AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

PNU301

Electric load forecasting on AWS

Pedram Jahangiri (he/him)
Solutions Architect
AWS Commercial Accounts

Abhineet Parchure (he/him)
Senior Solutions Architect
AWS Power & Utilities

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Agenda

Introduction to electric load forecasting

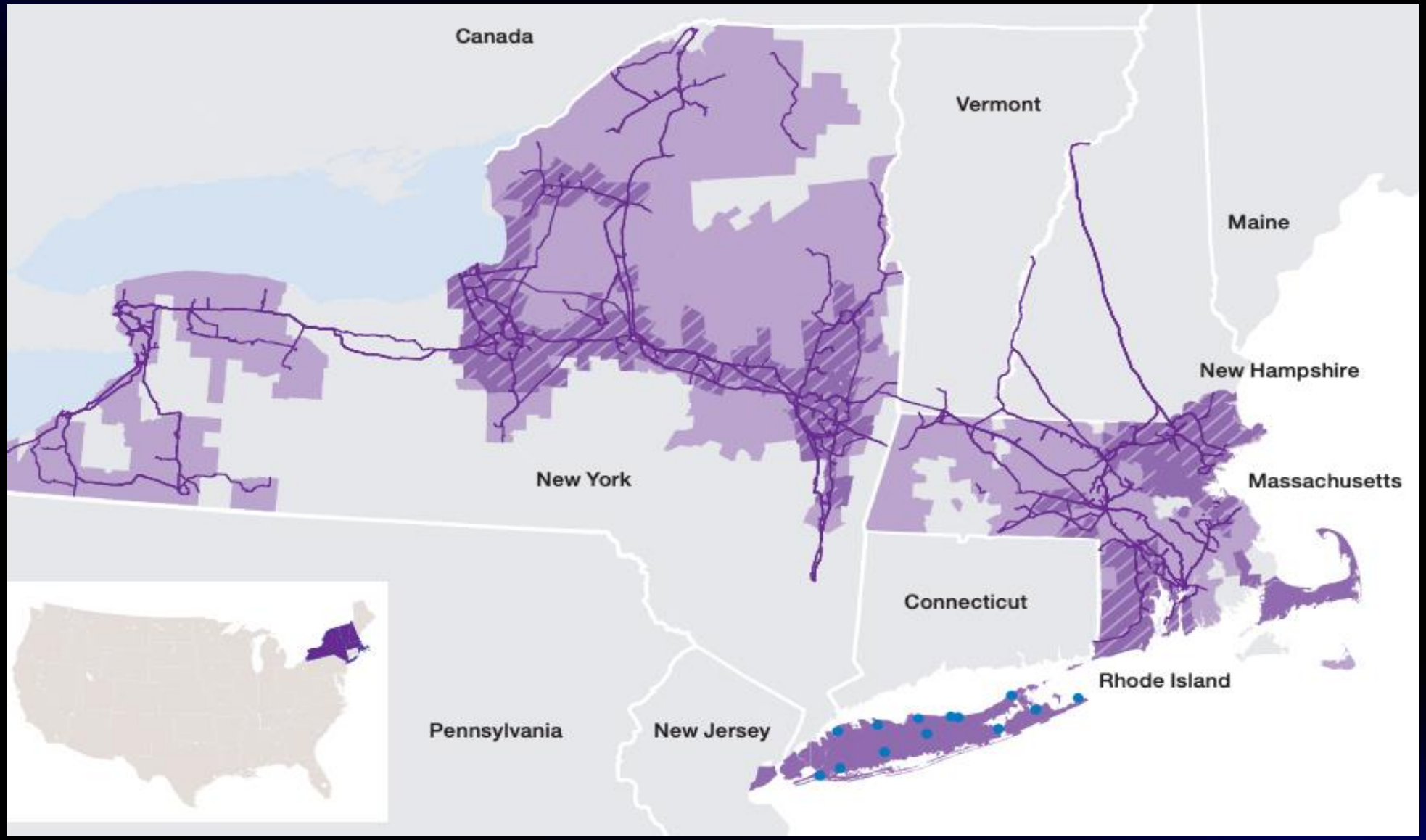
Grid-level forecasting

Customer meter forecasting

Q&A

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Electric load forecasting at all levels: Regional



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Electric load forecasting at all levels: Grid (feeder)



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Electric load forecasting at all levels: Household



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Why is load forecasting important at the feeder level?

- Operational planning
- Facilitating non-wire alternatives
- Demand response
- Optimizing utility-owned energy storage

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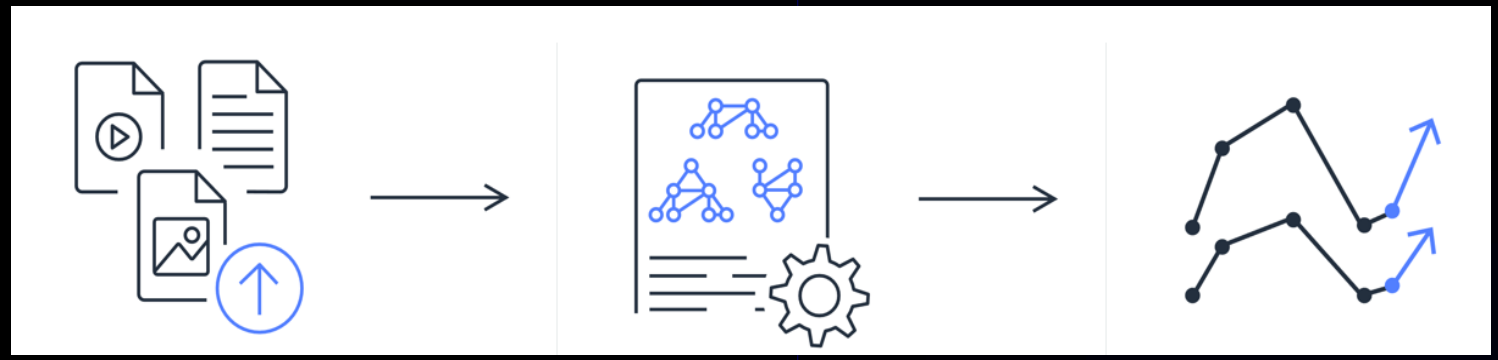
Business vison, proposed solution, and benefits

Vision

Building an accurate two-week-ahead forecast for each individual feeder load

Solution

Managed AWS ML service

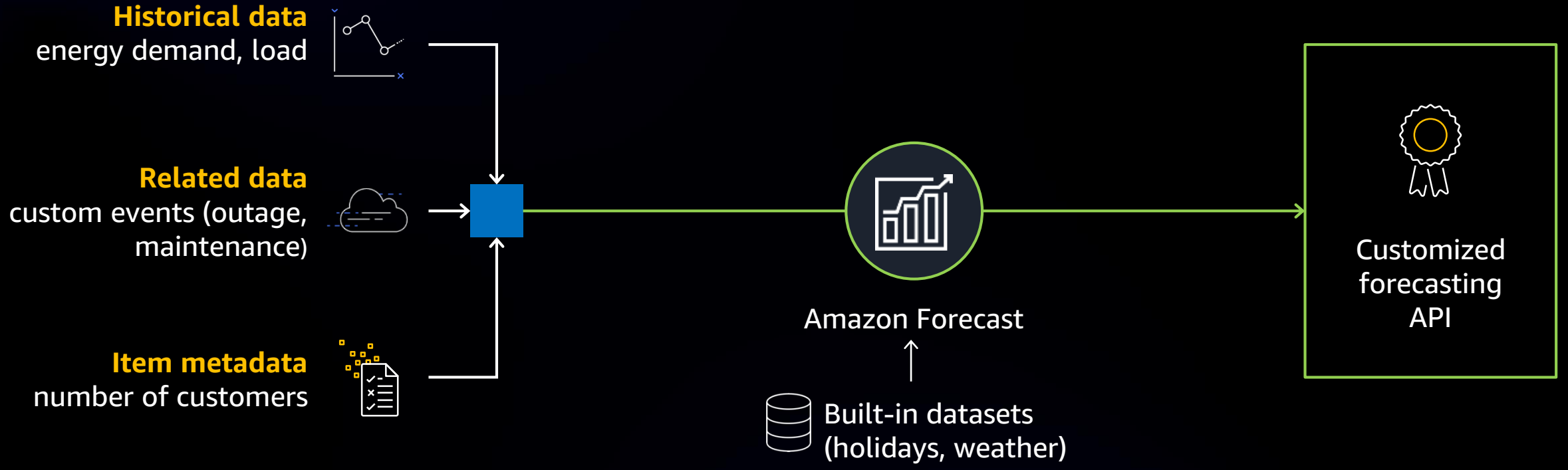


Benefits

- Automatically solve complex forecasting problem
- Up to 50% improvement in accuracy over traditional methods
- Utilize built-in features (weather, holidays)
- No need for dedicated data scientists

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Amazon Forecast: Fully managed ML service



more QUALITY 1st
Foxconn
Anaplan
axiom telecom seriously unlike others
SWIGGY
CJ LOGISTICS
planalytics
DEV FACTORY
Omnys
Heroleads
AffordableTours.com
O Motor
RX | RETENTION X
CASAONE
PSE PUGET SOUND ENERGY

Core features of solution

1

ETL

2

Forecast

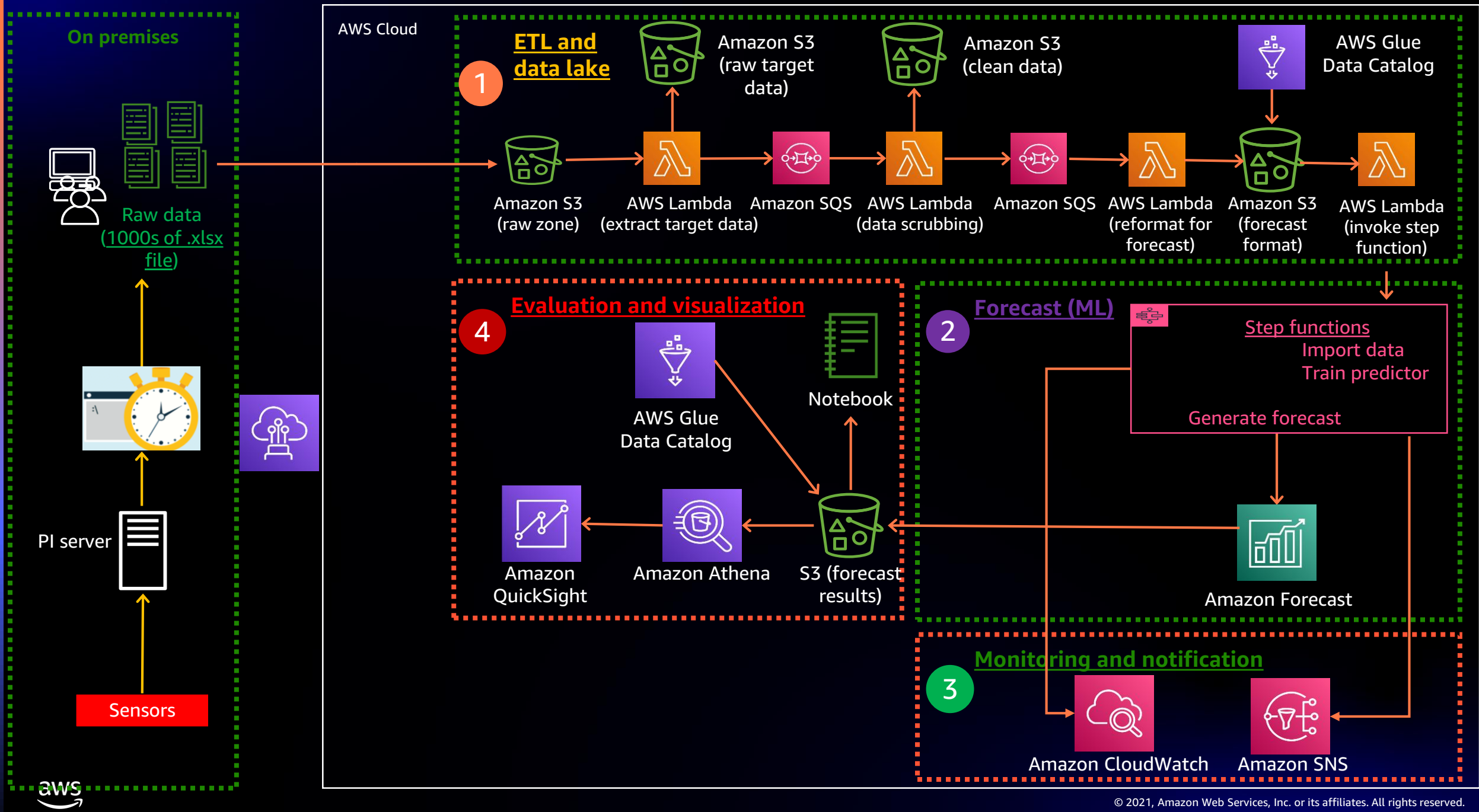
3

Monitoring and Notification

4

Evaluation and Visualization

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Example of evaluation visualization



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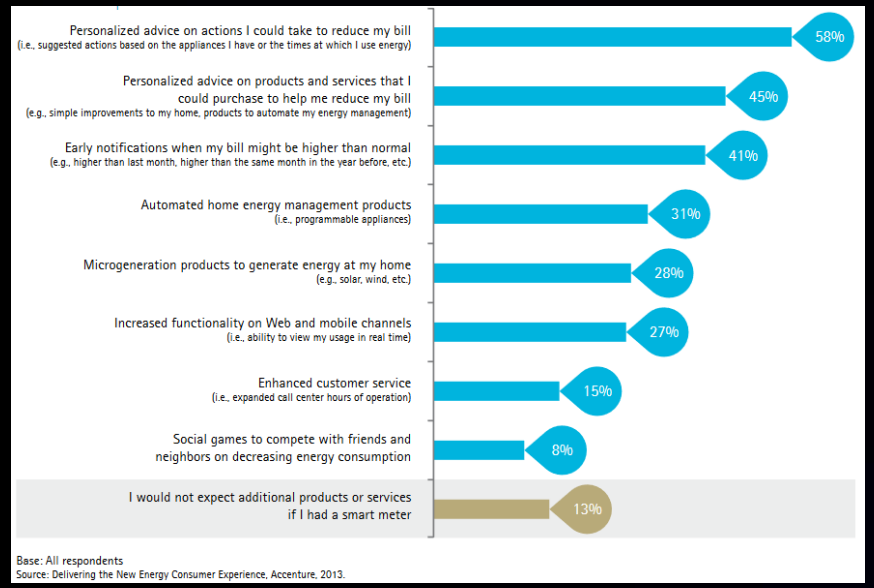
Customer-level load forecasting

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Customer expectation: Major driver for customer-level load forecasting

Top 3 customer expectations

Accenture study, 2013



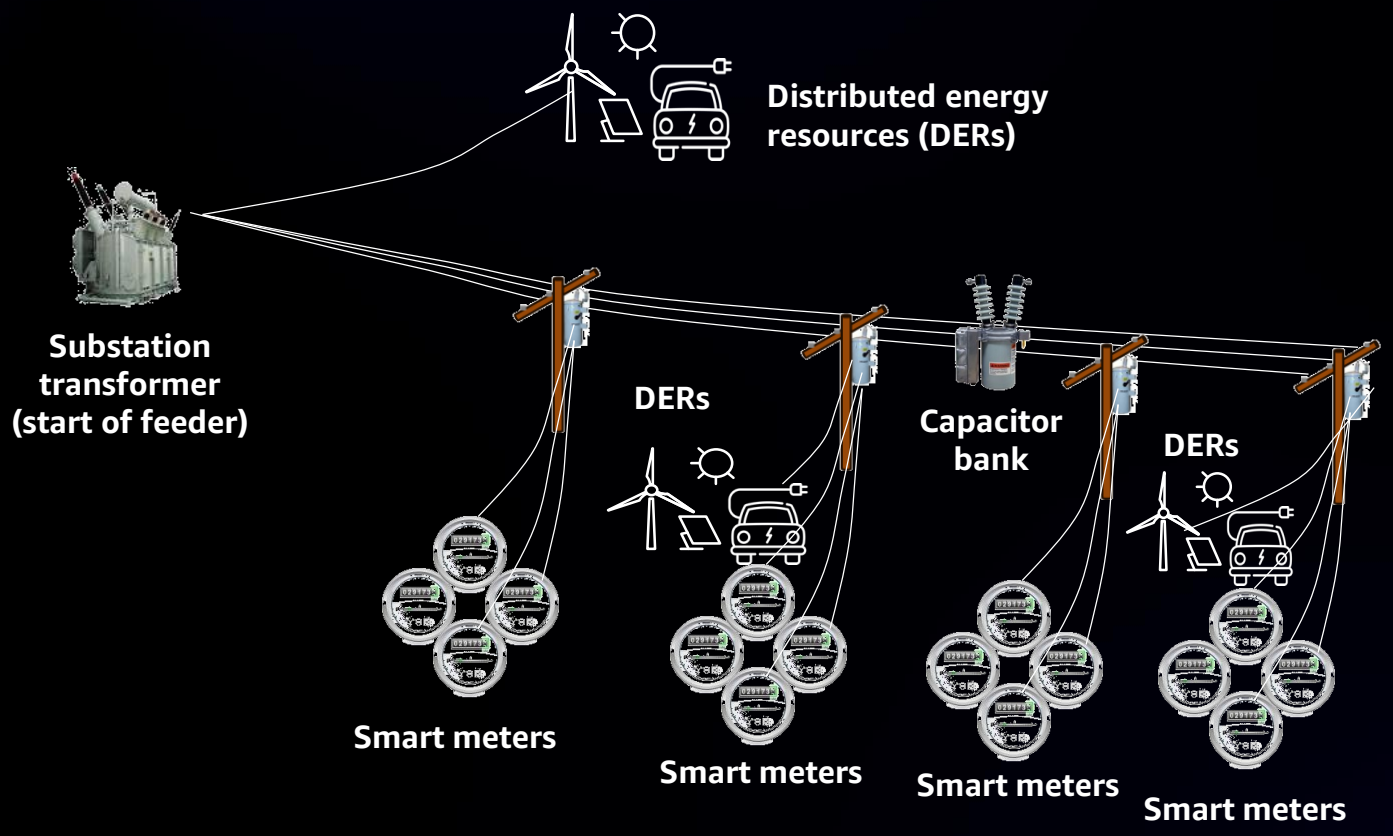
1) "Personalized advice on **actions** I could take to reduce my bill"

2) "Personalized advice on **products and services** that I could purchase to help me reduce my bill"

3) "Early **notifications** when my bill might be higher than normal"

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Other use cases addressed by customer-level load forecasting



- Grid management and analytics
- CVR_{factor} and demand reduction estimation
- Abnormality detection
- Grid model tuning

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Meter Data Analytics Quick Start

ENABLES FOUR USES CASES, INCLUDING RESIDENTIAL LOAD FORECASTING



MDA Quick Start enables four initial use cases

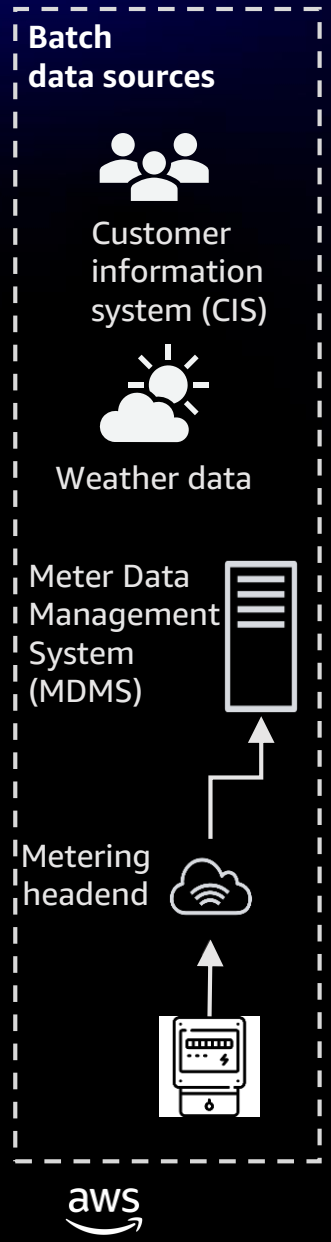
Actual usage	Forecasted energy usage	Unusual usage alerts	Momentary outage heat map
Actual usage vs. weather; aggregated daily, weekly or monthly	ML-driven energy usage forecast at the household level	Usage anomaly detection	Meter problems with latitude / longitude coordinates

https://aws.amazon.com/quickstart/architecture/utility-meter-data-analytics-platform/

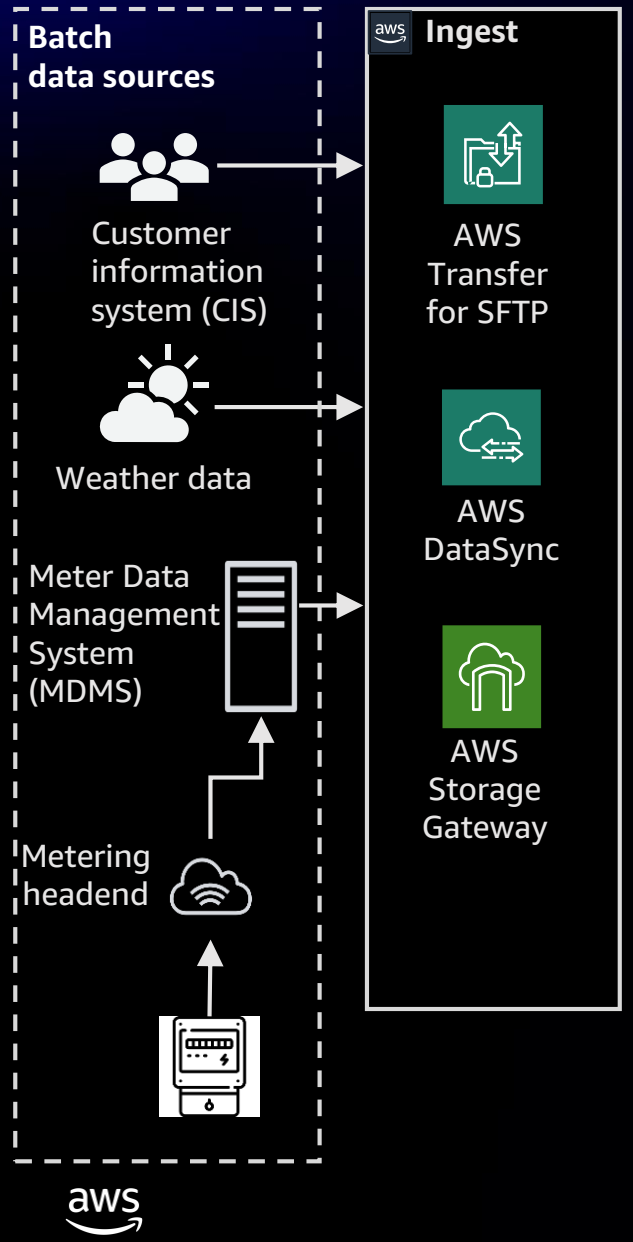
https://aws.amazon.com/blogs/industries/aws-releases-smart-meter-data-analytics-platform/

aws

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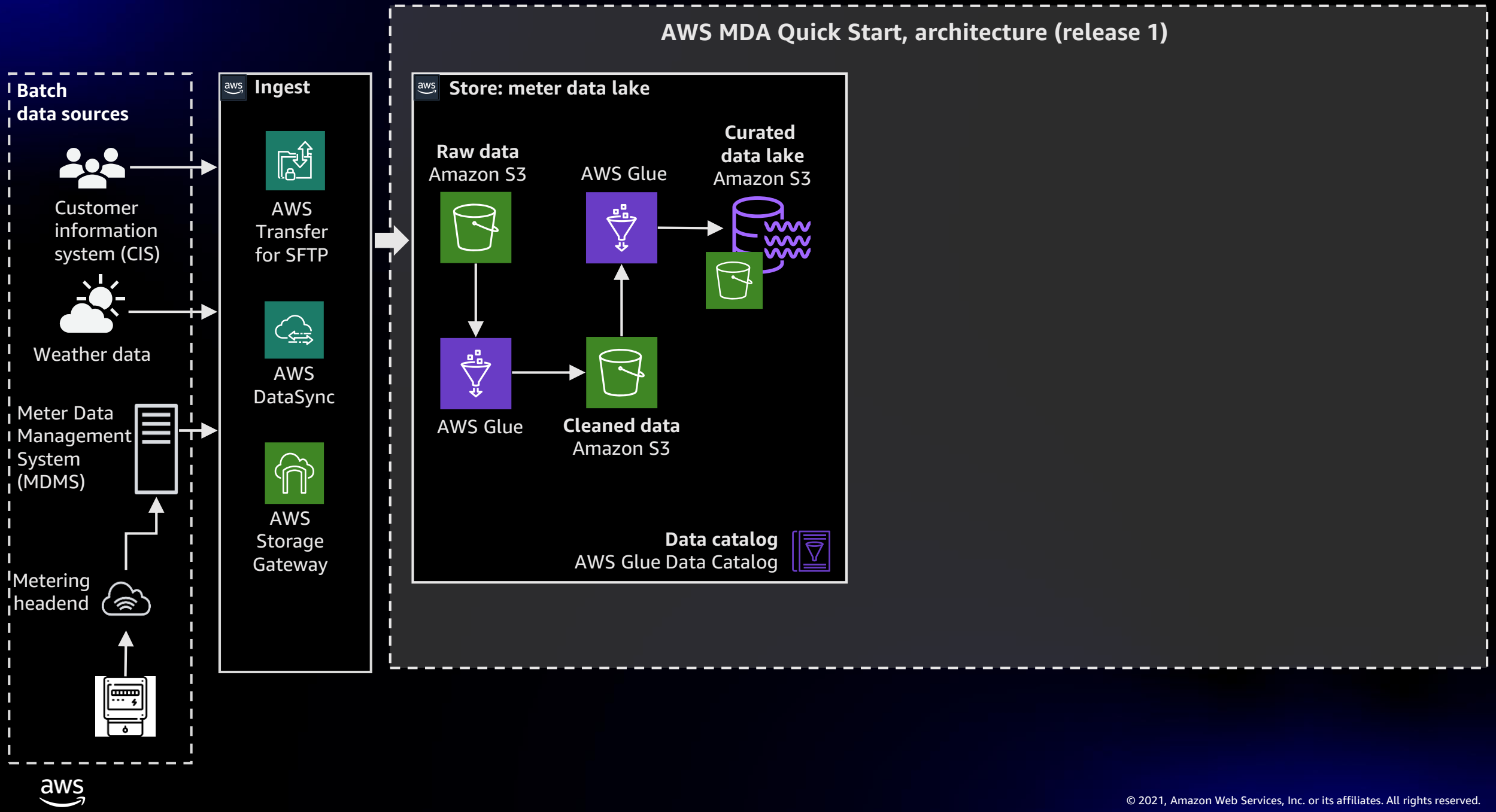


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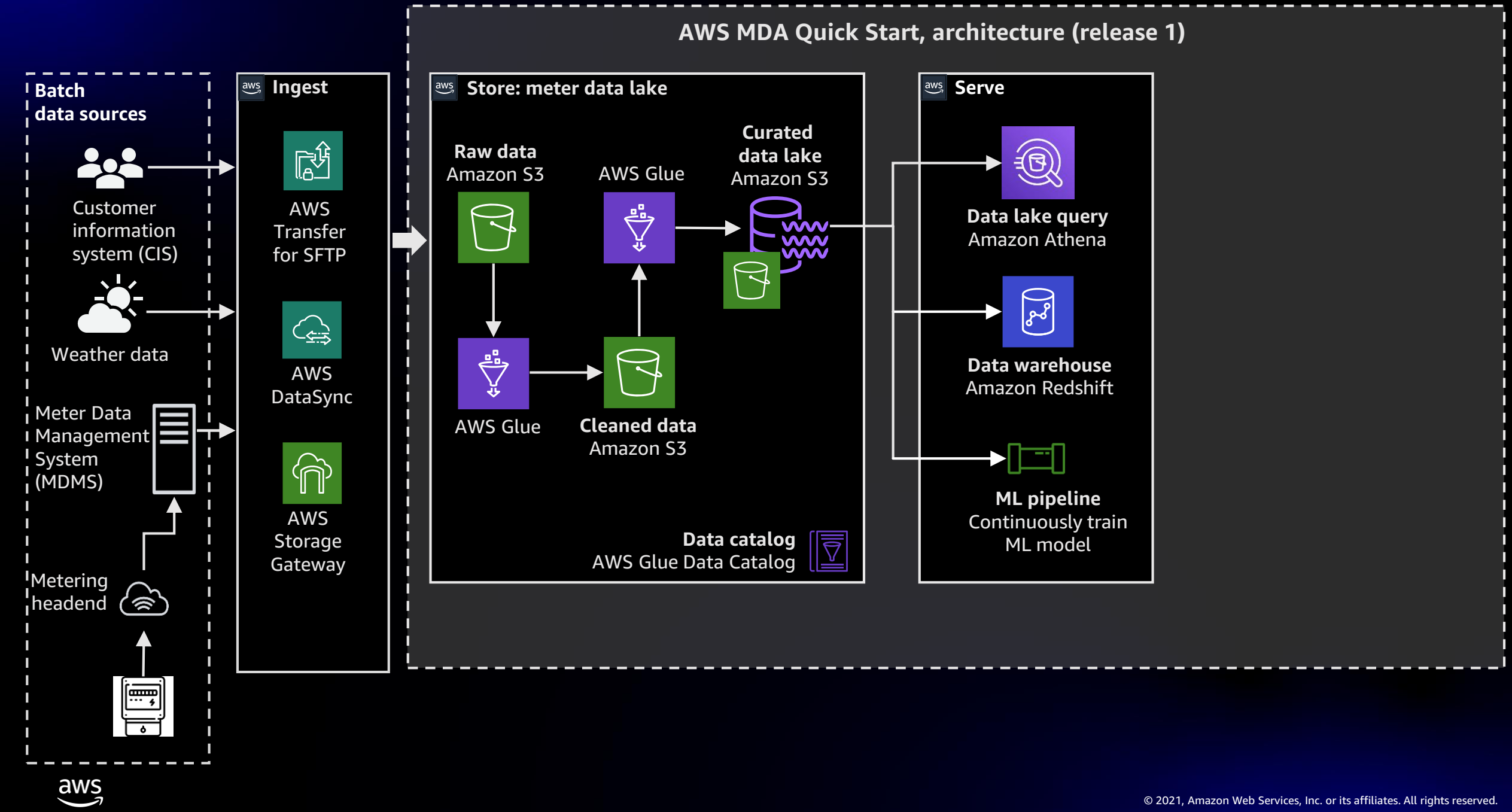


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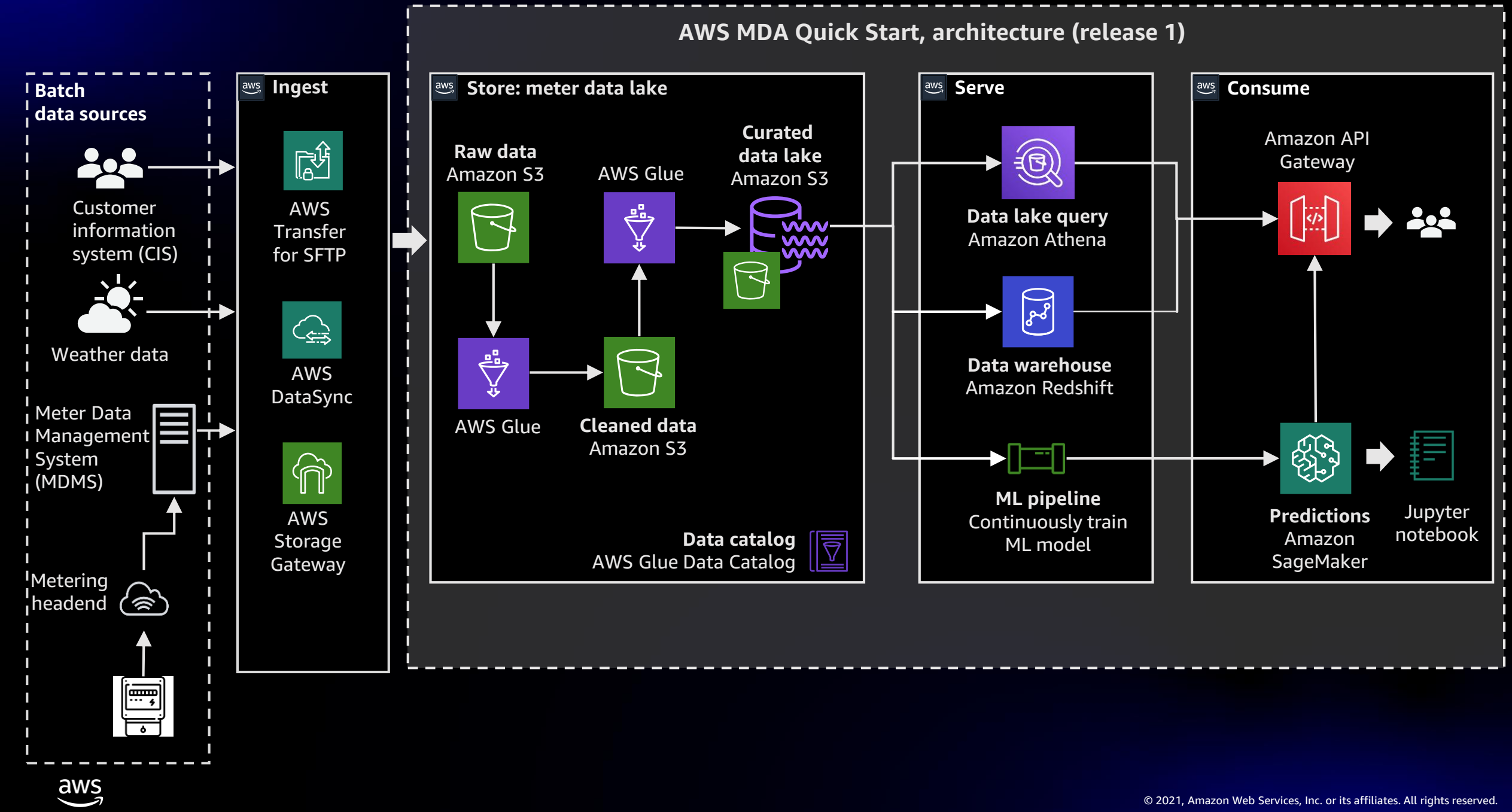
AWS MDA Quick Start, architecture (release 1)



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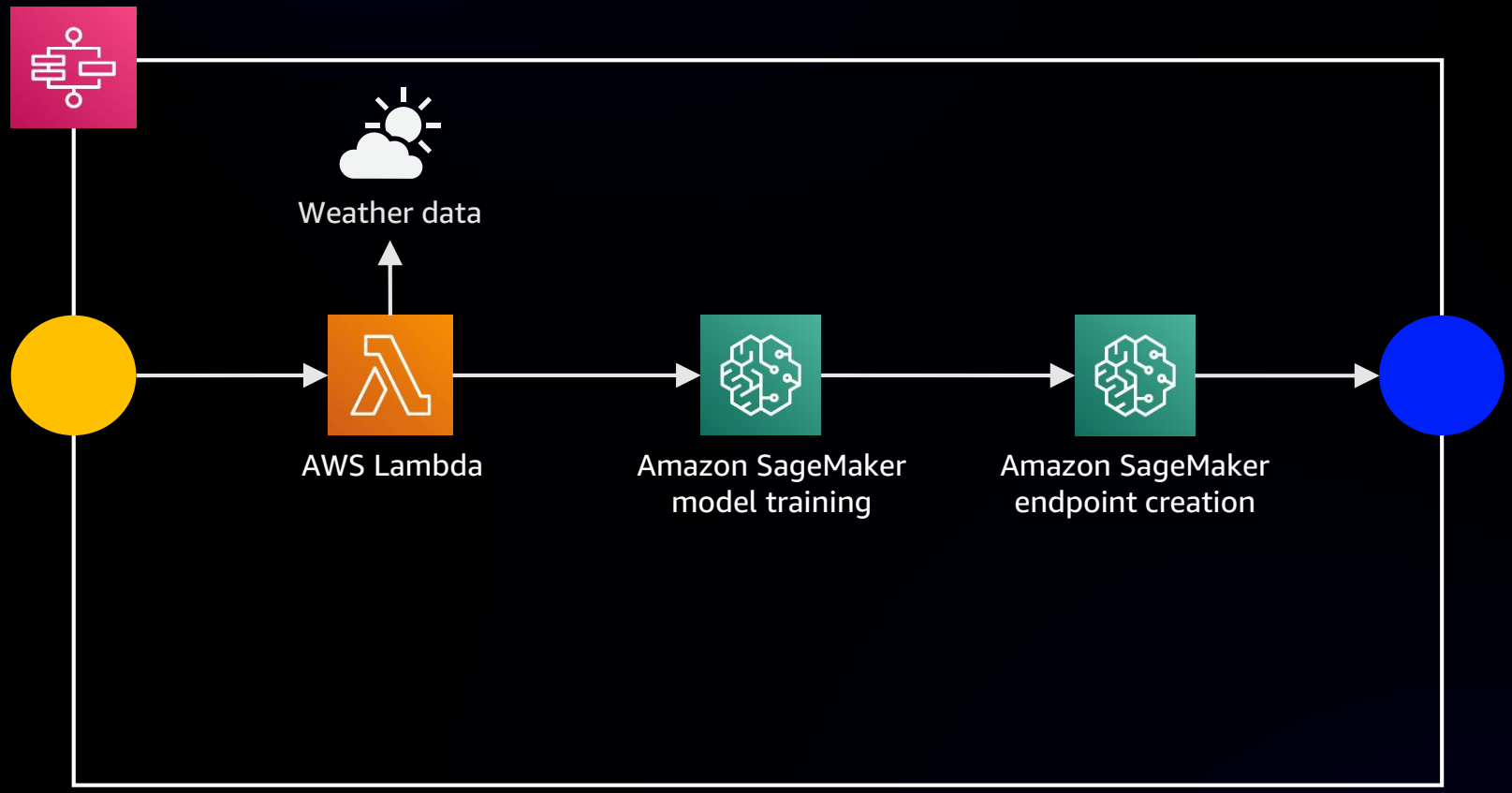


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Model training



- Uses weather data in conjunction with meter reads
- DeepAR forecasting algorithm
- Creates one model jointly over all meters
- Endpoint for online inferences

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DeepAR: Forecasting with deep autoregressive recurrent networks

- Supervised learning algorithm for forecasting scalar time series using recurrent neural networks (RNN)

- Train a single model jointly over all of the related time series
  - Use one or more “target” time series as input (Null values are accepted!)
  - Optionally, use categorical or dynamic feature sets
  - If a model is trained using any categorical or dynamic features, we must provide these for inference

- Use the trained model to generate forecasts for new similar time series

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Hyperparameter tuning

- Perform *automatic model tuning* with Amazon SageMaker
  - Define tunable hyperparameters, a range of values for each, and an objective metric, and let Amazon SageMaker do the rest!

- Tunable hyperparameters with the greatest impact for DeepAR
  - Epochs: The maximum number of passes over the training data
  - Context_length: The number of time points that the model gets to see before making the prediction

- Objective metrics
  - Root mean square error (RMSE): recommended for automatic model tuning
  - mean_wQuantileLoss
  - final_loss

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DeepAR: Best practice recommendations

- Pass entire datasets for training, testing, and inferences, regardless of context_length
- Avoid using very large values (>400) for the prediction_length
- Recommend training a DeepAR model on as many time series as are available
- As a starting point, recommend setting context_length to the value used for prediction_length

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Demo dashboard



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Thank you!

Pedram Jahangiri
jpedram@amazon.com

Abhineet Parchure
parchua@amazon.com

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