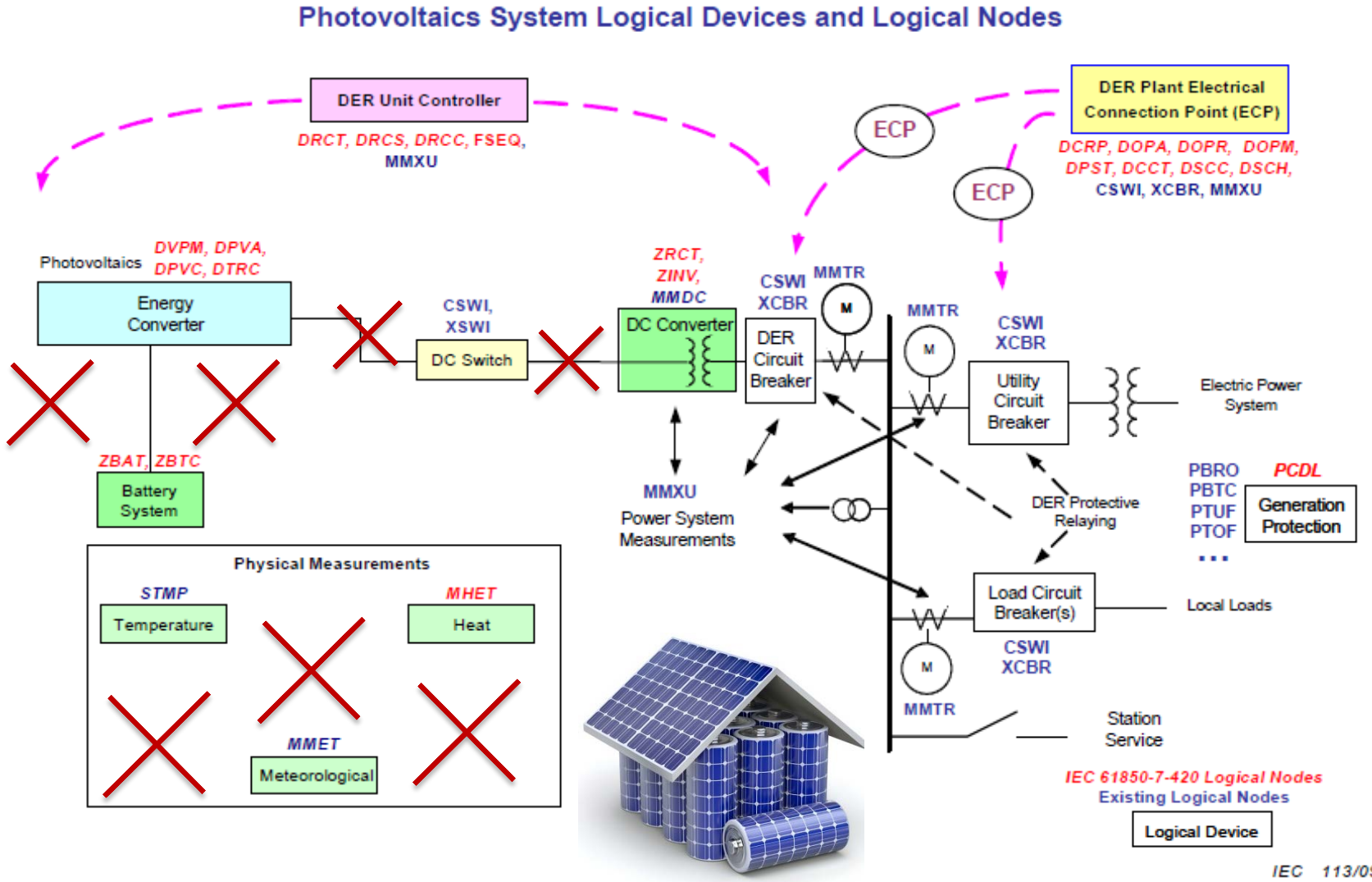




Design Examples with IEC 61850-7-420

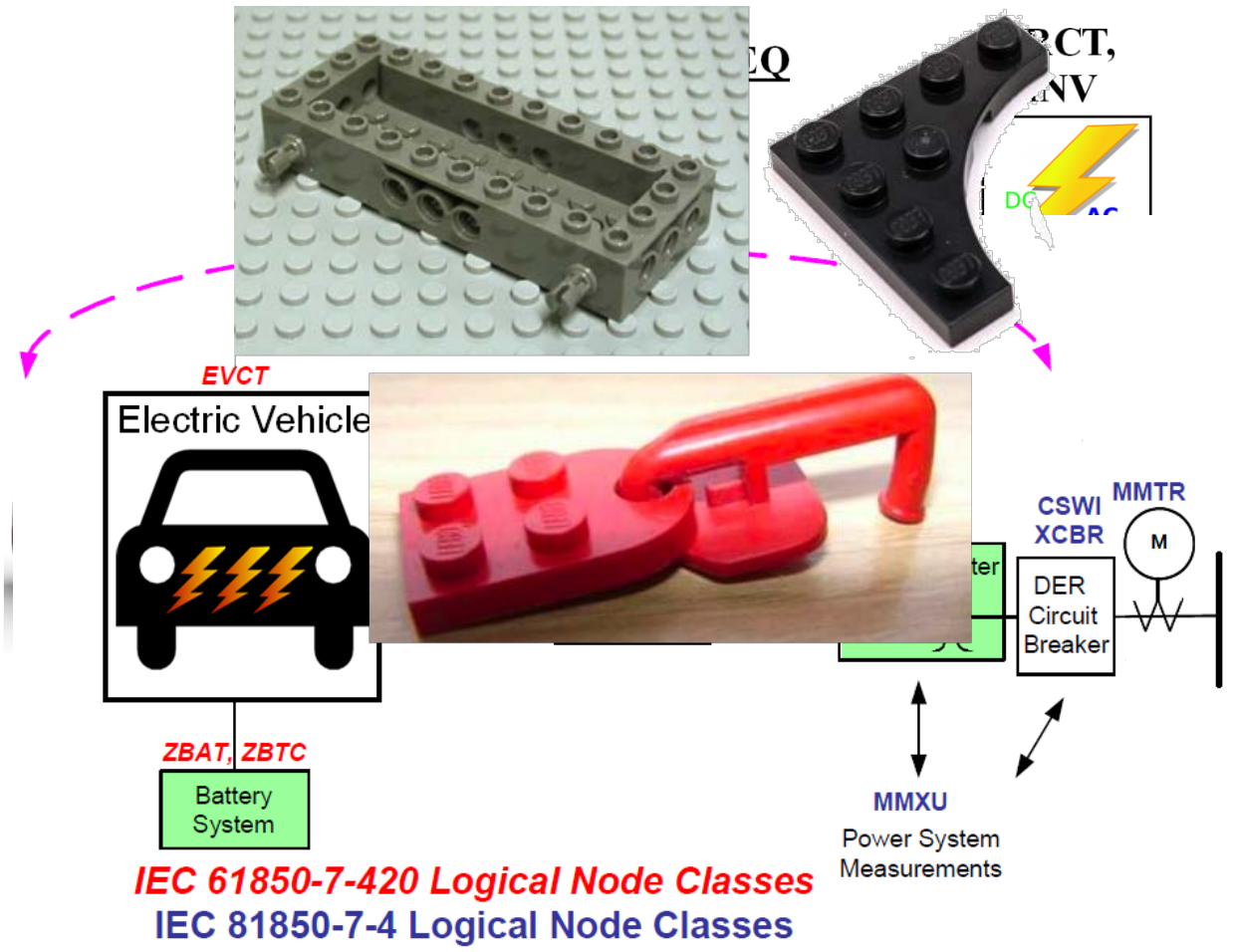


Design Examples with IEC 61850-7-420



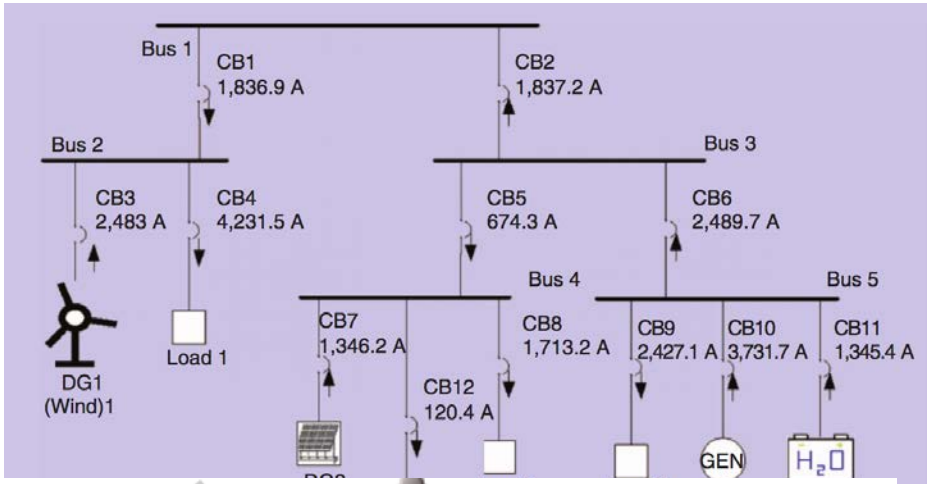
New Models Developed

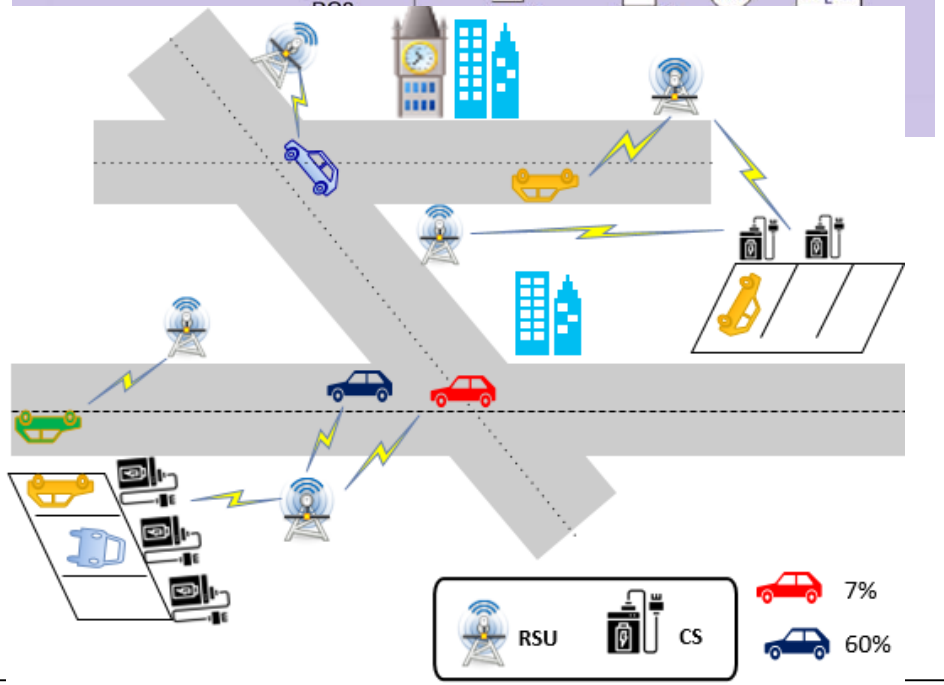
- New Equipment
  - New Models
  - Building Blocks
- Abstraction to Comms
- Logical Device
- Proposed Connection Point



New Models Developed

- New Equipment
  - New Models
  - Building Blocks
- Abstraction to Comms
- Logical Device
- Proposed Connection Point
- Different Implementations
  - V2G Coordination
  - Smart City Automation with IEEE 1609 Wave Standard





Required New Model: Smart Inverters

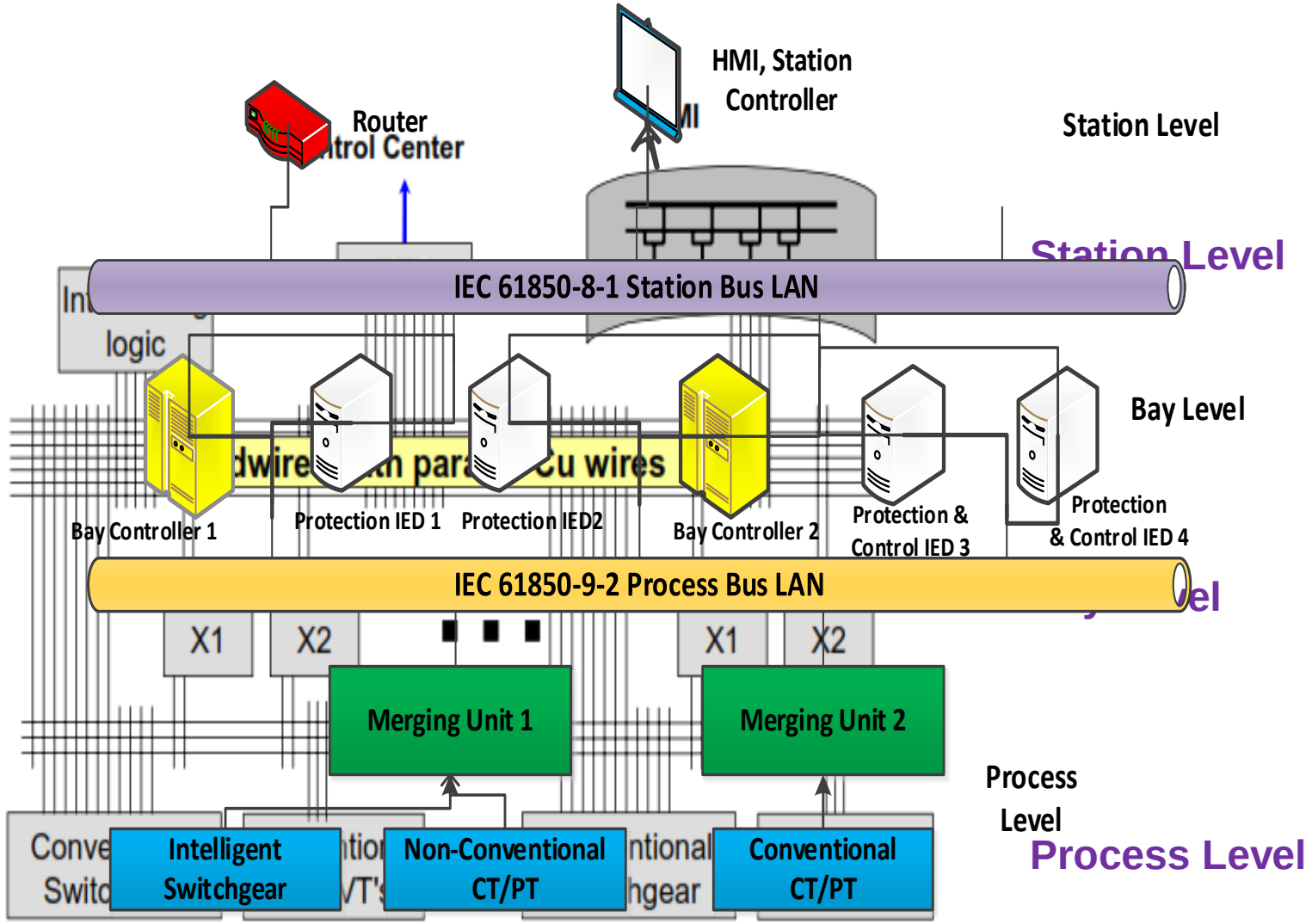
- A new player with new capabilities
  - Maybe based on old inverter models
  - But needs additions
- New Integrations
  - IEC 61850 and OpenADR

Modes	Functions
Immediate Control	INV1: grid connect/disconnect
	INV2: adjust max. generation level up/down
	INV3: adjust power factor
	INV4: request active power
	INV5: Pricing signal (charge/disch.)
Volt-Var Management	VV1: Available Var support, no P impact
	VV2: Max. Var support based on Wmax
	VV3: Static Power Converter
	VV4: Passive Mode (No Var support)
Frequency Related	FW21: High freq. reduces P
	FW22: Limiting generation with f
Dynamic Reactive Current Support	TV31: Support during abnormally high or low voltage
Low-high voltage ride-through	"Must disconnect" (MD) "Must remain connected" (MRC)
Watt triggered	WP41: Watt power factor
	WP42: Alternative watt power factor
Volt-watt management	VW51: Volt-Watt management (generation)
	VW52: Volt-Watt management (charging)
	DS94: Time synchronization requirements

IEC 61850

openADR ALLIANCE

Cybersecurity in Smartgrids, Why now?



Standardization benefits ALL!

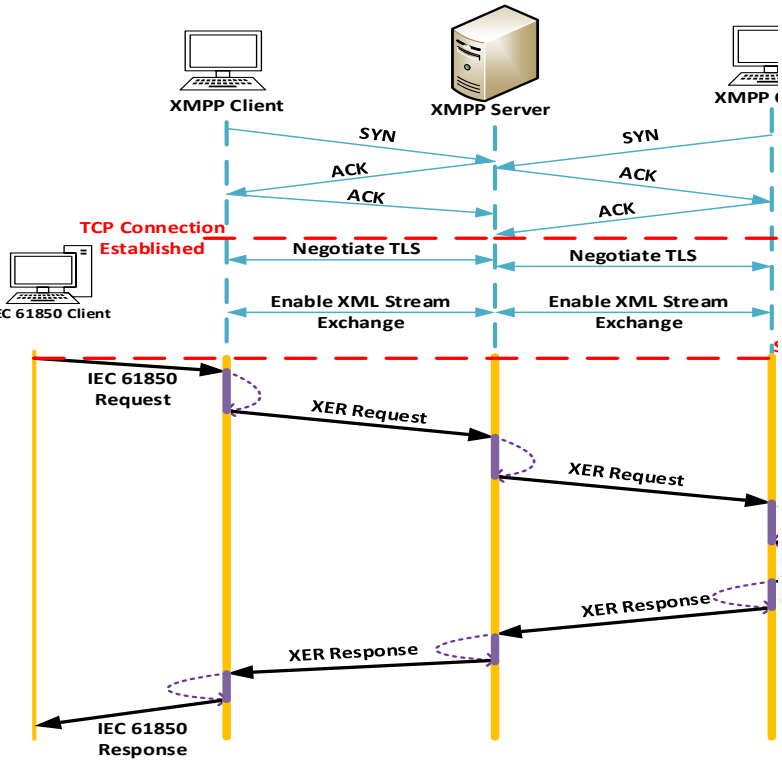
- Non-standard modeling
  - Confidential
  - Unknown
  - Different
- Standard modeling
  - Everything is known!
  - Variables
  - Functions
- All accessible!

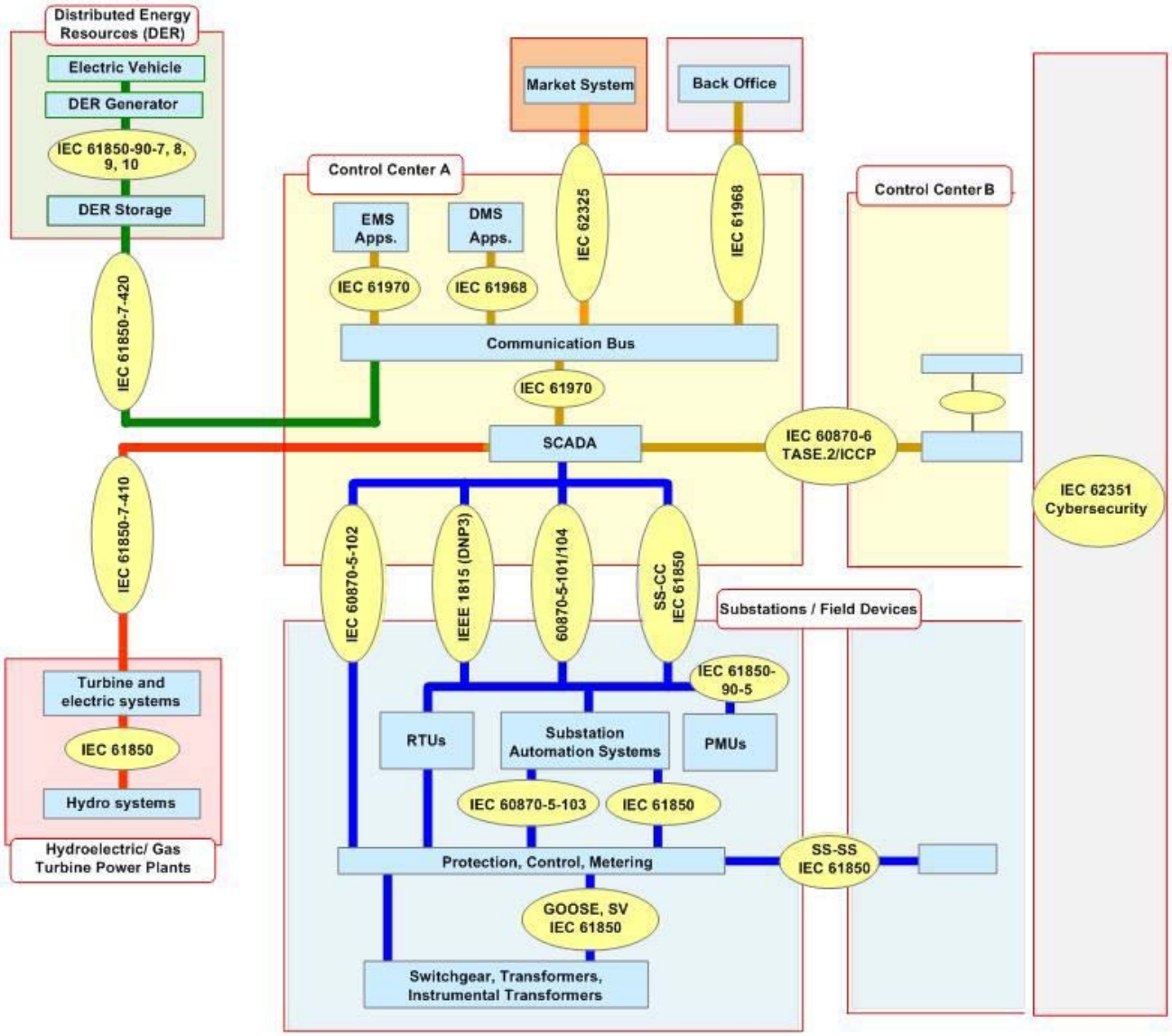
IEC 62351 Standard
Security Objectives

- authentication of entities through digital signatures
- ensuring only authorized access
- prevention of unauthorized instructions
- Catch the bad guys!

IEC 62351 Security Standards for Power Systems

- Overall Outlook
- XMPP Authentication
- Timing, Performance





Research Work

- IEC 62351 is a list of guidelines
  - Expertise to understand it is required
  - There are no fully-developed solutions
- Systems that follow IEC 62351 should be developed

Research Work

- Use cases
  - PMU communication, IEC 61850-90-5
  - Energy Management Systems, IEC 61970, IEC 61968
  - Systems based on IEC 61850
    - Protection systems such as Differential Protection
    - Distributed Generators IEC 61850-7-420
- Timing Performance is the key!

Conclusions

- IEC 61850's popularity is growing
  - More Modeling is required
  - Interoperability should be enhanced
- IEC 61850 has some loopholes
  - IEC 62351 is developed to that end
  - Understanding and implementing the guidelines
- Hardware-in-the-loop testing
  - For easier prototyping and testing
  - Overcoming the limitations of lab setups

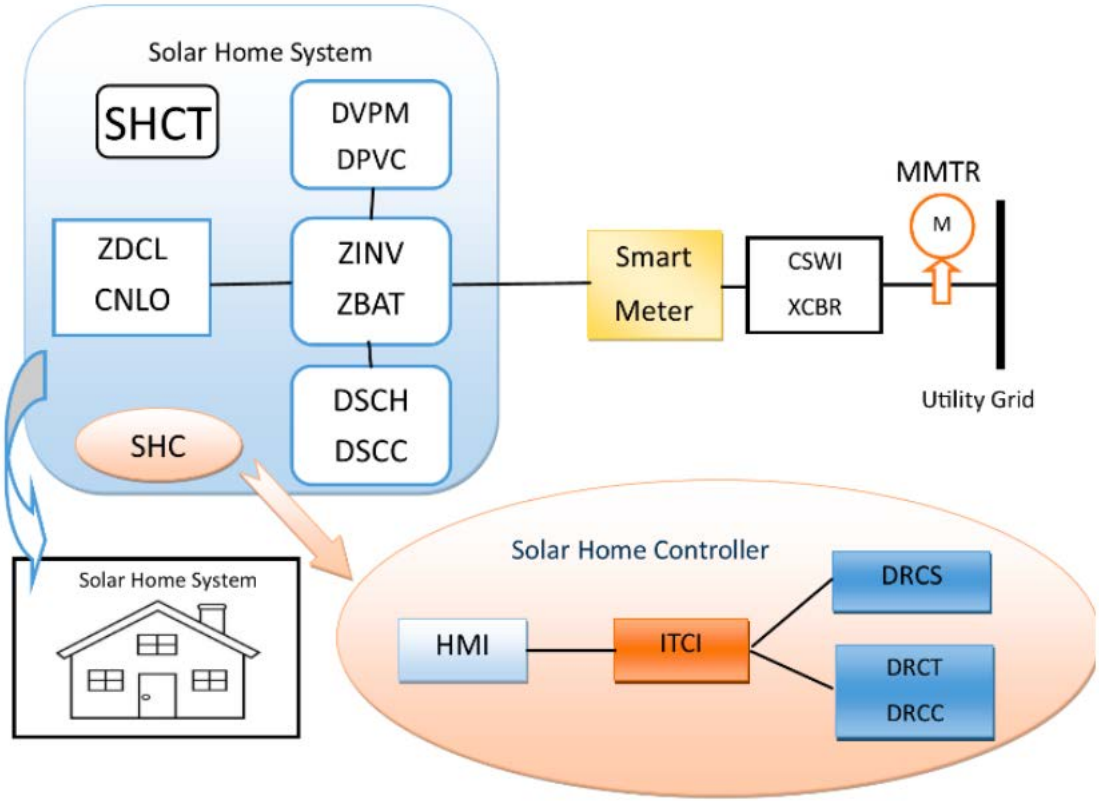
Deploying Renewables will be as fun as playing with LEGO!

Questions?

Disclaimer: This presentation is NOT sponsored by The LEGO Group!

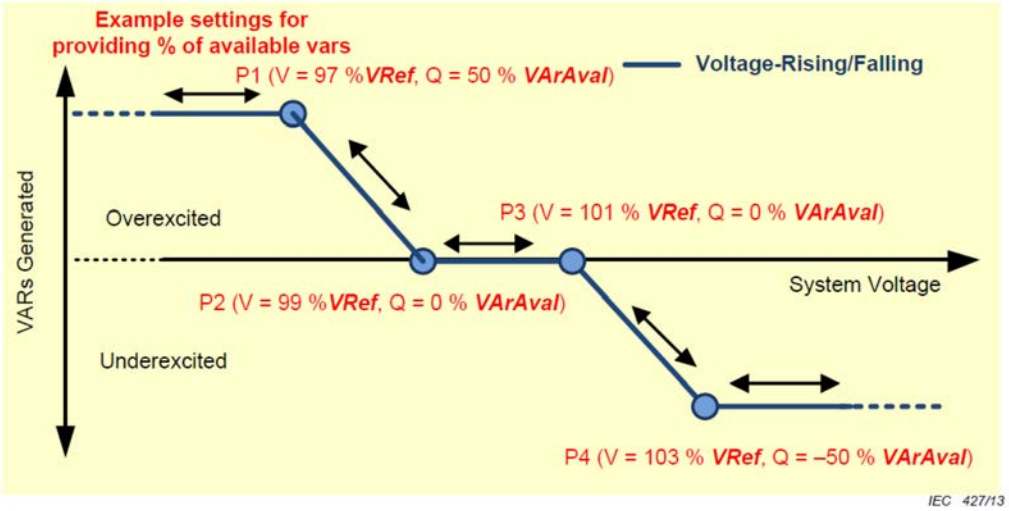
New Model 2: HEMS & Smart Meters

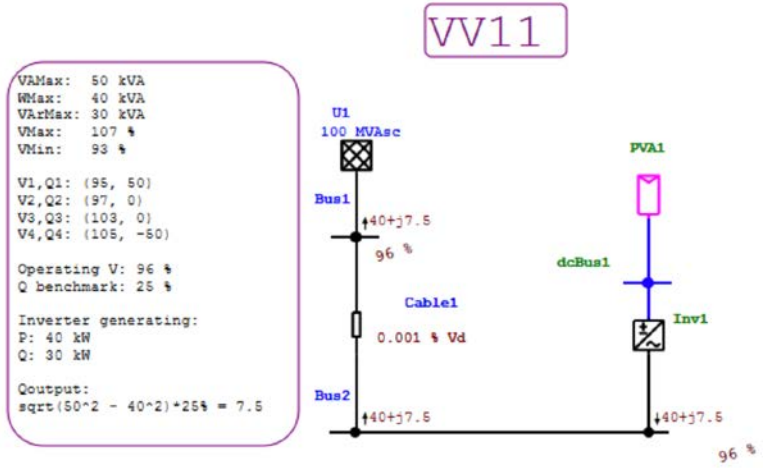
- Home Energy Management System
- SmartMeter – Interface
- Simulations for different setups, Comms Performance
  - Acceptable for Power System Operation



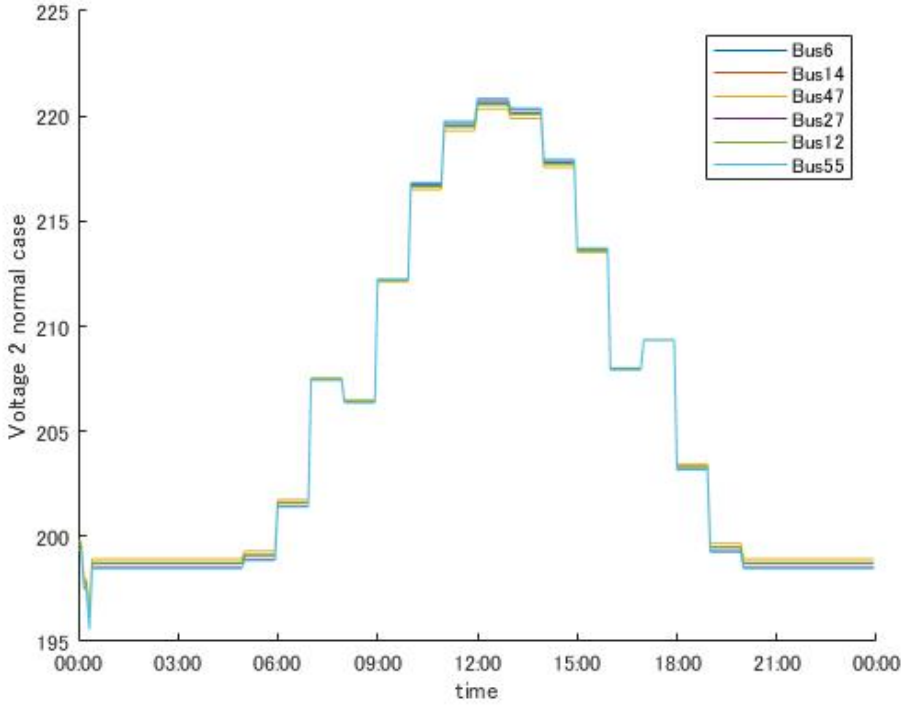
SI Cyber Attack Example

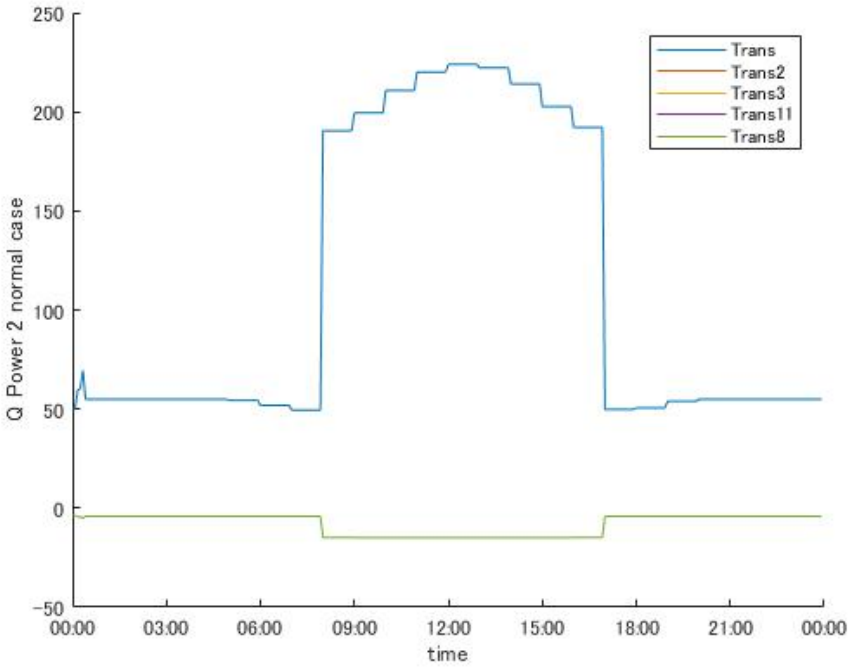
- E.g., Volt-Var Control
- We simulated some attacks and changed operating parameters
- Preliminary results
  - Abnormally high voltages & currents
- New software capabilities req'd





Normal SI Operation





Hacked SI Operation