

# Managing Factory Operations with the Internet of Things

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# Class Summary

Our smartphones are filled with apps that track numerous things like our heart rate, running speed, and sleep patterns, but what can this new world of internet-connected devices do for our work lives in industry? Growth of a new class of products called “connected devices” or the “Internet of Things (IoT)” will usher in a new era of smarter, more cost-effective factories. These devices will make production data visible and useful, and will do much to help factory managers make more strategic decisions. This class will cover emerging trends in the Internet of Things and introduce a new, easy-to-implement app for managing factory operations. The cloud-based application uses data collected from wireless, non-intrusive sensors, and displays it in the context of a digital model in order to deliver actionable insights for energy and production management.

# Learning Objectives

At the end of this class, you will be able to:

- Determine how the Internet of Things can help factory owners reduce energy consumption and costs
- Learn how to access performance analytics for the production floor
- Discover energy-intensive processes and idling equipment
- Discover how high-frequency sensor information can help reduce maintenance costs

# Agenda

- Trends in the Internet of Things (IoT)
- Project Aquila
  - Energy Management
  - Asset Management
  - Thermal Comfort
  - Production Efficiency
- Closing remarks

# Safe Harbor Statement

We may make statements regarding planned or future development efforts for our existing or new products and services. **These statements are not intended to be a promise or guarantee** of future availability of products, services or features but merely reflect our current plans and based on factors currently known to us. These planned and future development efforts **may change without notice**. Purchasing decisions should not be made based upon reliance on these statements.

These statements are being made as of December 1, 2015 and we **assume no obligation to update these forward-looking statements** to reflect events that occur or circumstances that exist or change after the date on which they were made. If this presentation is reviewed after this date, these statements may no longer contain current or accurate information.



An aerial view of a city skyline with a bridge over a river and a park area. The bridge has a rainbow-colored line running along its length. The city skyline features several tall buildings. The park area has green grass, trees, and a blue pond. The river is blue and flows through the city.

# Trends in the Internet of Things

# Are you prepared for the Fourth Industrial Revolution?

Figure 1:  
The four stages of  
the Industrial Revolution

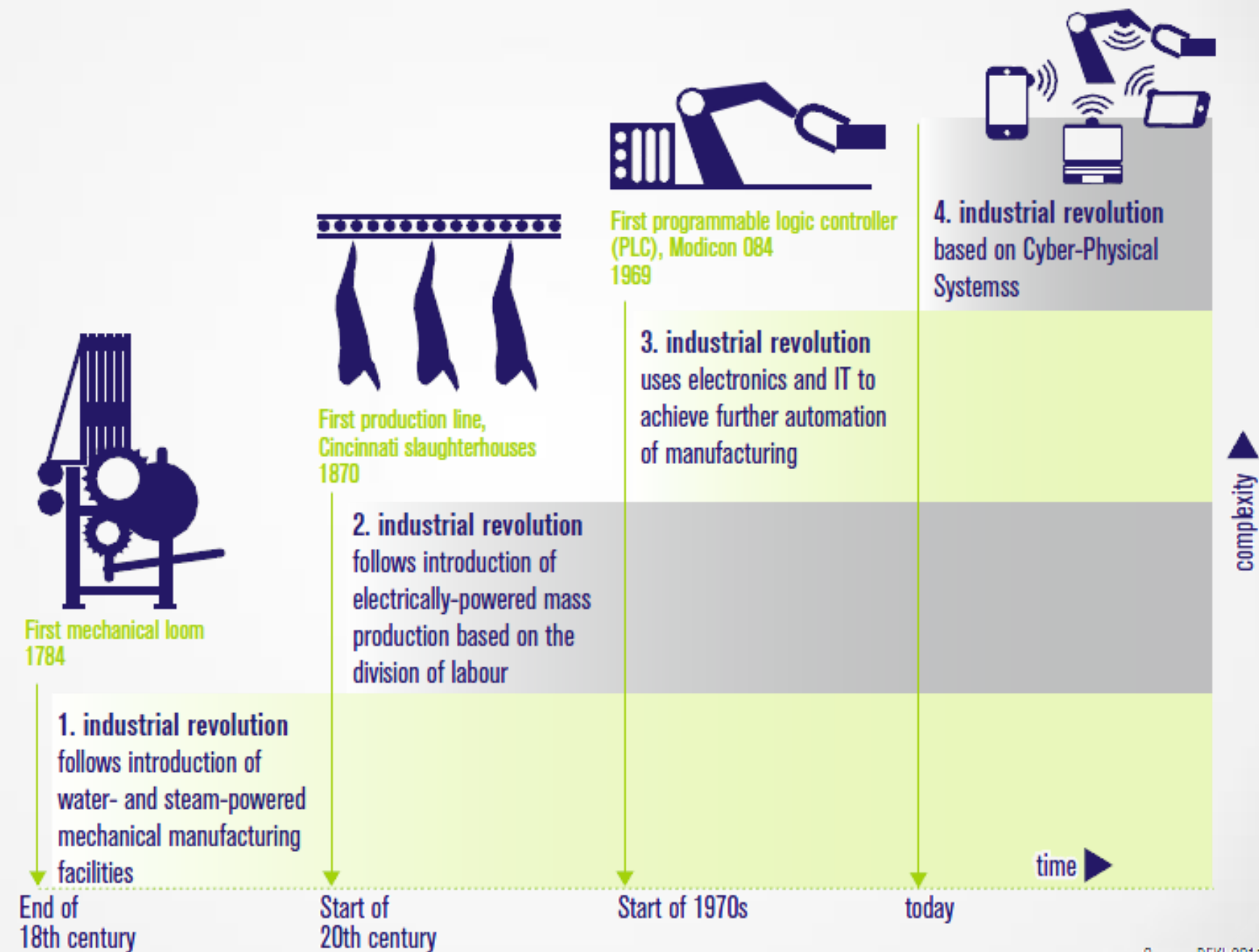


Image Source: DFKI 2011



Small Shop: 2~10 TB/year  
Medium Shop: 5~25 TB/year  
Large Shop: 16~80 TB/year  
Enterprise: 80~5000 TB/year

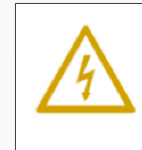
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US Machining Sector: 200 PB~1XB/year

Data Source: A. Vijayaraghavan (2015) "The Internet of Manufacturing Things"

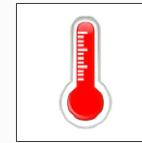


# Big Data Example: CNC Machine Tool

Big Data  
&  
Analytics



Electricity consumption



Machining temperature



Vibration of the spindle



Oil consumption



Spindle speed and feed rates





Sensors

Big Data  
&  
Analytics

Software





# Who will benefit from Project Aquila?

## Business Planning & Logistics



Plant Manager



Sustainability Manager



Industrial Engineer



Project Manager

## Operations



Facilities Manager



Manufacturing Engineer



Layout Engineer

## Assets, MFG, & Controls



Maintenance Engineer



Facilities Engineer



# How will you benefit?

- Manage energy footprints through access to real-time, circuit-level data and alerts
- See this information in context by mapping them in 2D floorplans, photographs and 3D models
- Analyze potential energy savings and missed savings opportunities
- Conduct financial analysis on desired energy conservation measures

# Panoramic Power Sensors provide the heart beat

- Tiny
- Wireless
- Self-Powered
- Non-Invasive
- Maintenance Free
- Cost Effective



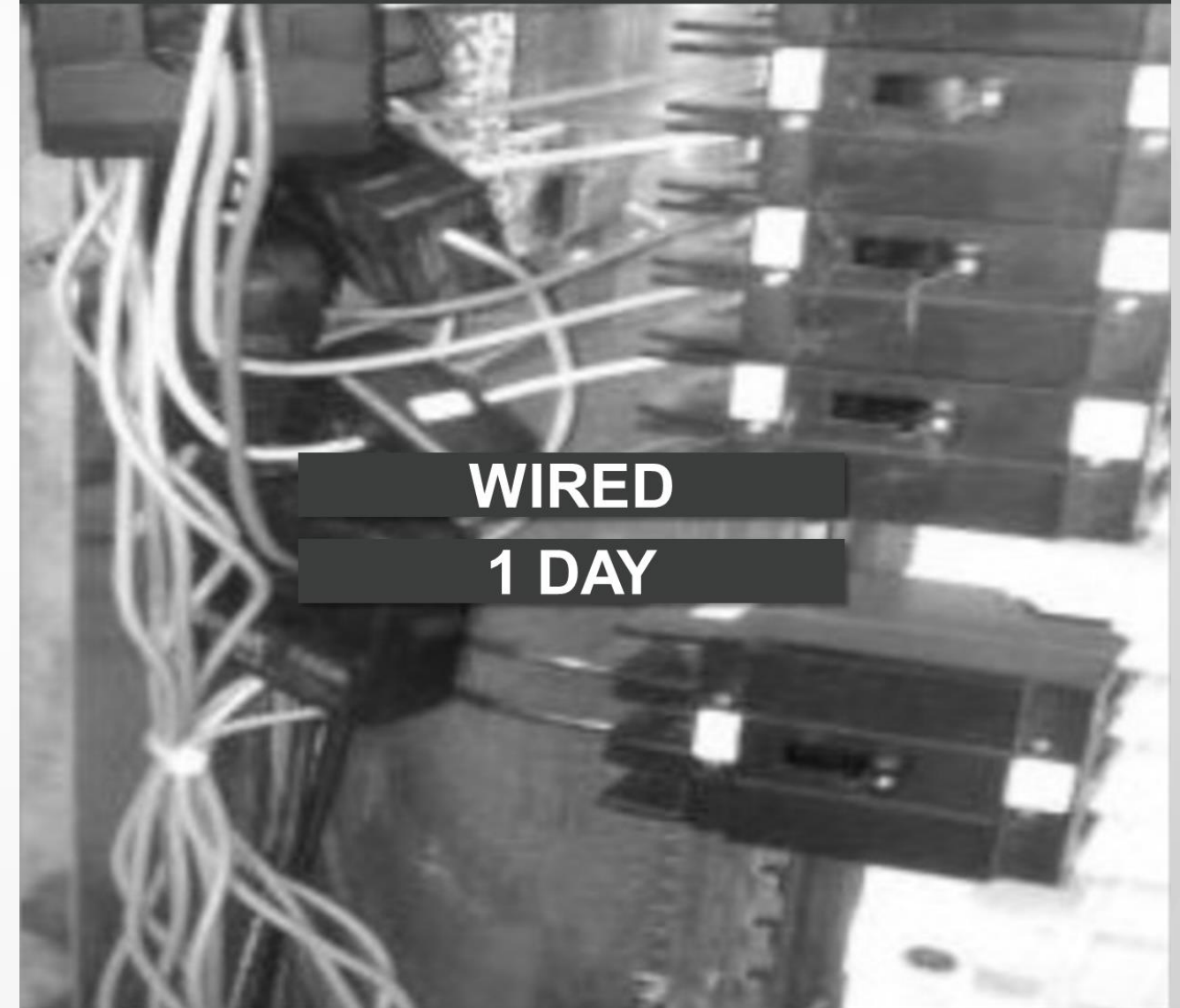


# Easy to deploy in a couple of hours

## Panoramic Power



## Competition





# Four Steps to Improved Facility Operations

## 1 Snap



- Easy install
- Wireless
- No disruption
- No maintenance
- Unlimited scale

## 2 Connect



- Plug & Play
- Cellular or WiFi

## 3 Set Up

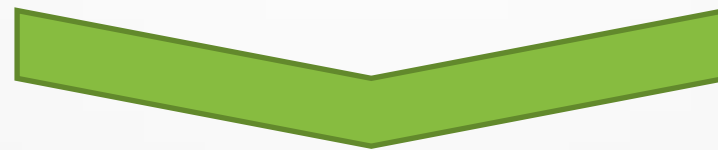


- Role definition
- Executive reports and alerts
- Set goals
- Measure benchmarks

## 4 Start Saving



- Scheduled reports
- Real time alerts
- Online analytics
- Manage chain-wide



**Actionable Insights for Energy and Operational Savings**

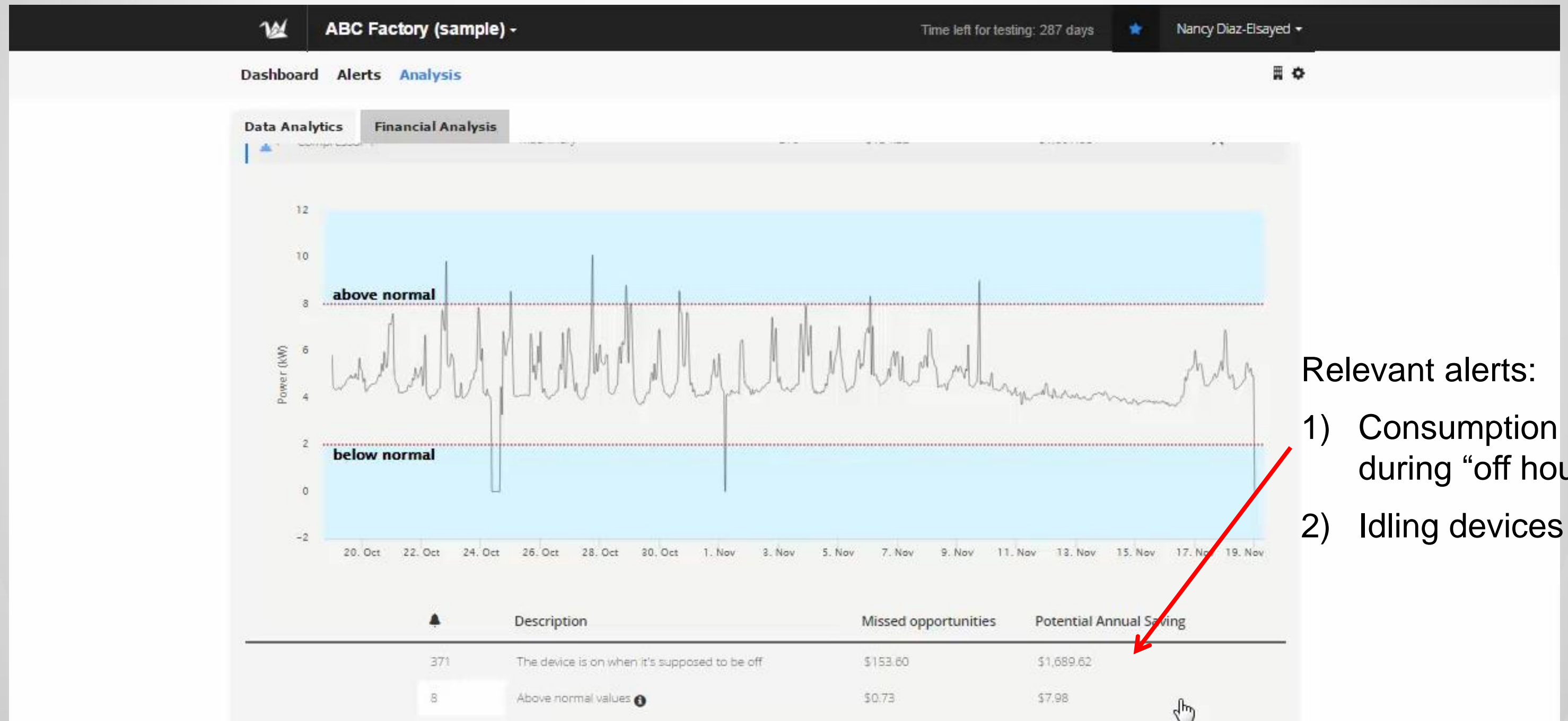


An aerial photograph of a city skyline, likely Chicago, with a large rainbow-colored energy footprint overlay. The footprint starts from a bridge over a river in the foreground and extends into the city center, highlighting the energy consumption of buildings and infrastructure. The text "Reduce your Energy Footprint" is overlaid in a large, blue, sans-serif font.

# Reduce your Energy Footprint



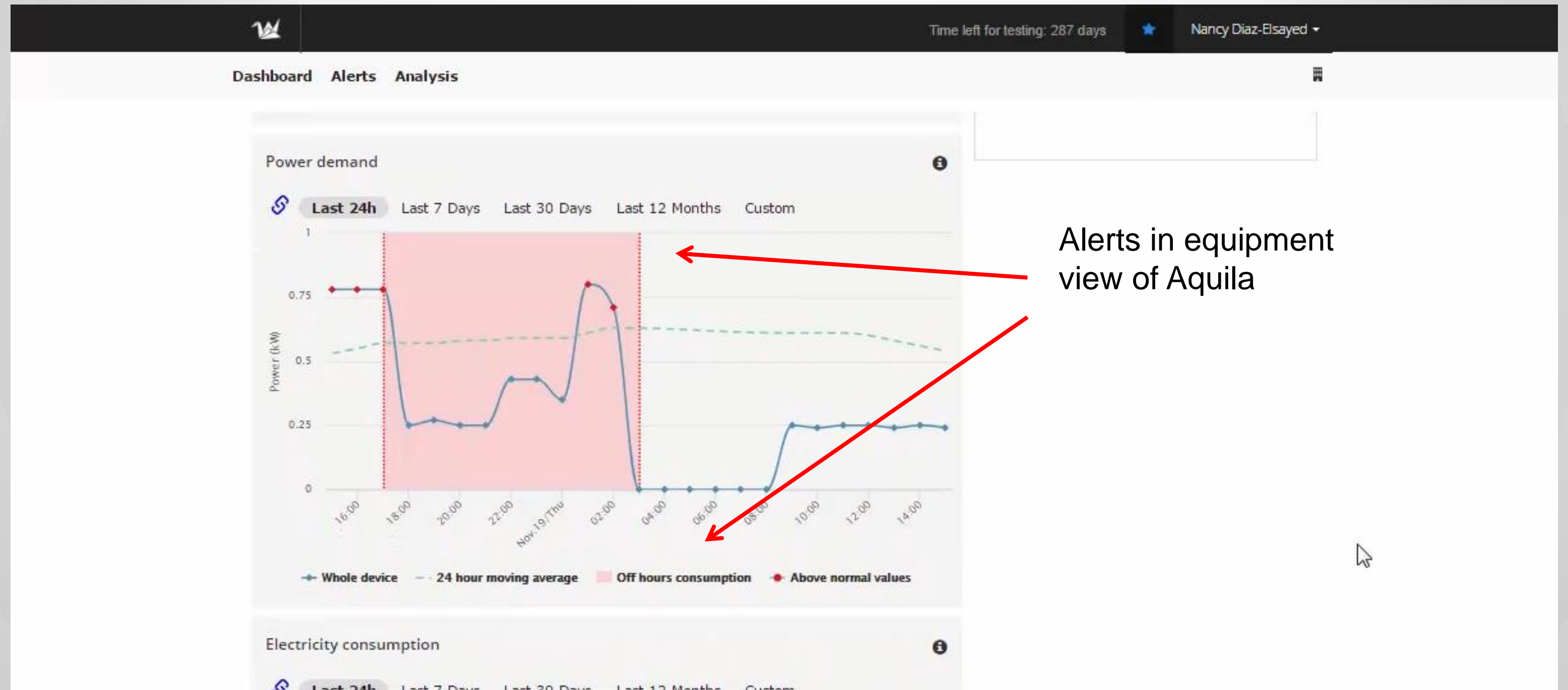
# Know what drives high energy consumption?



- Relevant alerts:
- 1) Consumption during "off hours"
  - 2) Idling devices



# Know what drives high energy consumption?



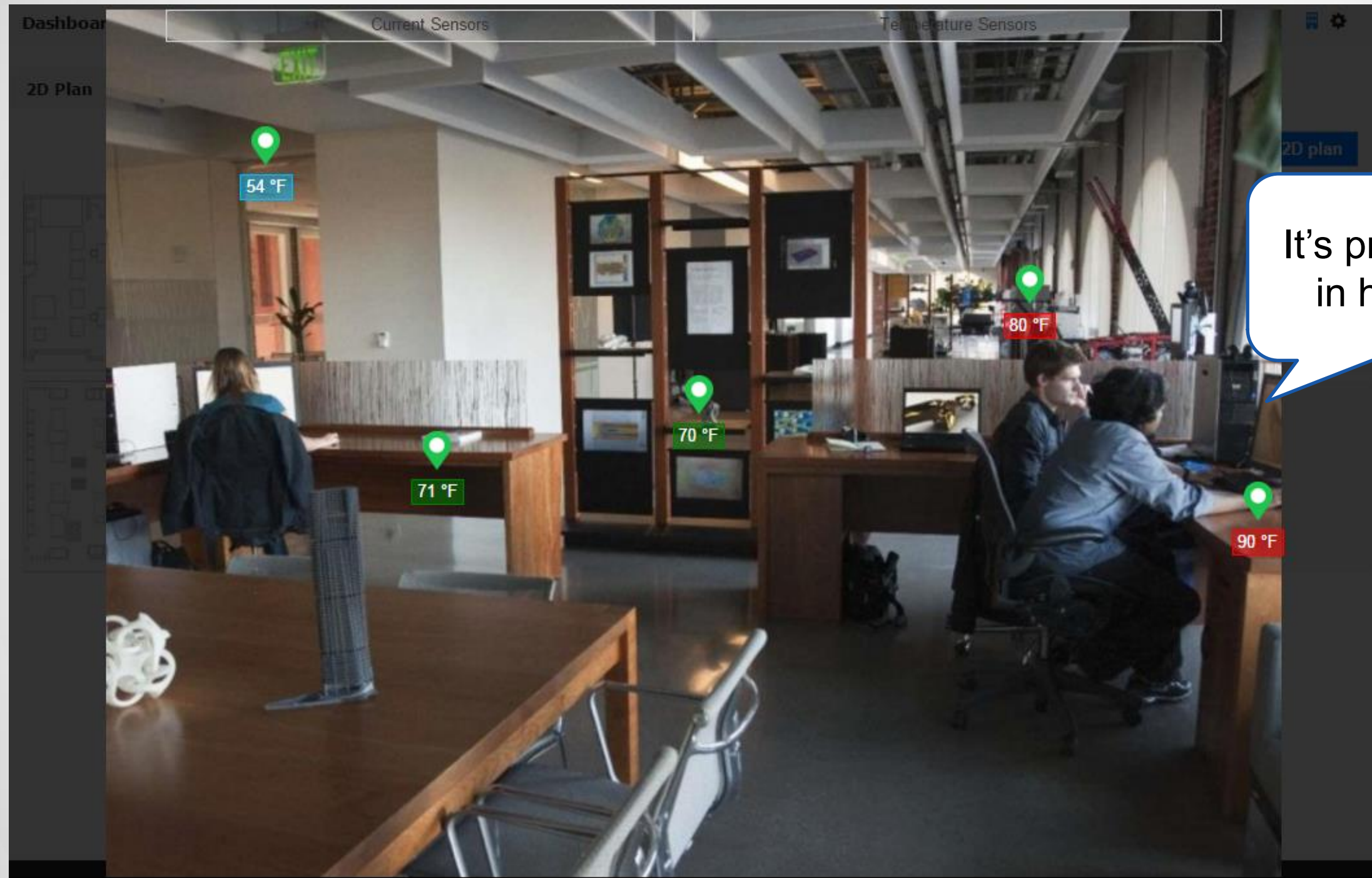


An aerial rendering of a city skyline, likely Chicago, featuring a large stadium and several skyscrapers. In the foreground, a multi-lane bridge spans a body of water, with a rainbow-colored line tracing its path. To the right of the bridge is a park area with green grass, trees, and a blue oval feature. A red car is visible on the bridge.

# Improve Occupant Comfort



# Review Occupant Comfort



It's pretty hot in here...



# Take Action to Improve Thermal Comfort

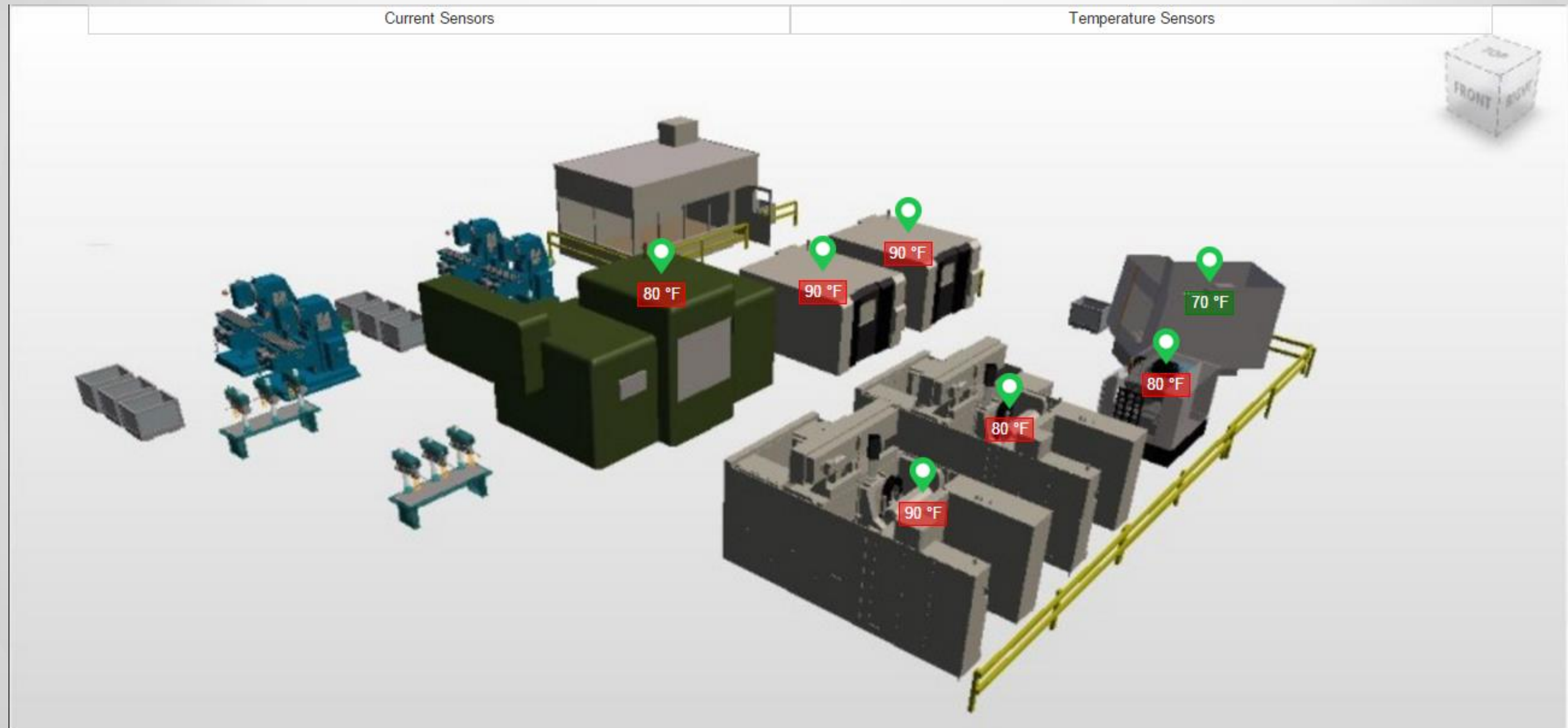
## *Create and manage a ticket*

[illegible]

# Manage the Temperature on Your Production Floor



Facilities  
Manager



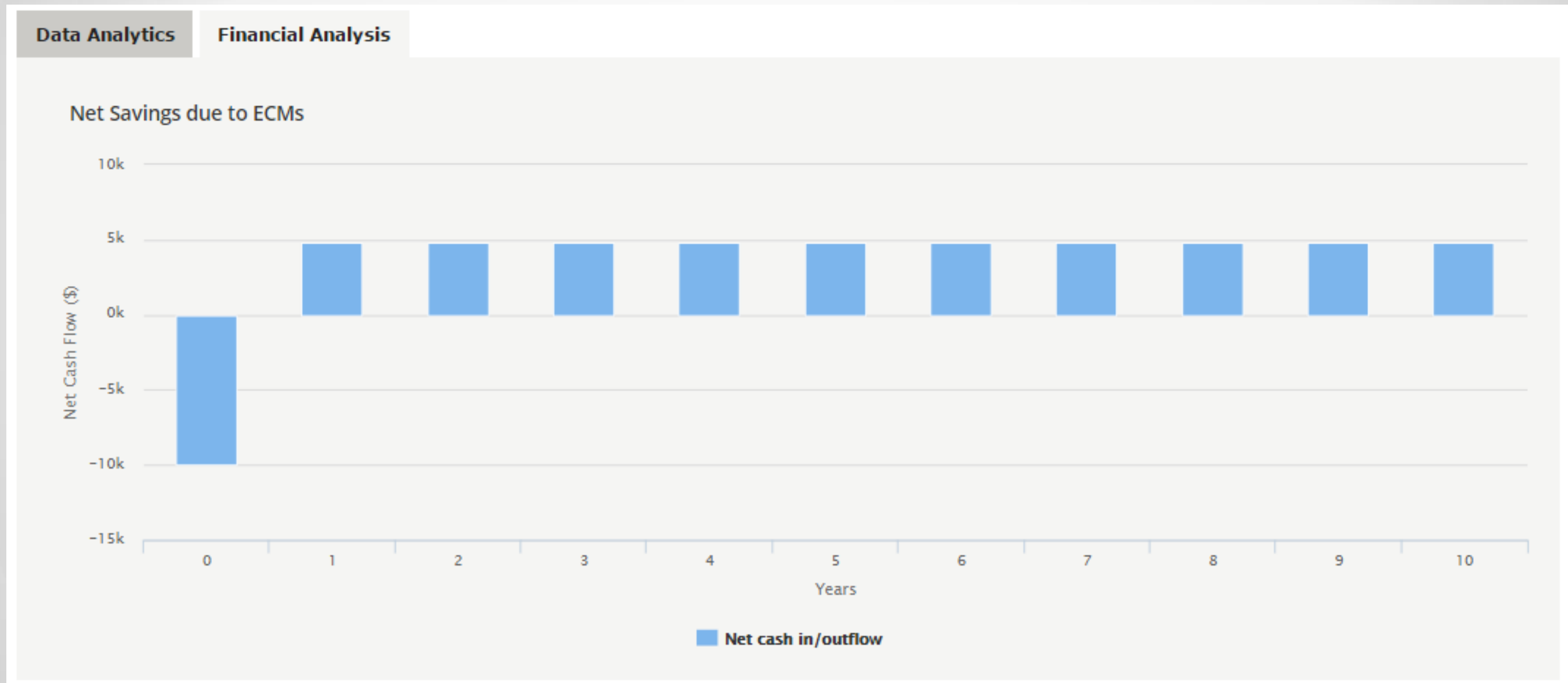


An aerial rendering of a city skyline featuring a bridge over a river, a sports field, and various buildings. A semi-transparent white box is overlaid on the center of the image, containing the main text.

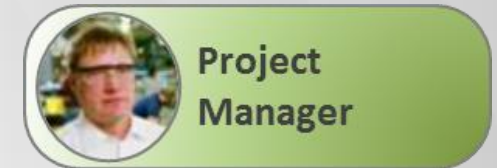
# Conduct Financial Analysis on desired energy conservation measures



# Understand the effect on your cash flow



# Evaluate Financial Metrics And compare Multiple Scenarios



Inputs		Financial Metrics		
Incremental Capital Investment (\$):	<input type="text" value="10,000"/>		Average	Per sq ft
Desired energy savings (%):	<input type="text" value="96.47"/>	Upfront Costs:	\$10,000.00	\$0.13/sq ft
		Annual Energy Cost Saved:	\$4,823.69	
		Discounted Payback (years):	3	
		Net Present Value over investment:	\$19,639.49	\$0.26/sq ft
		IRR over investment horizon:	47.23 %	
Basic Assumptions >				
Advanced Assumptions >				
			Refresh data	Save current scenario



An aerial perspective of a cityscape. In the foreground, a multi-lane bridge with a rainbow-colored light strip along its edge spans a wide river. A red sports car is driving on the bridge. To the right of the bridge, there's a green park area with a blue oval field and some trees. In the background, a large stadium with a circular roof is visible, surrounded by various city buildings and skyscrapers under a clear blue sky.

# Managing Your Assets



# Process Sequence and Fault Detection

Pump at constant operation  
regardless of chiller operations



Chiller #2  
stopped working



# Configure Rules for Equipment Maintenance



Facilities  
Manager



Facilities  
Engineer



Maintenance  
Engineer

←

→

↺

🏠

🔒


https://app.panpwrws.com/static\_new/rules.htm?v=013703






🔍


☆

🔴

☰







Pier 9 Building

Alert Center

Rules

Autodesk ▾

New Rule

General Properties

Rule Name:

☐ Active

Trigger Type:

Device has been on for too long

Consumption

Device has been on for too long

High daily energy consumption

High power consumption

Low daily power consumption

Low power consumption

Off hours consumption

Operational

Circuit overload

Device Idling

Device not cycling (beta)

Device short cycling (beta)

Device stopped working

Low power factor

Severity:

Email Subject:

Description:

☐ Only use rule description text in email message


🕒

Save

Close

Get notified...






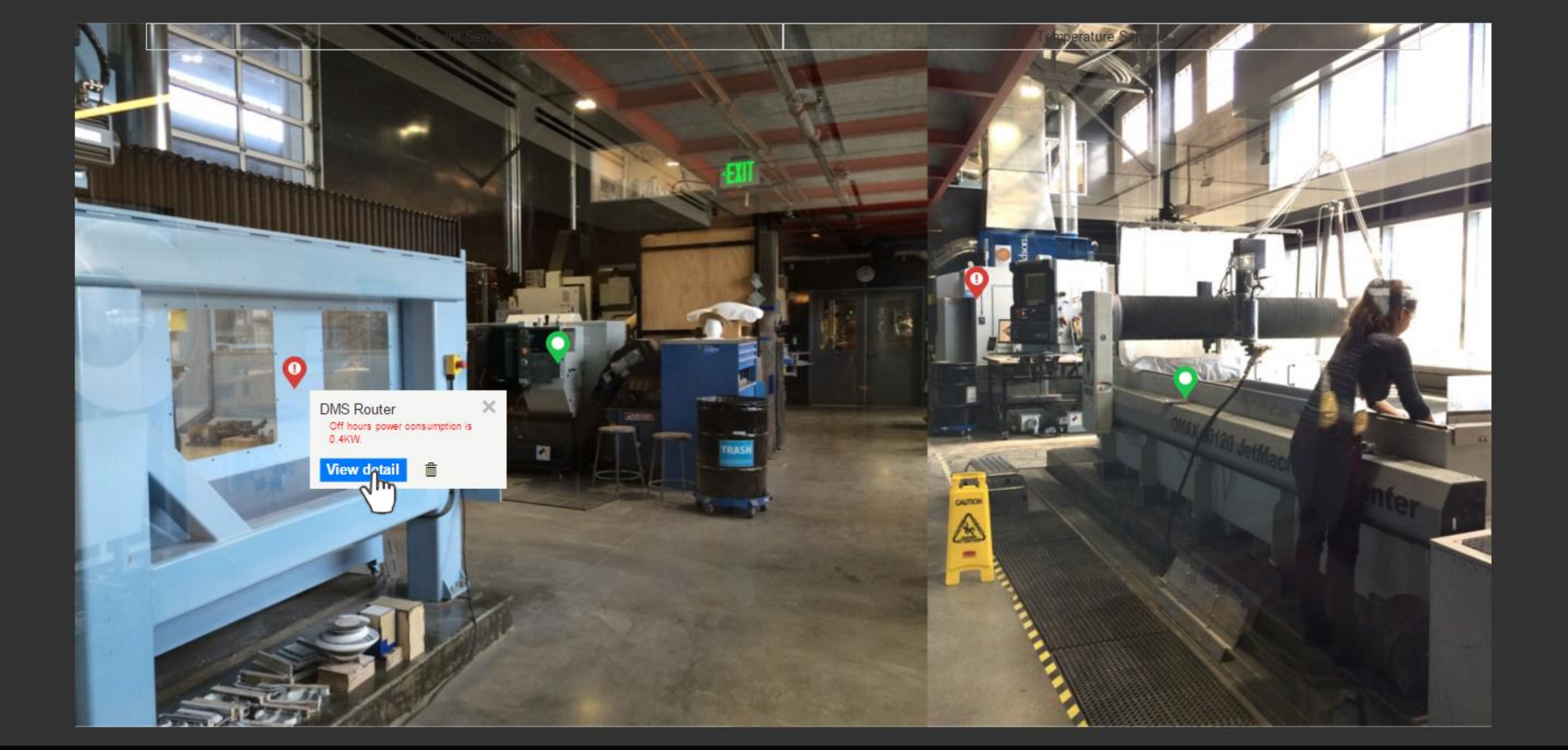
➡

Project Aquila



 BUILDING OPS

# Visualize Alerts in the Context of the Factory





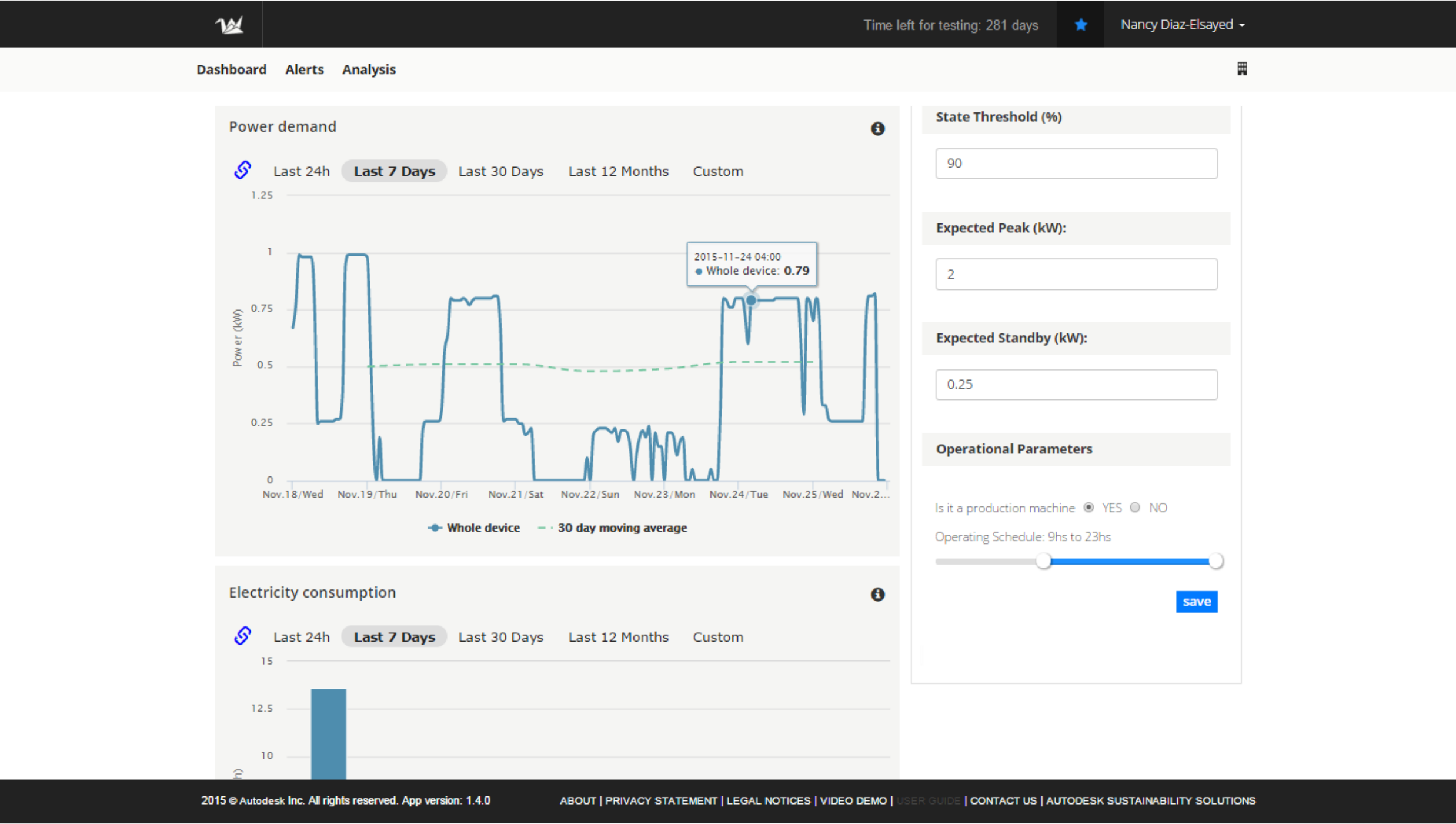
# Access Historical Data on the Production Floor



Facilities Engineer



Maintenance Engineer

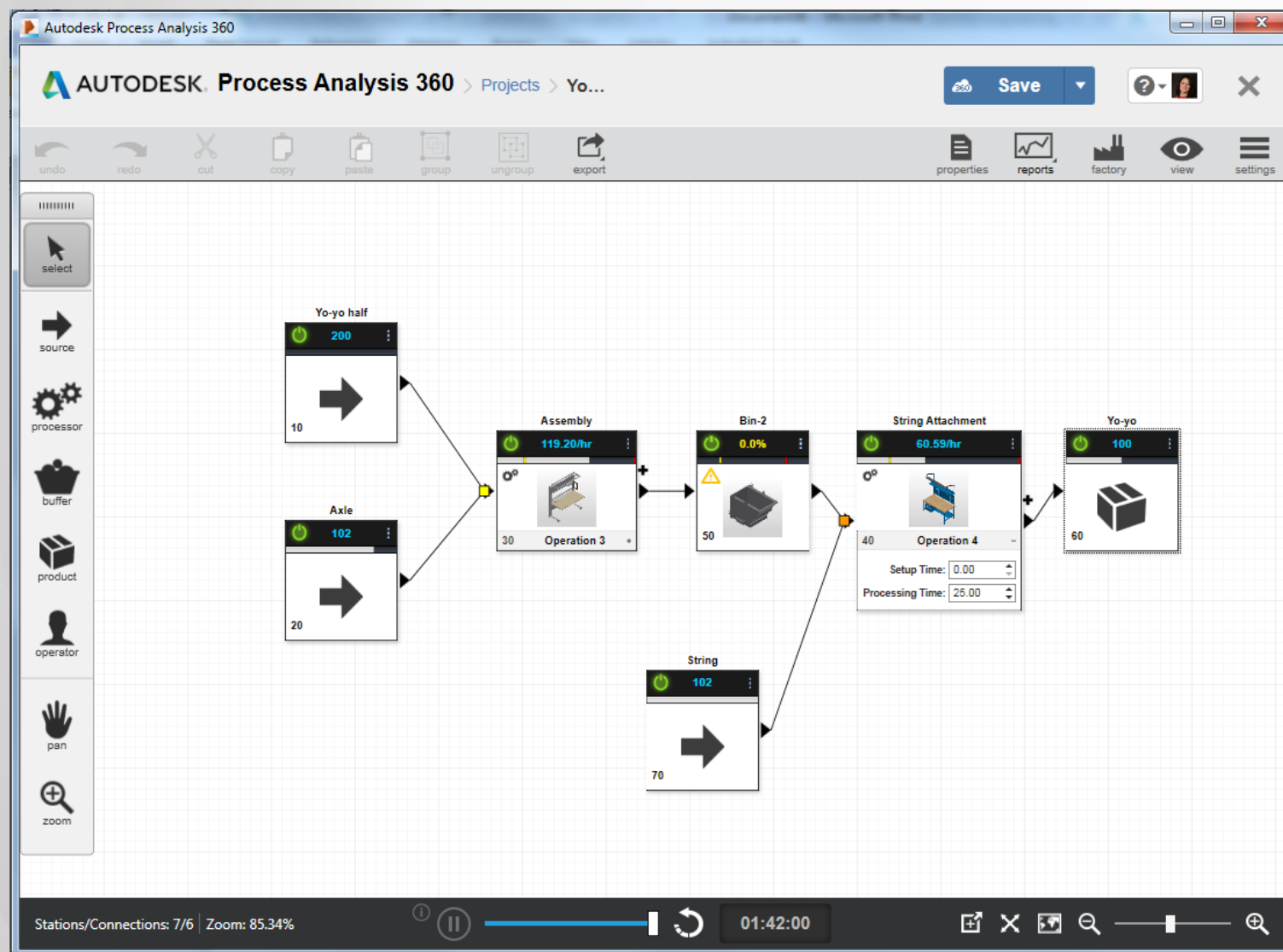
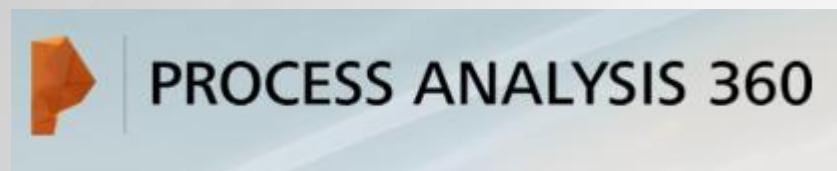


An aerial view of a city landscape. In the foreground, a multi-lane bridge with a rainbow-colored line along its edge spans a river. A red car is visible on the bridge. To the right of the bridge is a green park area with a blue oval field and some trees. In the background, a large stadium with a circular roof is visible, surrounded by various city buildings and a dense skyline of skyscrapers under a clear blue sky.

# Insight into Asset Utilization



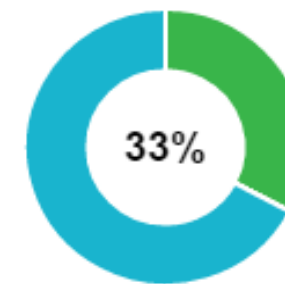
# How is Asset Utilization Typically Modeled?



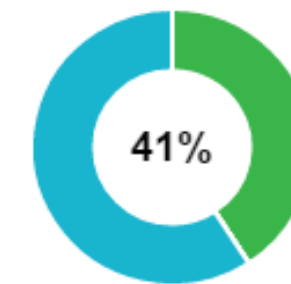
## Processor Utilization Charts

Utilization of processors relative to one another:

### Assembly



### String Attachment



#### KEY

Producing (Green) Idle (Blue) Setup Time (Grey) Blocked (Yellow) Downtime (Red)

## Detailed Report

### Source (Yo-yo half) - Op Sequence 10

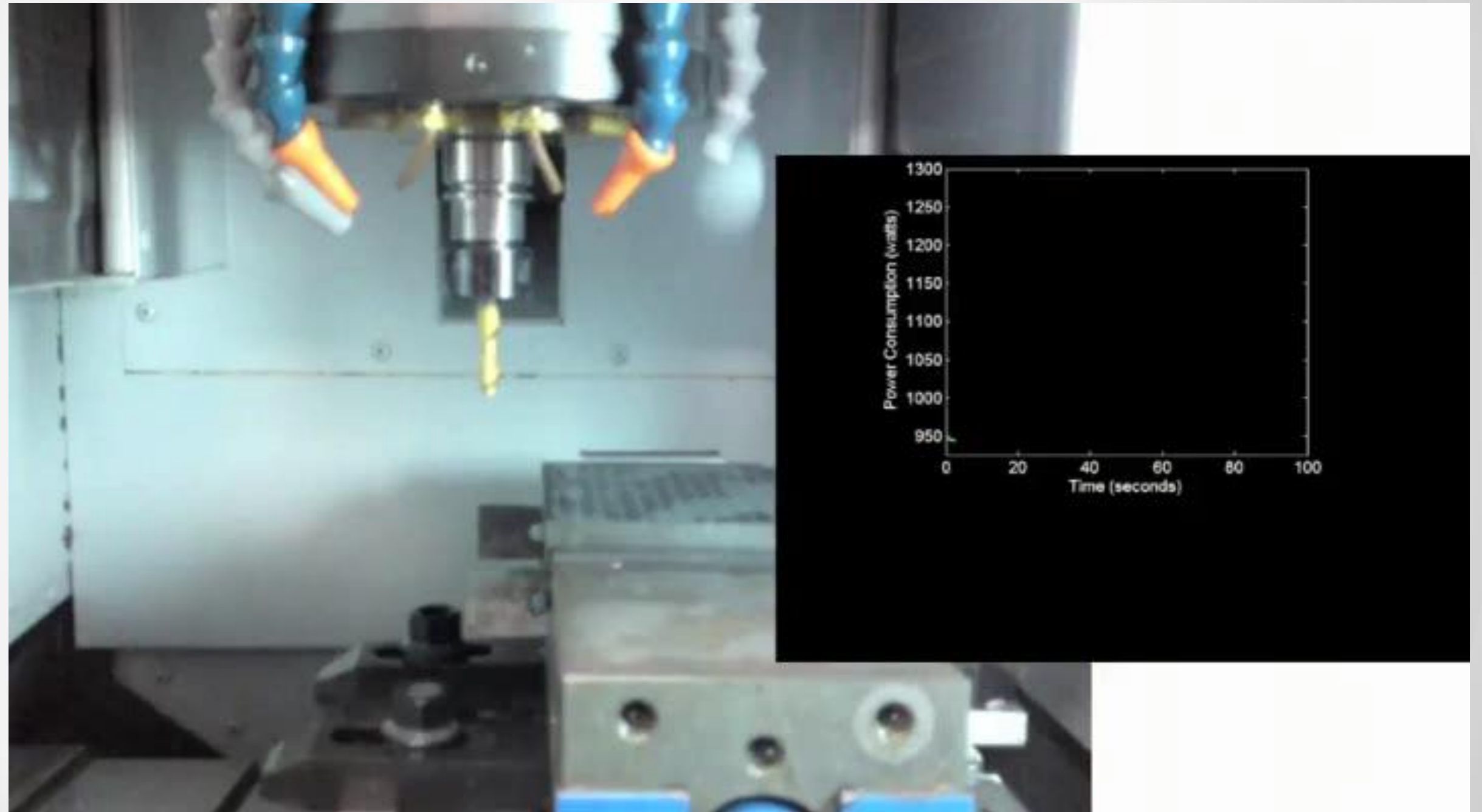
Setting	Value
Units Produced	200
Average Output Rate	1.96 units per Minute
Quantity Remaining	0

[\(+ show settings\)](#)

# The Power of a CNC Machining Center



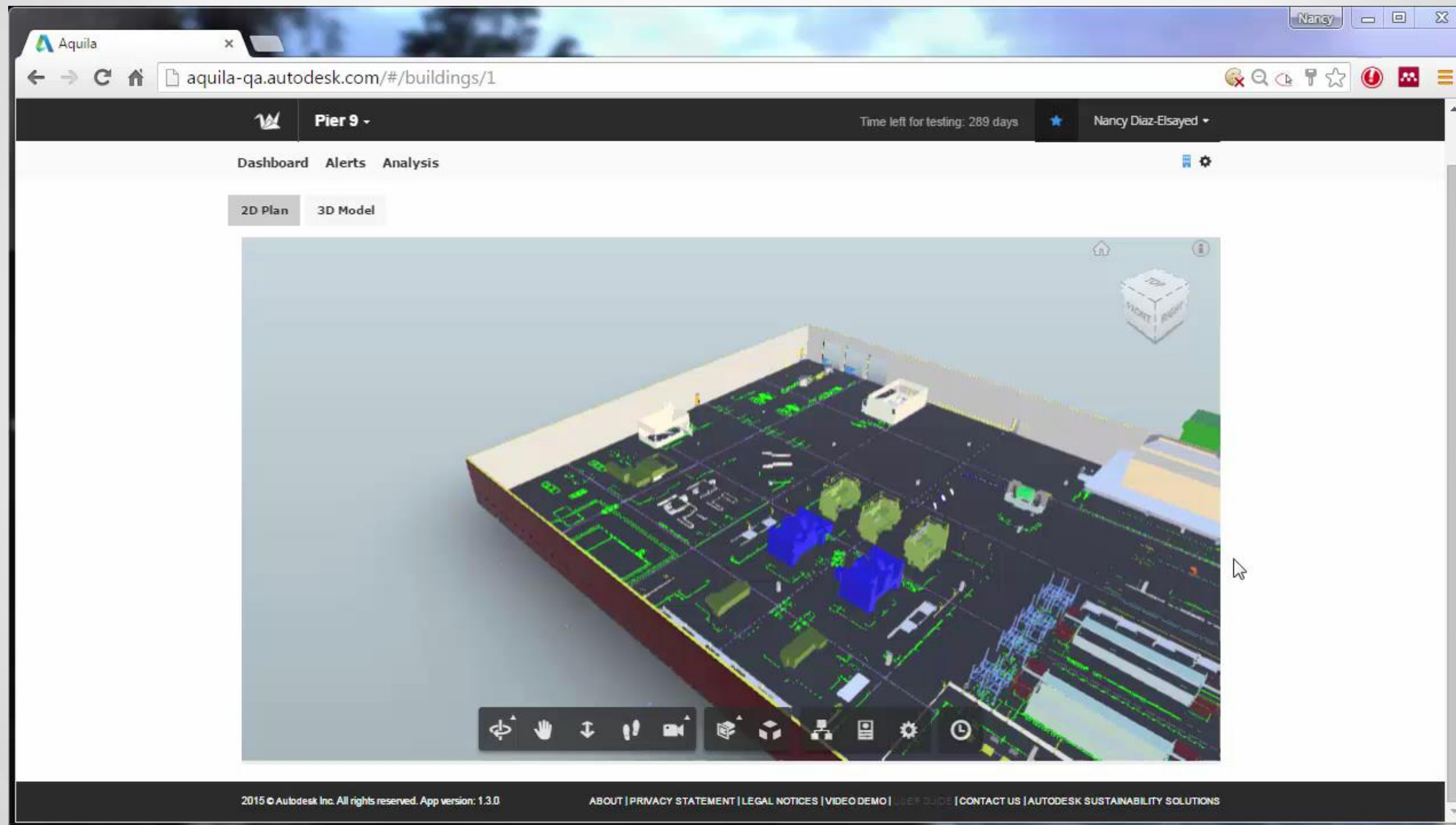
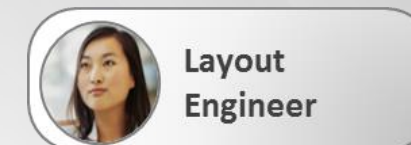
**Mori Seiki NVD 1500**



Video source: Laboratory for Manufacturing and Sustainability, (2010) "Energy Consumption During Machining", [http://youtu.be/\\_UOtoTBpex4](http://youtu.be/_UOtoTBpex4)



# Gain Access to Performance Analytics



# Project Aquila: Insight at Your Fingertips

## Business Planning & Logistics



Plant Manager



Sustainability Manager



Industrial Engineer



Project Manager

## Operations



Facilities Manager



Manufacturing Engineer



Layout Engineer

## Assets, MFG, & Controls



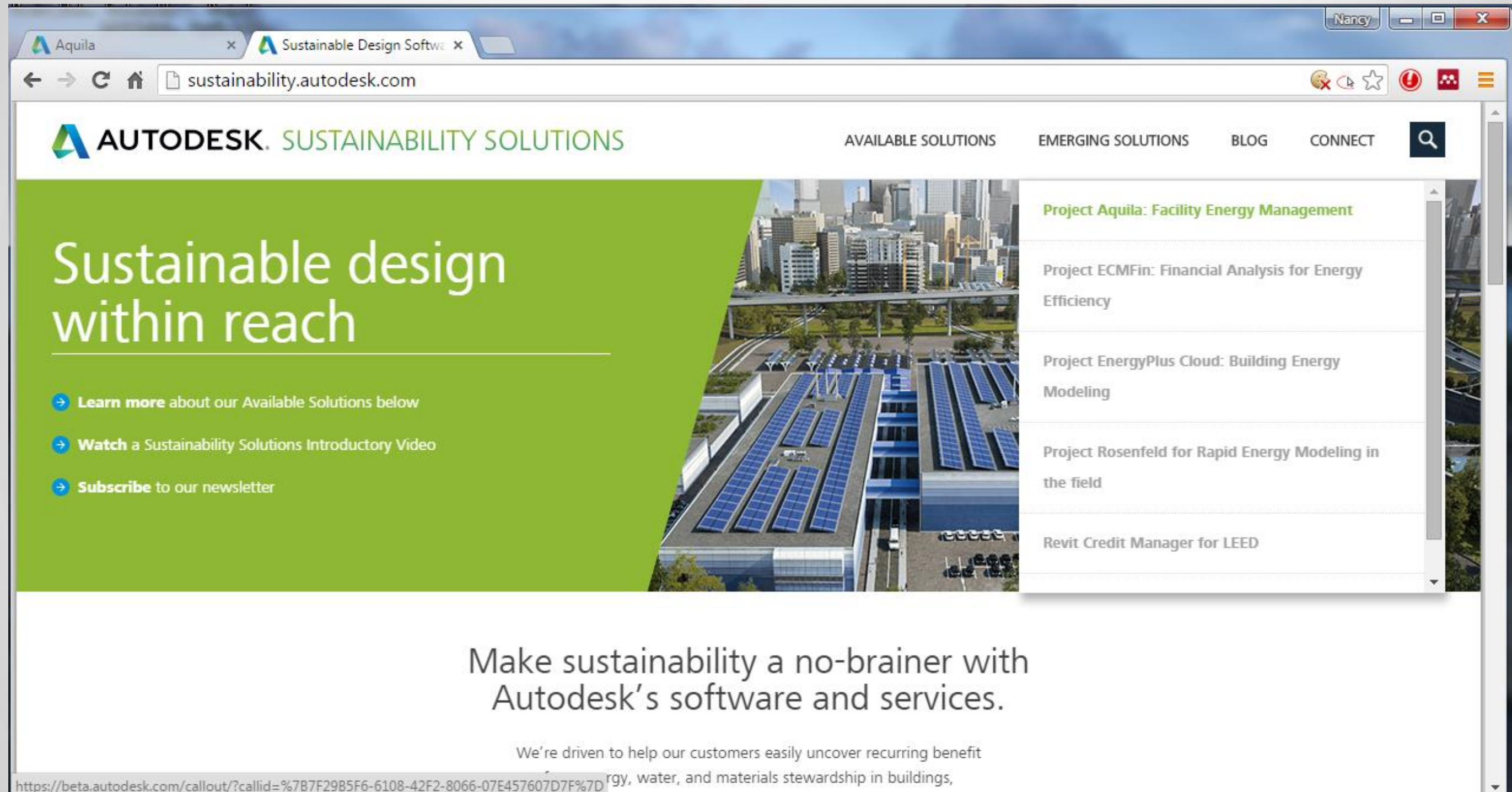
Maintenance Engineer



Facilities Engineer



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