



vCampus **Live! 2011**

Machine Learning for Prediction Purposes on PI System Data

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WHERE PI GEEKS MEET



Machine Learning



The Smart Sneezing Colleague



“We are drowning in information and starving for knowledge”

Extracting important patterns and trends

Understanding what the data says

Applications span many industries

Relationship with PI System



PI System as the system of reference for enterprise data

- Collecting and serving historical data efficiently on demand
- **Data = Value!** This method heavily relies on *historical data*
- All data in one place

Handling large amounts of valuable data

- Better statistical results
- Improved discovery of correlations



Prediction

- Load forecasting
- Production forecasting
- Preemptive maintenance
- Enterprise Resource Planning

Patterns and Trends

- Discovering patterns of interest
- Classification and clustering

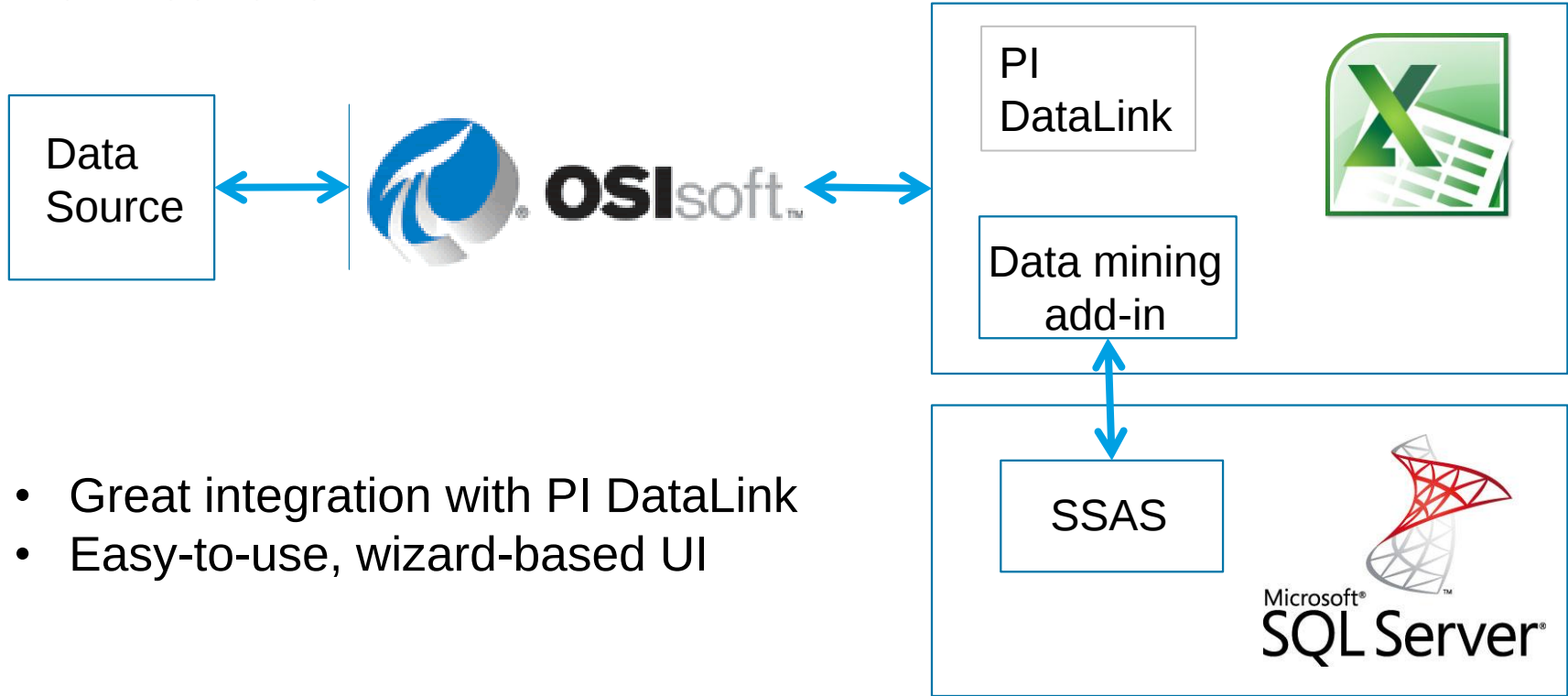


Available Tools



Microsoft SQL Server Analysis Services

MS Excel Client



- Great integration with PI DataLink
- Easy-to-use, wizard-based UI



$$\text{tag3} = \text{SIN}(2 * \text{tag1} + \text{tag2}) + \text{Noise}$$

Build the model and learn
10,000 observations

	A	B	C
1	tag1	tag2	tag3
2	0.010969	4.475	0.44734
3	0.87126	7.5911	-0.33864
4	1.6099	5.773	0.55604
5	6.9728	3.6668	0.98572
6	0.41531	1.6093	-0.47274
7	1.1255	8.0387	-0.99713
8	1.405	9.2744	0.89313
9	2.3256	4.3005	-0.99762

Make predictions

tag1	tag2	tag3	Actual Value
1.2	4.1	0.024955583	0.0248
3	7.5	-0.791421192	-0.751
4.2	1.2	0.306884366	0.3115
9.3	2.6	0.912550902	0.9349

MATLAB

Several ways to integrate with PI System

- PI SDK, PI OPC, PI ACE, ADO DB

Powerful machine learning

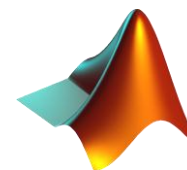
- Statistics and Neural Network Toolboxes

Can be combined with other advanced analytics

External
Data Source



MATLAB



Load Prediction



Using PI System and MATLAB in a Real World Scenario

Predict *power demand* at OSIsoft headquarters

MATLAB Statistics Toolbox

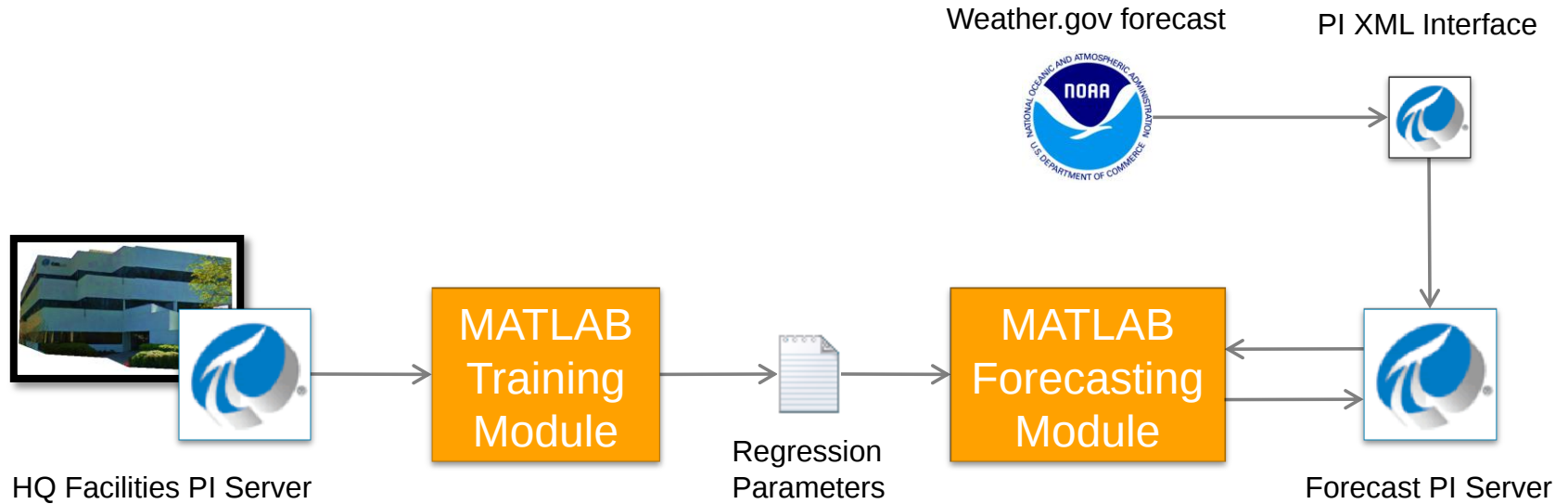
- Regression (Decision) Tree

Investigate multiple predictors

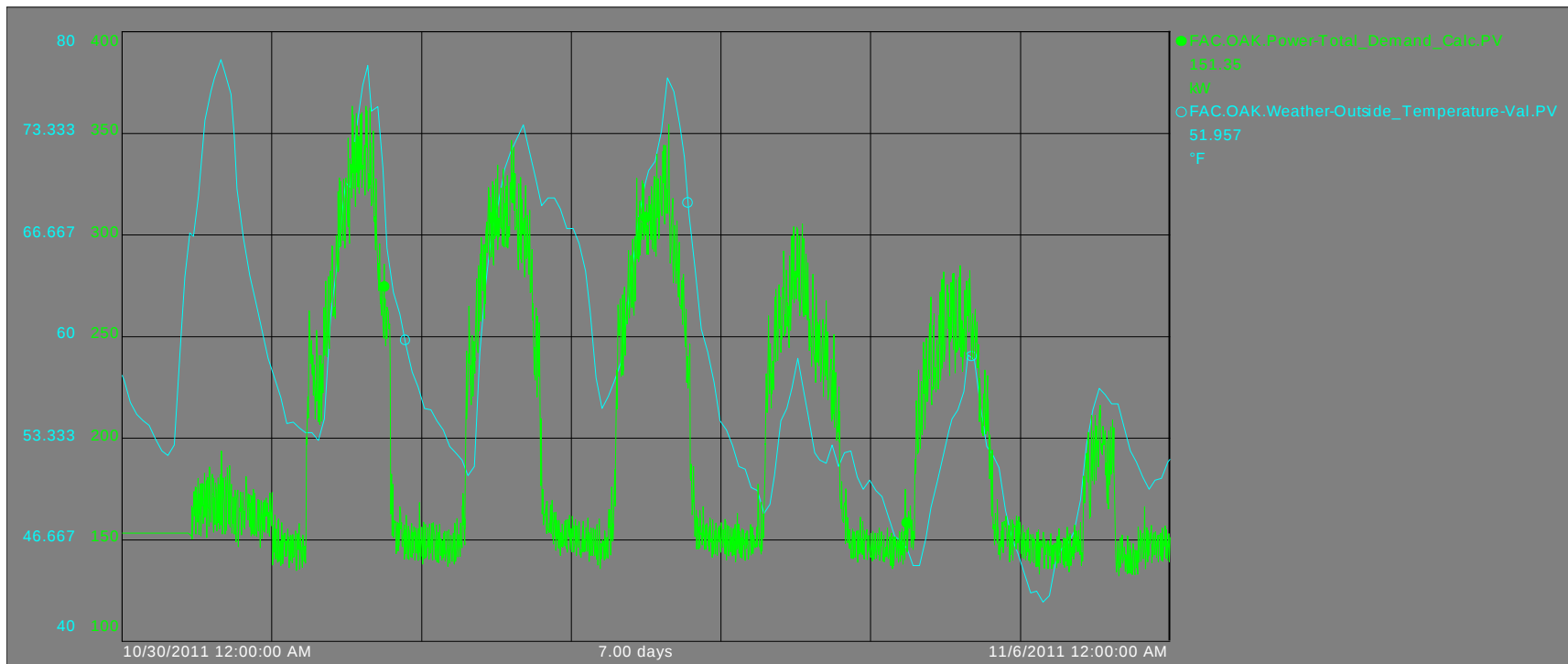
- Outdoor temperature
- Day of the week
- Hour of the day



Architecture

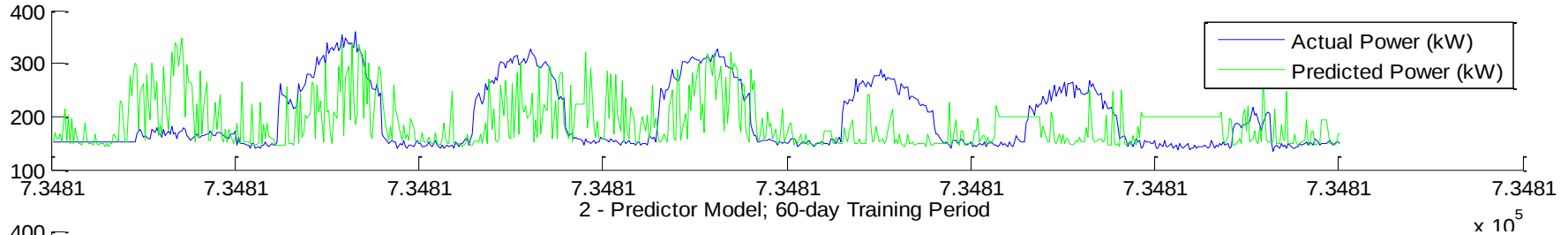


Facilities Historical Data

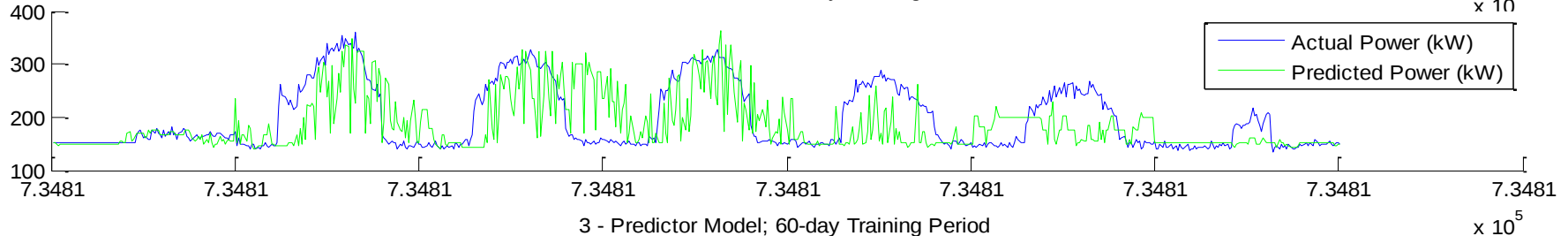


Choosing Predictors

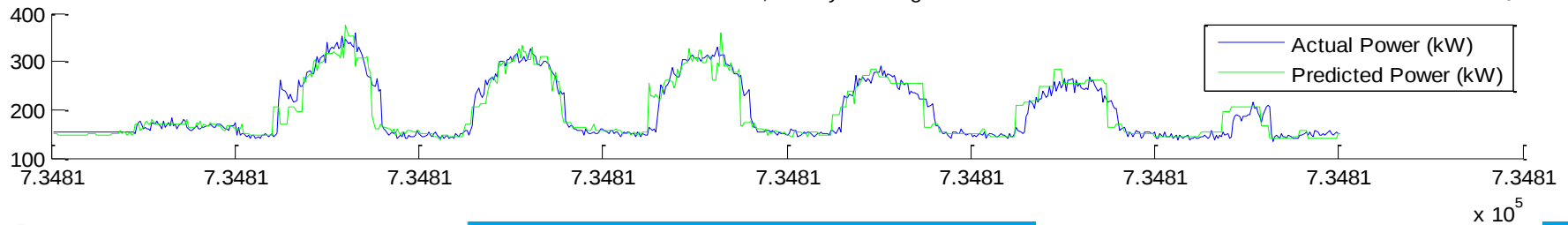
1 - Predictor Model; 60-day Training Period



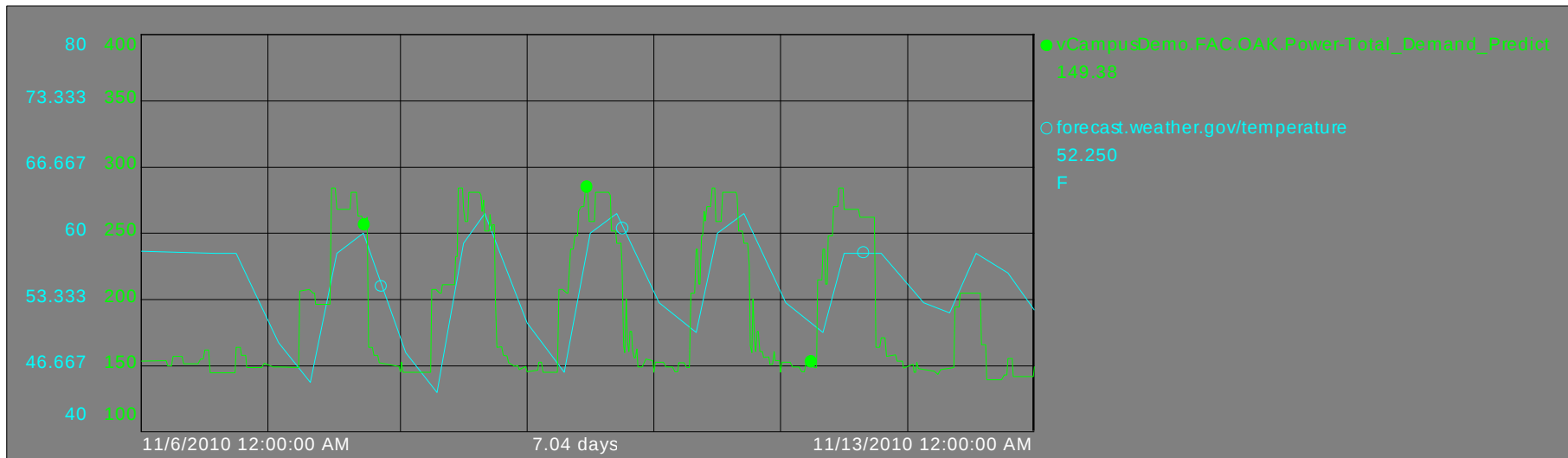
2 - Predictor Model; 60-day Training Period



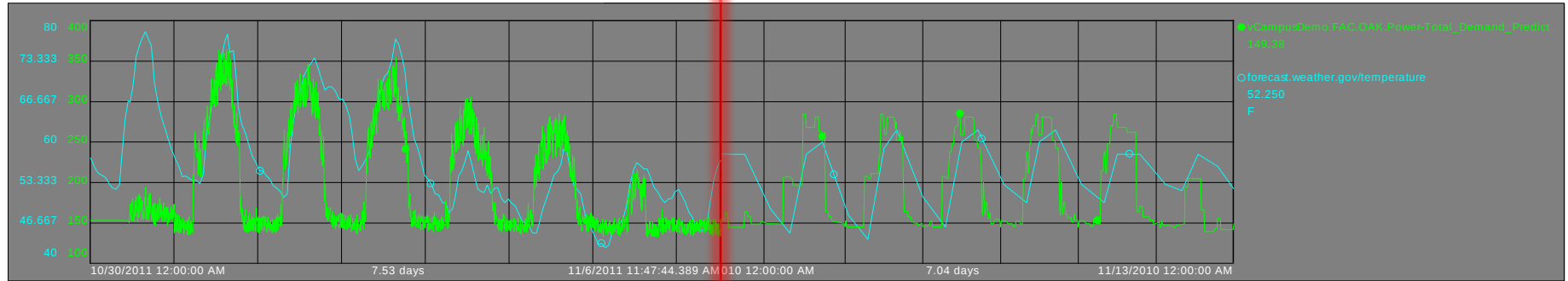
3 - Predictor Model; 60-day Training Period



Forecasts



Observations and Forecasts



Observations

Forecasts

So What?

Resource Planning

- Combine with knowledge of commercial electric rates and internal schedule

Preventative Maintenance

- Alarm on trends off the norm

Conclusion



Introducing **Machine Learning**

Explaining how it can save **money** and **resources**

Showing how it can be done on **PI System Data**

Demonstrating a real-world example of how it can **predict** load and **detect faults**



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Thank you

