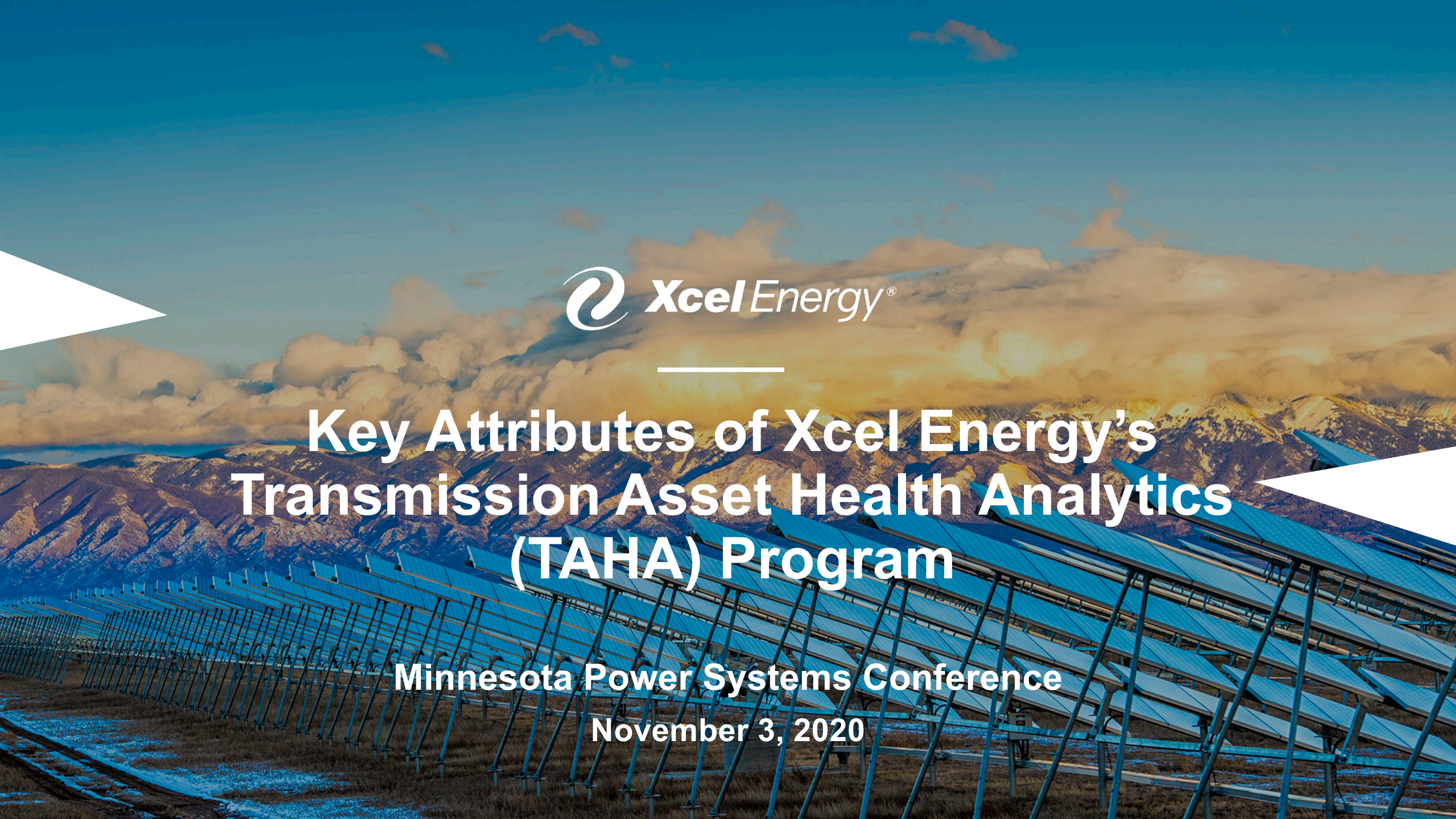


Key Attributes of Xcel Energy's Transmission Asset Health Analytics (TAHA) Program

Minnesota Power Systems Conference

November 3, 2020

TAHA Vision

- **Dependable, reliable, transactional data** with complete health analysis and state of assets
- Cognitive, predictive abilities to understand Xcel Energy assets with immediate situational awareness
- **Adaptable and expandable enterprise** capabilities with agility across the company
- Ability to measure asset performance within Xcel Energy and compare industry wide

Goals of TAHA Project

SUBSTATIONS:

Approx. 75,000 substation assets analyzed for quantity, age, and condition

- Batteries
- Circuit Breakers
- Instrument Transformers
- Substation Transformers
- Regulators
- Relays

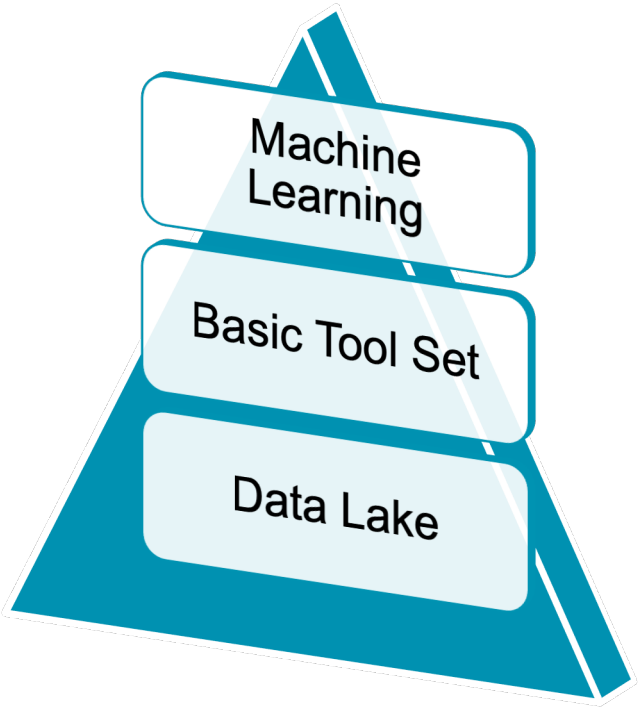
TRANSMISSION LINES:

Approx. 20,000 line miles analyzed for extent, age, and condition

- Bulk System
- Load System
- Structures
- Conductors
- Insulators

Goals of TAHA Project

- Utilize money/resources at the right place and the right time
- Provide visibility and awareness of assets
- Prioritized maintenance within and among asset classes
- Automation of manual processes
- Promote a process of continuous data improvement
- Self-service Analytics and Reporting

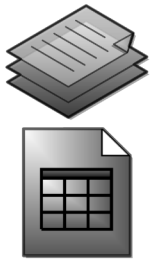


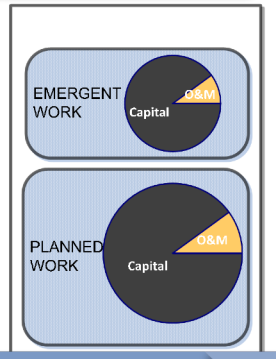
TAHA Strategic View

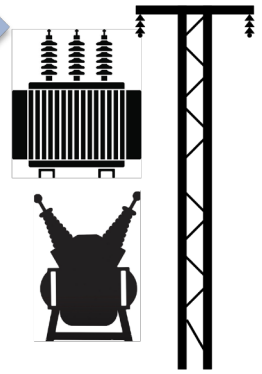
Keeping Customer Bills Low and Improving Reliability

From:

Manual Collection → Data → SME Ranking → Budget Process → Portfolio

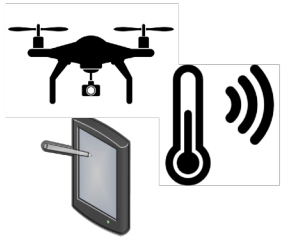
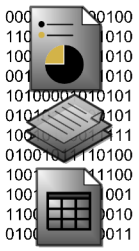
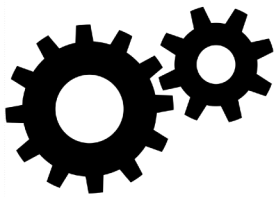


- 7 **Unconnected** data systems
- **Manual** data processing
- Qualitative decision making
- **Reactive** asset management

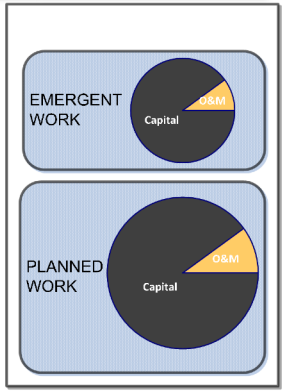
To:

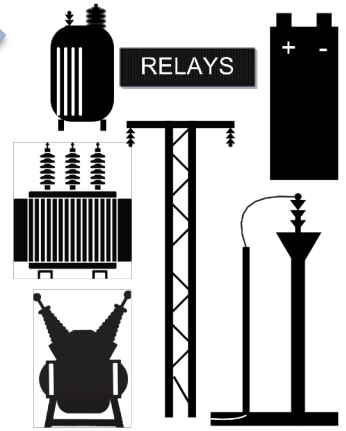
- More **Automated** and centralized data processing
- **Data-driven**, real-time decision making
- **Proactive** asset management
- Improved long-term planning

Sensors & Measurements → Data → Analytic Engine → Risk → Asset Investment Planning → Portfolio







Work Streams

- ARCM and DGA using OSI-PI
- Data Lake
- Advanced Analytics (New vendor platform)

Workstream 1: ARCM & DGA

- **Challenge**
  - **Manual processes used for Dissolved Gas Analysis (DGA) and Adaptive Reliability Centered Maintenance (ARCM)**
- **Solution**
  - **Automate by leveraging existing technology (OSI-PI) and streamlining data uploading from labs and other sources**
- **ARCM**
  - **New OSI-PI Software Solution**
  - **Performance data**
  - **Operational data**
  - **User interface**
  - **Repeatable solutions**

Workstream 1: ARCM & DGA

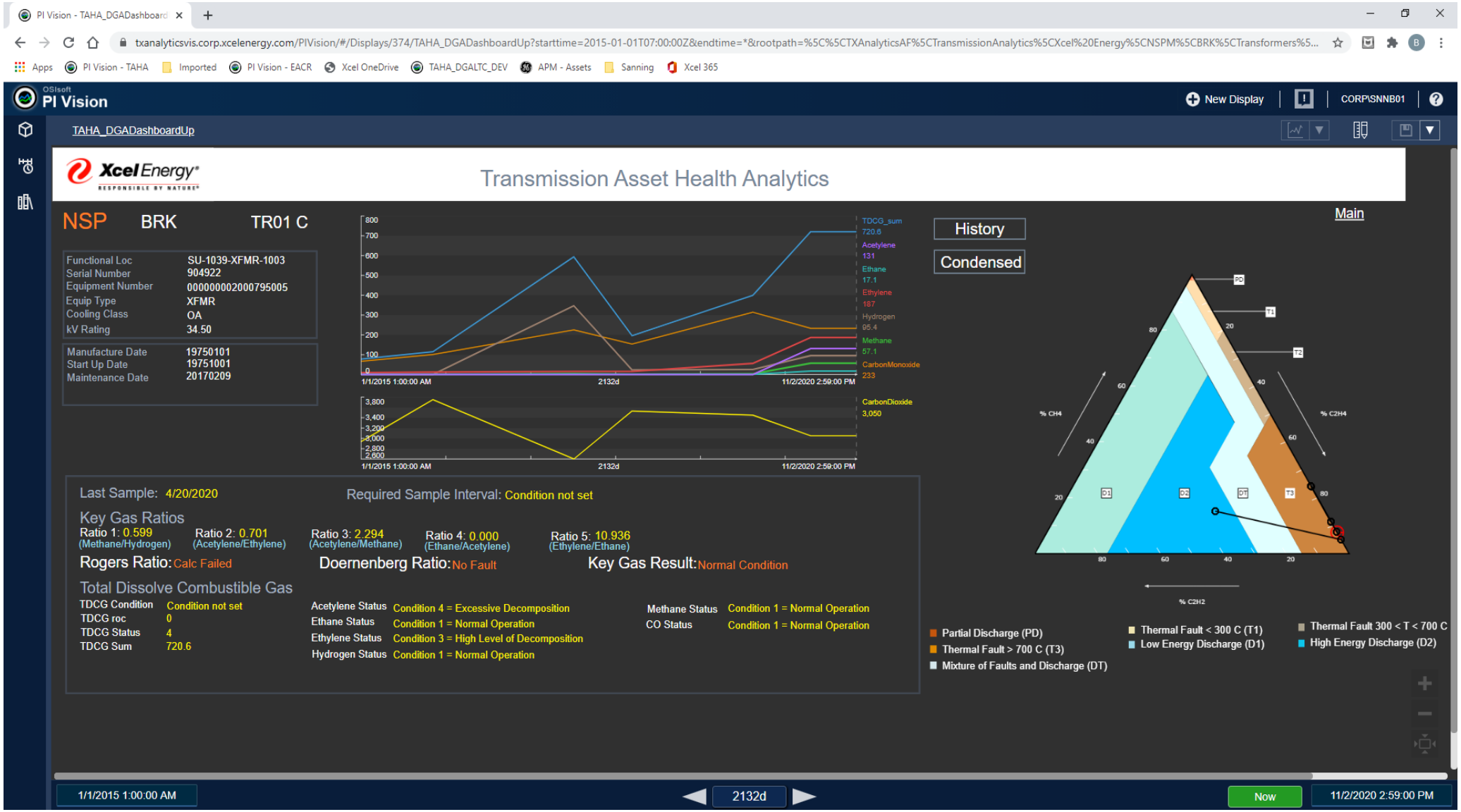
- **DGA**
  - **OSI-PI Dashboard provides overall conditions of oil-filled transformers @ substations.**
  - **Gas concentration trending**
  - **User interface**
  - **Repeatable Solutions**

- **NEXT STEP**
  - **Continue implementing User-generated enhancements**

ARCM Preventive Maintenance Scoring

Row Label	Company Code	Functional Location	Equipment Name	System Code	Op System Long Description	Area	Division	Mn	Mnm	Asset Equip Type	Breaker Nominal Voltage	Maintenance Require	ARCM REQUIRE	2021 Plan
PSC	V100	SU-1905-BRKR-1016	9066	ETS	VALMONT SUBSTATION	BOULDER	SUB_BOUL	9186	99	BKRGS	115	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1016	2519	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	9070	112	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1697-BRKR-1040	7040	ETS	DANIELS PARK SUBSTATION	DENVER	SUB_MET	8775	93	BKRGS	345	Minor (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1001	1511	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	8256	144	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1002	1512	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	8256	184	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1896-BRKR-1017	2247	EDS	TOWER SUBSTATION	ADAMS	SUB_MET	7995	1162	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1010	2510	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	7984	1482	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1015	2514	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	7953	193	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1003	1513	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	7887	193	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1716-BRKR-1000	1510	EDS	FITZSIMONS SUBSTATION	ADAMS	SUB_MET	7820	1162	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1733-BRKR-1006	1435	EDS	GREENWOOD SUBSTATION	ARAPAHOE	SUB_MET	7724	94	BKRAR	13.8	Mechanism (AIR)	Maintenance Due	2021 plan
PSC	V100	SU-1629-RCLR-1002	1375	EDS	ANTONITO SUBSTATION	ADAMS	SUB_SLV	7702	112	RECLR	13	Complete (OIL) RCL	Maintenance Due	2021 plan
PSC	V100	SU-1661-BRKR-1000	5189-1	ETS	BLUE SPRUCE NUG SUBSTATION	ADAMS	SUB_MET	7624	98	BKRVC	230	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1629-RCLR-1001	1374	EDS	ANTONITO SUBSTATION	ADAMS	SUB_SLV	7385	166	RECLR	13	Complete (OIL) RCL	Maintenance Due	2021 plan
PSC	V100	SU-1818-BRKR-1009	5506	ETS	PARACHUTE SUBSTATION	GARFIELD	SUB_WEST	6750	369	BKROL	242	Mechanism (OIL)	Maintenance Due	2021 plan
PSC	V100	SU-1903-BRKR-1028	R3260	ETS	UTE RIFLE SUBSTATION	ADAMS	SUB_WEST	6509	94	BKRGS	345	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1733-BRKR-1034	5705	ETS	GREENWOOD SUBSTATION	ARAPAHOE	SUB_MET	6401	94	BKROL	242	Mechanism (OIL)	Maintenance Due	2021 plan
PSC	V100	SU-1788-BRKR-1023	2627	EDS	MARCY SUBSTATION	ADAMS	SUB_MET	6249	1162	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1776-BRKR-1030	9289	ETS	LEETSDALE SUBSTATION	DENVER	SUB_MET	6193	244	BKROL	115	Mechanism (OIL)	Maintenance Due	2021 plan
PSC	V100	SU-1629-RCLR-1000	1371	EDS	ANTONITO SUBSTATION	ADAMS	SUB_SLV	5900	112	RECLR	13.8	Complete (OIL) RCL	Maintenance Due	2021 plan
PSC	V100	SU-1734-BRKR-1025	9117	ETS	GREELEY SUBSTATION	WELD	SUB_GREE	5855	180	BKRGS	115	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1643-BRKR-1005	B501	ETS	BASALT SUBSTATION	EAGLE	SUB_WEST	5790	615	BKRGS	115	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1781-BRKR-1006	4823	ETS	LAMAR DC CONVERTER STATION	No Data	SUB_PUEB	5774	118	BKRGS	69	Minor (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1643-BRKR-1012	B571	ETS	BASALT SUBSTATION	EAGLE	SUB_WEST	5765	615	BKRGS	115	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1708-BRKR-1004	1092U	EDS	ELATI SUBSTATION	DENVER	SUB_MET	5680	104	BKRVC	15	Mechanism (VAC)	Maintenance Due	2021 plan
PSC	V100	SU-1872-BRKR-1023	5172IPO	ETS	SMOKY HILL SUBSTATION	ADAMS	SUB_MET	5052	99	BKRGS	230	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1905-BRKR-1014	9064	ETS	VALMONT SUBSTATION	BOULDER	SUB_BOUL	5049	96	BKRGS	115	Mechanism (SF6)	Maintenance Due	2021 plan
PSC	V100	SU-1896-BRKR-1011	2241-1	EDS	TOWER SUBSTATION	ADAMS	SUB_MET	4998	171	BKRVC	13.8	Mechanism (VAC)	Maintenance Due	2021 plan

Pi System Transformer DGA Analysis



Workstream 2: DATA LAKE

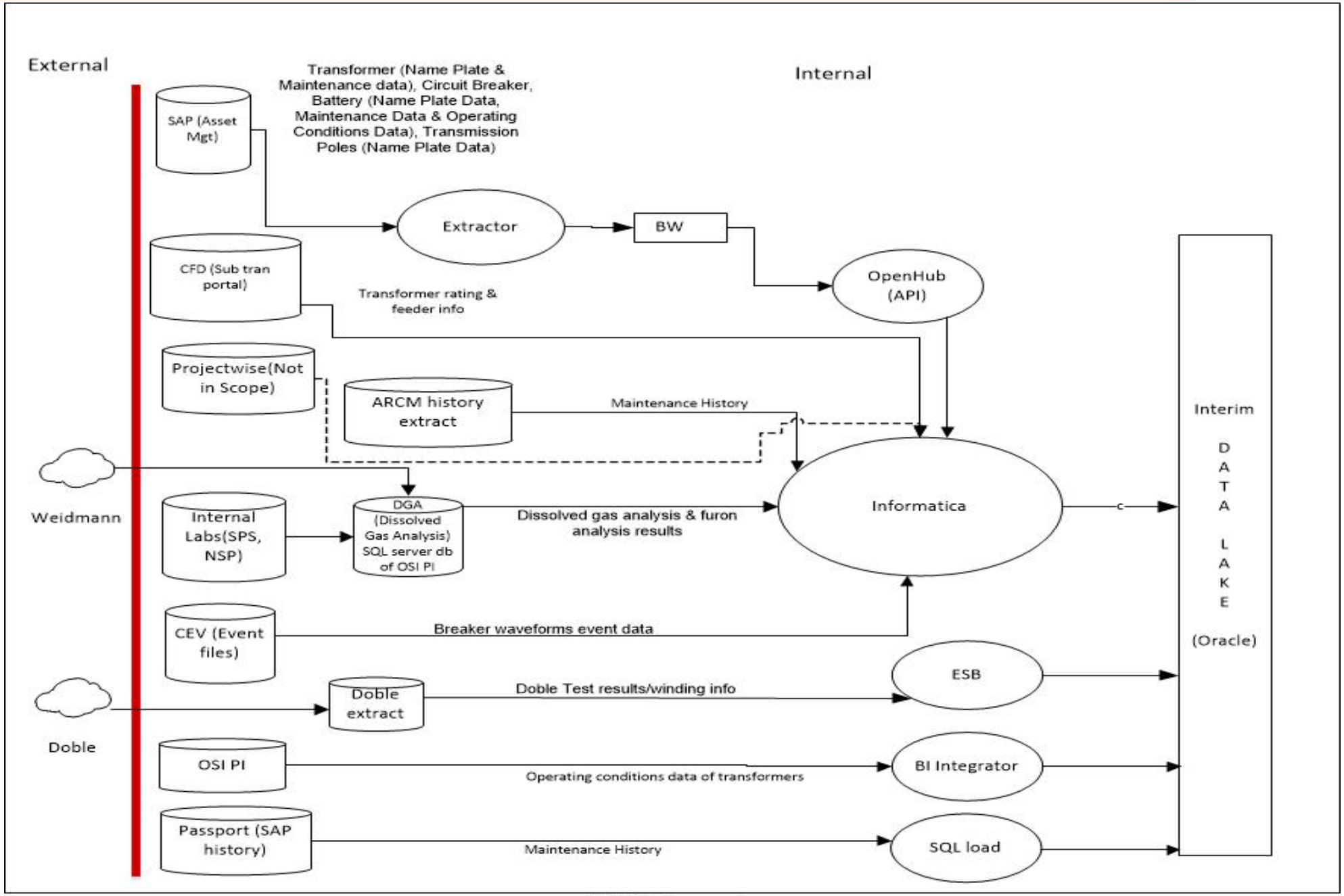
- **Challenge**
  - Data scattered among many systems, different formats, recorded at different time intervals from various groups and no common key for asset information.
- **Solution**
  - Create series of “data pipelines” to a central staging and processing data base to create conformance
- **Data**
  - Identified data quality issues
  - Started cleaning process

Workstream 2: DATA LAKE

- **DGA & Power Transformer Expert (EPRI)**
  - Housed data from sources to complete calcs
  - Enabled EPRI PTX health models for Transformers

- **Next Steps**
  - Allow selected vendor to access data for TAHA
  - Enable internal data science and analytics on data
  - Continued Data Quality improvements to ensure trustworthiness of data

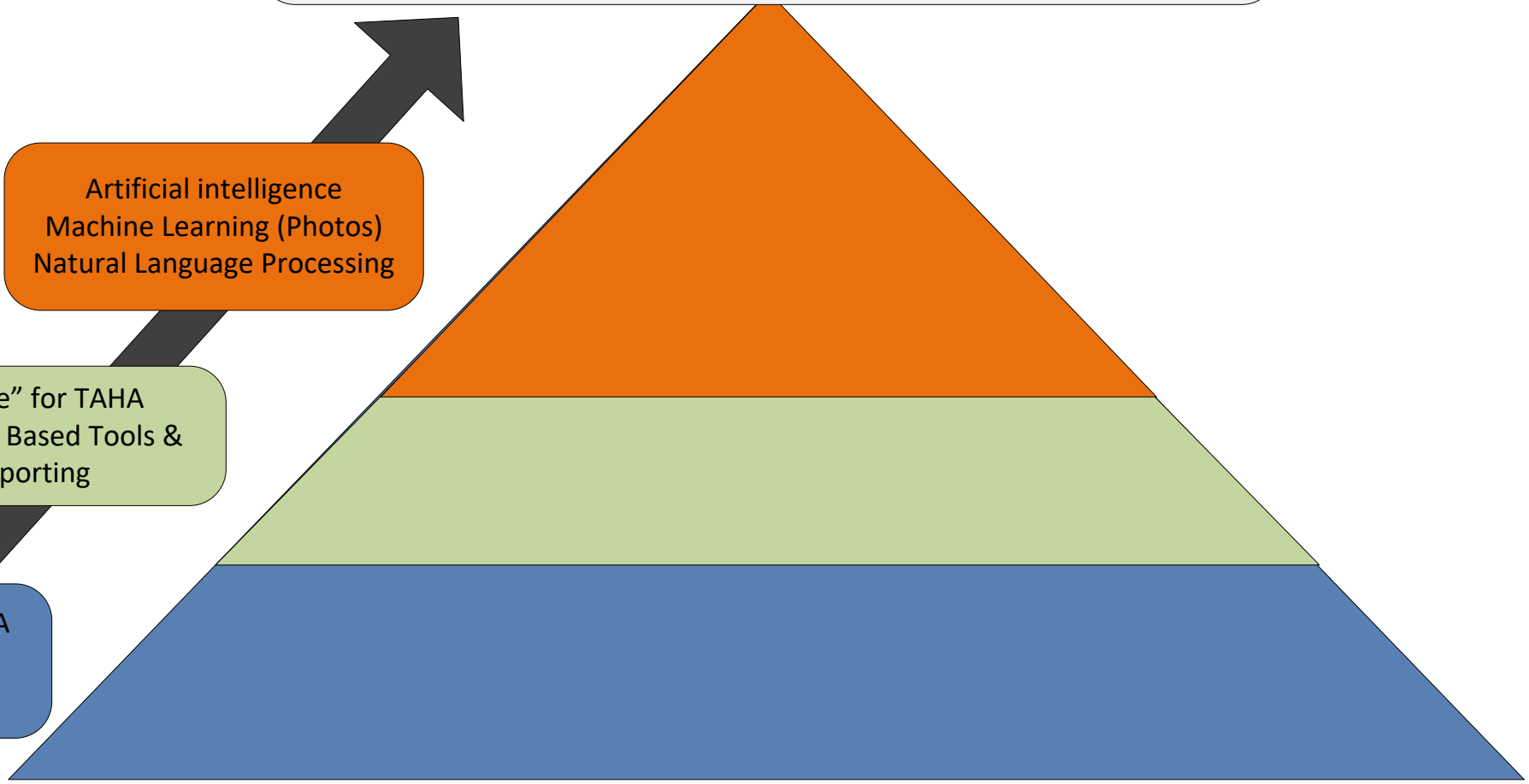
Data Lake Architecture



TAHA Current State

Data Lake: TAHA Foundation

- Optimized Asset Management
- Situational Awareness
- Prioritization & Justification for Long and Short Term Planning



Workstream 3: Advanced Analytics

- **Challenges**
  - Lack of situational awareness of asset health and risk.
  - Manual inputs required to build and maintain assets
  - Inconsistent criteria application across OpCos
  - Lack of real time reporting
- **Solution**
  - Use advanced analytics (algorithms and AI)
  - Consistently report on the state of the asset across all asset categories
  - Enable long and short-term planning and execution
  - Deliver high levels of service, control costs, and balance risk

Workstream 3: Advanced Analytics

- **RFP**
  - Generated 250 questions based on use cases
  - Interviewed peers from multiple proposals and scored for comparison
  - Narrowed to two vendors, then selected GE's Asset Performance Management platform
- **Next Steps**
  - Vendor recommendation
  - Build phase, implementation, continuous improvement phase, etc.

General Purpose of TAHA

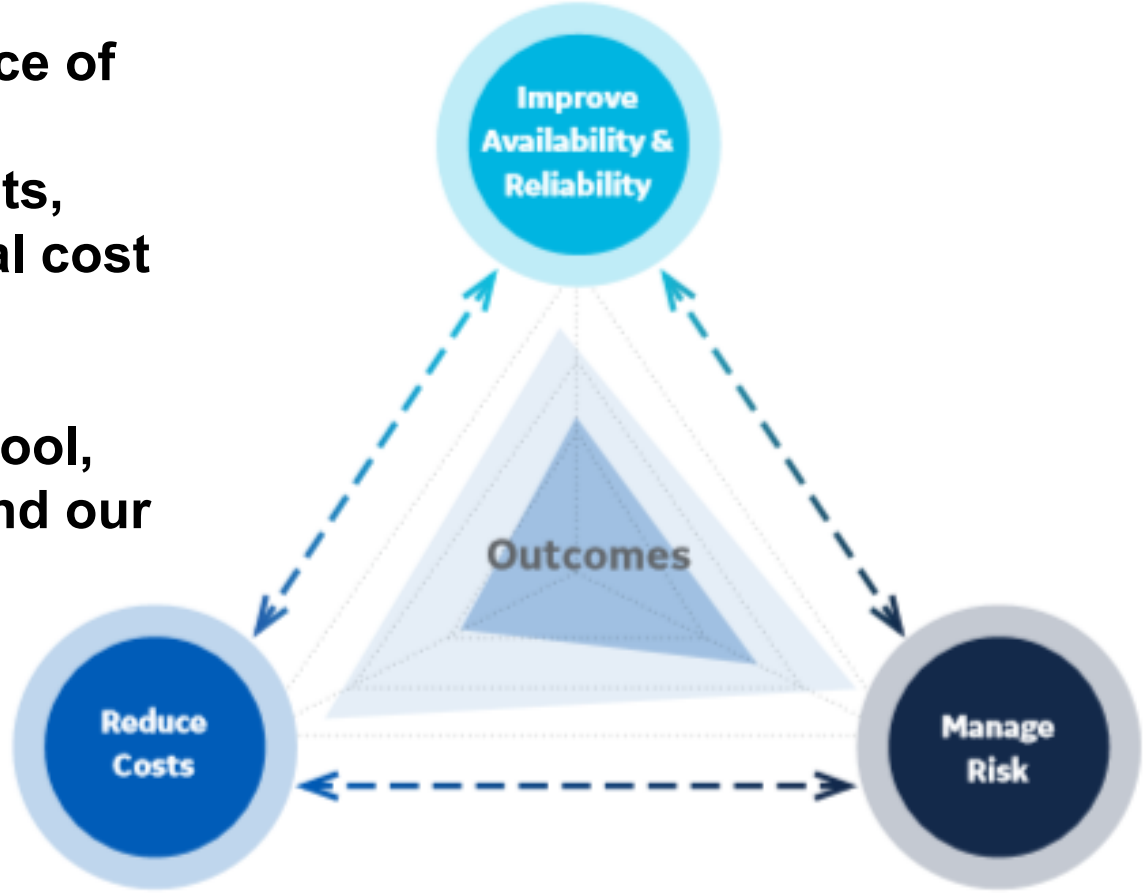
- Combine different types of asset data
- Explore capabilities
- Provide analytics for maintaining, replacing right equipment at right time with operational awareness
- GE Asset Performance Management (APM) system: explore data by introducing algorithms for different assets

GE Asset Performance Management (APM)

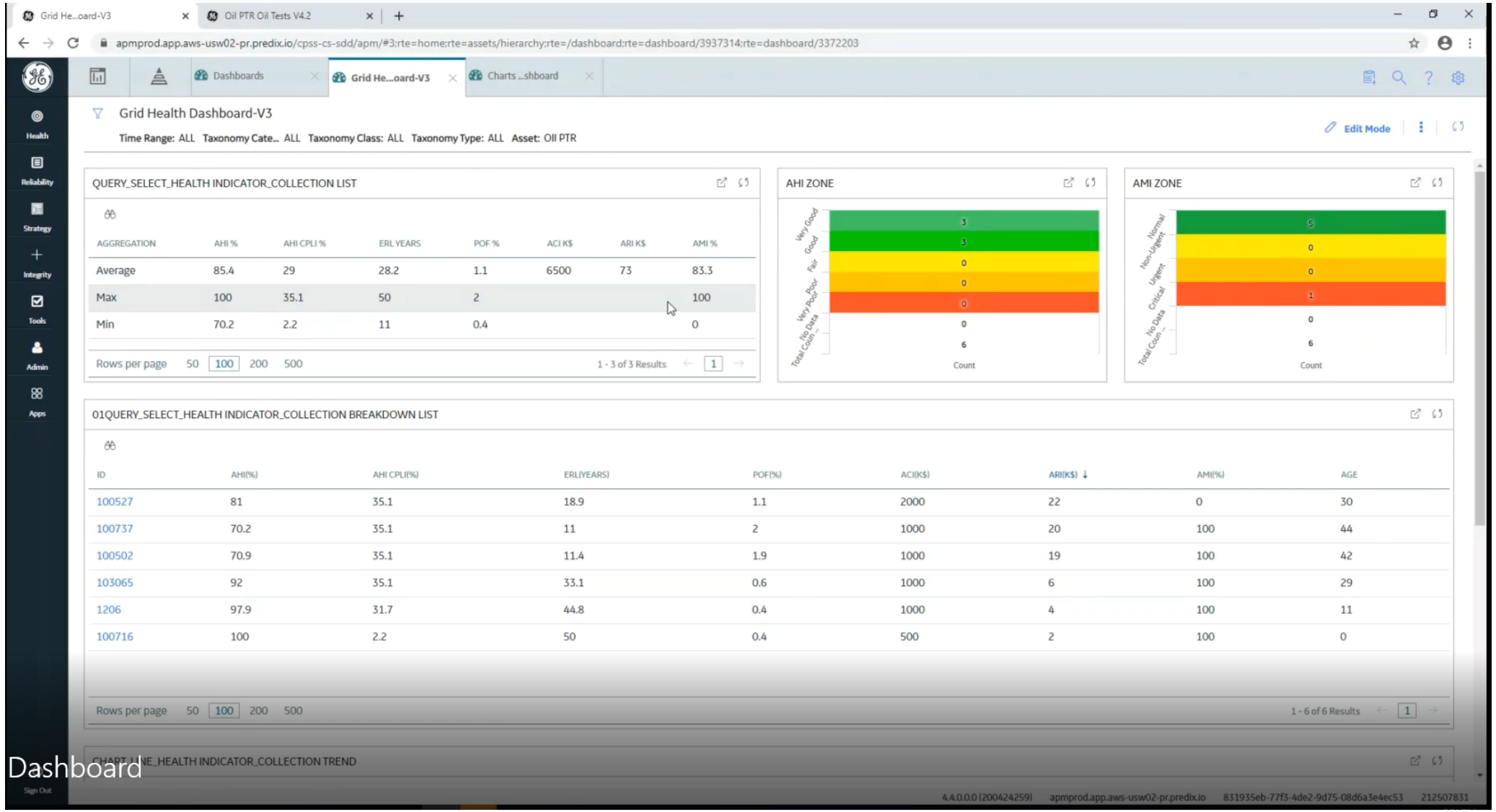
A continuous loop of improvement

Xcel Energy seeks to optimize the performance of our assets. Increasing asset reliability and availability while optimizing maintenance costs, mitigating operational risks and reducing total cost of ownership.

By optimizing our data for our assets in one tool, TAHA will allow us to reduce costs, understand our assets and failures and manage risks.

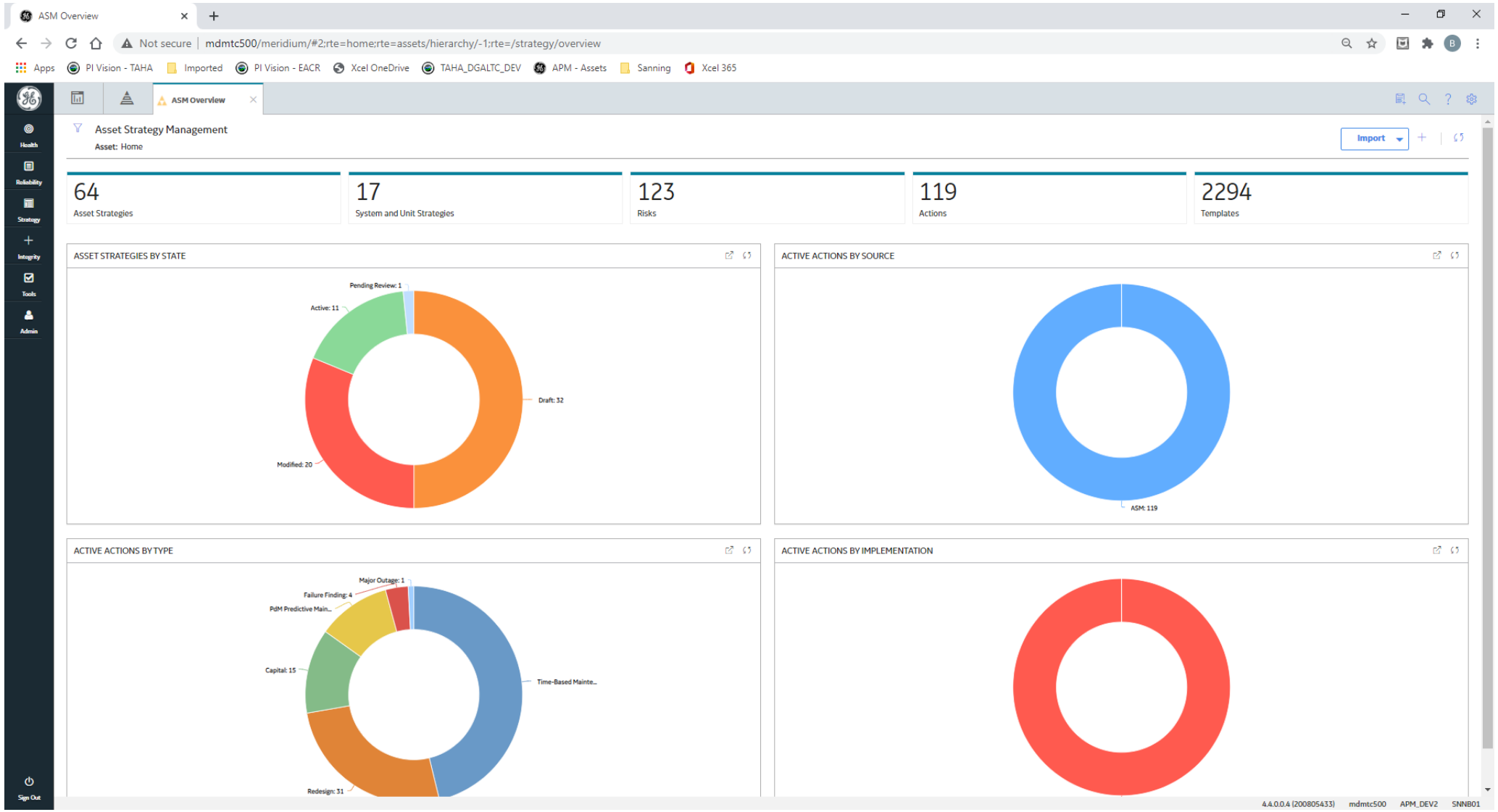


APM Grid Health Dashboard



Dashboard

APM Asset Strategy Overview Page



TAHA APM Plan/Vision

2020 & 2021	2022 & Beyond
Criticality	Advanced Analytics
Health	Cloud Migration
Reliability	Automation
Asset Strategy	Additional Assets Onboarded
Reliability Centered Maintenance	Integration With Unmanned Aerial Vehicles
Grid content	
EPRI algorithms	
KPIs and Metrics	


Xcel Energy SM