



**NERC TPL-007-2  
GMD Outage Description**

May 16, 2019

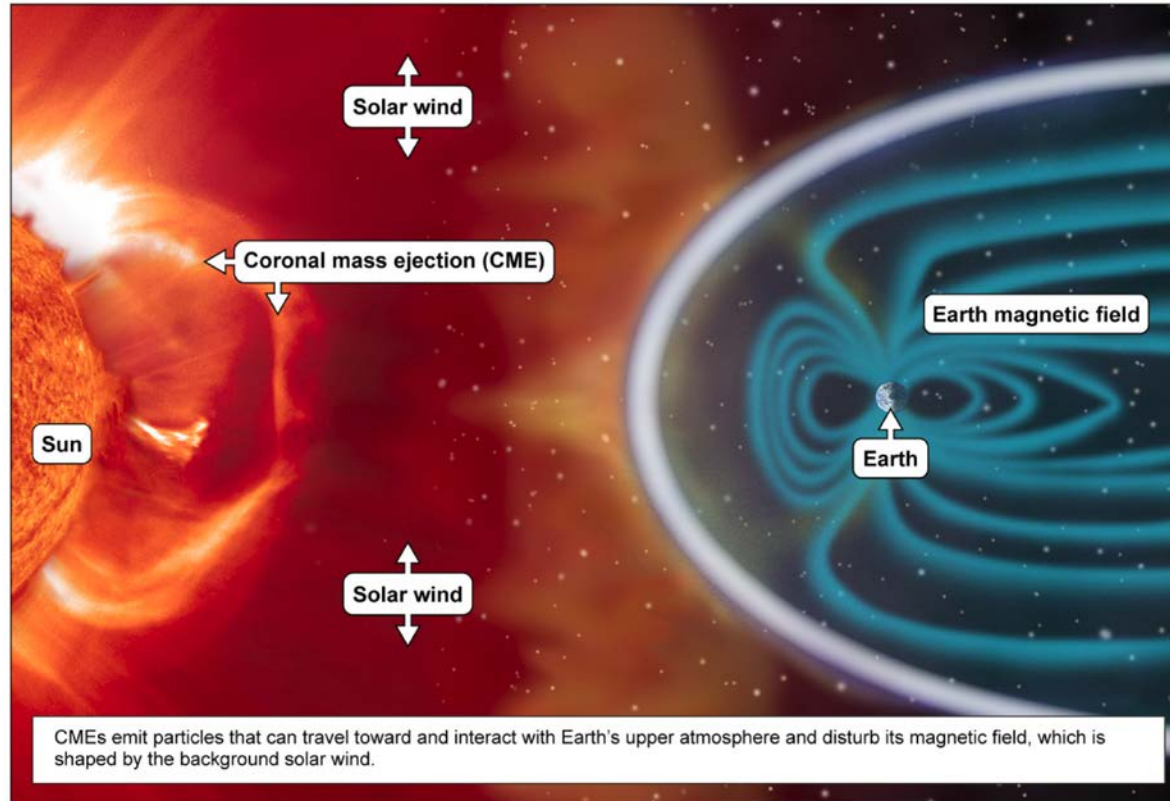
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# Agenda

- ▶ The Phenomenon – Quick Review
- ▶ Origin of Your GMD Outage Description Obligation
- ▶ Grid Consequences
  - Vulnerability Assessment & GMD Outage Descriptions
- ▶ BMCD GMD Outage Roadmap

# The Phenomenon

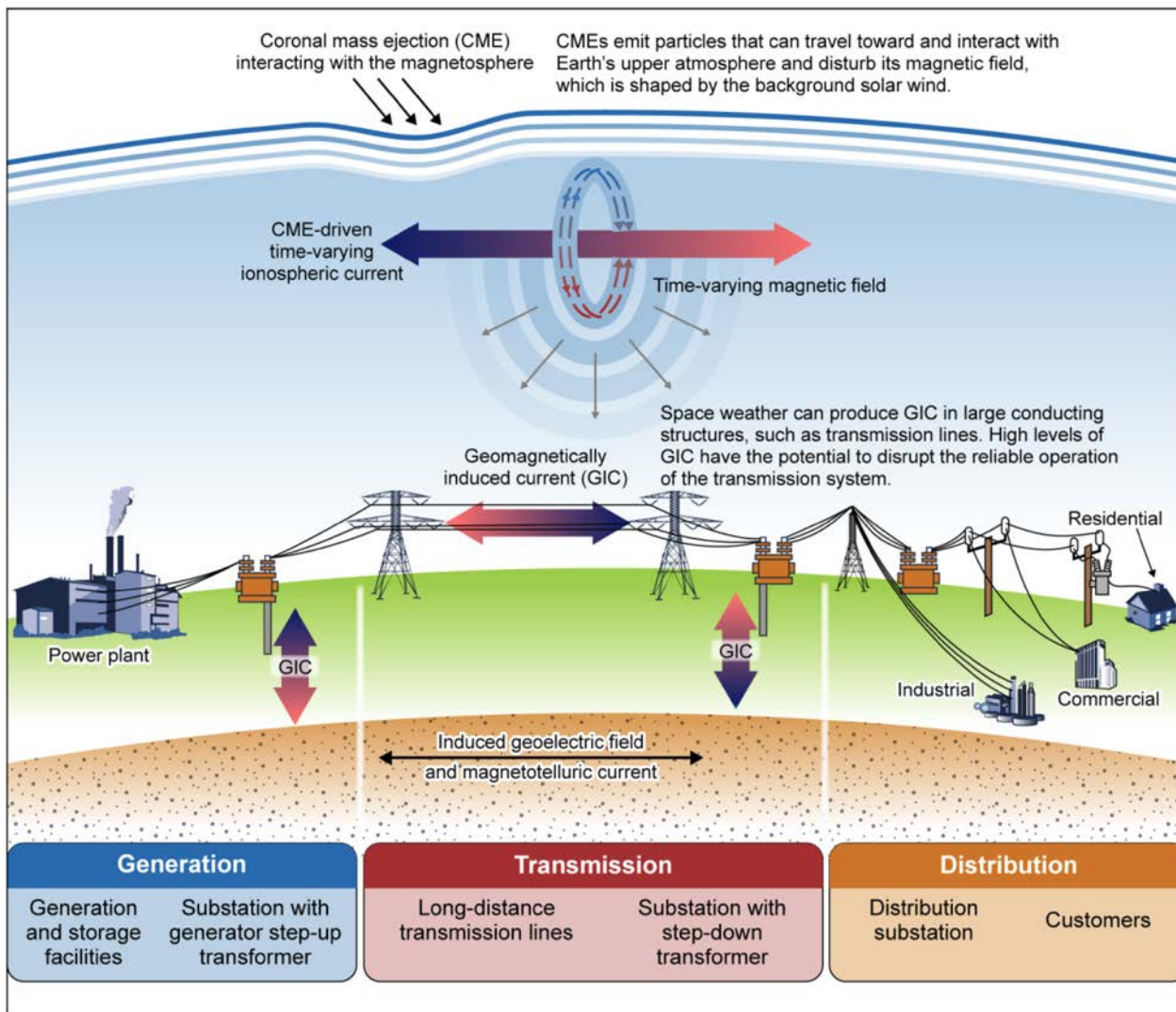
# Geomagnetic Disturbance



Source: National Aeronautics and Space Administration (illustration). | GAO-19-98

- ▶ Coronal mass ejection; a cloud of solar material and magnetic fields
- ▶ Last 24 to 48 hours
- ▶ Geomagnetic Storm creates Geomagnetically Induced Current(GIC)

# Geomagnetic Induced Current Production



Sources: GAO (presentation); Art Explosion (images). | GAO-19-98

# ERCOT Obligation

# Origin of GMD Outage Obligation

Table 1: Steady State Planning GMD Event				
<b>Steady State:</b>				
a. Voltage collapse, Cascading and uncontrolled islanding shall not occur. b. Generation loss is acceptable as a consequence of the steady state planning GMD events. c. Planned System adjustments such as Transmission configuration changes and re-dispatch of generation are allowed if such adjustments are executable within the time duration applicable to the Facility Ratings.				
Category	Initial Condition	Event	Interruption of Firm Transmission Service Allowed	Load Loss Allowed
<b>Benchmark GMD Event - GMD Event with Outages</b>	1. System as may be postured in response to space weather information <sup>1</sup> , and then 2. GMD event <sup>2</sup>	Reactive Power compensation devices and other Transmission Facilities removed as a result of Protection System operation or Misoperation due to harmonics during the GMD event	Yes <sup>3</sup>	Yes <sup>3</sup>
<b>Supplemental GMD Event - GMD Event with Outages</b>	1. System as may be postured in response to space weather information <sup>1</sup> , and then 2. GMD event <sup>2</sup>	Reactive Power compensation devices and other Transmission Facilities removed as a result of Protection System operation or Misoperation due to harmonics during the GMD event	Yes	Yes
Table 1: Steady State Performance Footnotes				
1. The System condition for GMD planning may include adjustments to posture the System that are executable in response to space weather information. 2. The GMD conditions for the benchmark and supplemental planning events are described in Attachment 1. 3. Load loss as a result of manual or automatic Load shedding (e.g., UVLS) and/or curtailment of Firm Transmission Service may be used to meet BES performance requirements during studied GMD conditions. The likelihood and magnitude of Load loss or curtailment of Firm Transmission Service should be minimized.				

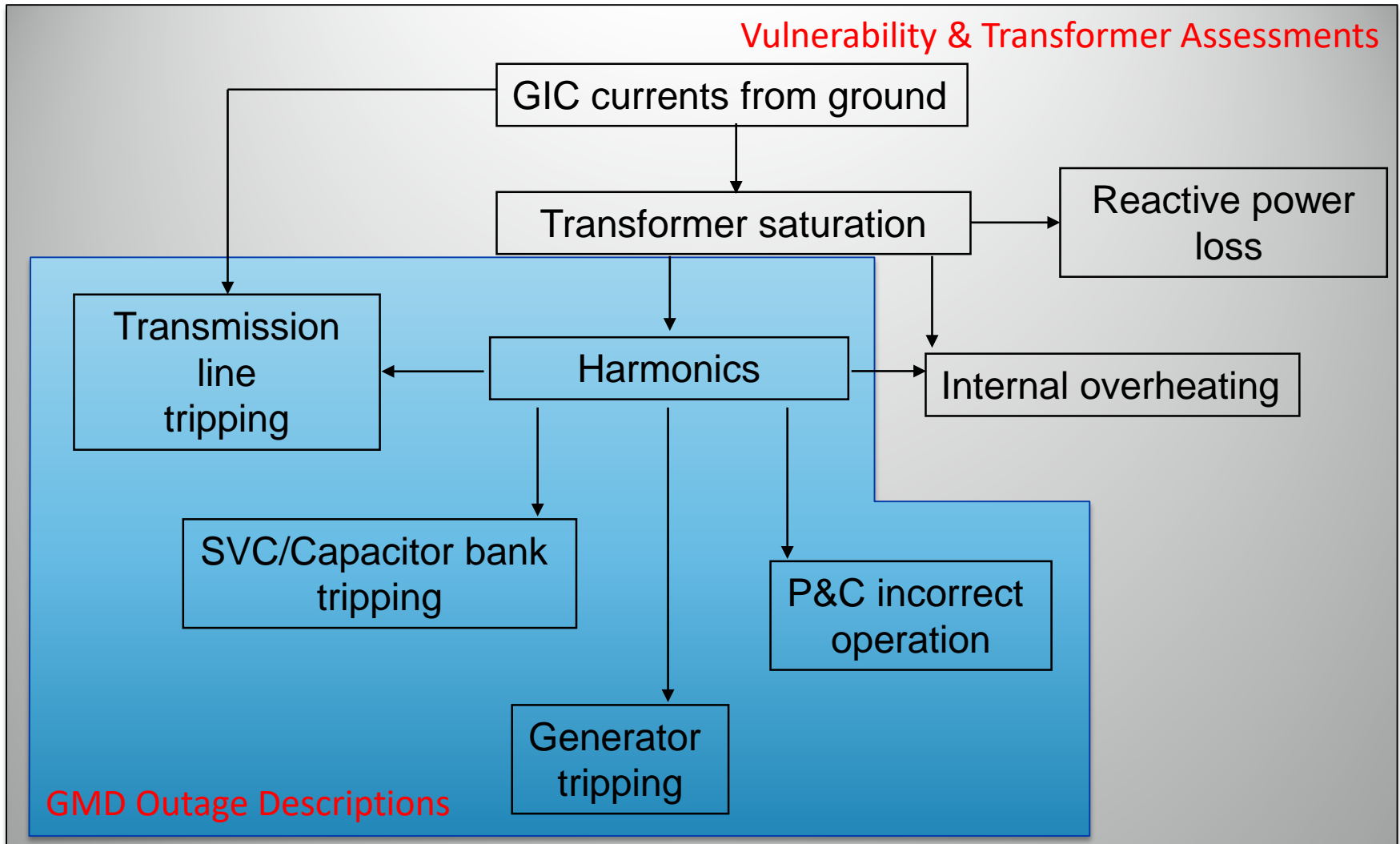
## ERCOT Planning Guide Section 6.11

- (2) Each TSP and Resource Entity shall provide to ERCOT a list of GMD event contingencies as described in the applicable NERC Reliability Standard for use in the GMD vulnerability assessment as outlined in Section 3.1.8, Planning Geomagnetic Disturbance (GMD) Activities.

# Grid Consequences

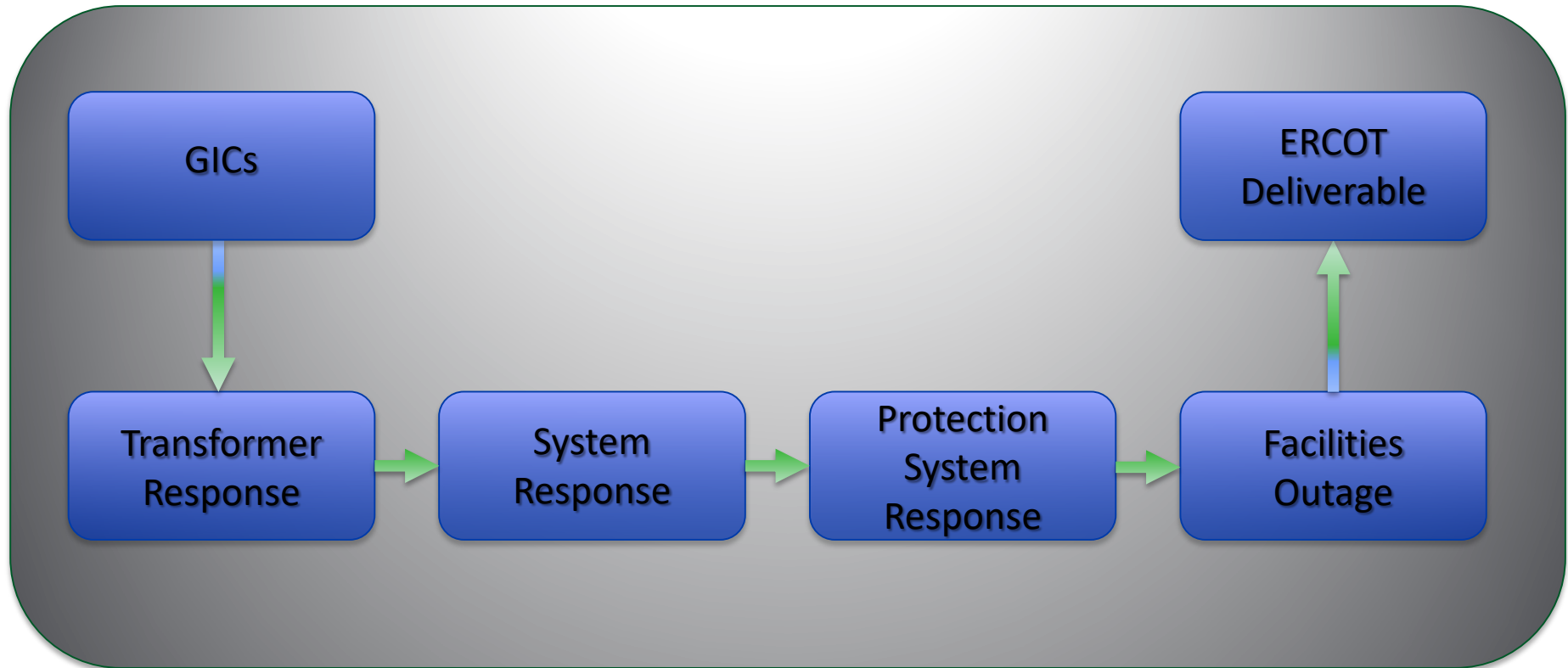


# GIC Grid Consequences

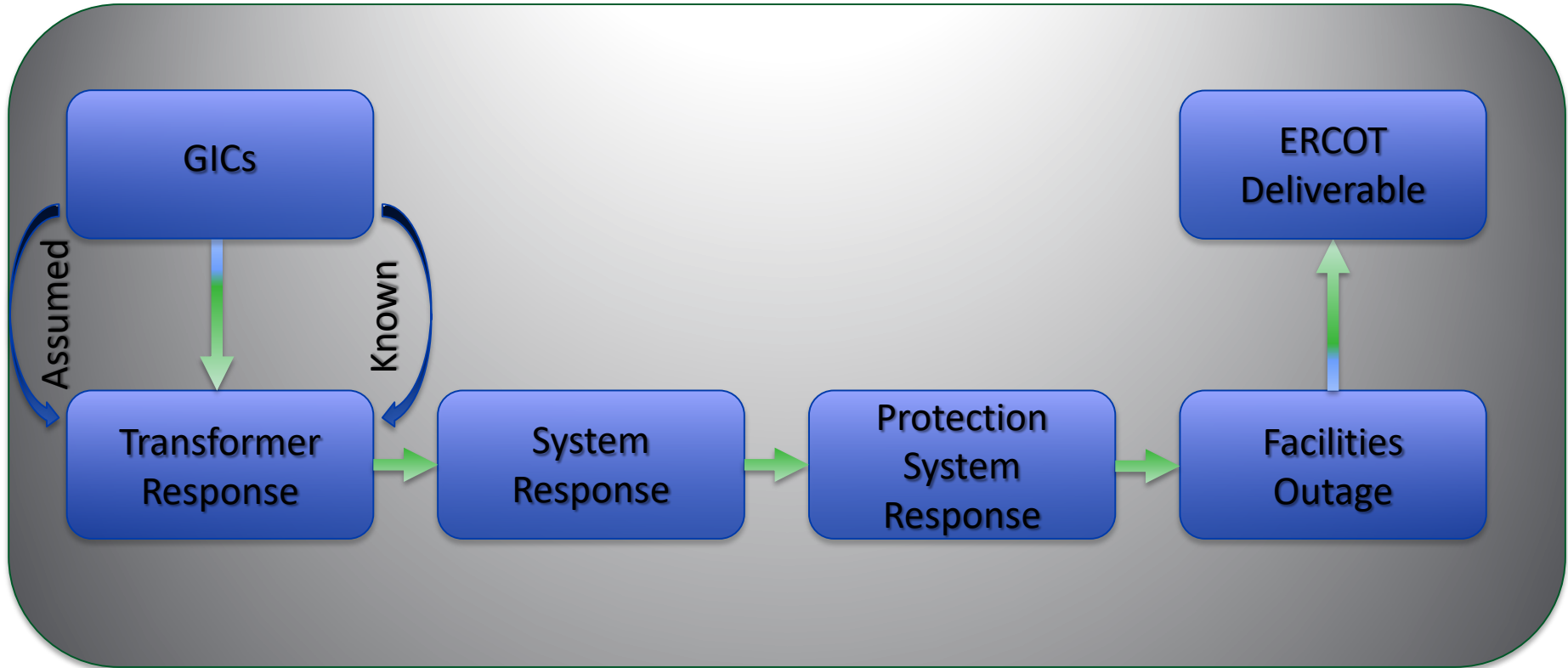


# **B M C D G M D O u t a g e D e s c r i p t i o n R o a d m a p**

# Burns & McDonnell GMD Outage Description Roadmap



# Burns & McDonnell GMD Outage Description Roadmap



# Harmonic Production - Half-Cycle Saturation

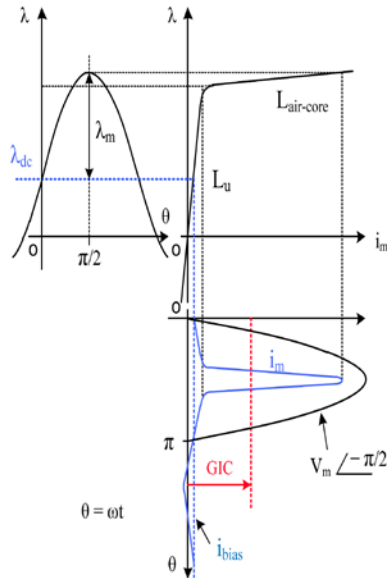
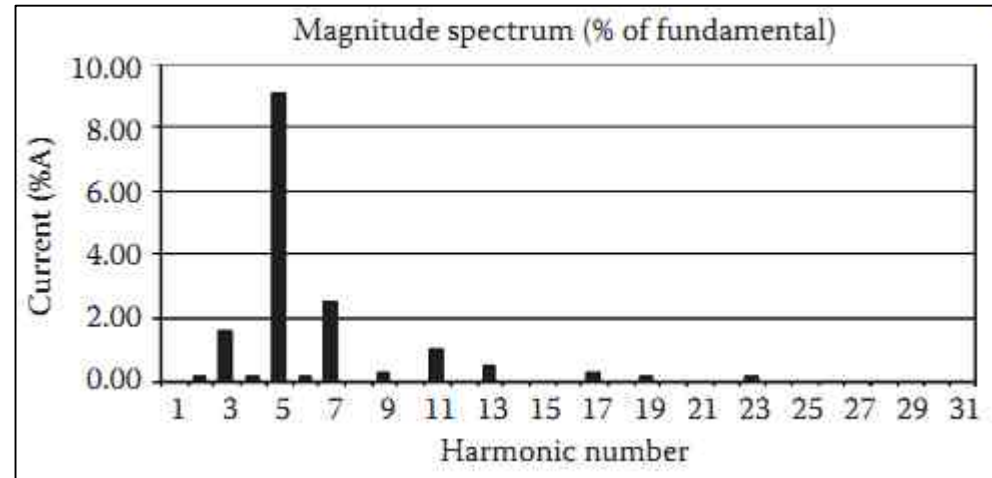
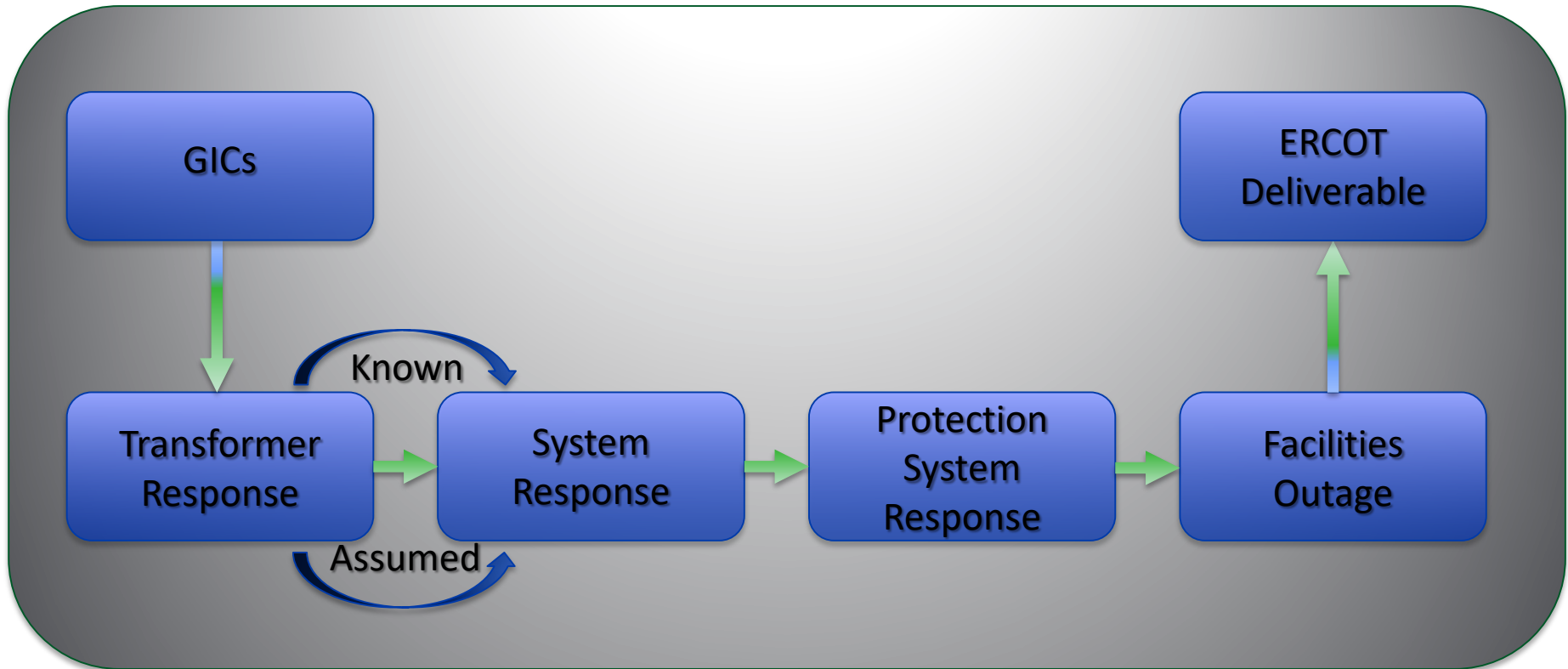


Figure 1: Mapping Magnetization Current to Flux through Core Excitation Characteristics

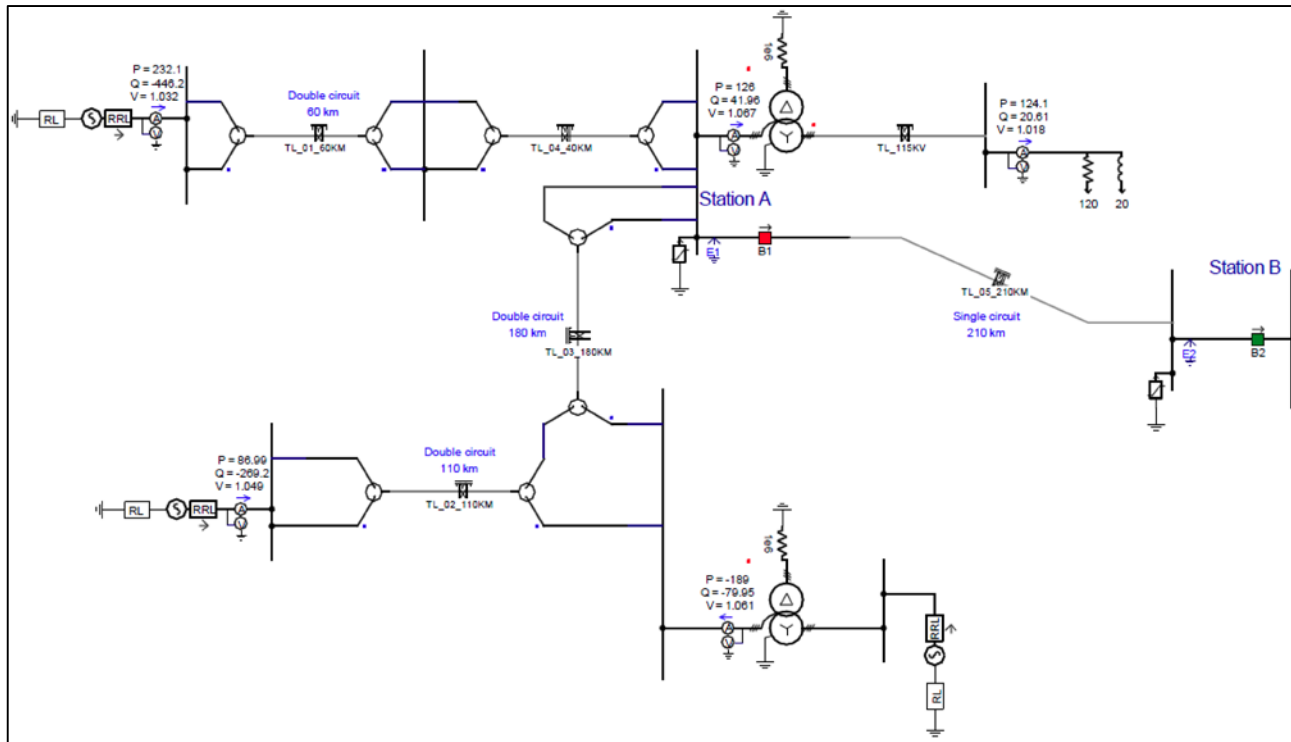


- ▶ “GIC results in an offset of the ac sinusoidal flux resulting in asymmetric or half-cycle saturation”
  - Harmonic Production at Transformers

# Burns & McDonnell GMD Outage Description Roadmap

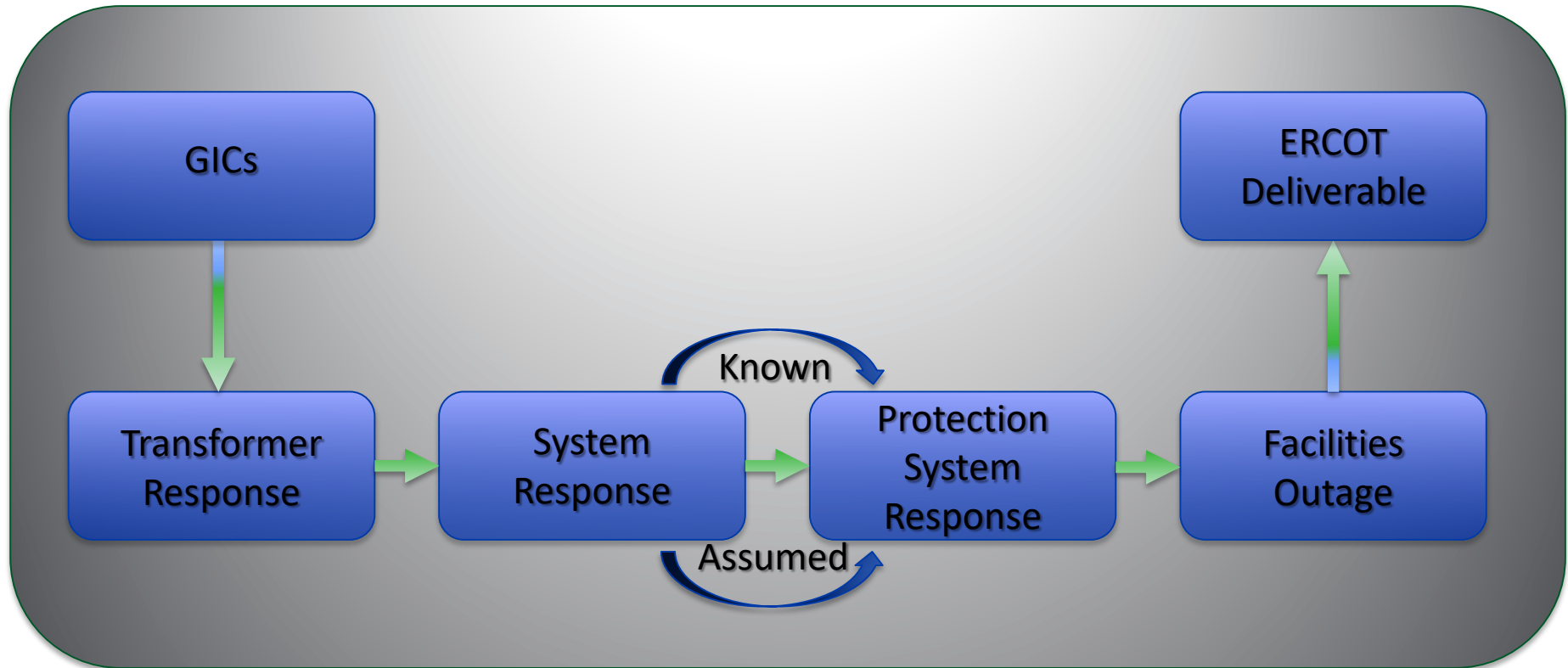


# System Response - Harmonics Analysis



- ▶ The system response depends on the energy storage elements and their configuration around the harmonic sources.
  - Energy storage elements include, transmission line coupling, shunt/series capacitors and reactors, etc.

# Burns & McDonnell GMD Outage Description Roadmap





# Protection System Response

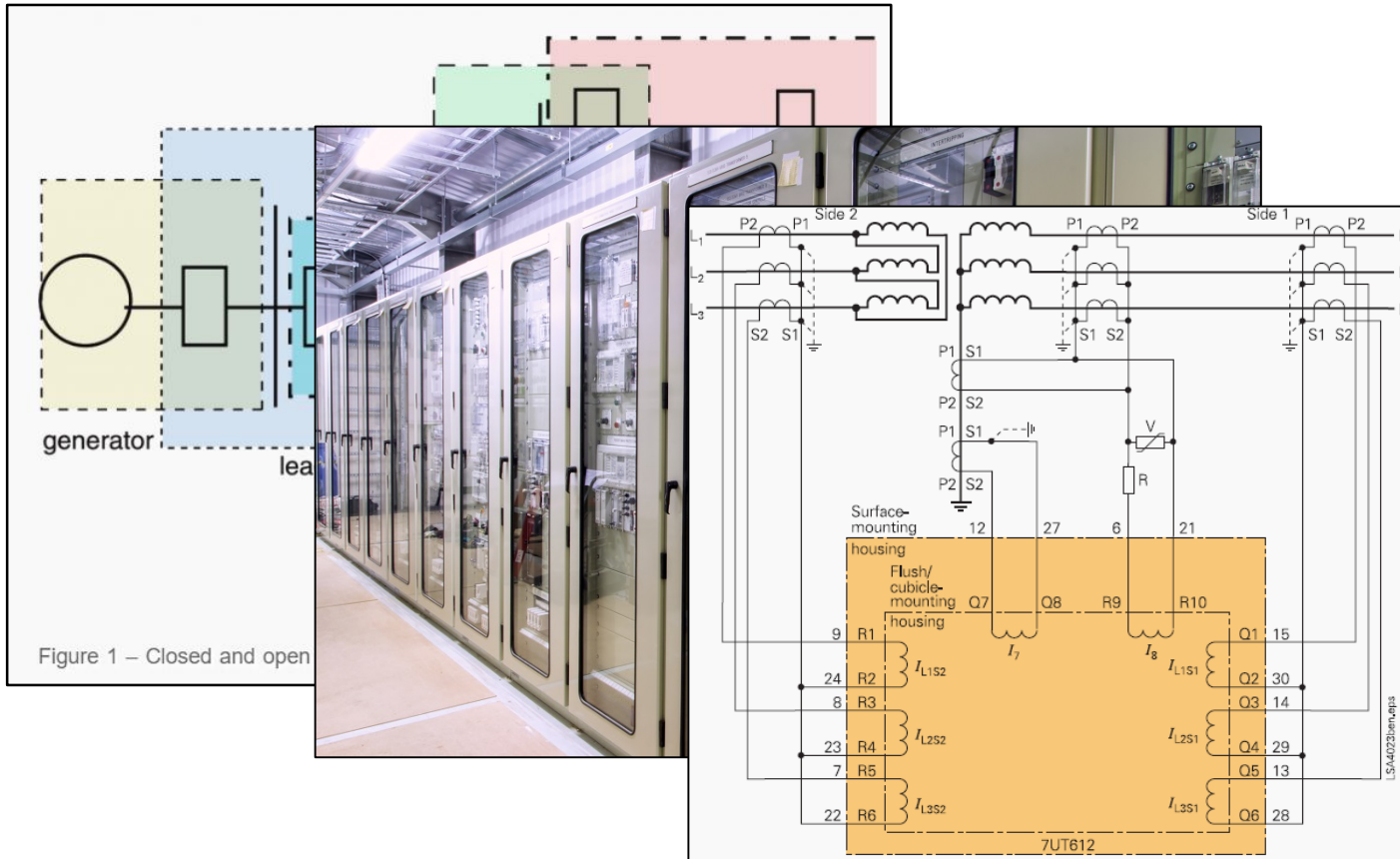
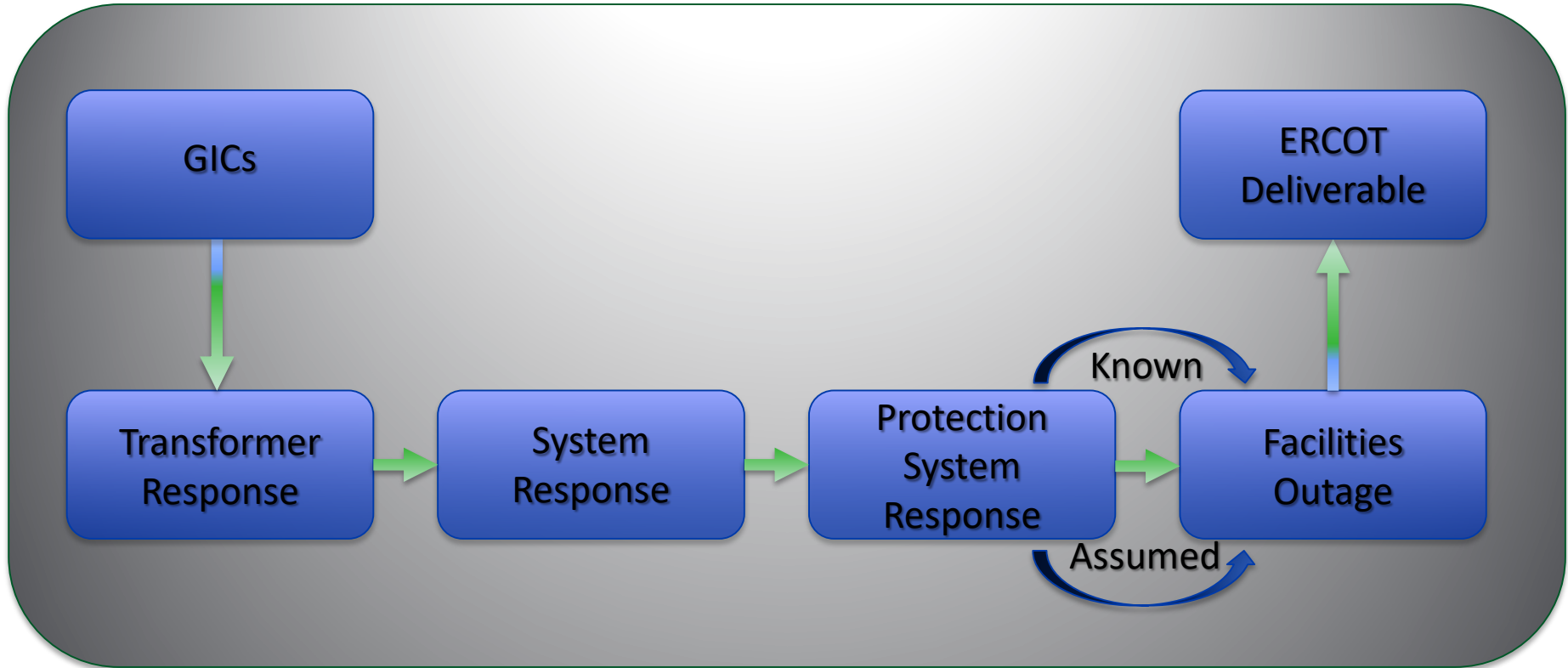


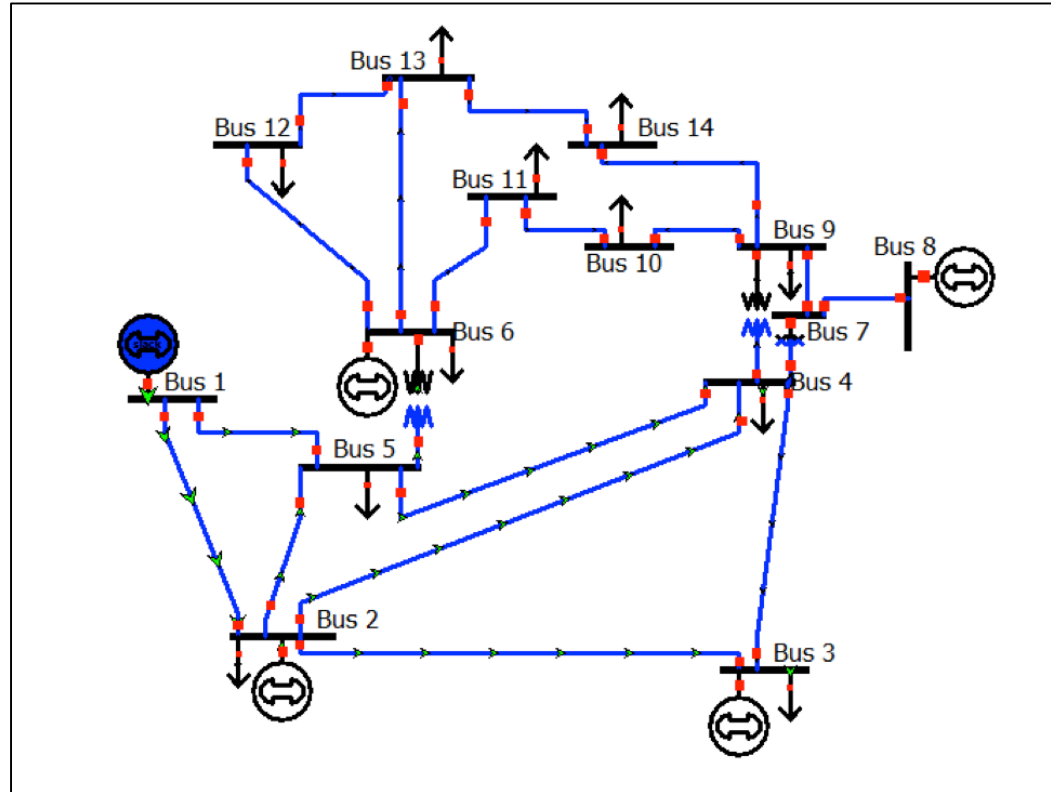
Figure 1 – Closed and open

- ▶ The protection system response depends on the zones of protection, the equipment used, and the types of schemes that make up the protection system

# Burns & McDonnell GMD Outage Description Roadmap

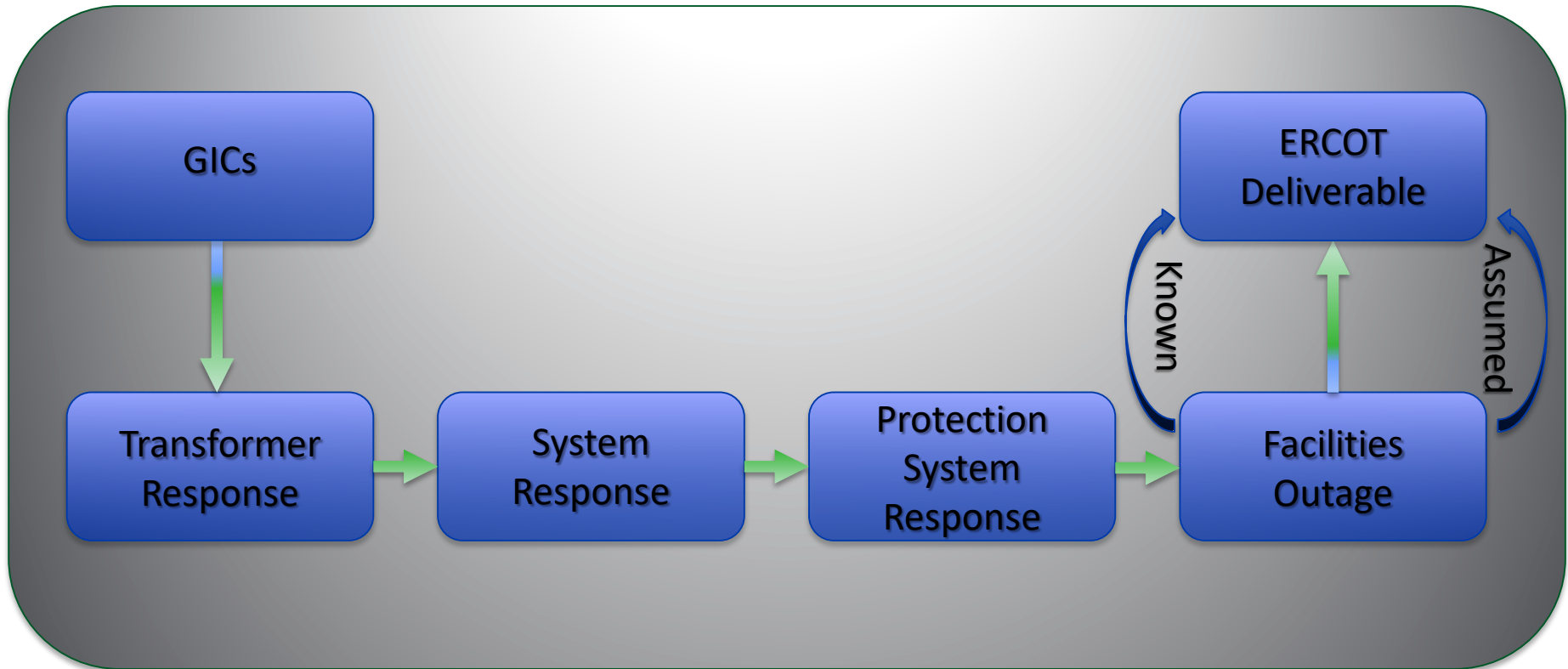


# Facilities Outage



- ▶ The protection system response is translated into facilities outages as viewed from a system standpoint (outage of a cap bank, svc, generator, transmission line, etc.)

# Burns & McDonnell GMD Outage Description Roadmap



# Deliverables

GMD Outages:  
Methodology & Results

For

Jones Road Electric  
2019

```
///// GMD_Outages.con /////  
CONTINGENCY "Jones to Jacobs1"  
    DISCONNECT BRANCH FROM BUS 456218 TO BUS 825421 CKT 1  
END  
CONTINGENCY "Mary St. 161/345 xfrm"  
    DISCONNECT BRANCH FROM BUS 85741 TO BUS 632517 CKT 3  
END  
CONTINGENCY "Dunkel GSU1"  
    DISCONNECT BRANCH FROM BUS 4578 TO BUS 10254 CKT 1  
END  
CONTINGENCY "George Plant GT1"  
    DISCONNECT BUS 54168  
END  
END
```

- ▶ The key deliverable for this type of work is not only the contingencies to be submitted to ERCOT but also a compliance document that outlines the methodology and results.



CREATE AMAZING.