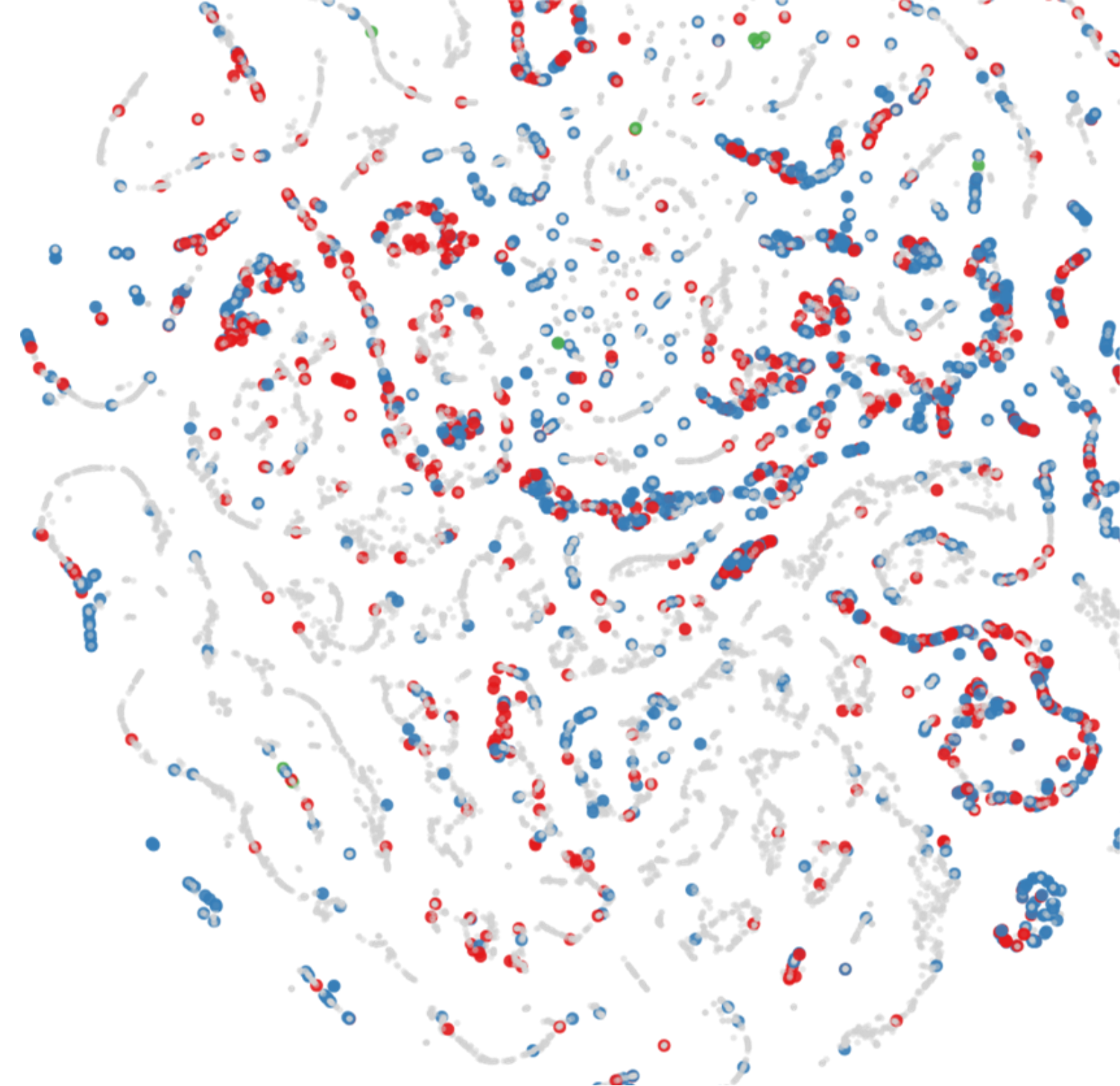


Using Machine Learning to Predict Ratio Transformer Failures

CIGRE Grid of the Future 2021

10/19/2021

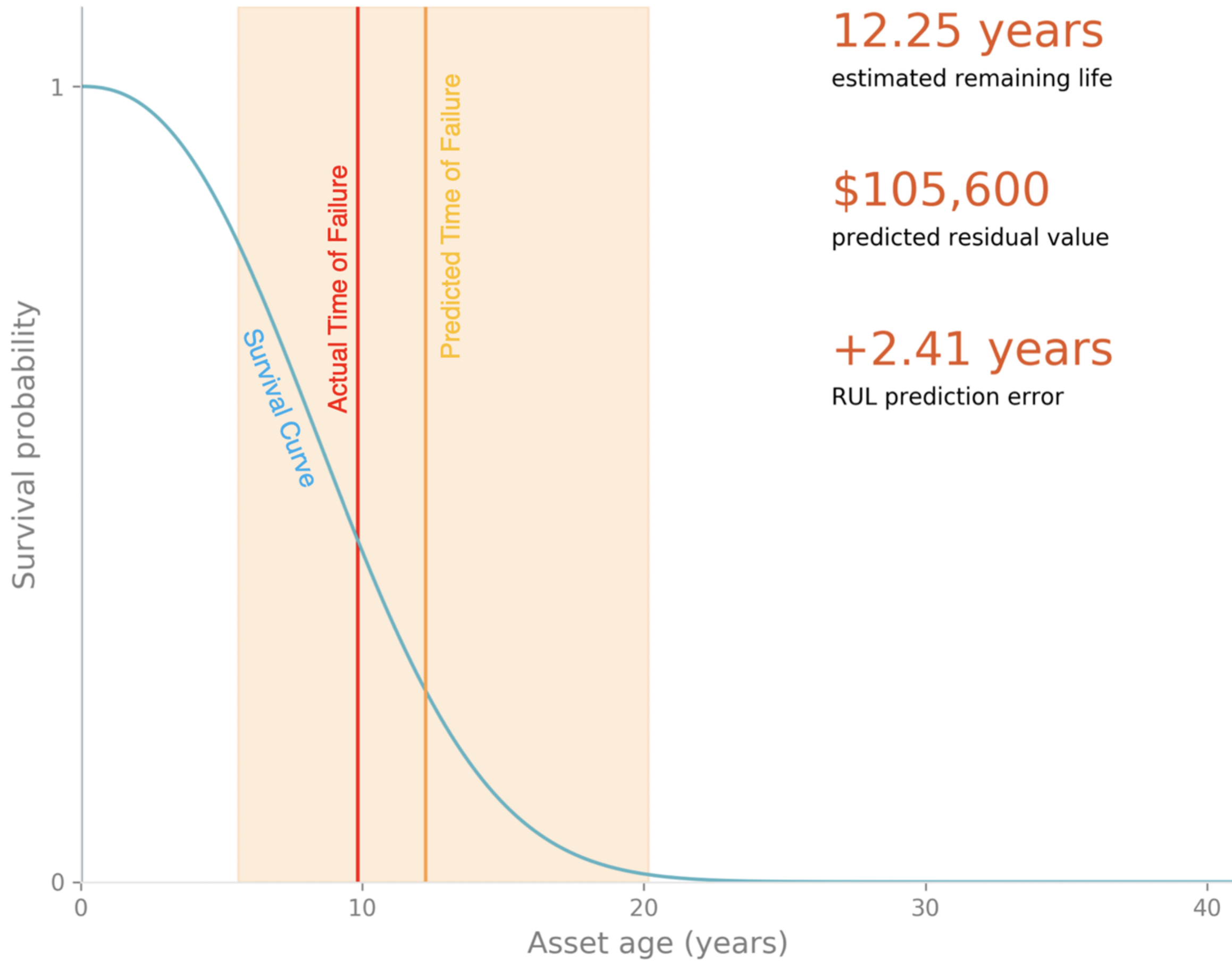


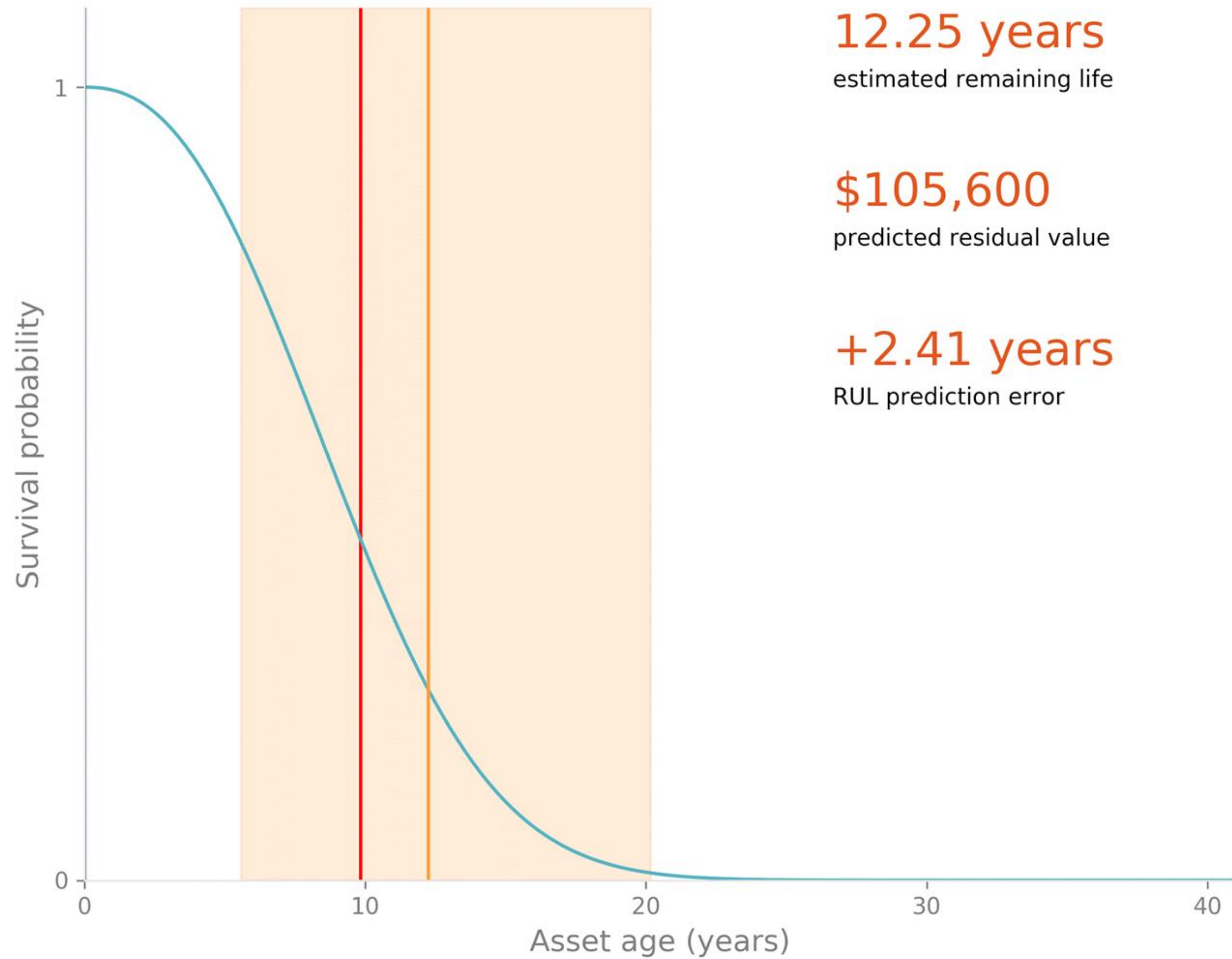


TECHNICAL OBJECTIVE

Use machine learning to predict National Grid's ratio transformer failures using diverse data (including nameplate information, feeder-level loading data, weather, etc.)



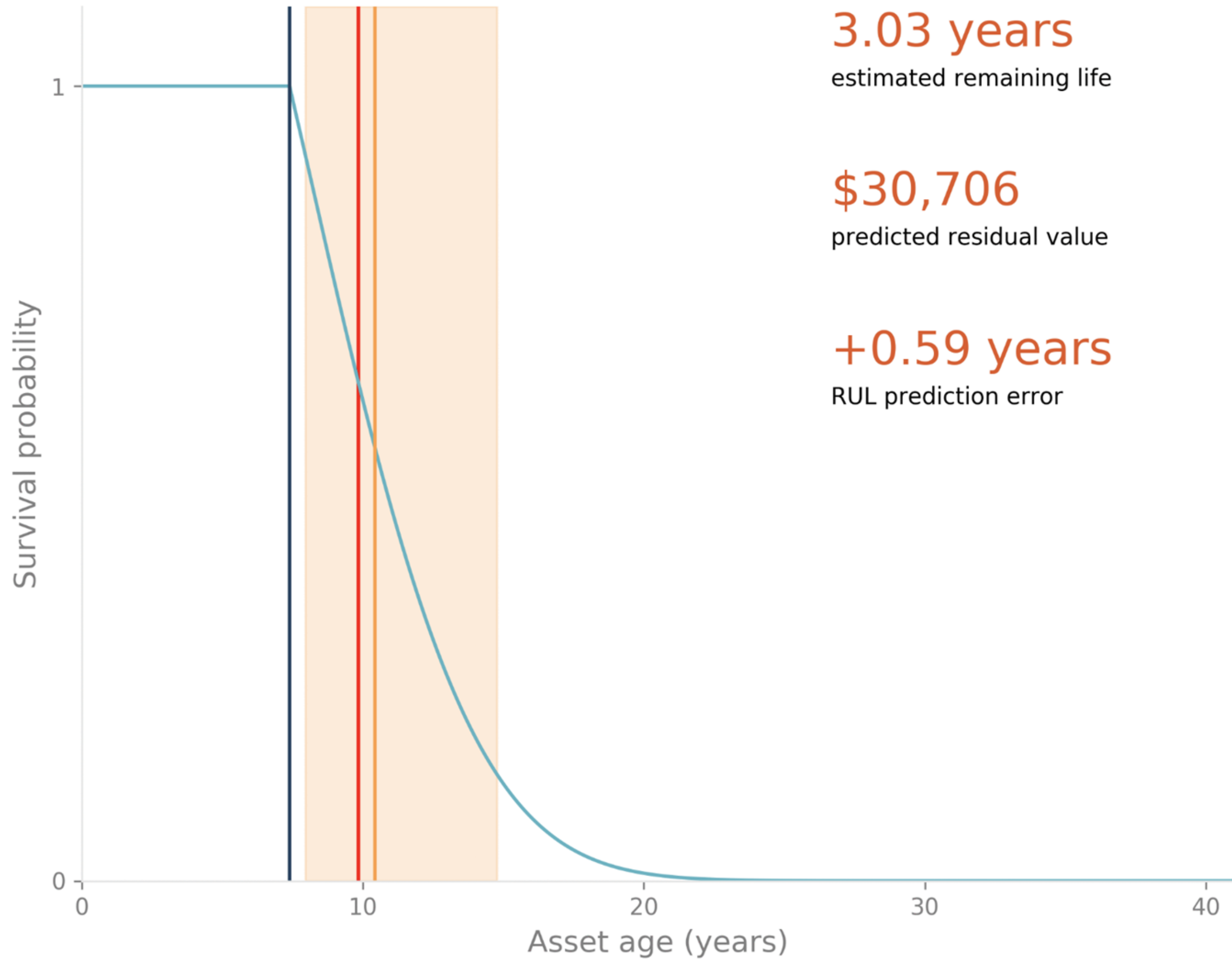




12.25 years
estimated remaining life

\$105,600
predicted residual value

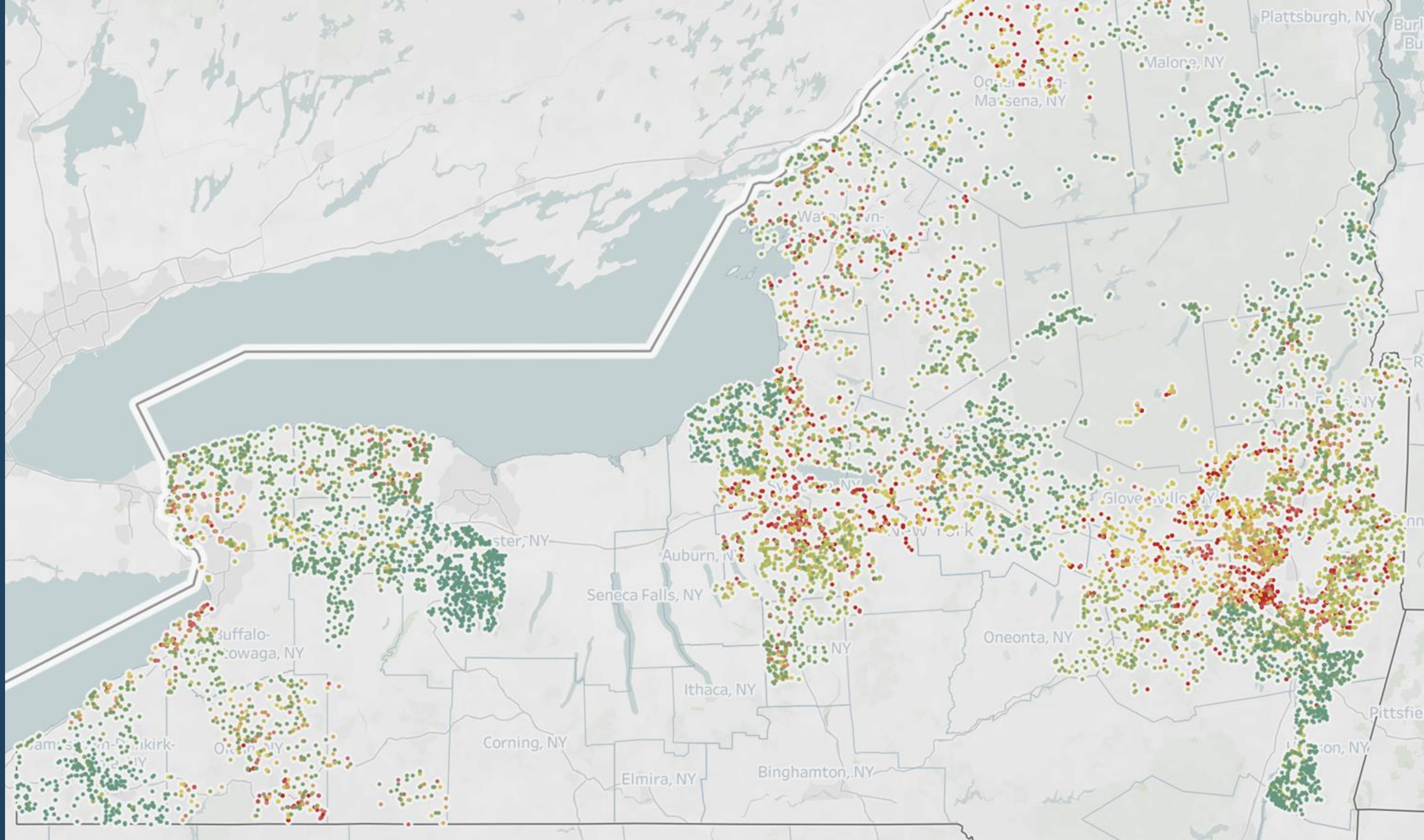
+2.41 years
RUL prediction error

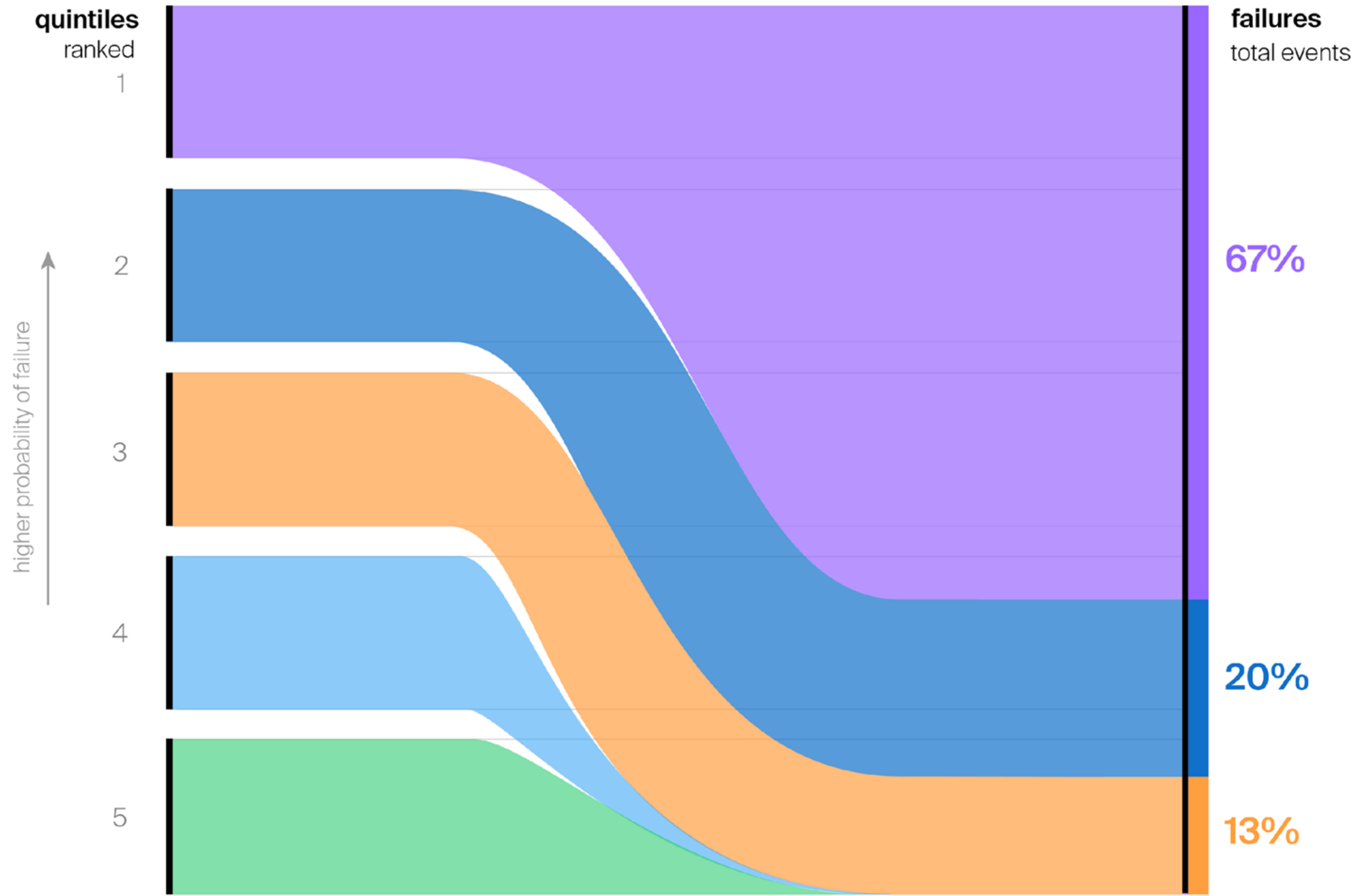


3.03 years
estimated remaining life

\$30,706
predicted residual value

+0.59 years
RUL prediction error







Install Base Summary



Install Base Summary

Total assets (OH & UG): ~17,000
Expected Annual Failure Rate: ~0.2%

Static Attributes

- 1. Manufacturer name
- 2. Installation type
- 3. Rating
- 4. ...

Time Series

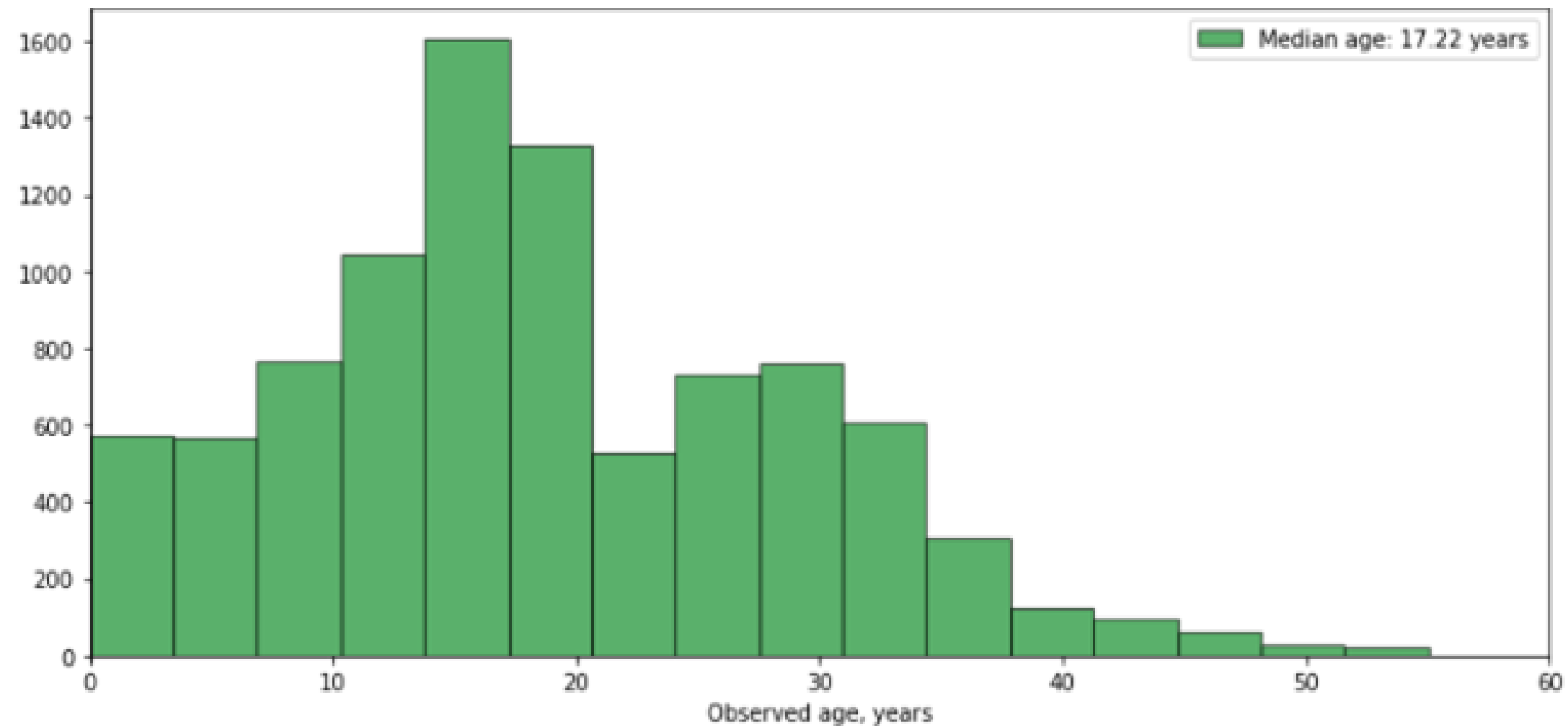
- 1. Ambient temperature
- 2. Humidity
- 3. Recloser operation
- 4. ...

Unstructured Data

- 1. Asset photos
- 2. Work requests
- 3. Visual inspection records
- 4. ...

Events

- 1. Upgrades
- 2. Retirements
- 3. Faults
- 4. ...





Validation Results



VALIDATION SPECIFICATION

As of June 15, 2021, identify the top 10% of transformers by removal probability over the next 90 days (the priority list). As of September 15, 2021, evaluate the number of observed failures that fall within the priority list.

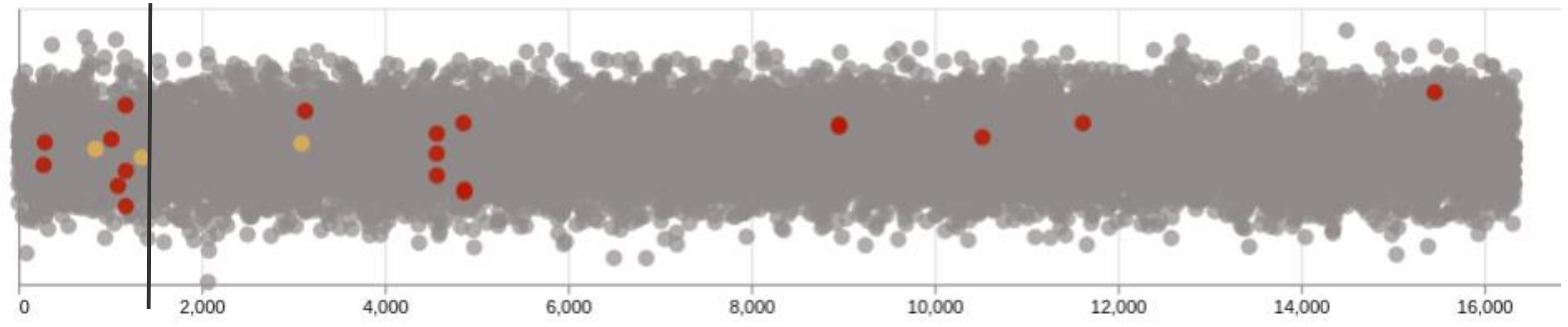




- Validation Period: June 15, 2021 through September 15, 2021
- Failure probabilities estimated for each transformer and shared amongst stakeholders prior to validation period start
- Observed failures through the validation period are catalogued and compared against the ranked list of transformers
- Objective: what percent of observed failures fall within the priority list? (the top decile)



10TH
percentile





VALIDATION RESULTS

- 0.1% of the install base experienced an in-service failure during the validation period
- 41% of these in-service failures were captured in the priority list
- 14% of the in-service failures were captured in the priority list generated by benchmark heuristic
- Failures captured in the priority list correspond to 77% of customers interrupted and 55% of customer minutes interrupted due ratio transformer failures

Q&A



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Static features

- Manufacturer name
- Installation type
- Number of phases
- Winding configuration
- Load side voltage
- Source voltage
- Size
- Rewound
- Manufacture date
- Install date
- Number of customers

Time series features

(weather)

- Weather summary
- Precipitation intensity
- Precipitation probability
- Temperature
- Humidity
- Cloud cover
- UV index
- Visibility
- Wind gust