Solar Farm Analytics

Automated Machine Learning Deployed at Scale

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Steve Enck, SAS Senior Manager Consulting

Presenters Background

Advisory Industry Consultant

GE Power
- Industrial Apparatus Sales Engineer
- Six Sigma Black Belt

GE Research
- Systems Engineer (Remote Services)
- Operations Research (Digital Twins)

SAS
- Industry Consultant (Partners/Ecosystem)

Sr. Manager IoT Consulting

SAS
- 20+ years analytical consulting experience
- Delivered real-time analytics projects related to:
  - HVAC analytics
  - Flood prediction
  - Manufacturing optimization
  - Solar farm monitoring
- Development of automated approach to simplify model training and deployment

SAS Introduction

Our Resume

#1 Market Leader in **AI & ADVANCED ANALYTICS**

47 Years of **BUSINESS ANALYTICS**

SAS deemed a **World's Most Innovative Company** (Fast Company March 2021)

Our Customers

80,000+ Customer sites in 150 countries

88 of the top 100 Companies on the GLOBAL LIST ARE SAS CUSTOMERS or their affiliates

FORTUNE 500

Our Peers

8 YEARS RUNNING
Only vendor named leader in Gartner's Magic Quadrant for Data Science and Machine Learning Platforms

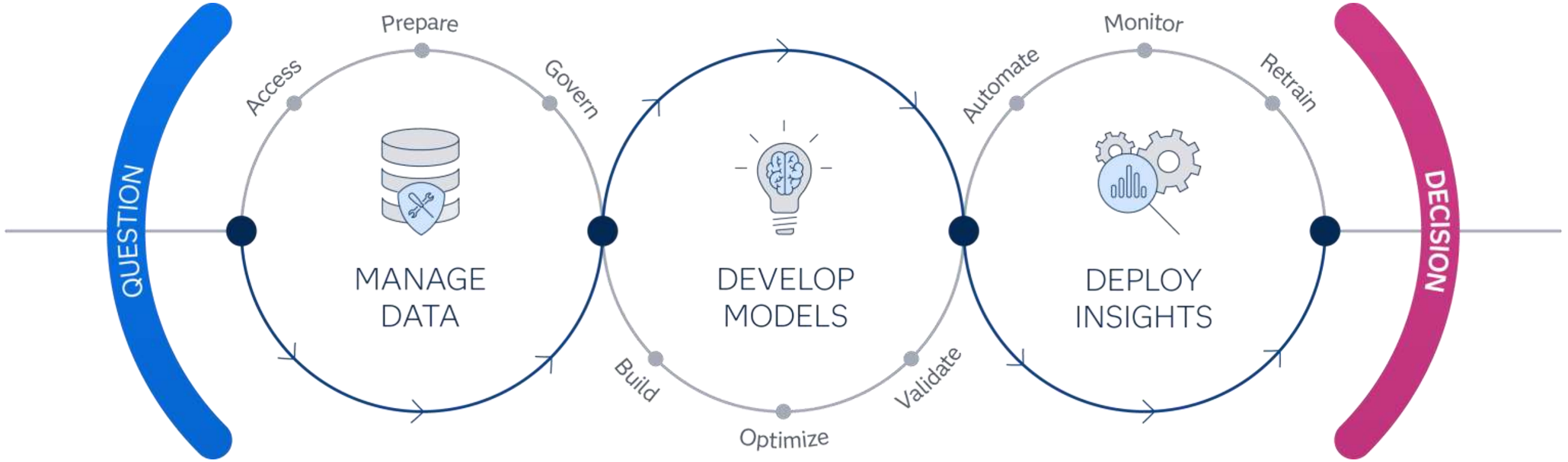
SAS recognized as leader in **more than 30** vendor ranking reports in 2021

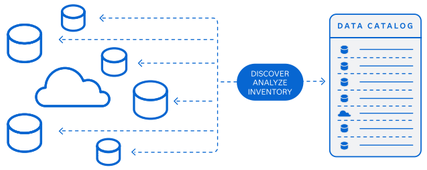
Utility Scale Solar Growth Rate Up

50%

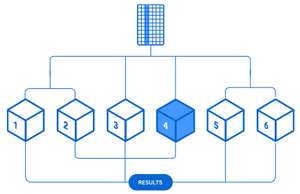
Machine Learning makes it possible to accurately monitor optimal performance for ALL assets and controllable variables

SAS Viya

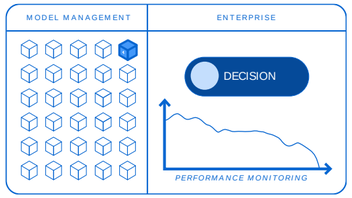




Any Data, Any Where



Model Development & Automation



Insights/Decisions at Scale

AutoML for IoT

Cross Domain Application

Extensible, Cross Industry Framework

Smart Building
Predictive Maintenance & Energy Efficiency

SAS Campus

⬇

(Cities, Universities)

Manufacturing
Operation Improvement Yield & Safety

Georgia Pacific

Smart City
Situational Awareness & Flood Prediction

Town of Cary

Solar Farm
Predictive Maintenance & Energy Efficiency

SAS Campus

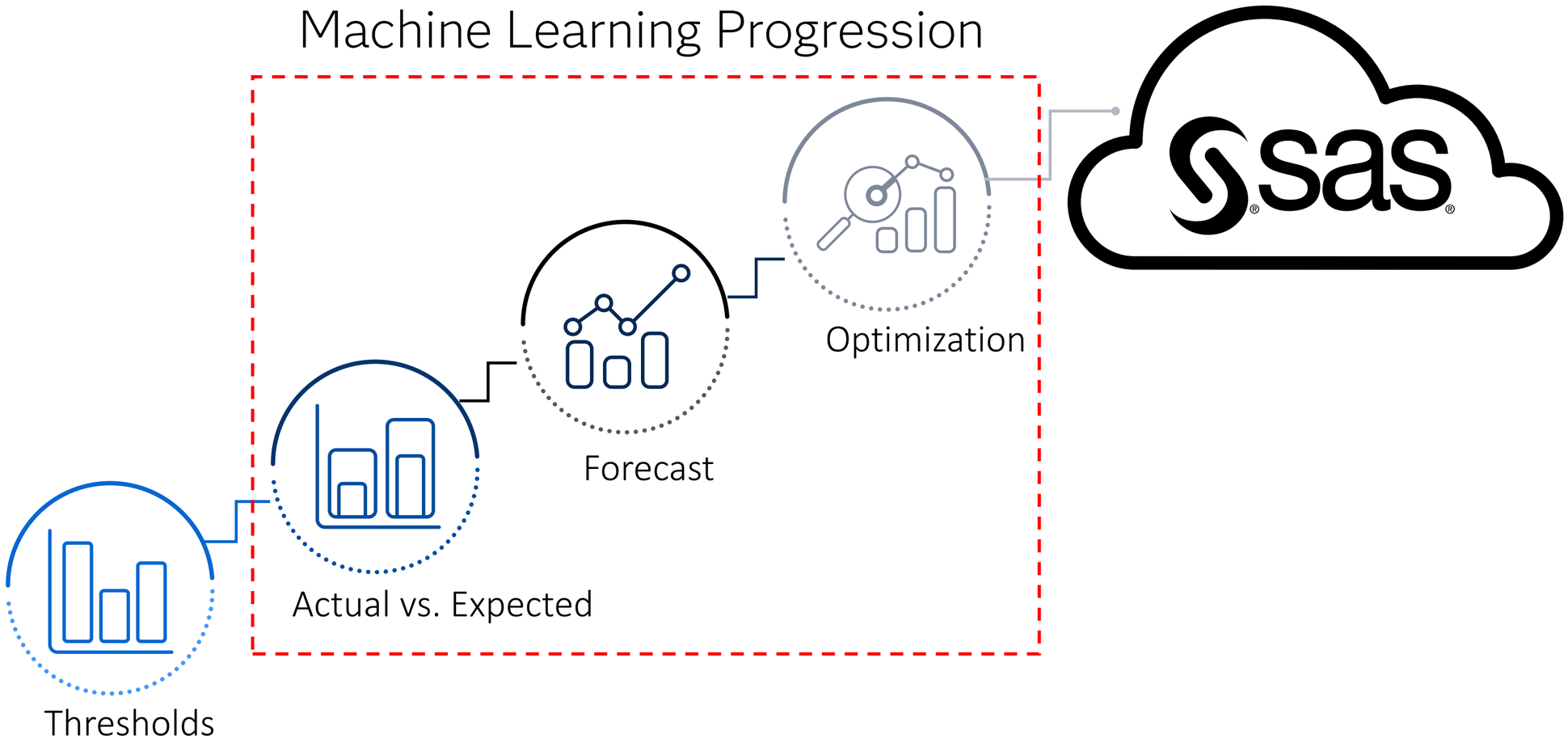
⬇

(DEPCOM Power)

Description

- Transform thousands of seemingly disparate raw sensor readings
- Integrate hundreds of ML models to monitor operation and predict future outcomes
- Deploy meaningful alerts to your end users and are designed to offer immediate value
- Highlight potential root causes
- Configure based on simple inputs that a subject matter expert could provide

Logical Progression of Analytics Complexity



Harvard Business Review

AI And Machine Learning

The AI Hype Cycle Is Distracting Companies

by Eric Siegel

June 02, 2023

Illustration by Skizzomat

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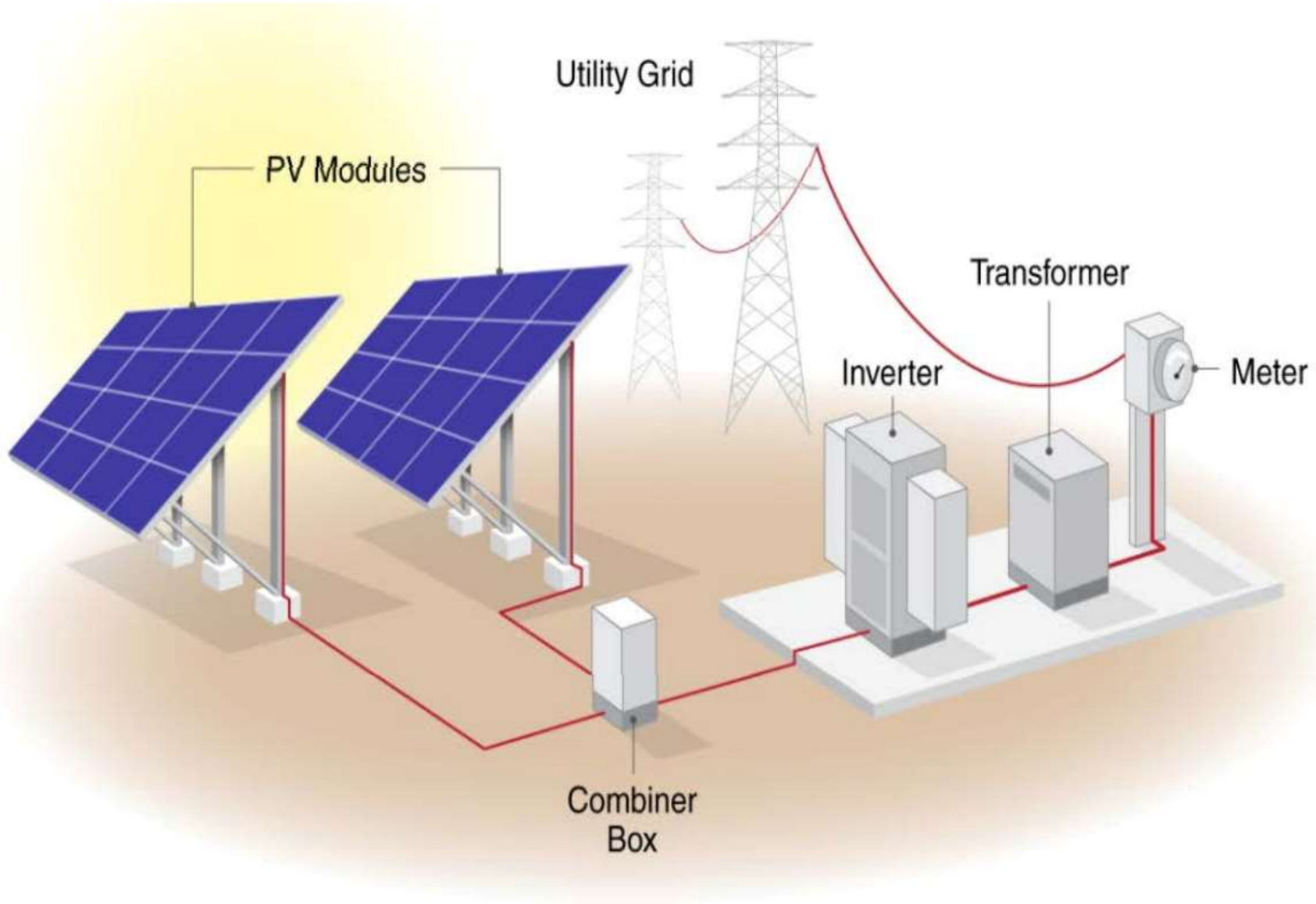


Source: NREL

Solar Farm

Irradiance: 742.8 W/m^2
Power: 235.5 kW
Expected Power: 282.5 kW
% of Expected: 83%

Inverter

Input DC Power: 247.9 kW
Output AC Power: 235.5 kW
Temperature: 59.9 C
Conversion Efficiency: 95%

Combiner Box

Temperature: 35 C

Solar Panels

Current 1: 24.75 A (25.7 expected = 96%)
Current 2: 11.75 A (12.2 expected = 96%)
Current 3: 6.45 A (10.5 expected = 61%)
Angle: 32 degrees (optimal 41 degrees)

The Vision

Integrating Machine Learning Models Throughout Everyday Operation

- ML Models Deployed to Monitor…
  - Key performance metrics
    - e.g., Energy generation from each asset in the solar farm
  - Key settings that we can change
    - e.g., solar panel angle
  - Trends/forecasts in measurements that are critical to operation
    - e.g., temperatures

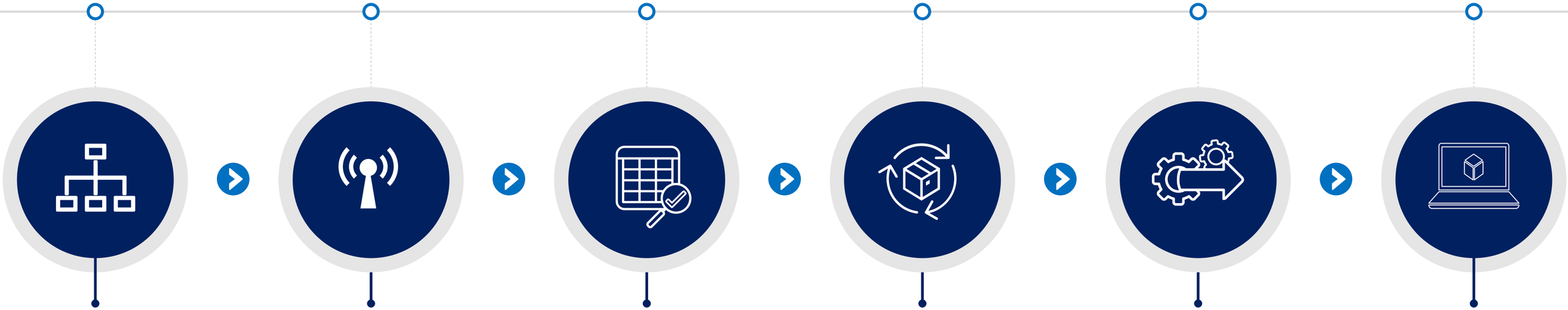
Continuous monitoring for unexpected decreases in energy generation for each asset

Ongoing review of settings given current conditions

Proactively anticipate potential issues before they impact operation

AutoML for IoT – Solar Farm Use Case

A Solution Accelerator for Rapidly Developing & Deploying Streaming Analytics

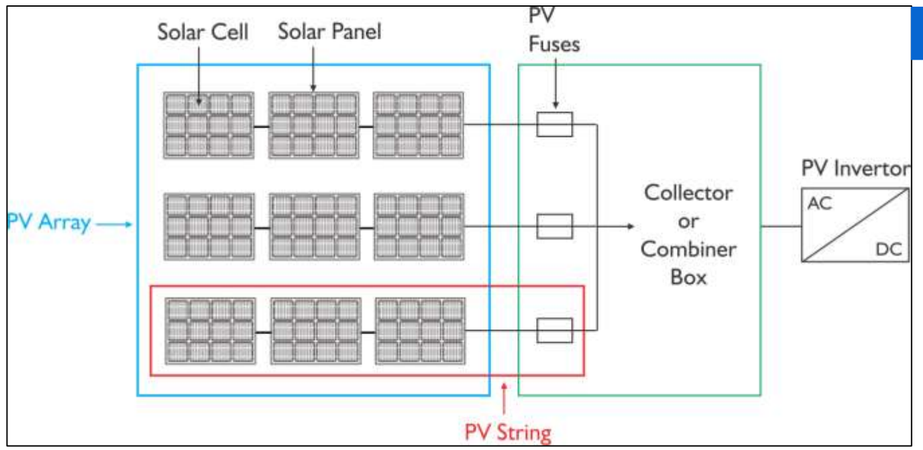


AutoML for IoT

Step 1 – Digital Model Representation

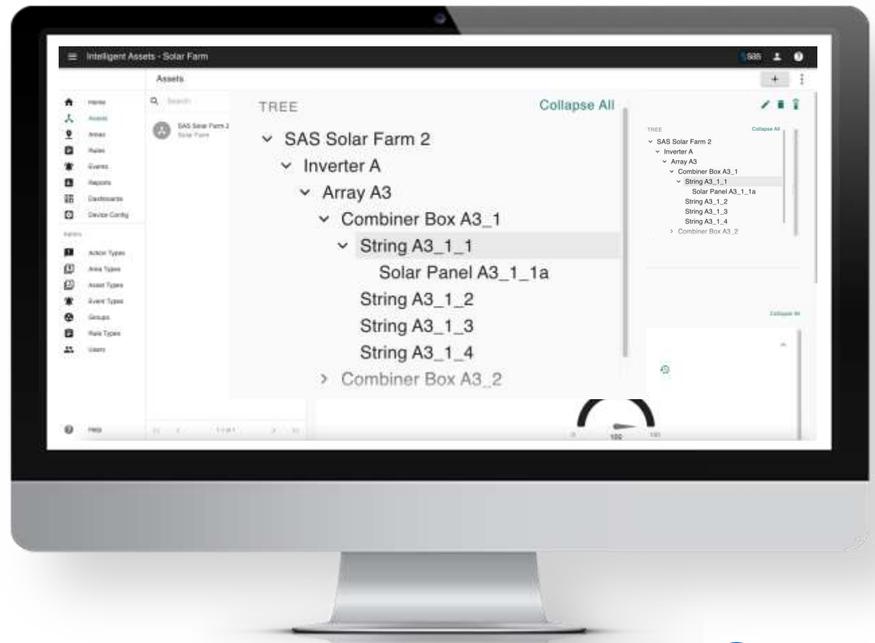
Overhead View

Asset Structure



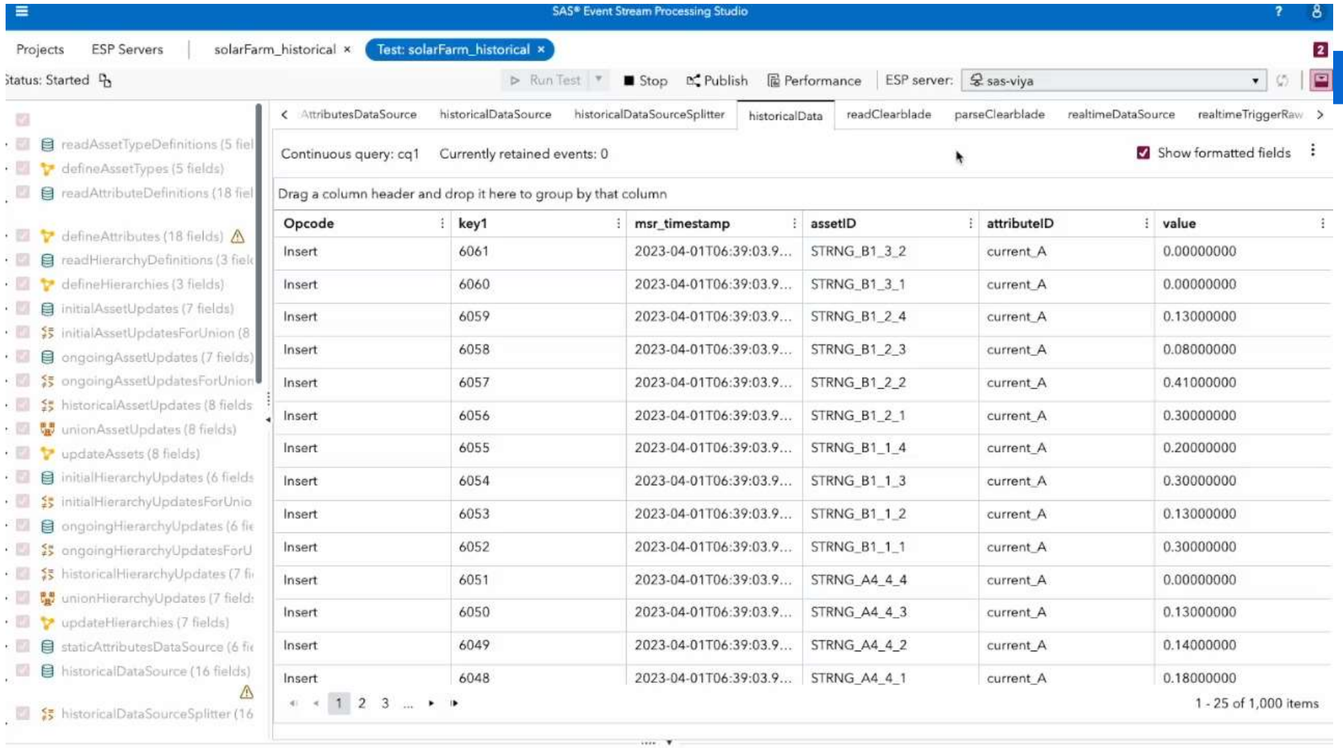
Source:
https://www.swe-check.com.au/editorials/solar-pv-circuit-protection-guide.php

Digital Map

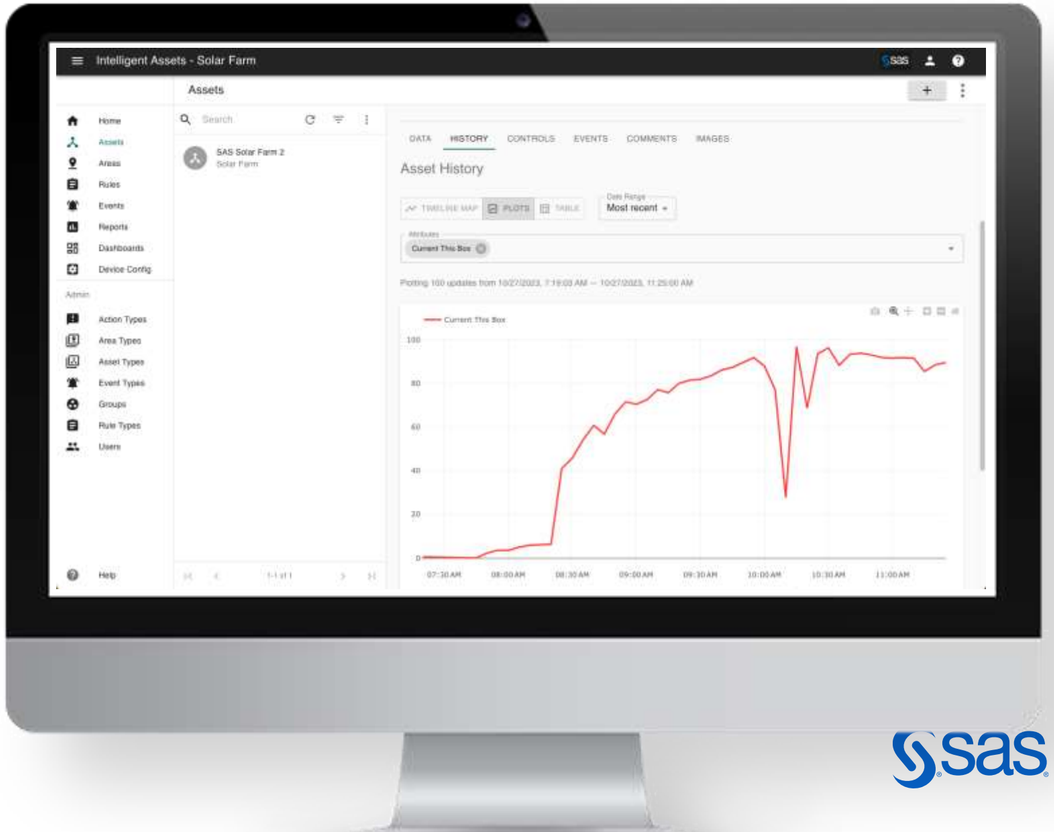


AutoML for IoT

Step 2 – Connect to real-time sensors

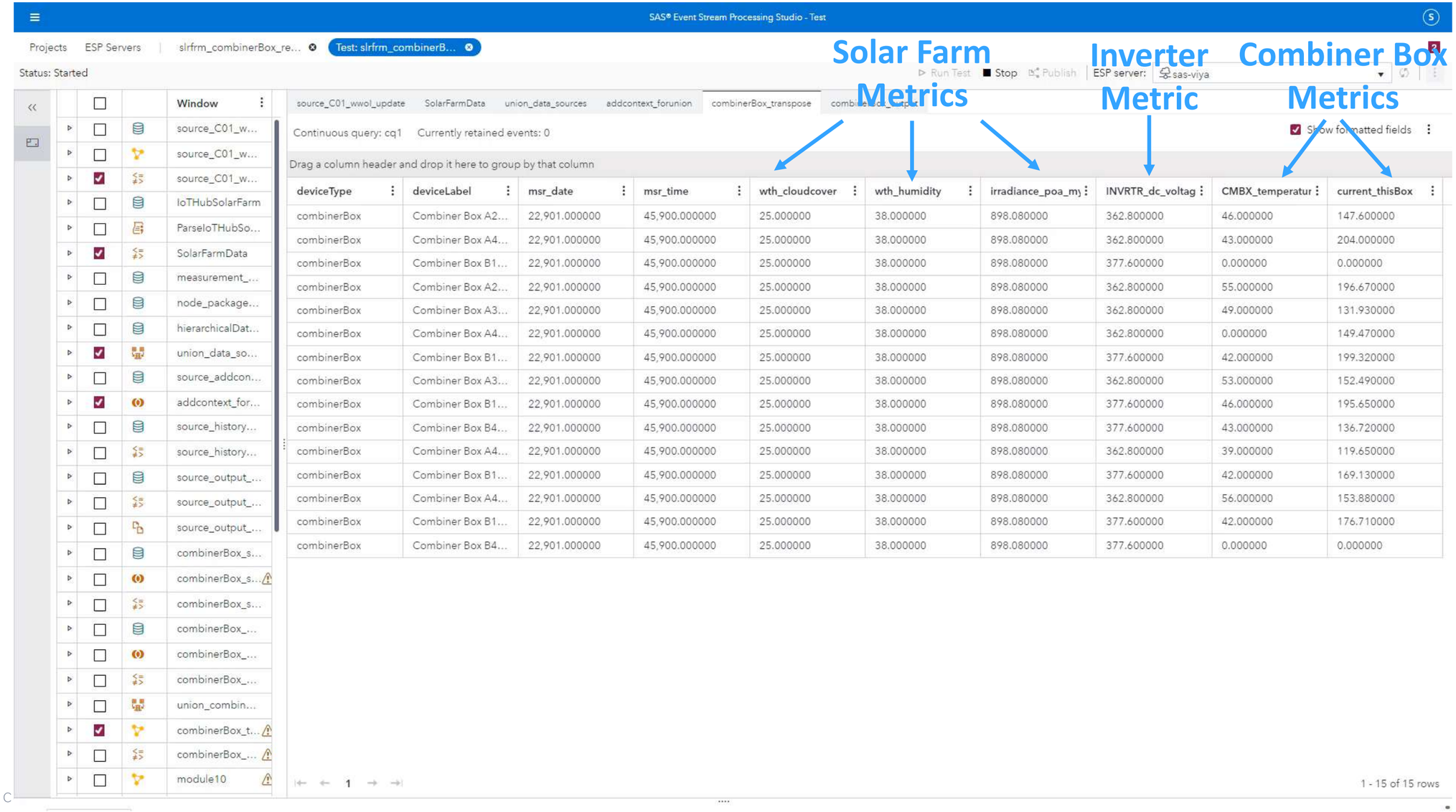


Real-time raw data dashboard



AutoML for IoT

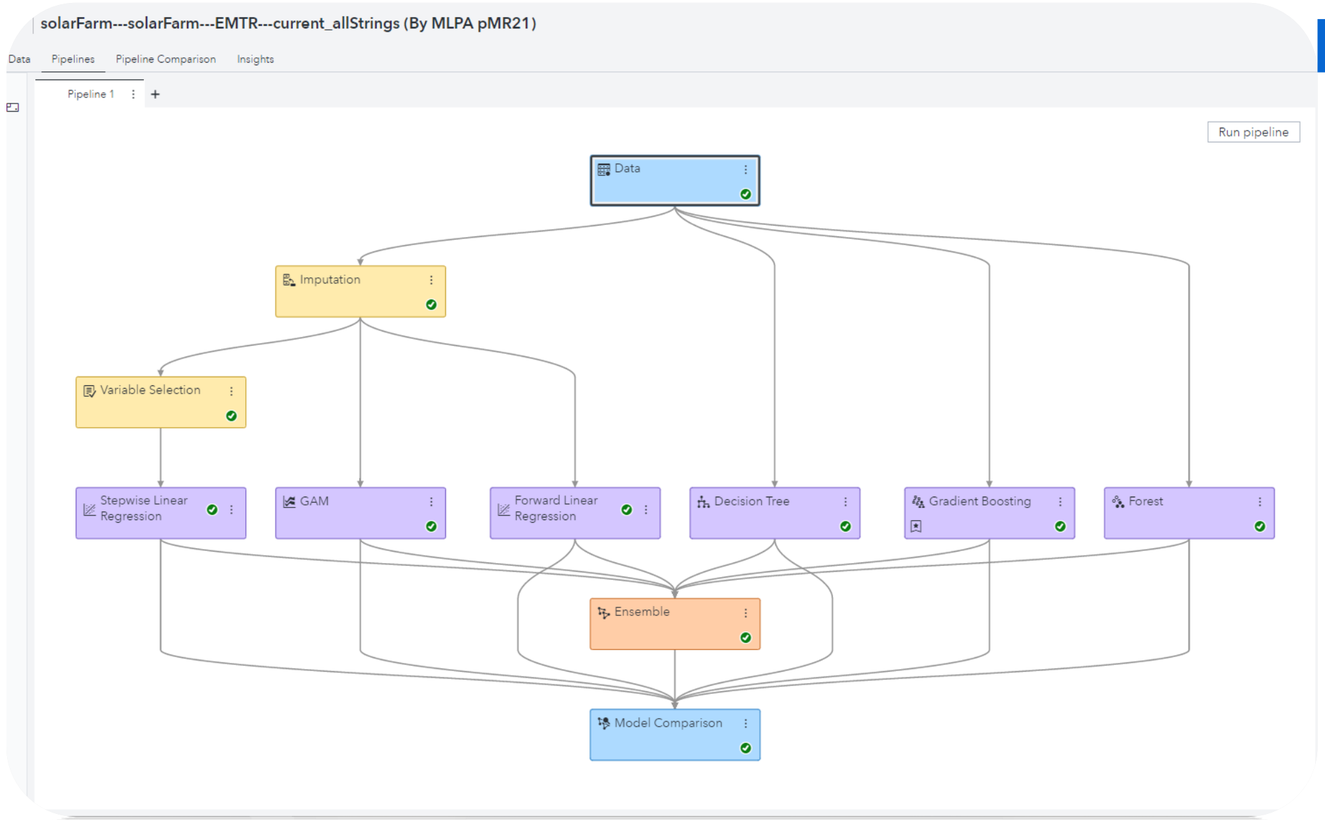
Step 3 – Feature Engineering



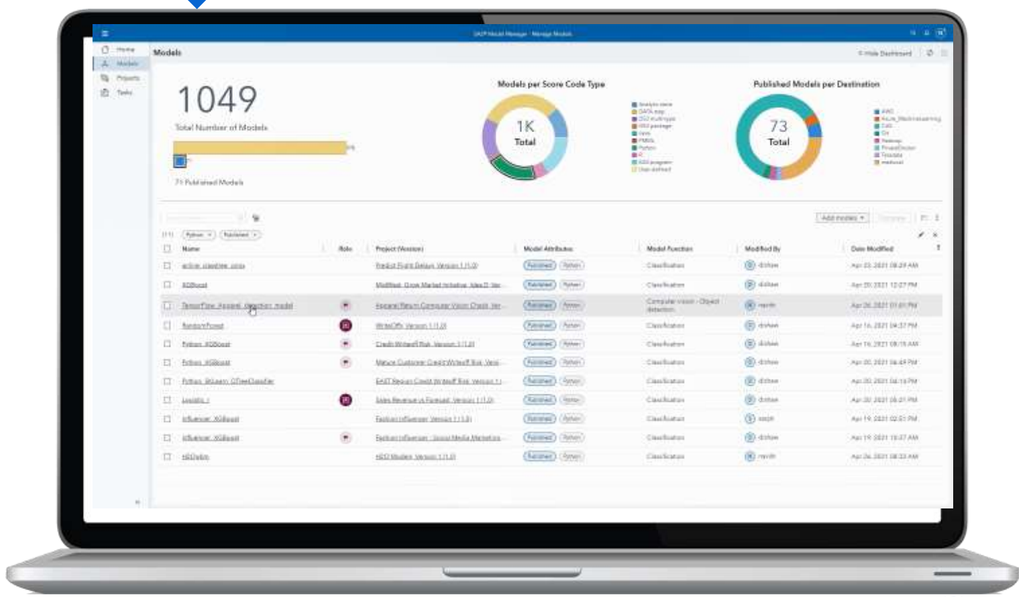
AutoML for IoT

Step 4 – Train ML Models and Register in Model Management

Train Models using
Machine Learning Pipeline Automation



Register / Manage using
Model Manager



AutoML for IoT

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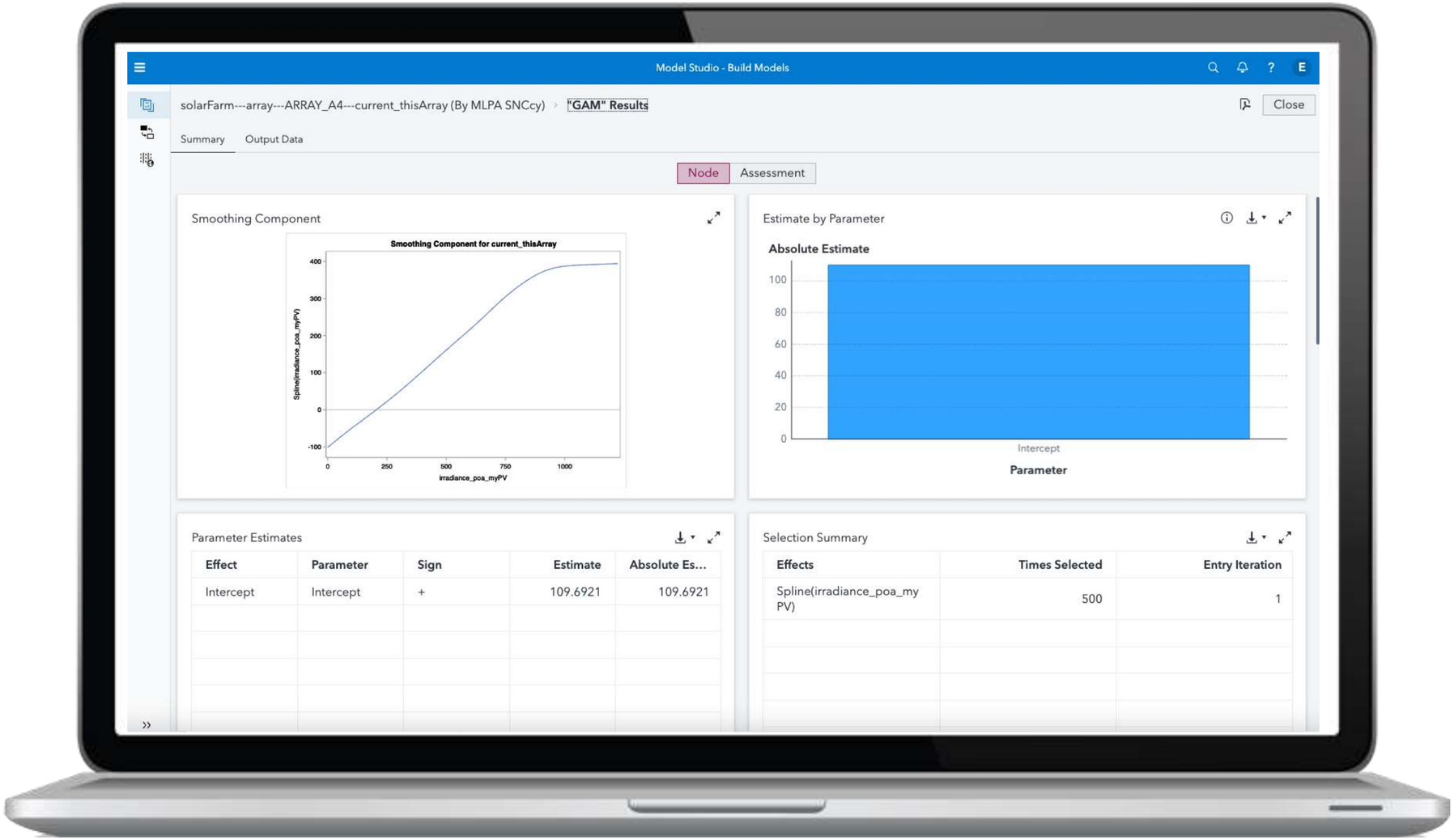
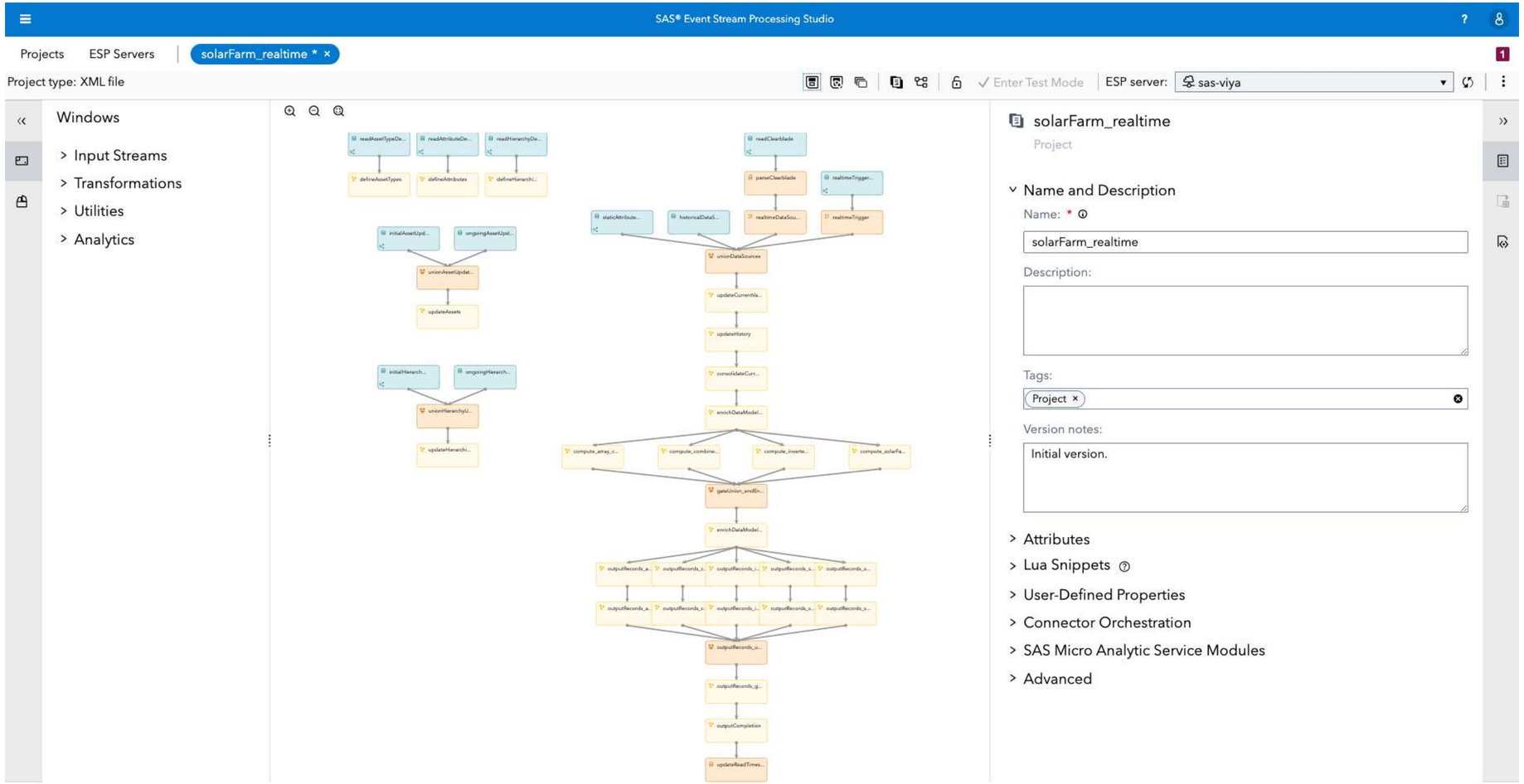


AutoML for IoT

Step 5 – Operationalize Streaming ML Models



Auto-generated SAS Event Streaming Processing Project

Result

ML Models Running Alongside Key Metrics and Settings

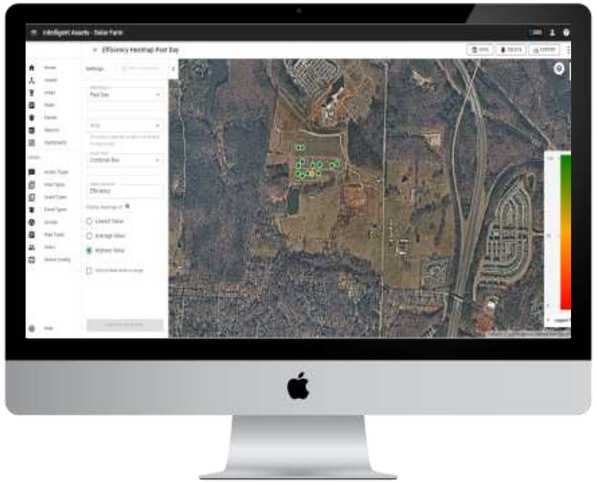
AutoML for IoT

Step 6 – Application Insights

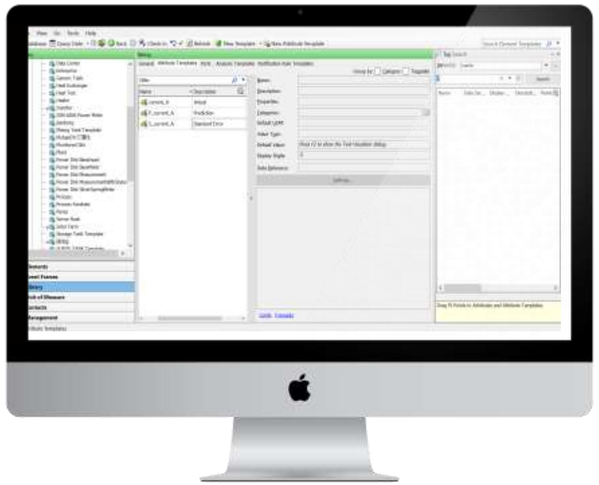
SAS EVENT STREAM PROCESSING

SAS Visual Analytics Dashboards

ClearBlade Intelligent Assets Dashboard



OSI PI Vision User Interface



Siemens Operation Insights Dashboard

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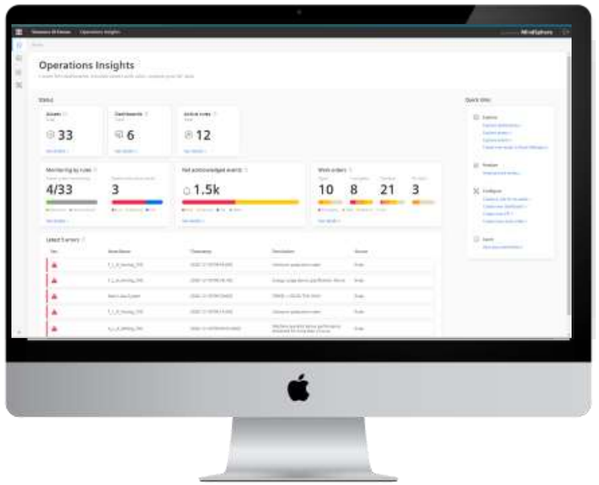


Flexible options to deploy streaming ML projects into existing architectures (edge &/or cloud)

Translating to Industry

DEPCOM Power

DEPCOM designs, builds, and operates utility-scale solar power plants. They also offer energy storage solutions, maintenance services, and consulting services for the renewable energy industry

Key Challenges

As PV power plants continue to expand in size, it is critical to develop automated data processing tools to easily highlight operational impairments not efficiently identified by field personnel

Data efficiencies for reporting and analysis; currently very manual.

Need to move from reactive to proactive, eventually predictive.

Trustworthy KPI's & Advanced Analytics to enable performance guarantee success.

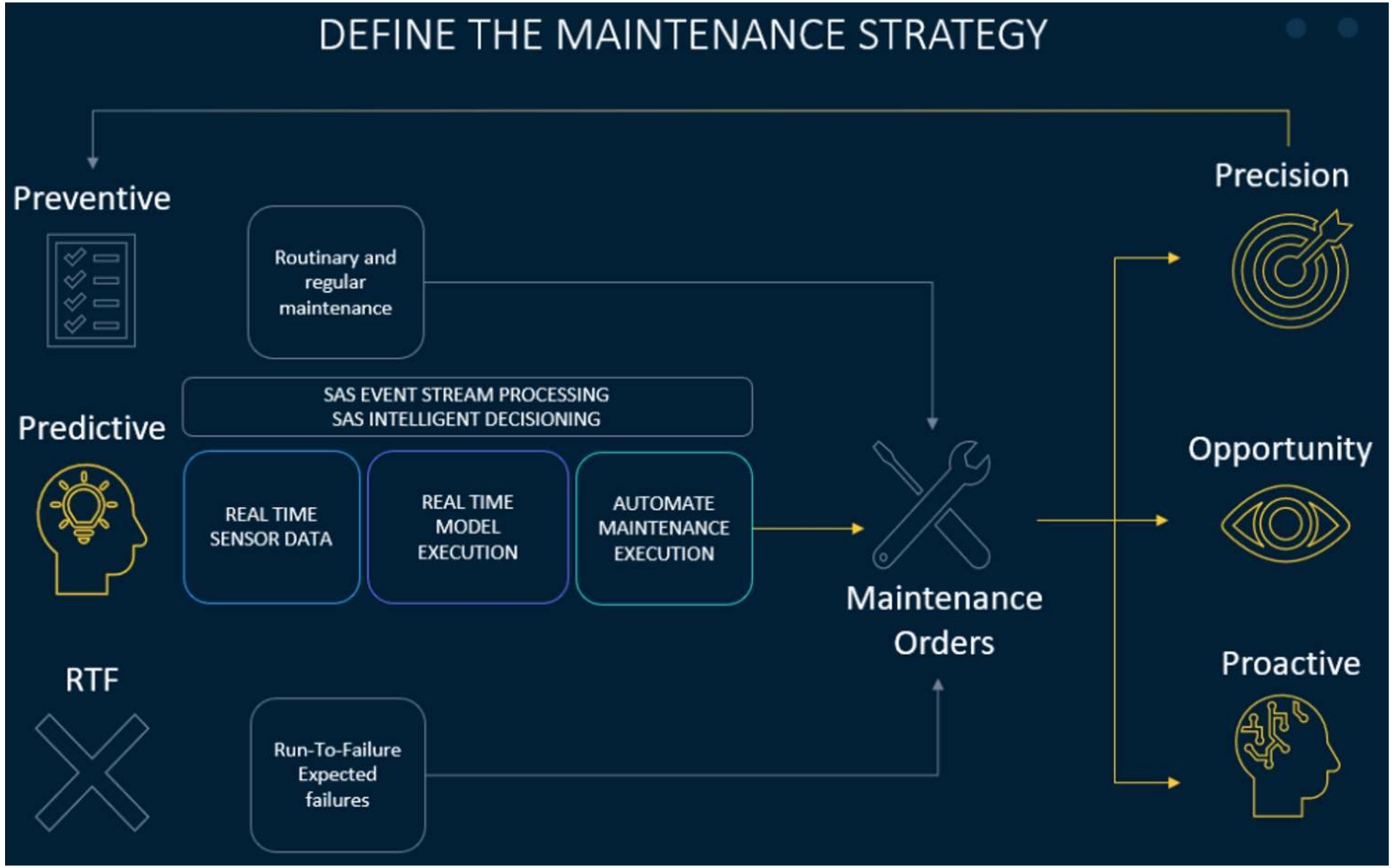
How SAS® supported the process

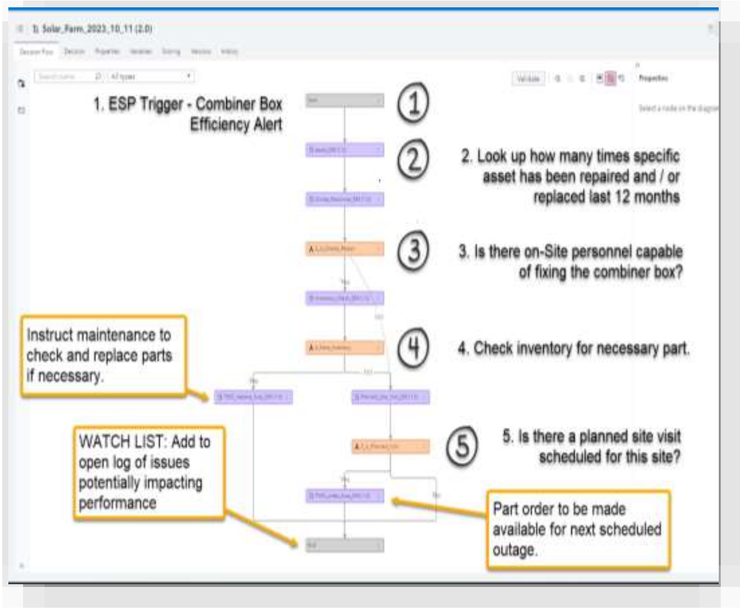
Expected Results

- Initial focus on DC Health of Large Utility Scale Solar Farms, ability to detect anomalies specifically to PV model and DC collection subsystems. (Combiner Box DC current data to flag underperforming combiner boxes to better guide field personnel to investigate and diagnose failures such as blown DC fuses and take corrective action
- Provide Operations Center proper digital tools to process increasingly large datasets to efficiently present actionable information.
- Future use cases include Spare Part/Inventory Strategy, Intelligent Decisioning, Next Generation Service offering w/Advanced analytics for DC Health, Ray Tracker Health, Plant Health

Future Directions

Solar Farm Maintenance Decisioning





Supporting Content

SAS Explore 2023 Session

Ultra-Agile Approach for the Deployment of Real-Time Analytics