OCTOBER 26, 2023

Bringing Industrial Operations Data into your Analytics Platform with AVEVA™ Data Hub Data Views

Alicia Coppock and Stephen Christian

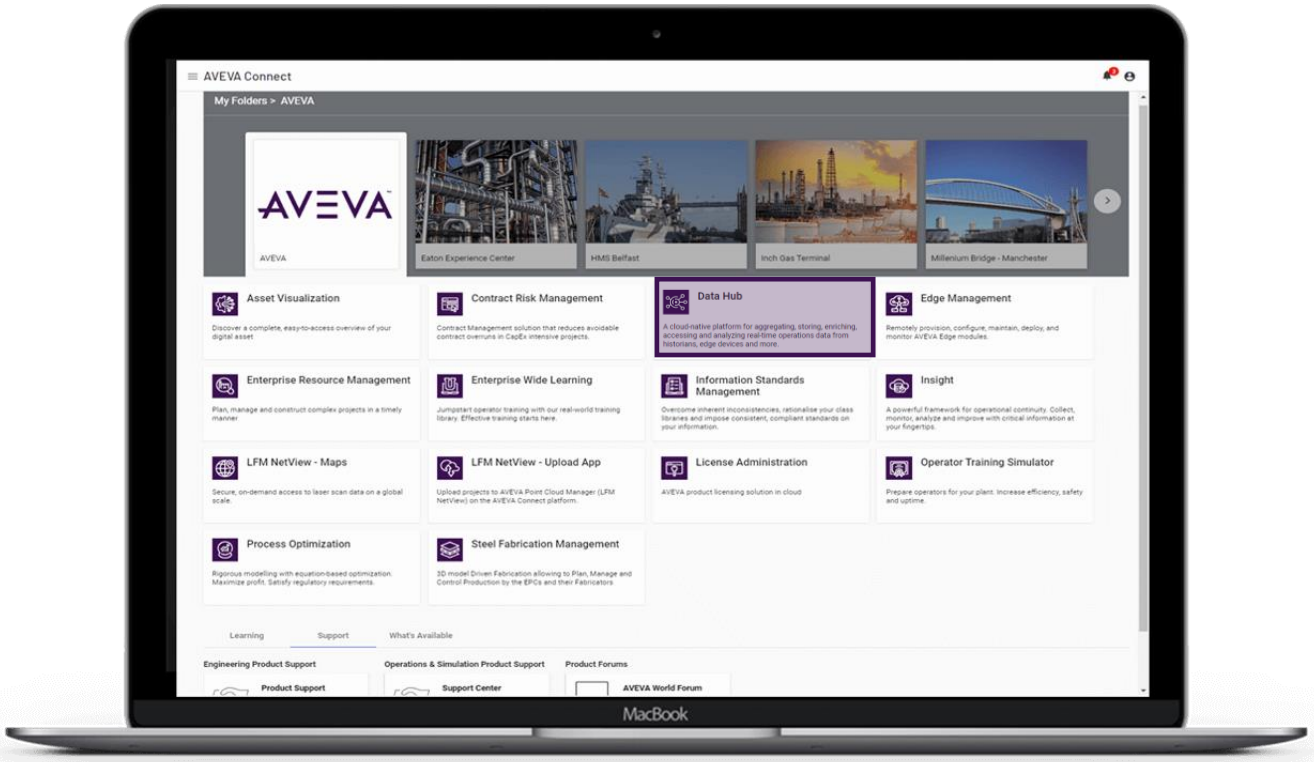
AVEVA

Agenda

- Intro to Data Hub
- Challenges in Data Science
- Enabling Data Science with AVEVA Data Hub
- Demo
- Q&A

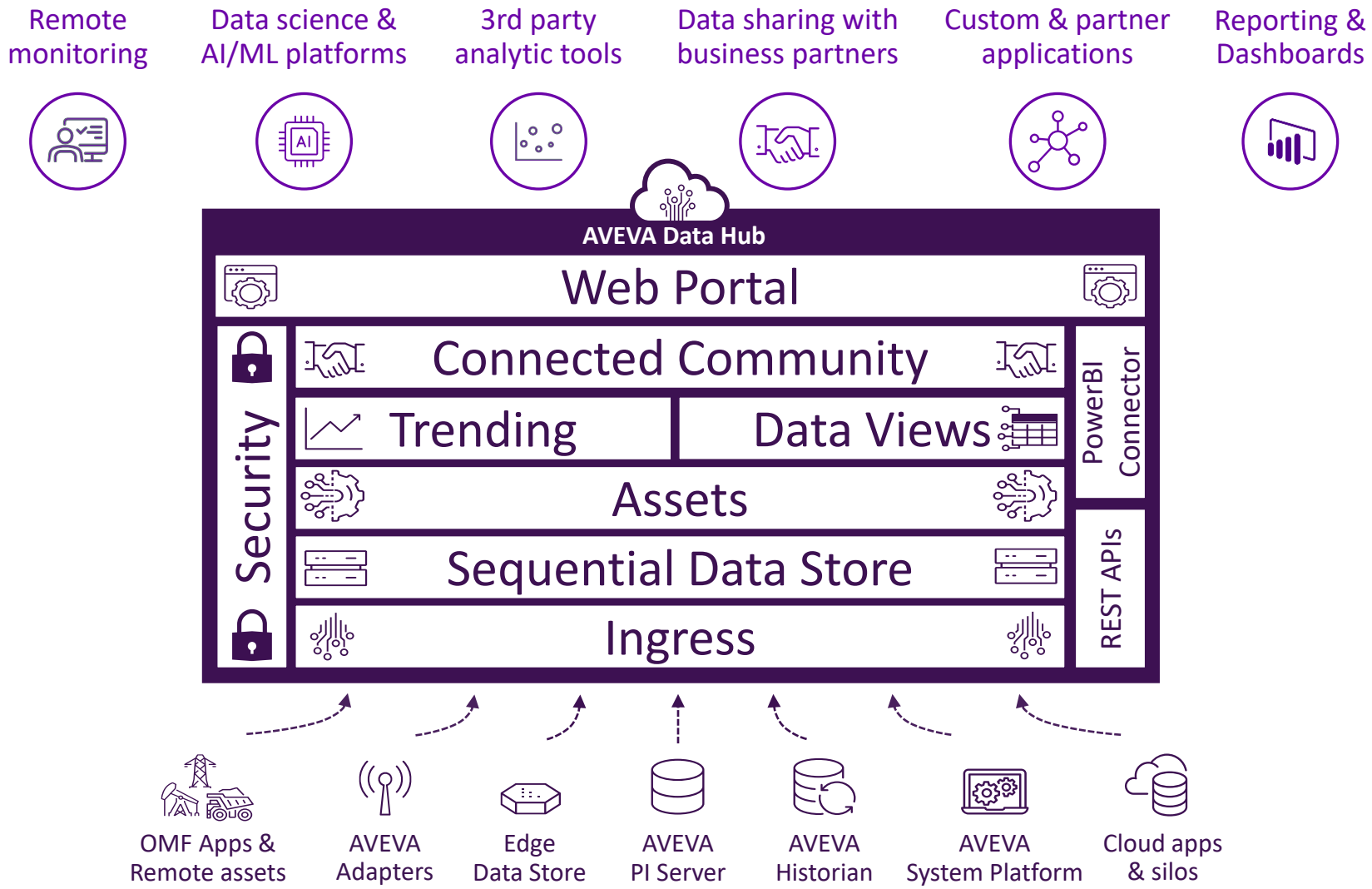
AVEVA Connect: Our industrial cloud platform

Our industrial cloud platform is your digital transformation hub



- ✓ Transform faster
- ✓ Enable new ways of work
- ✓ Connect and collaborate
- ✓ One single source of truth
- ✓ Move from CapEx to OpEx
- ✓ Lower dependency on IT
- ✓ Always the latest and greatest features
- ✓ Easily scale up and down
- ✓ Built with security, resiliency, high-availability

AVEVA Data Hub



A cloud-native industrial platform designed for aggregating, storing, enriching, accessing, analyzing, and securely sharing real-time operations data from historians, edge devices, and more

- Managed, secure, multi-tenant platform
- Operated & maintained by AVEVA
- High speed, scalable, elastic, & resilient
- Modern, secure REST APIs
- Built & deployed on Microsoft Azure

Supported Regions
West US (California)
North Europe (Ireland)
Australia East (New South Wales)

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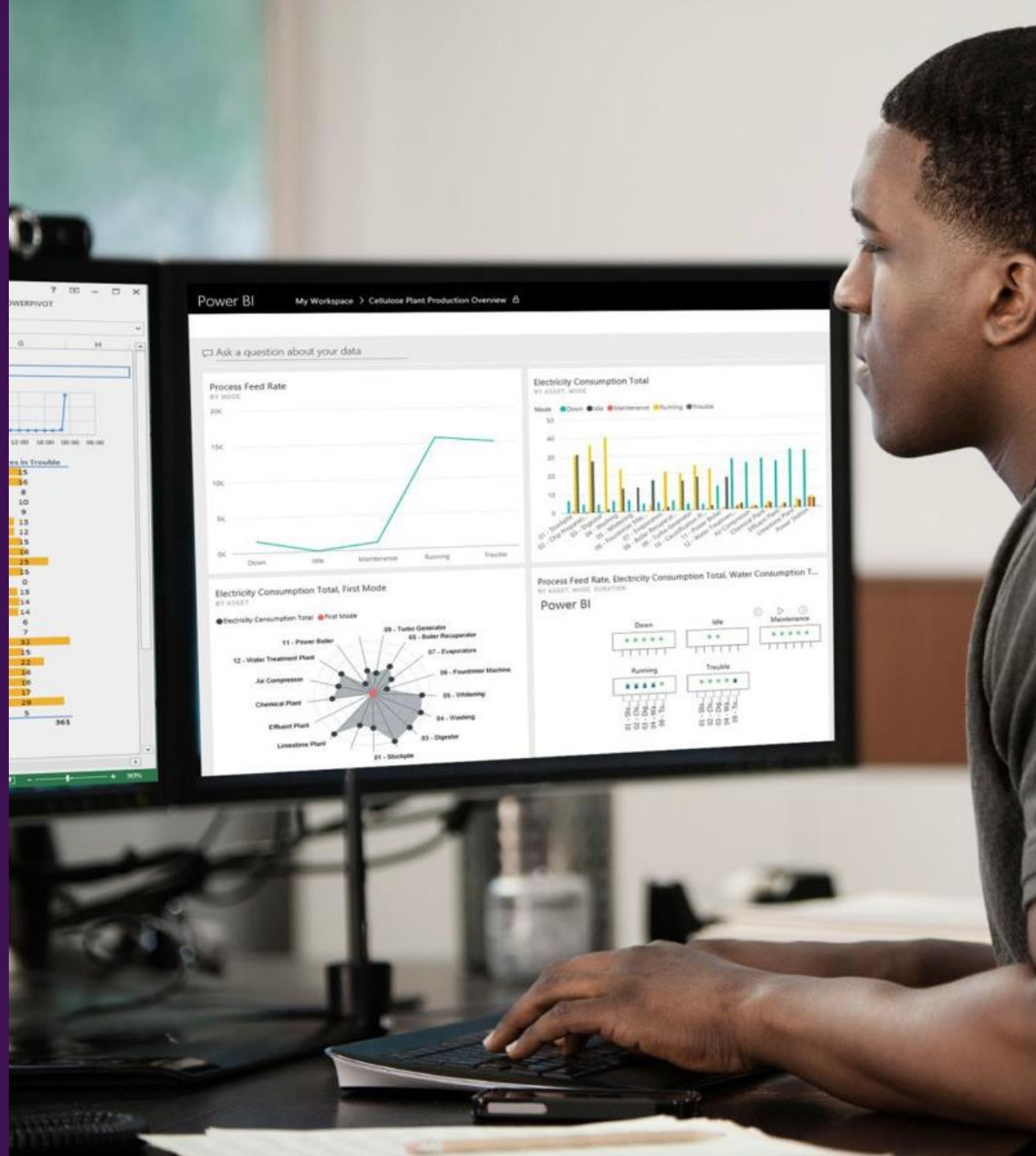
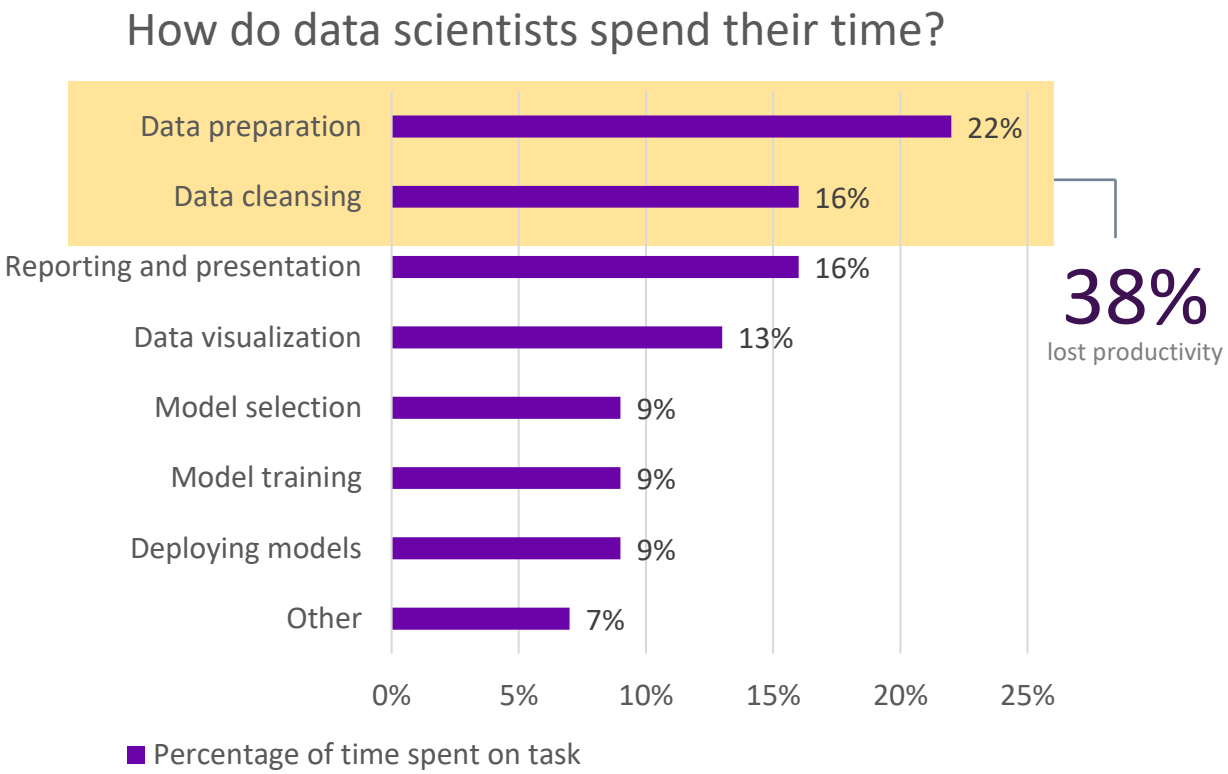
Customers face challenges to realizing the promise of data science

- Easy, secure access to **trustworthy data**
- **Flexible integration** enabling different users and applications
- Support for **enterprise-wide scale**
- **Curated, decision-ready data** that's contextualized, aggregated, and shaped for consumption



Preparing data for analytics

It’s time consuming, even for data scientists



Source: Anaconda’s State of Data Science 2022 Survey

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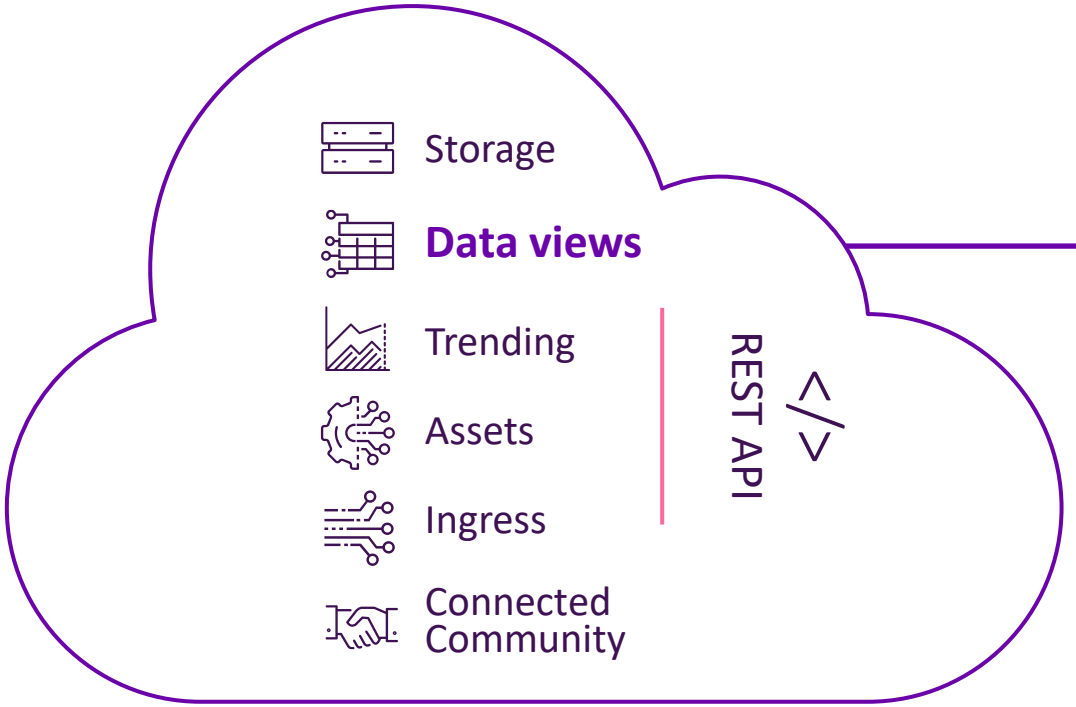
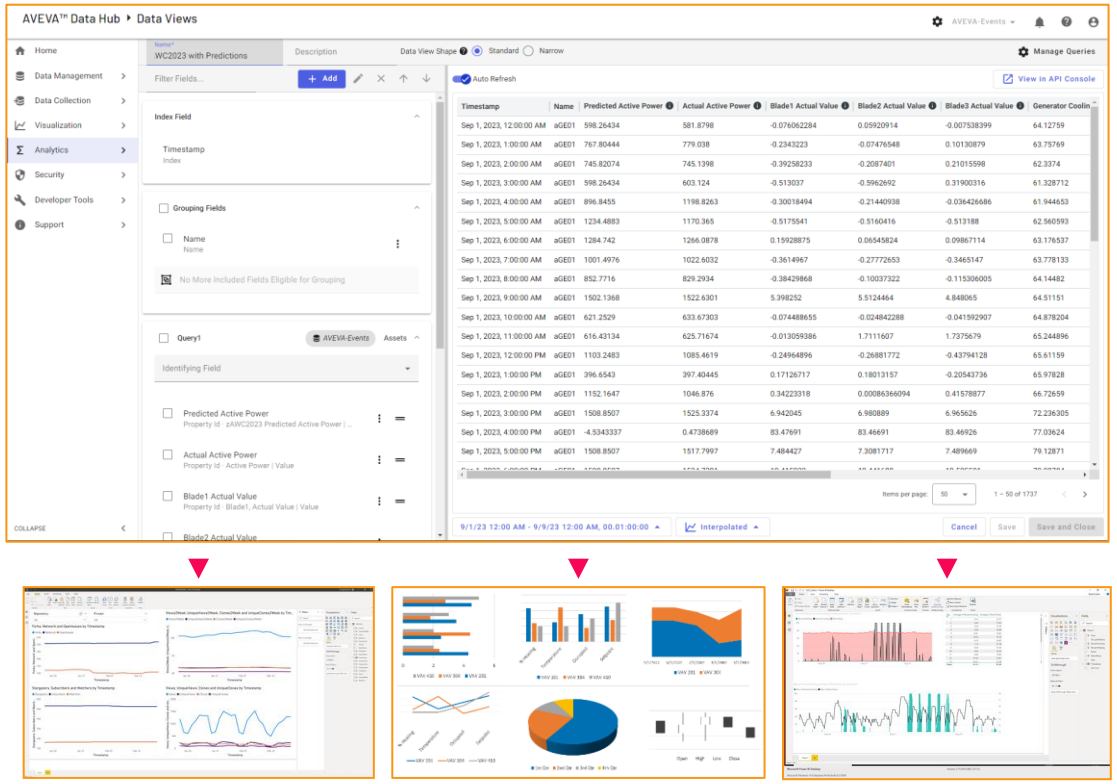
Data Views curate operational data for external consumption

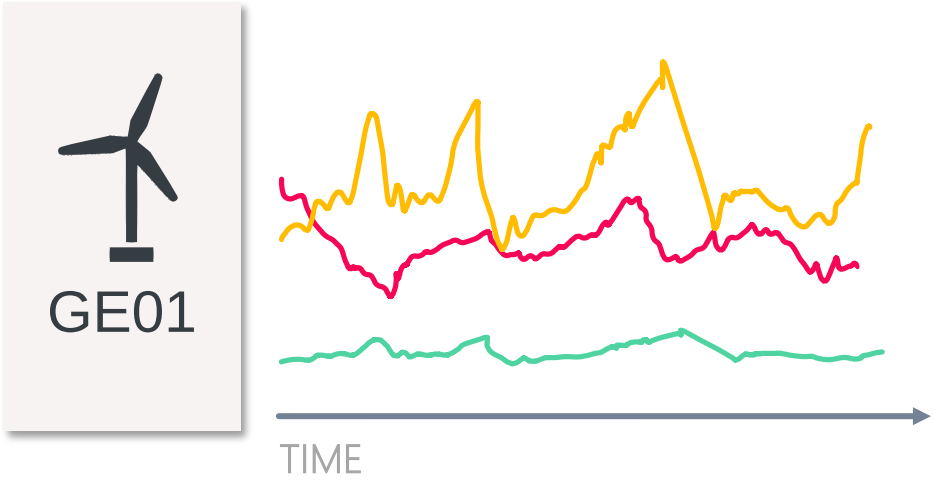


AVEVA Data Hub

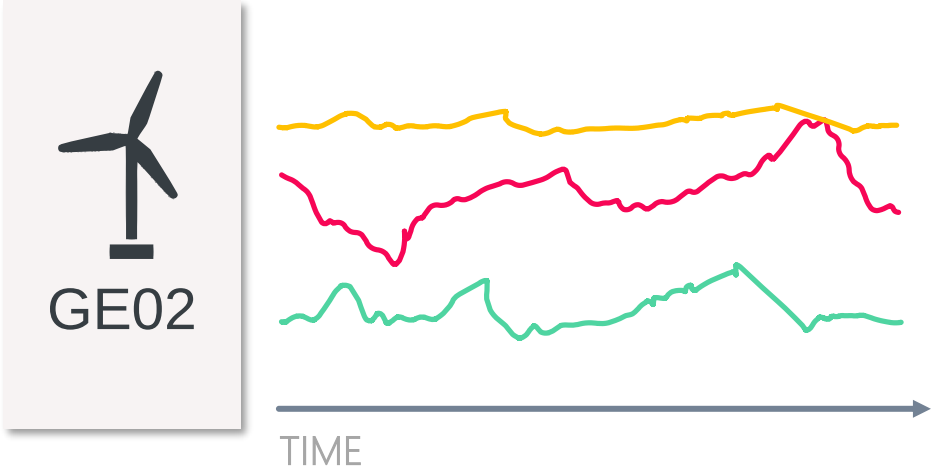
Enabling data exploration and integration



Data is aggregated and context-aware

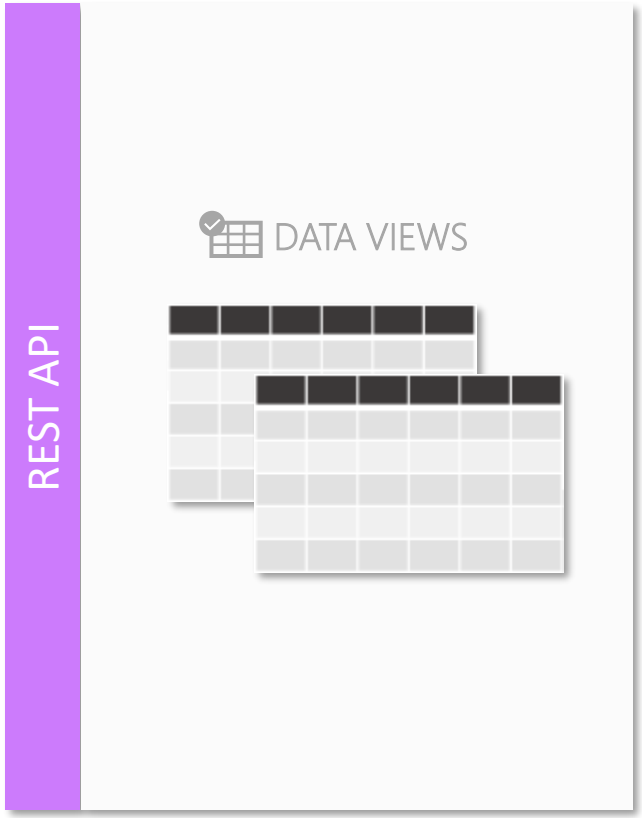


STREAMS	ASSETS + METADATA	
GE01_BL1.ACT_PV	*Turbine Measurement*	**GE01 Blade 1, Actual**
GE01_BL2.ACT_PV	*Turbine Measurement*	**GE01 Blade 2, Actual**
GE01_P.ACT_PV	*Turbine Measurement*	**GE01 Active Power**

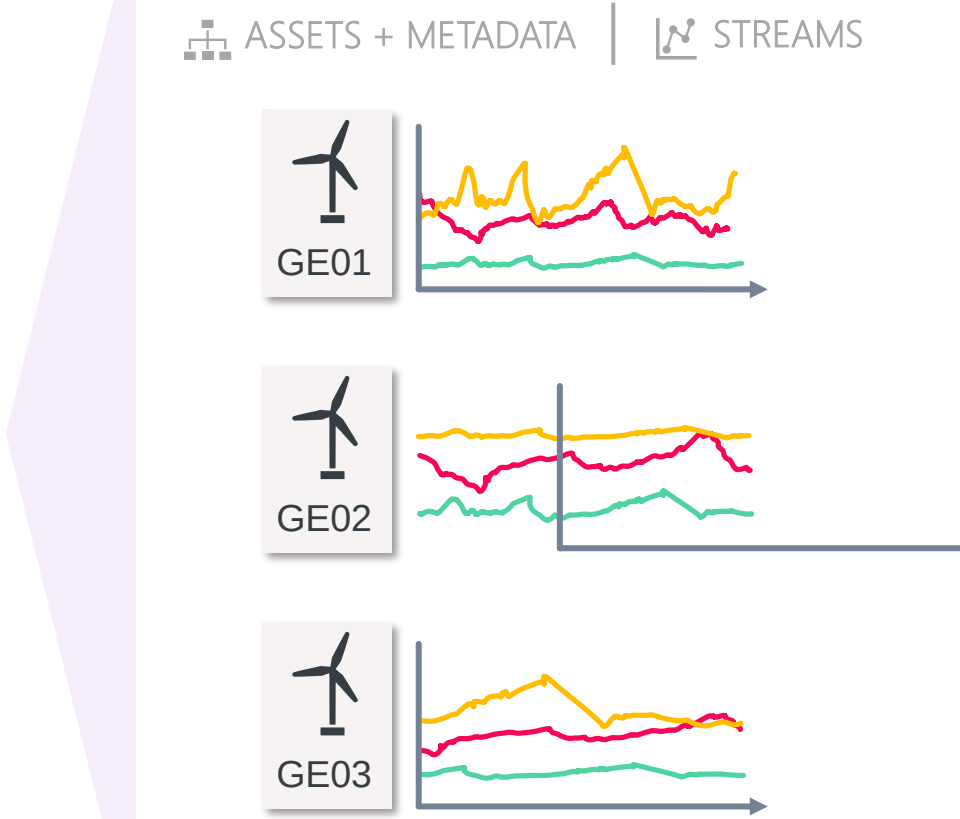


STREAMS	ASSETS + METADATA	
GE02_BL1.ACT_PV	*Turbine Measurement*	**GE02 Blade 1, Actual**
GE02_BL2.ACT_PV	*Turbine Measurement*	**GE02 Blade 2, Actual**
GE02_P.ACT_PV	*Turbine Measurement*	**GE02 Active Power**

Data is shaped for consumption



- Dynamic asset and stream queries
- Data selection & grouping
- Summary calculations
- Streams shared through AVEVA Data Hub Communities



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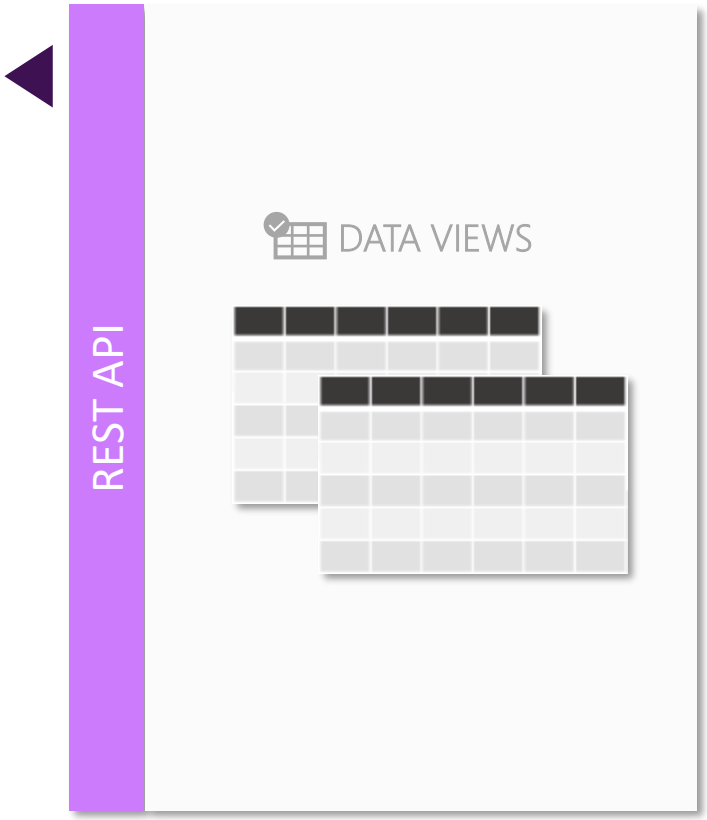
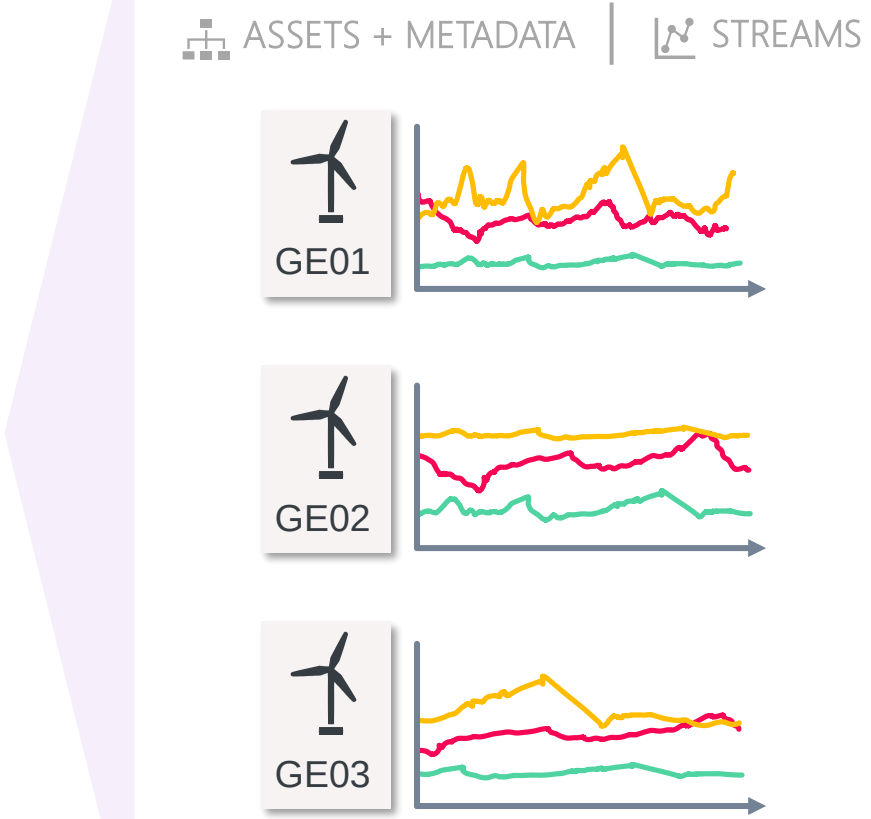
Curated data on-demand

Defined at runtime

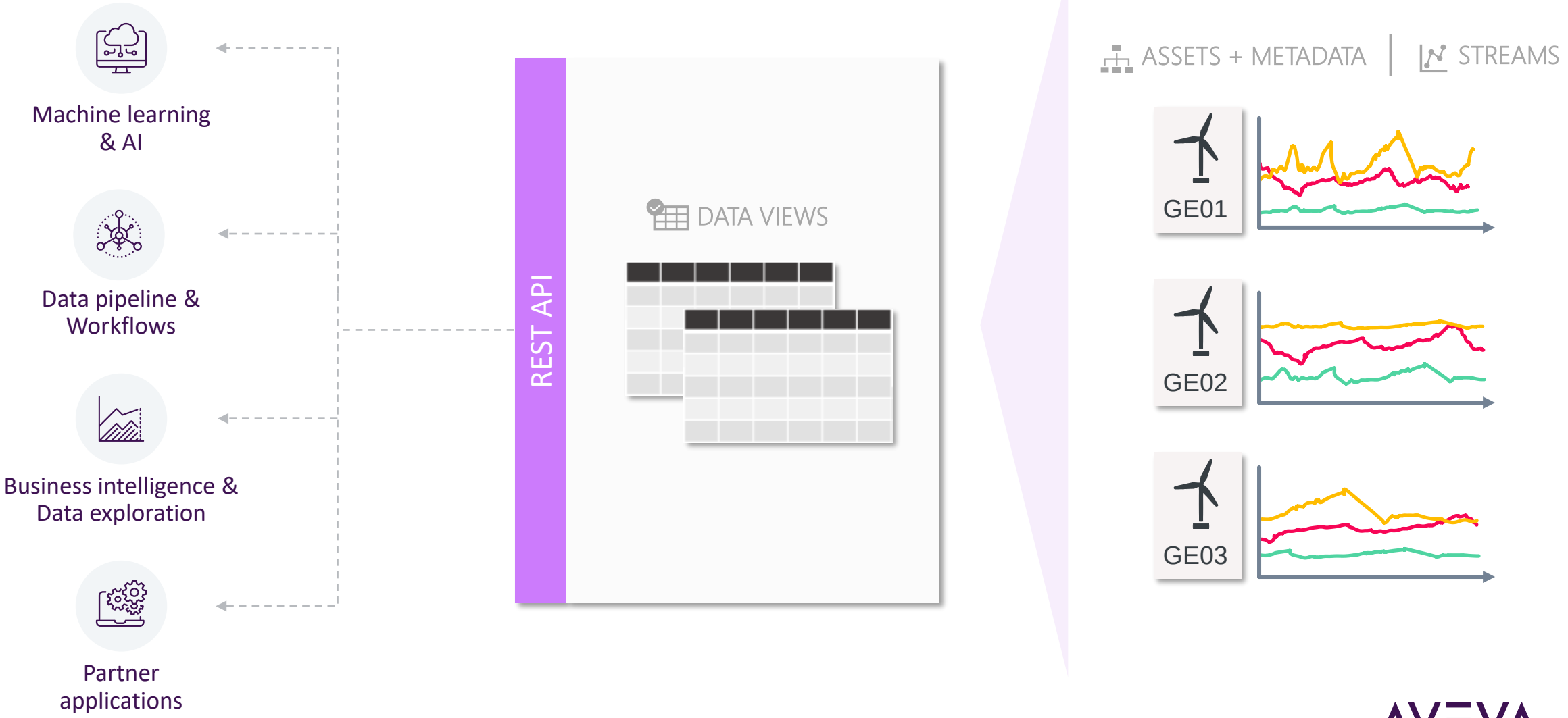
- Time range
- Stored or Interpolated data
- Interpolation interval
- Data format
  - JSON
  - CSV
  - Table

New Parquet File

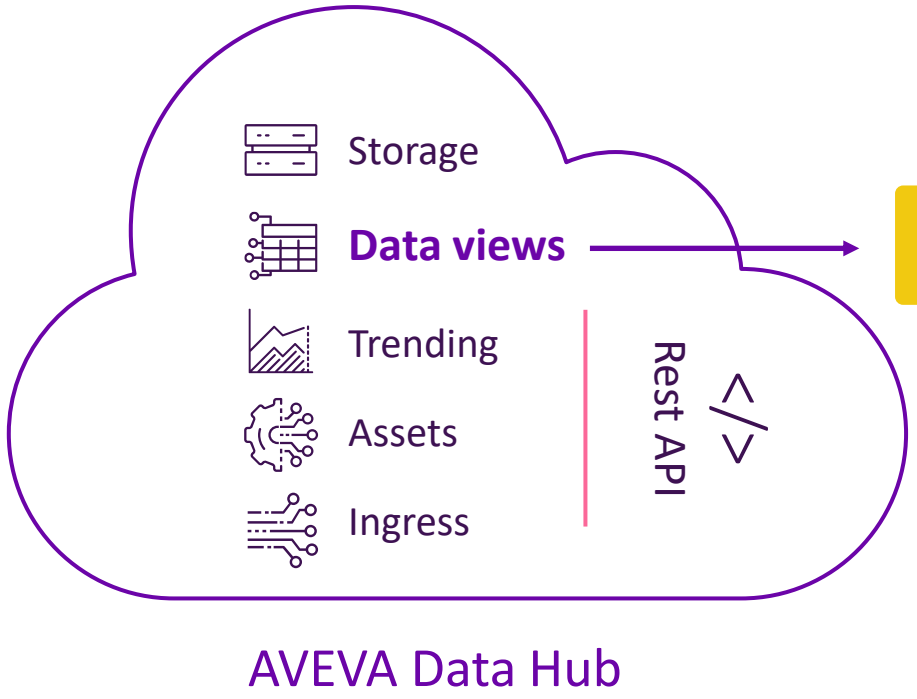




Data is available for many analytics applications



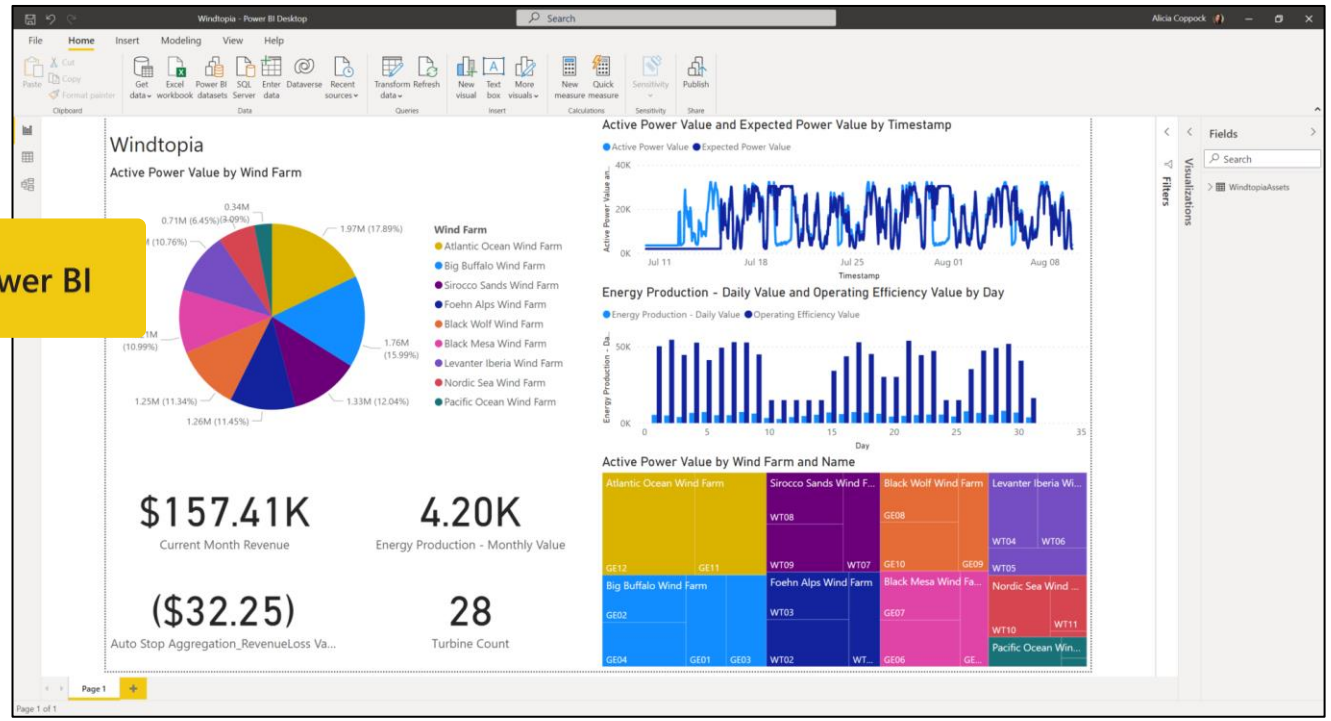
Easily slice & dice your data in Microsoft Power BI



AVEVA Data Hub

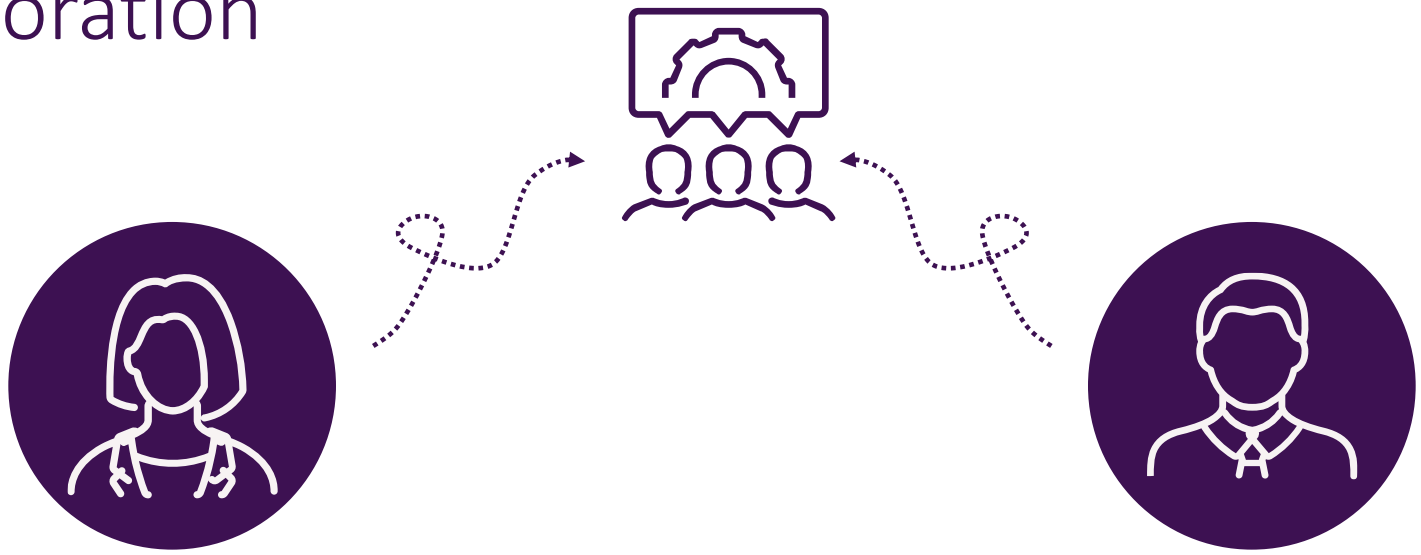
Power BI

AVEVA Data Hub Power BI Connector



New Authentication with Client Credentials

OT/IT Collaboration



Engineer

Data Scientist

- Operations subject matter expert
- Organize and shape data for analysis
- Add meaningful context to data

- Access Data Views
  - REST API
  - AVEVA Data Hub Power BI Connector
- Use AI / ML and visual analytics to enable new insights

Demo: Powering analytics with curated data from AVEVA Data Hub

Stephen Christian

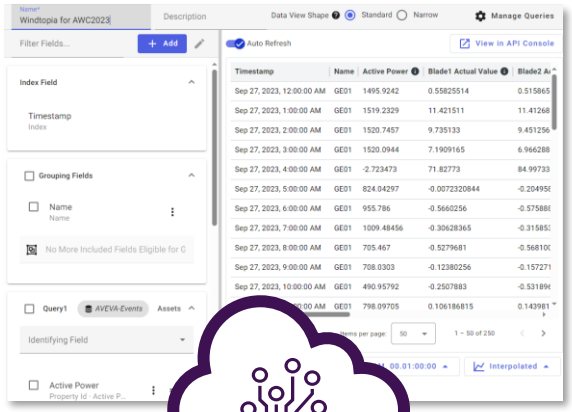
Demo: Forecasting wind farm power production

GE01

GE02

GE03

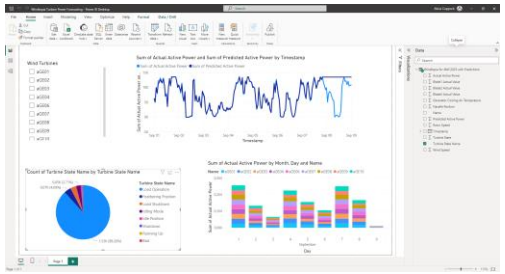
Aggregate and curate data for analysis



AVEVA Data Hub

databricks

Forecast power with machine learning



Power BI

Visualize power forecast report

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COLLAPSE

Name*
Windtopia AWC2023

Description

Data View Shape (Standard) (Narrow)

+ Add

Query1 | AVEVA-Events | Streams

Query Id*
Query1

Query Source
AVEVA-Events

Query Type
(Streams) (Assets)

Query Value
Search...

Search for Streams

Enter a Query Value above to search for streams. For more information see the search documentation.

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Python

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Cmd 1

```
!python -m pip install --upgrade pip
!python -m pip install adh_sample_library_preview --upgrade
!python -m pip install mlflow --upgrade
```

```
Requirement already satisfied: pip in /local_disk0/.ephemeral_nfs/envs/pythonEnv-6d9f2831-51c6-4920-8c18-e9fd0c62daf4/lib/python3.9/site-packages (21.2.4)
Collecting pip
  Downloading pip-23.2.1-py3-none-any.whl (2.1 MB)
     |████████████████████████████████| 2.1 MB 30.8 MB/s eta 0:00:01
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 21.2.4
    Uninstalling pip-21.2.4:
      Successfully uninstalled pip-21.2.4
Successfully installed pip-23.2.1
Collecting adh_sample_library_preview
  Downloading adh_sample_library_preview-0.9.13rc0-py3-none-any.whl (116 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 116.5/116.5 kB 6.0 MB/s eta 0:00:00
Collecting jsonpatch>=1.32 (from adh_sample_library_preview)
  Obtaining dependency information for jsonpatch>=1.32 from https://files.pythonhosted.org/packages/73/07/02e16ed01e04a374e644b575638ec7987ae846d25ad97bcc9945a3ee4b0e/jsonpatch-1.33-py2.py3-none-any.whl.metadata
  Downloading jsonpatch-1.33-py2.py3-none-any.whl.metadata (3.0 kB)
Requirement already satisfied: python-dateutil>=2.8.2 in /databricks/python3/lib/python3.9/site-packages (from adh_sample_library_preview) (2.8.2)
Collecting requests>=2.28.2 (from adh_sample_library_preview)
  Obtaining dependency information for requests>=2.28.2 from https://files.pythonhosted.org/packages/70/8e/0e2d847013cb52cd35b38c009bb167a1a26b2ce6cd6965bf26b47bc0bf44/requests-2.31.0-py3-none-any.whl.metadata
```

Command took 34.63 seconds -- by schristian@osisoft.com at 9/21/2023, 8:58:48 AM on Stephen Christian's Cluster

Cmd 2

```
import mlflow
import mlflow.sklearn
import requests
import json
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
from datetime import date, timedelta
from pyspark.sql.functions import col, to_timestamp
from pyspark.pandas import DataFrame
from adh_sample_library_preview import ADHClient

mlflow.sklearn.autolog()
```

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Cmd 4

```python
def retrieve_data_view(client, namespace_id, data_view_id, start_index, end_index, interval):
  data_page, next_page, first_page = client.DataViews.getDataInterpolated(
    namespace_id, data_view_id, start_index=start_index, end_index=end_index, interval = interval)
  df = spark.read.json(sc.parallelize([json.dumps(data_page)]))

  # Iterate through each subsequent page of results until there are no more pages
  while next_page != None:
    data_page, next_page, first_page = client.DataViews.getDataInterpolated(url=next_page)
    df = df.union(spark.read.json(sc.parallelize([json.dumps(data_page)])))

  return df

df = retrieve_data_view(client, namespace_id, data_view_id, start_index, end_index, interval)
display(df)
```

(17) Spark Jobs

df: pyspark.sql.dataframe.DataFrame = [Active Power: double, Blade1 Actual Value: double ... 9 more fields]

Table +

	Active Power	Blade1 Actual Value	Blade2 Actual Value	Blade3 Actual Value	Generator Cooling Air Temperature	Nacelle Position	Name	Rotor Speed	Timestamp	Turbine State
1	1380.4193	-0.15358979	-0.116629474	-0.110596865	65.60718	132.68161	GE01	19.844124	2023-09-01T00:00:00Z	16
2	990.1805	-0.18358225	-0.03936434	-0.16621605	65.60101	133.75717	GE01	19.729055	2023-09-01T00:01:00Z	16
3	1524.5835	4.0551815	4.009701	4.047217	65.59485	134.83272	GE01	19.954031	2023-09-01T00:02:00Z	16
4	1228.2428	-0.28279698	-0.27758697	-0.25653037	65.588684	135.90828	GE01	19.820591	2023-09-01T00:03:00Z	16
5	1113.4883	0.08640607	0.11865816	0.10602036	65.58252	140.33691	GE01	19.764425	2023-09-01T00:04:00Z	16
6	1265.8788	0.5062732	0.5142392	0.44296938	65.576355	141.93181	GE01	19.988466	2023-09-01T00:05:00Z	16

10,000 rows | Truncated data | 25.20 seconds runtime — Refreshed 8 days ago

Command took 25.20 seconds -- by schristian@osisoft.com at 9/21/2023, 9:05:13 AM on Stephen Christian's Cluster

Cmd 5

```python
# Remove the GE05 turbine rows from the data frame because it has a lower rating relative to all the other turbines
df_filter = df.where(col('Name') != 'GE05')

# Remove any rows with nulls - these will interfere with plots and the machine learning below
```

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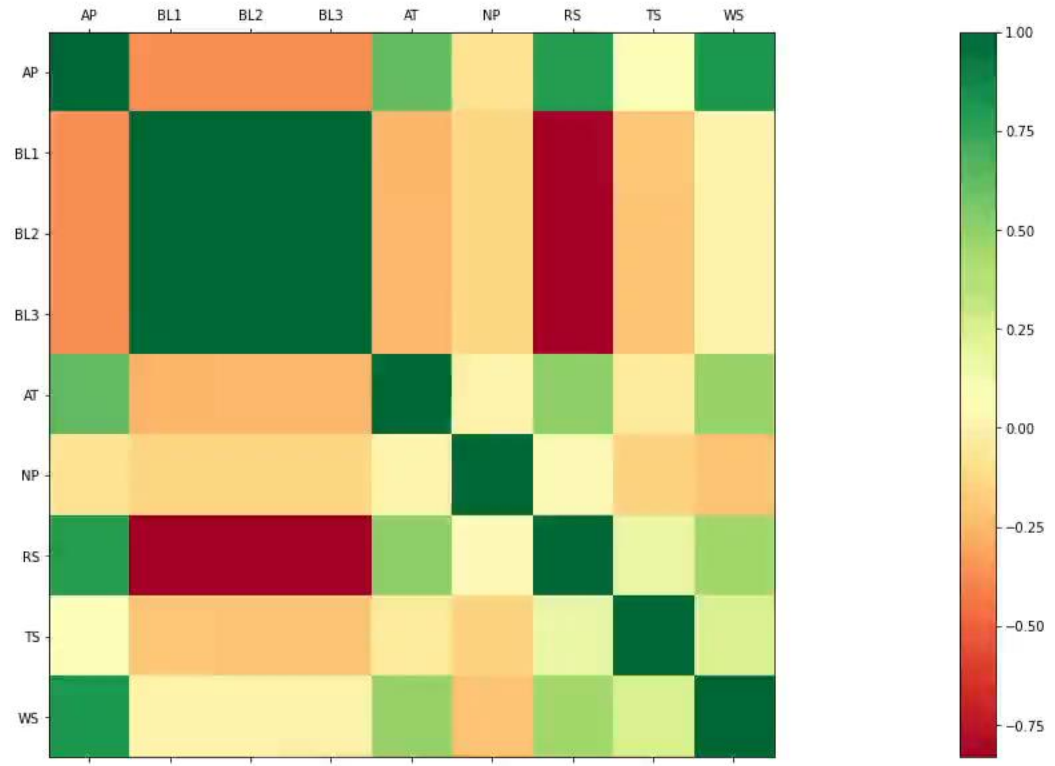
```
16
17  # Make sure to show all the labels
18  ax.set_xticks(np.arange(len(labels)))
19  ax.set_yticks(np.arange(len(labels)))
20
21  # Setting labels for the x and y axes of the correlation plot
22  ax.set_xticklabels(labels)
23  ax.set_yticklabels(labels)
24
25  plt.show(block=False)
```



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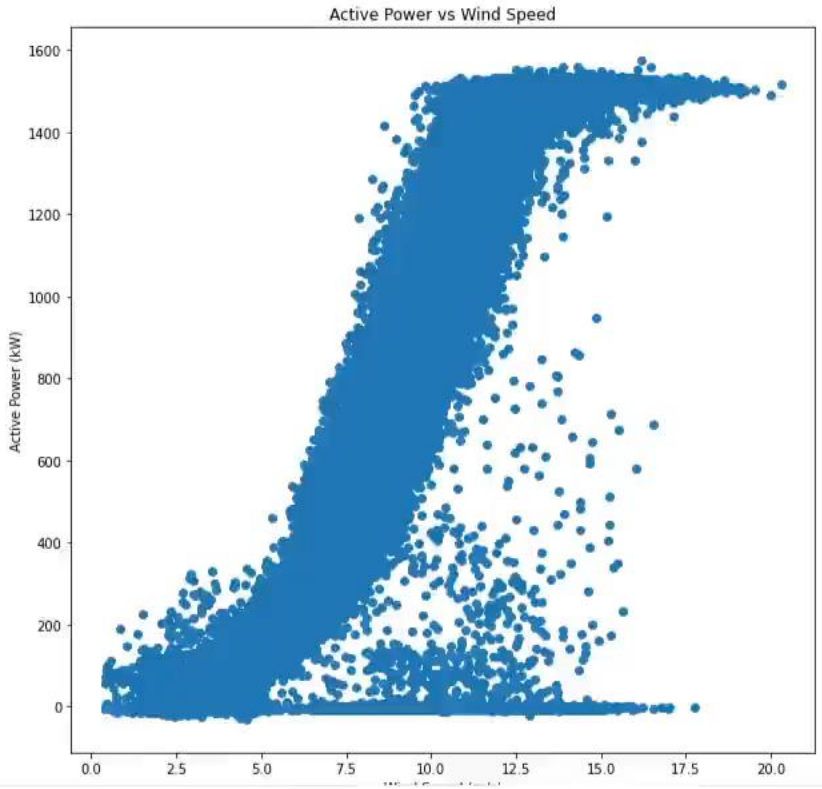
Cmd 8

```
# Plotting Active Power versus Wind Speed
fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111)
ax.scatter(df3['WS'].to_numpy(), df3['AP'].to_numpy())
ax.set_xlabel('Wind Speed (m/s)')
ax.set_ylabel('Active Power (kW)')
ax.set_title('Active Power vs Wind Speed')

plt.show(block=False)
```



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Python

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Cmd 9

```python
from sklearn.model_selection import train_test_split

X = df3.filter(items=['BL1', 'BL2', 'BL3', 'AT', 'NP', 'RS', 'TS', 'WS'])
y = df3.filter(items=['AP'])

# Split the dataset randomly into test and train sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_state=42)
```

Command took 0.13 seconds -- by schristian@osisoft.com at 9/21/2023, 9:07:21 AM on Stephen Christian's Cluster

Cmd 10

```python
# Use the Decision Tree Regression Machine Learning model from scikit-learn
from sklearn.tree import DecisionTreeRegressor

# Try multiple depths of decision tree to see which is best
depths = list(range(1, 21))

regressors = [DecisionTreeRegressor(max_depth=depth) for depth in depths]
for regressor in regressors:
    regressor.fit(X_train, y_train)
```

```
2023/09/21 13:44:04 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:04 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:05 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:05 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:05 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:06 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:06 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:06 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:07 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:08 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/python_shell/scripts/db_ipykernel_launcher.py configure`
2023/09/21 13:44:08 WARNING mlflow.utils.autologging_utils: Encountered unexpected error during sklearn autologging: You haven't configured the CLI yet! Please configure by entering `/databricks/pyt
```

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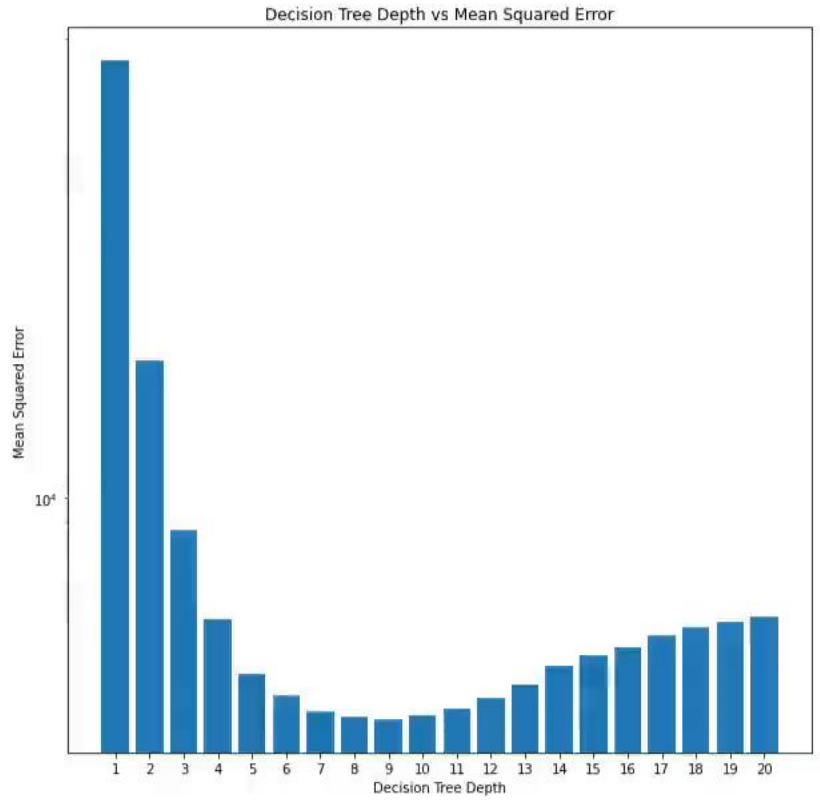
```
13 fig = plt.figure(figsize=(10,10))
14 ax = fig.add_subplot()
15 ax.bar([str(depth) for depth in depths], errors)
16 ax.set_yscale('log')
17 ax.set_xlabel('Decision Tree Depth')
18 ax.set_ylabel('Mean Squared Error')
19 ax.set_title('Decision Tree Depth vs Mean Squared Error')
20
21 plt.show(block=False)
```



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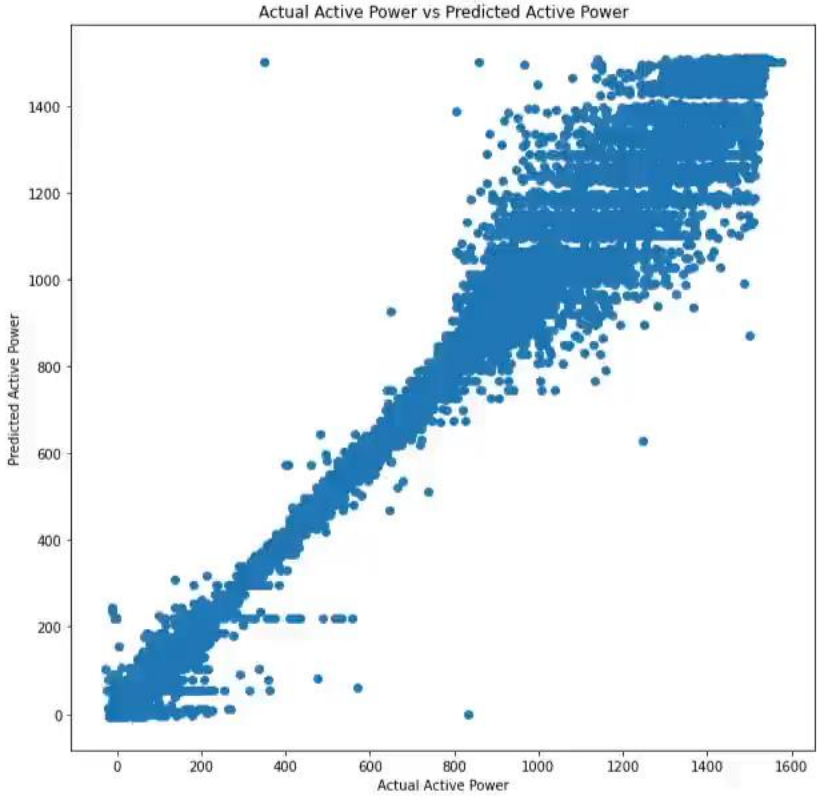
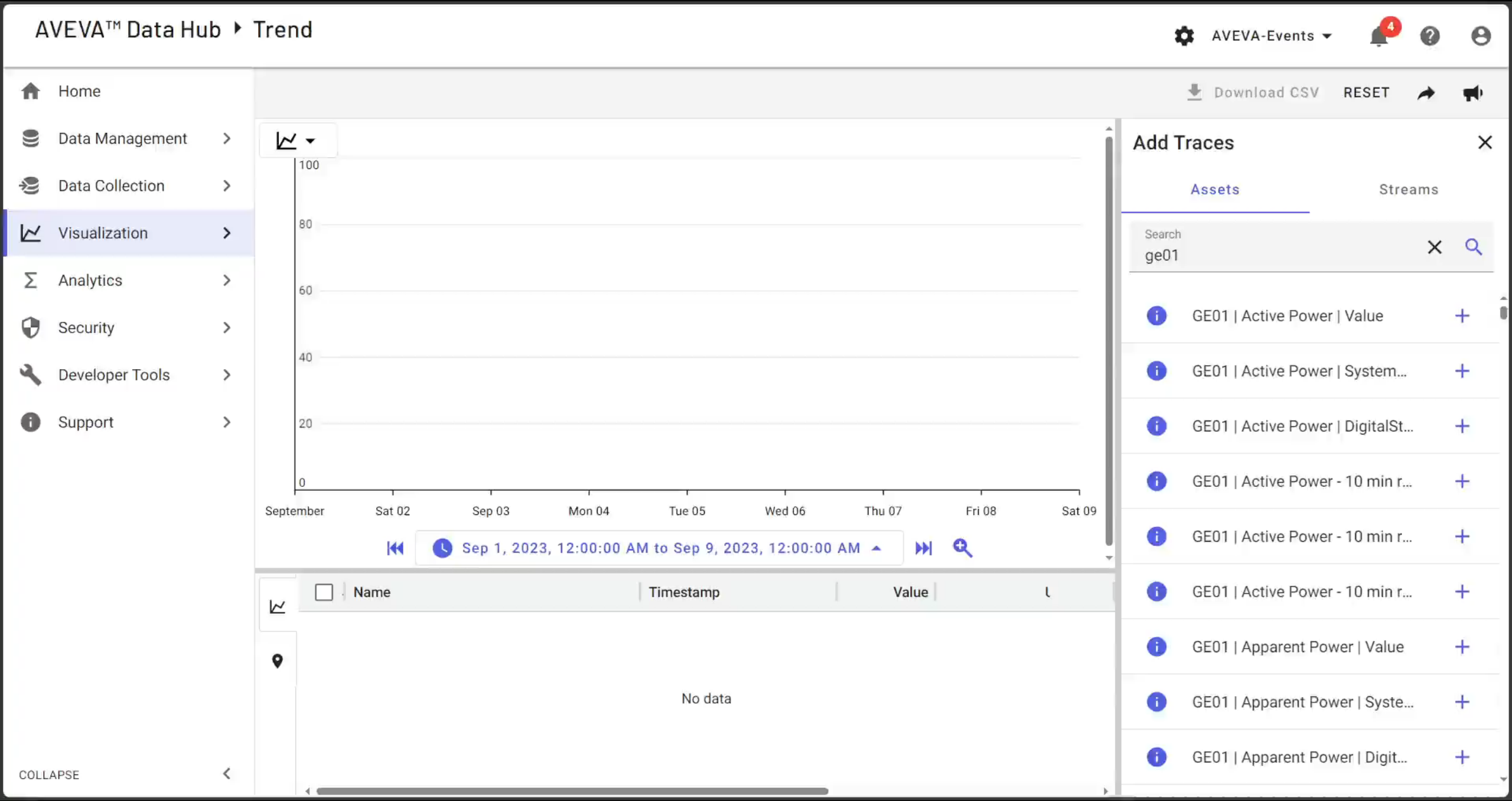
```
best_index = np.array(errors).argmin()
best_regressor = regressors[best_index]
y_predict = best_regressor.predict(X_test)

# Plotting Actual Value versus Predicted Value
fig = plt.figure(figsize=(10,10))
ax = fig.add_subplot(111)
ax.scatter(y_test, y_predict)
ax.set_xlabel('Actual Active Power')
ax.set_ylabel('Predicted Active Power')
ax.set_title('Actual Active Power vs Predicted Active Power')

plt.show(block=False)
```

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Add data to your report

Once loaded, your data will appear in the **Data** pane.

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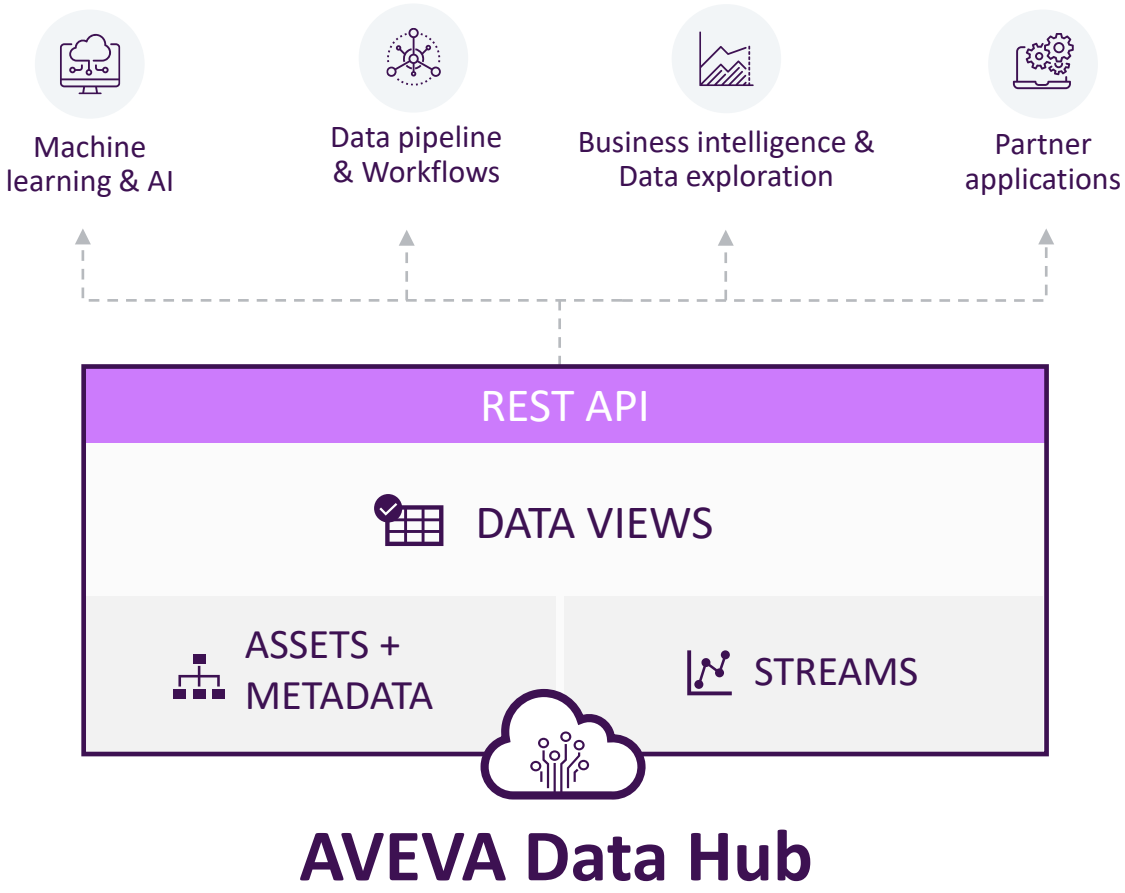
Enable analytics with AVEVA Data Hub

- Data is aggregated and in context
- Data is curated and shaped for consumption
- Data is fresh and trustworthy
- Data is Secure
- Scalable and resilient
- Flexible integration with 3rd party platforms



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