



Smart Manager

Maker Board Designs To Industrial Grade Systems

Building The Real Internet of Things



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Opto 22

Overview

- A Bigger Opportunity
- Industrial Systems vs Consumer Systems
- Porting applications over



#define thing

- What is an IoT device?
 - Sense
 - Communicate
 - Control
- Technology is available TODAY



const Legacy_Device =

- A device or system already installed
- Capital expenditure already made
- Old
- Still functioning
- Not connected

#define Control_System

- A device, or set of devices, that manages, commands, directs or regulates the behavior of other devices or **systems**
- **Control systems** are used in production for controlling equipment or machines



Maker Boards Are Awesome

- Designed for software education
- Made inventors and tinkerer of many



A Bigger Opportunity



- Leverage maker community in industrial applications
- Over 10 Million Pi's shipped
- Huge pool of engineering talent

Scaling IoT to Industrial IoT

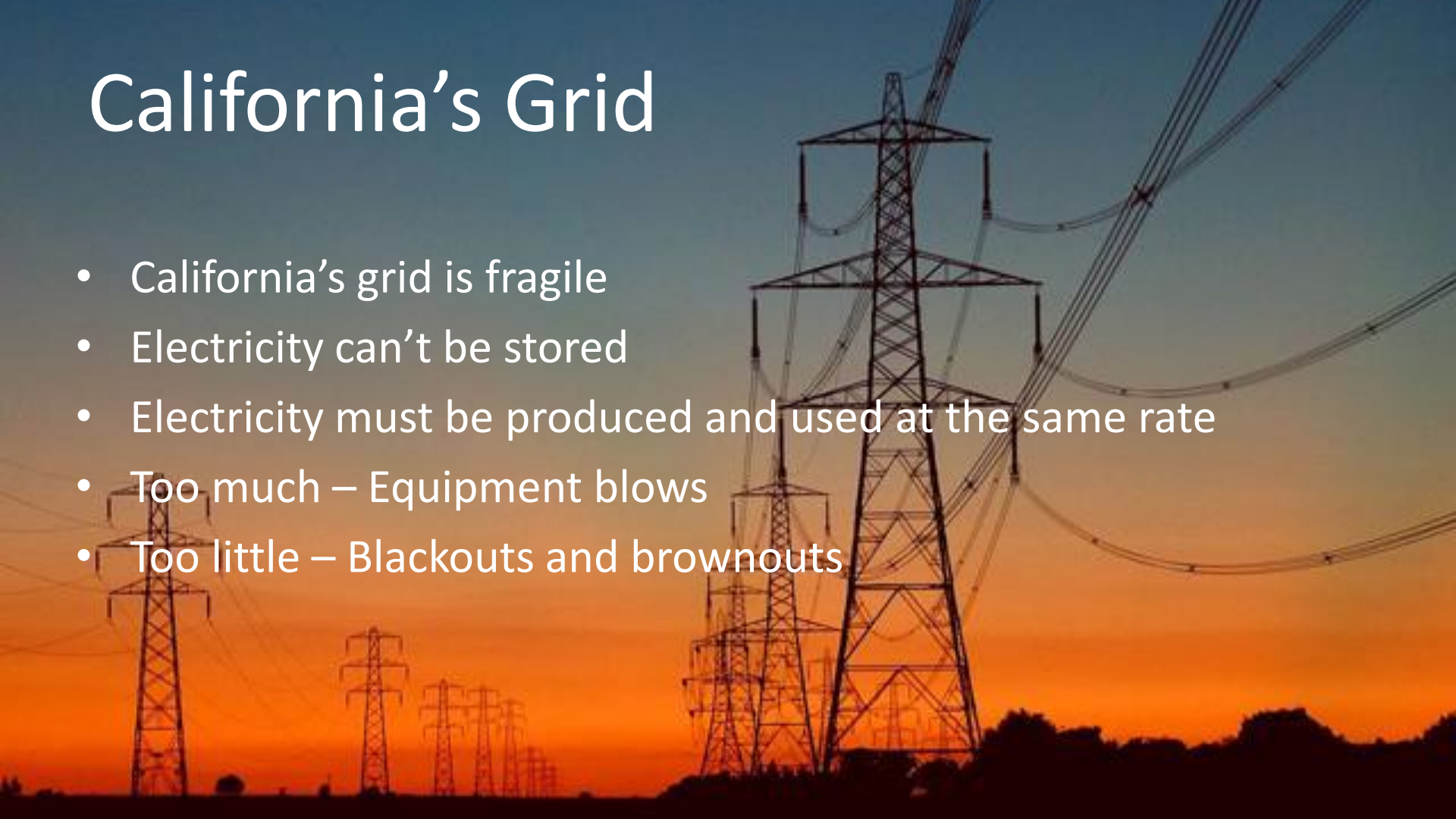
The Big Opportunity

- California's green grid
- Up to 19% of California daily energy requirement comes from green renewable sources
 - Solar panels, hydroelectric, wind turbines
- GREAT – With a couple hurdles
 - Not always available
 - Not always needed
 - No way to store the extra electricity



California's Grid

- California's grid is fragile
- Electricity can't be stored
- Electricity must be produced and used at the same rate
- Too much – Equipment blows
- Too little – Blackouts and brownouts



Demand Fluctuates

- Oversupply of electricity on the grid during the day
- As people return home from work, they turn on appliances, TVs, & AC increasing demand as supply decreases

CA Duck Curve



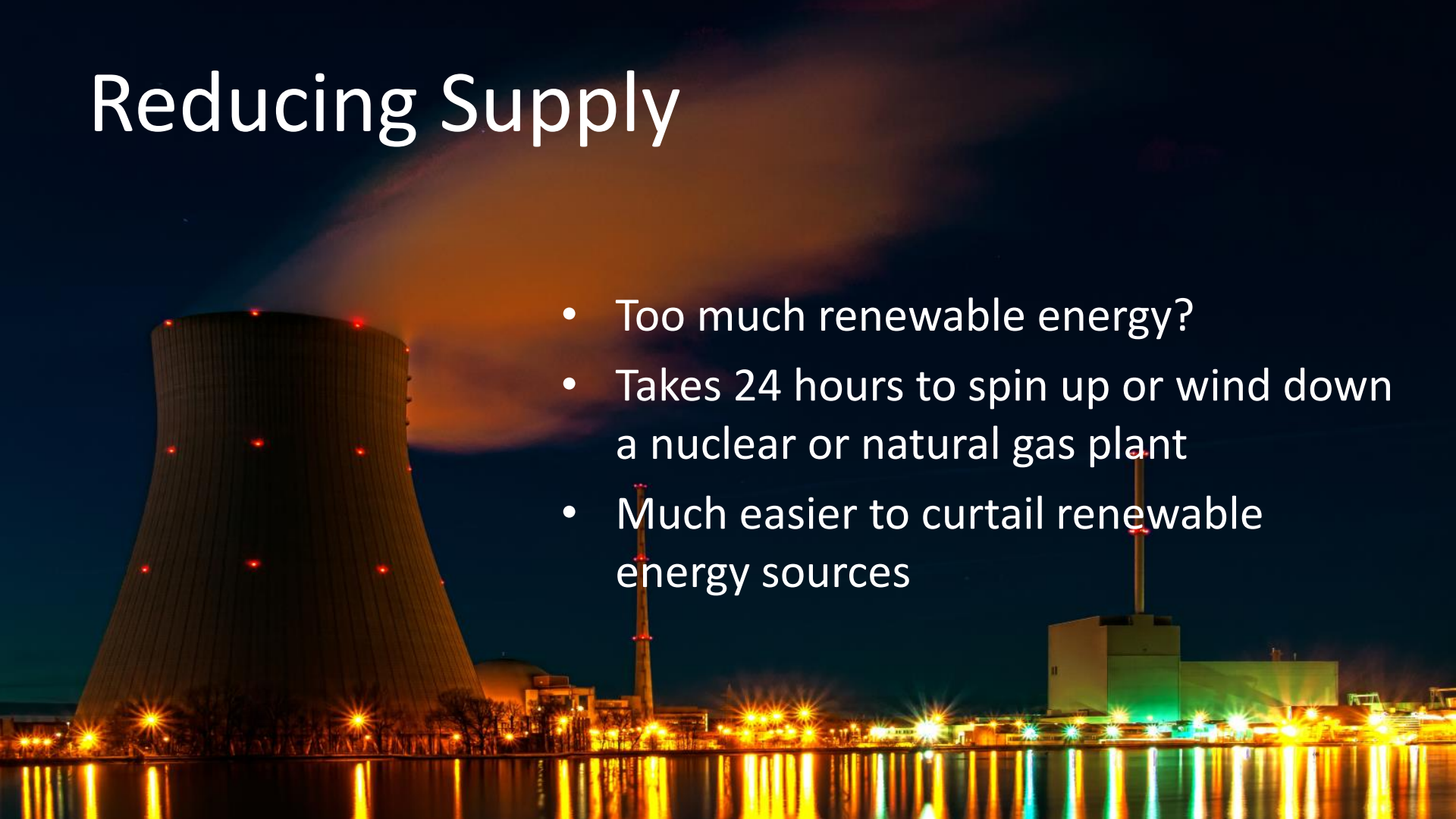
Load Response

- Not enough energy for the grid
- Utilities notify producers
- Increase production - generate electricity
- Reach supply/demand equilibrium
- Grid must kept in balance



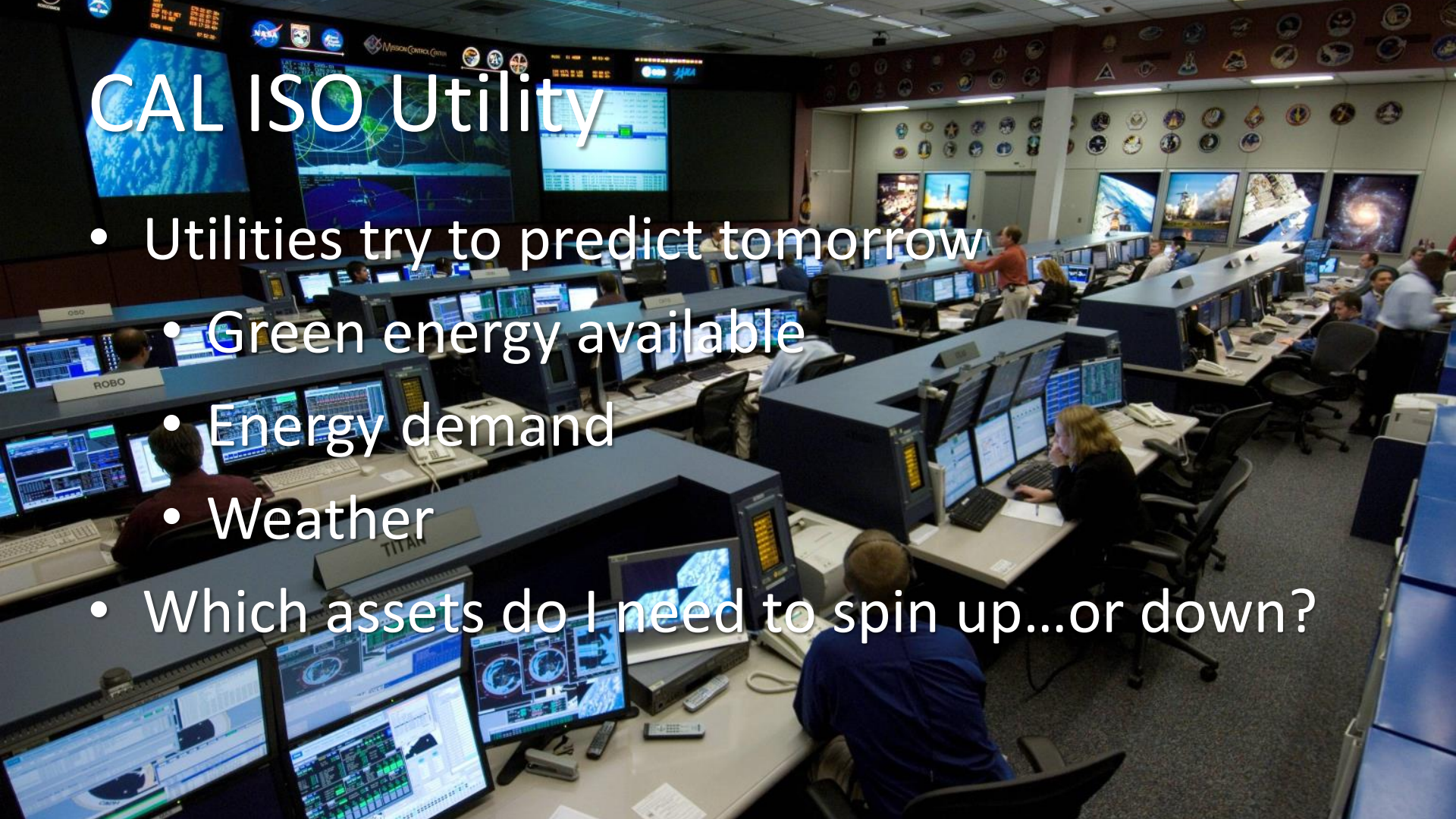
Reducing Supply

- Too much renewable energy?
- Takes 24 hours to spin up or wind down a nuclear or natural gas plant
- Much easier to curtail renewable energy sources



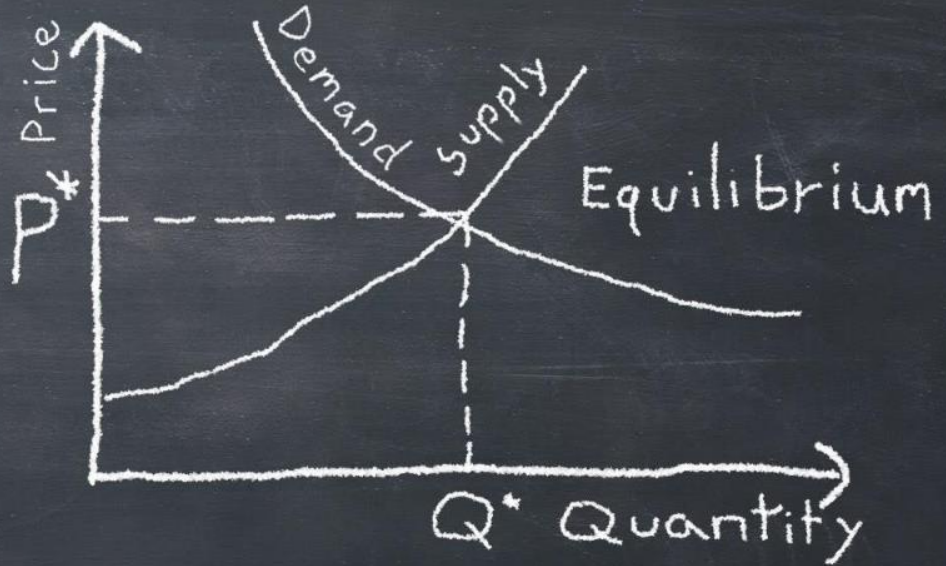
CAL ISO Utility

- Utilities try to predict tomorrow
 - Green energy available
 - Energy demand
 - Weather
- Which assets do I need to spin up...or down?



Equilibrium

- Supply & Demand
- Spot price of electricity
- Price fluctuates by minutes



A Tale of Two Turbines

The background of the slide is a photograph of two large, white, three-bladed wind turbines standing on a grassy, rolling hill. The sky is a clear, deep blue. In the distance, more hills and a line of smaller wind turbines are visible on the horizon.

- Turbines have their own control system – Application specific
- Before duck curve was a problem
- Today - Quickly get to each turbine before price drops to negative value
- Failure prone and inefficient

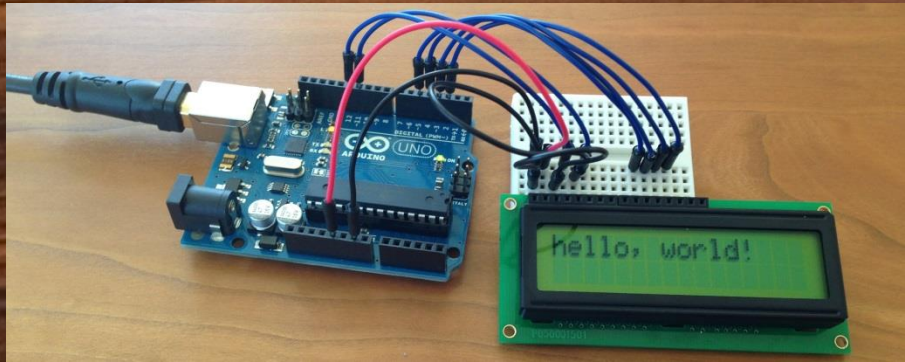
Imagine this scenario...

- 3:00 a.m. remote wind farm
- Cold desert hills with six old wind turbines installed 20 years ago
- The “dark ages” - No WWW, WiFi, cloud or big data
- Turbines have no intelligence
- Designed to be controlled from the PHYSICAL WORLD (Green ON, Red OFF buttons)



What's an IoT device again?

- It senses – Temperature, speed, humidity
- It Communicates – Internet protocols
- It controls – Maybe using 3.3 VDC



BLADES

Lift and rotate when hit by wind, causing the rotor to spin.

ROTOR

Combination of the blades and hub.

PITCH SYSTEM

Turns blades out of the wind to control rotor speed. Also, stops the rotor from spinning in conditions where wind is blowing too slow or too fast.

GENERATOR

Produces 60-cycle AC electricity within the turbine.

CONTROLLER

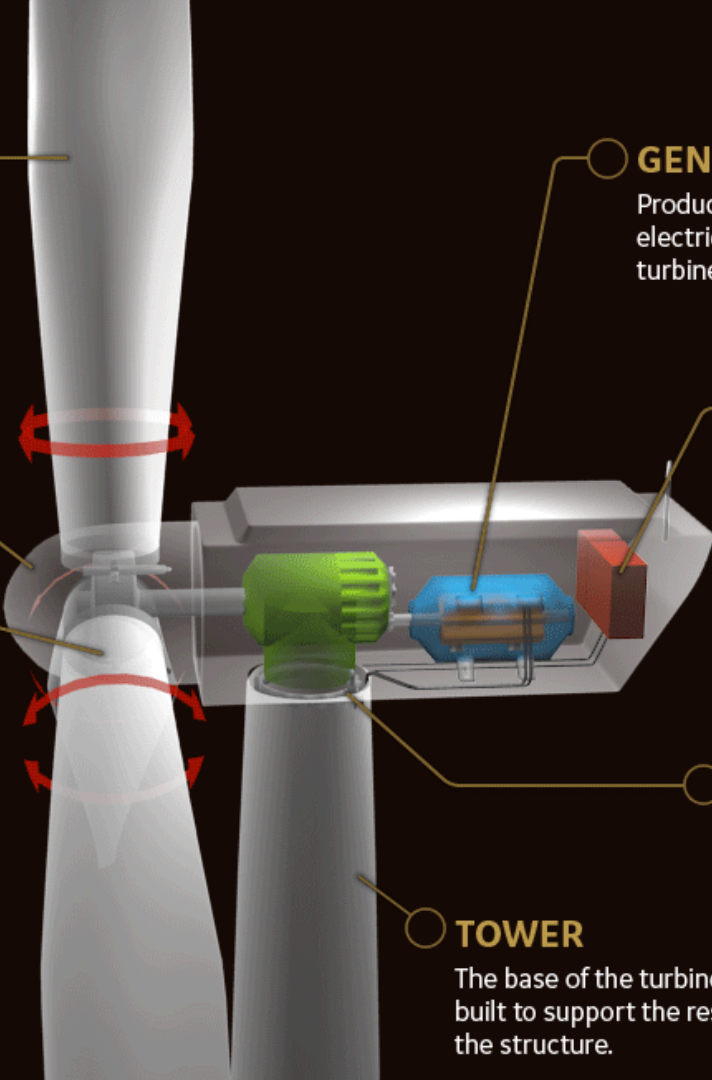
Starts and stops the turbine from working, depending on conditions.

YAW DRIVE

Controls upwind turbines to orient them should wind direction change.

TOWER

The base of the turbine, built to support the rest of the structure.



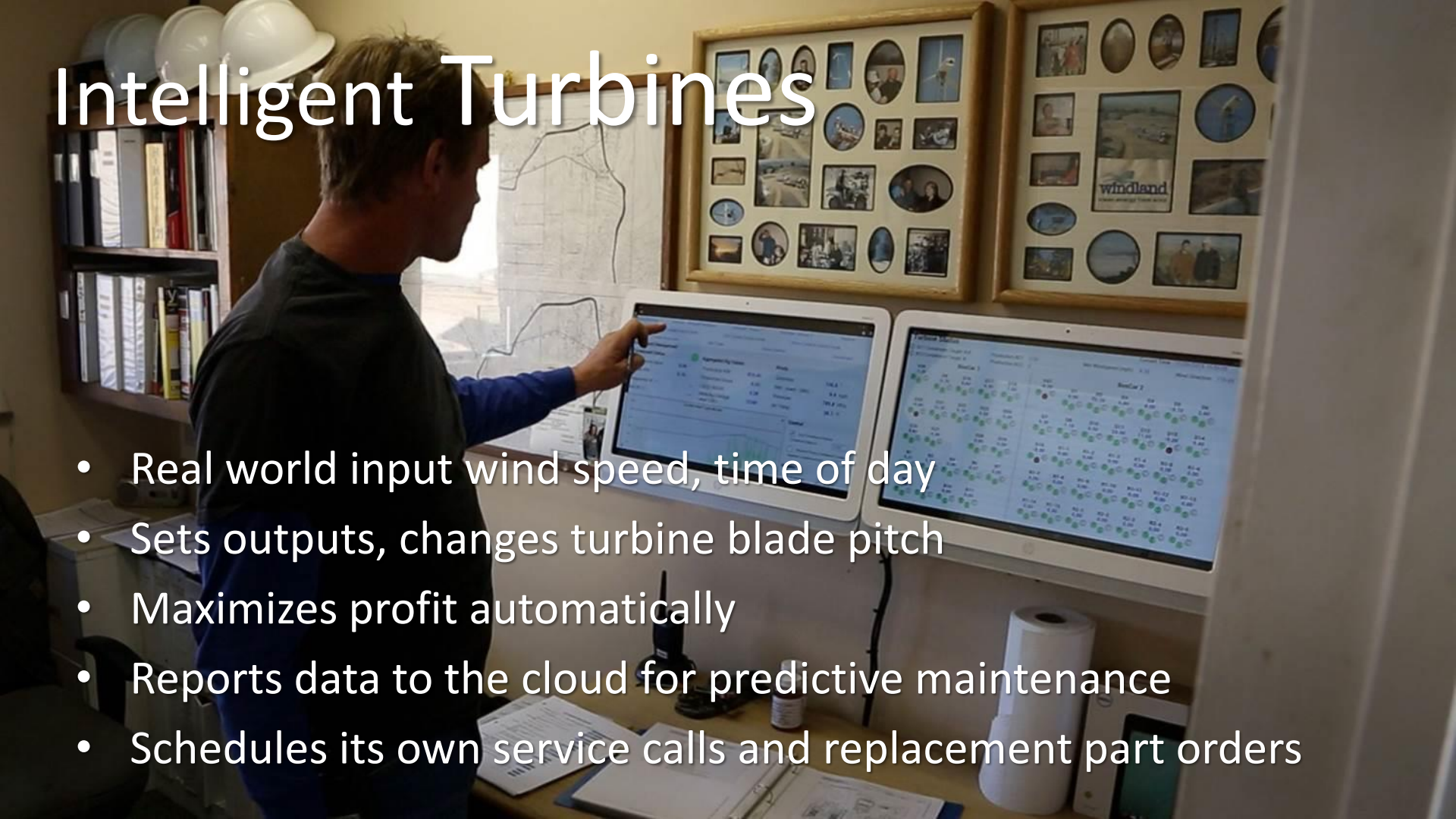
What if they joined IoT?

- Legacy systems increased value
- Digital world can peer into physical world
- Check website for spot price, start or stop?



Intelligent Turbines

- Real world input wind speed, time of day
- Sets outputs, changes turbine blade pitch
- Maximizes profit automatically
- Reports data to the cloud for predictive maintenance
- Schedules its own service calls and replacement part orders



The REAL Internet of Things



- Things autonomously monitoring digital world
- Determining when to take action in the real world
- Based on big data they generate
- Analyzed in the cloud they're now connected to

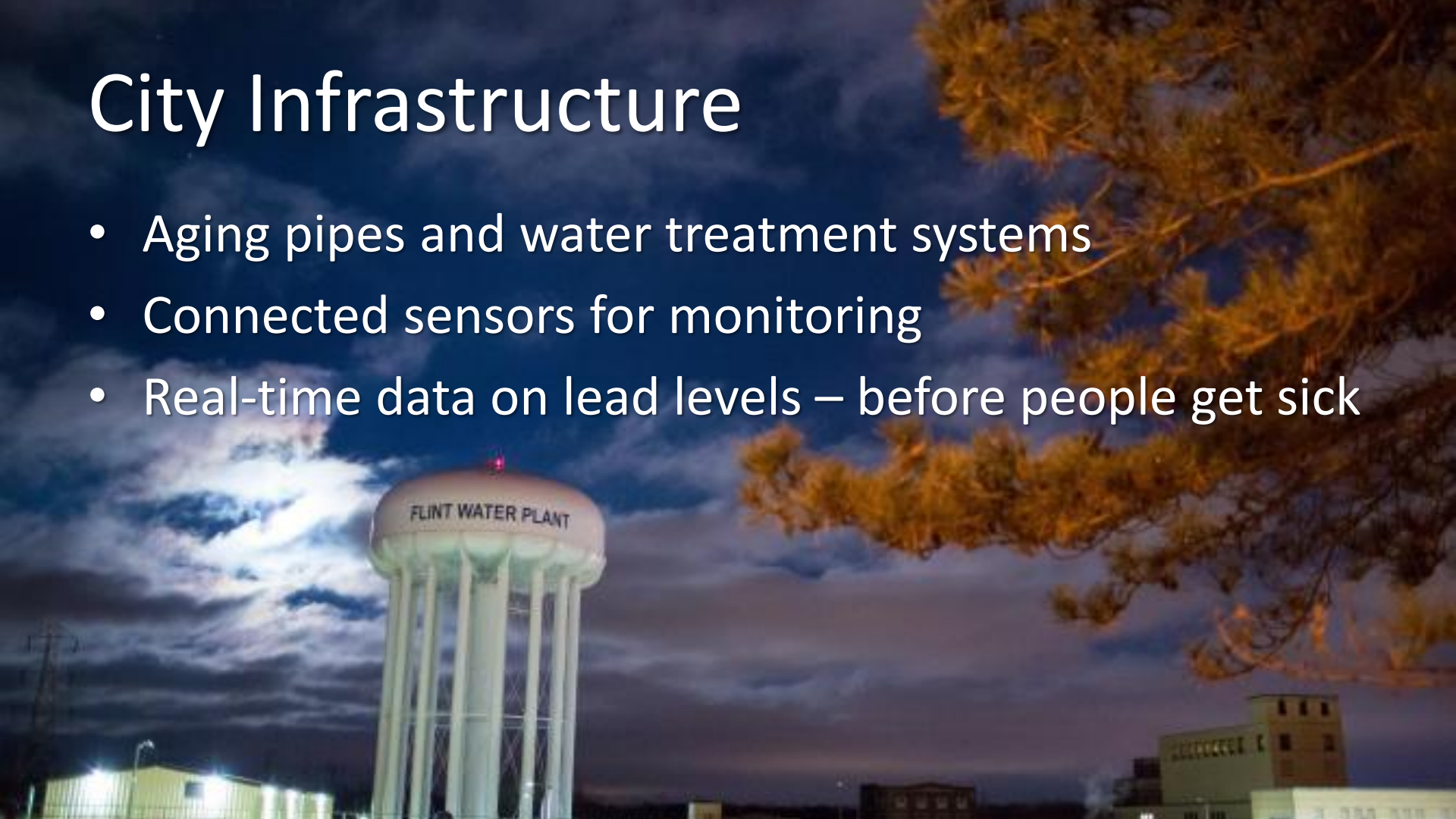
Environmental Applications



- 2010 Gulf oil spill – 3.2 million barrels
- 16 previous fires and numerous safety issues
- 77 people evacuated after accidental ballast pipe removal
- Remote asset data acquisition
- Could a predictive analytics system have caught the problem before it happened?

City Infrastructure

- Aging pipes and water treatment systems
- Connected sensors for monitoring
- Real-time data on lead levels – before people get sick





Manufacturing Applications

- Cut costs
- Decrease waste
- Make manufacturing more competitive
- Create jobs

The Big Opportunity

A large industrial pipeline, likely for oil or gas, runs horizontally across the frame. It is supported by several dark, vertical metal pillars. The pipeline and pillars are covered in a layer of snow. The background shows a snowy field with some bare trees and a hazy, orange-tinted sky, suggesting a winter or early morning setting.

- Bridge physical & digital worlds
- Billions of physical “things” already installed
- Not connected...yet
- Sensors, relays, circuits and transmitters
- Cloud-enable unconnected “things”

The image depicts an offshore wind farm with several wind turbines on a dark, choppy sea under a cloudy sky. A large, semi-transparent digital overlay is present, featuring a network of yellow lines connecting the turbines, suggesting a data or communication network. Binary code (0s and 1s) is scattered across the upper portion of the image, and various technical diagrams, including circular patterns and rectangular outlines, are visible in the lower-left and lower-right areas. The overall aesthetic is high-tech and futuristic.

The Challenge

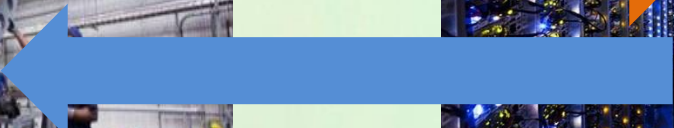
Technology Gap

Industrial World

- Physical value creation
- *Legacy* HW/SW reliable & risk averse
- Ladder logic, function block
- Long-life, high-cost hardware
- Voltages and currents
- Proprietary networks
- Sensors, motors, pumps

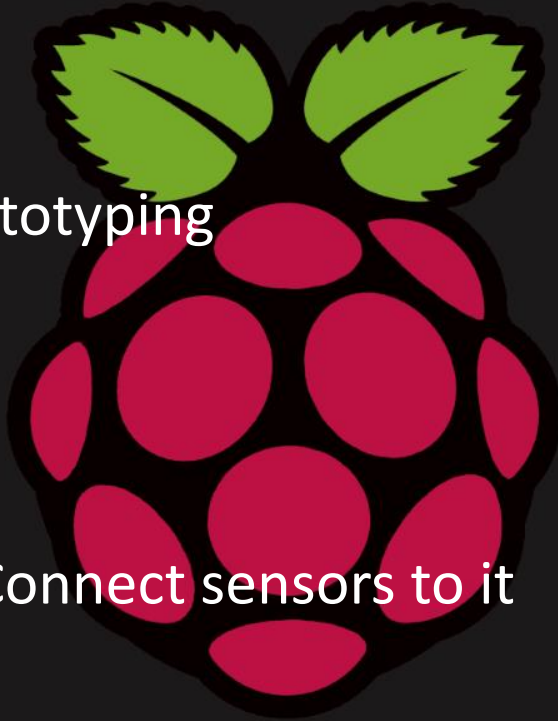
Maker Community

- Applications bridge digital and physical
- Latest technology & constant change
- RESTful APIs, JavaScript, node.js
- Low-cost PIs, PCs
- Bits and bytes
- TCP/IP, HTTP/S, MQTT
- Open Technology



Why use a PI?

- Great for rapid prototyping
- Easy to learn
- Cheap
- Available
- Has some GPIO – Connect sensors to it
- SD card for storage



Why *not* use a PI?



- The industrial world is a vicious and frightening place
- Extremely hot or cold things get dropped, run over and hit
- Uses high voltage, not GPIO

Mission Critical Applications

- I/O channel isolation
- EMI Resistance
- Power loss recovery
- File system recovery
- Pi's not designed for deployment



The Real Cost

- Delta between cost of Pi and industrial failure is huge
- Someone could die
- Expensive equipment could be destroyed

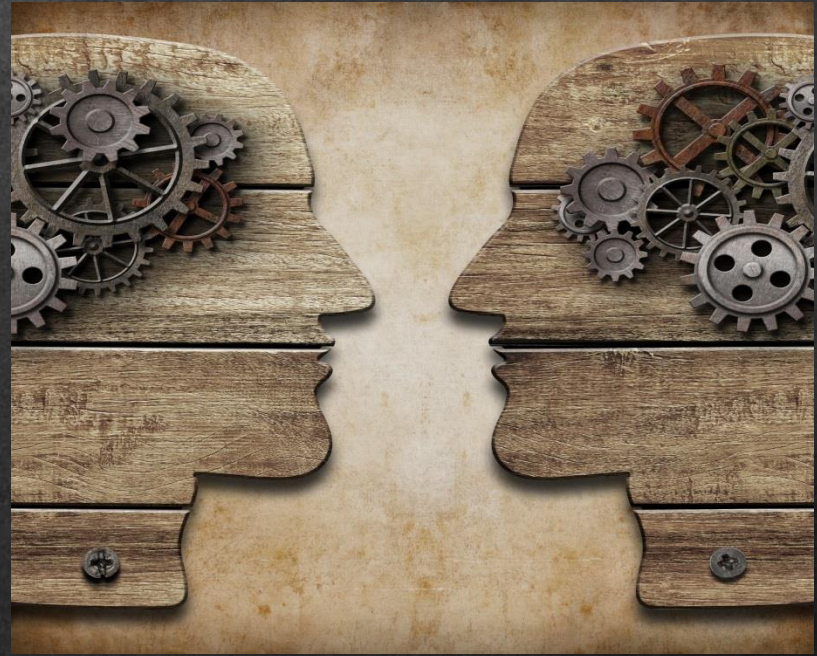
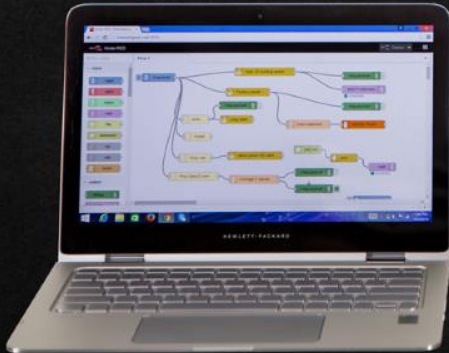




The Solution

Bridge The Gap

- Eventually makers become engineers
- Physical world and digital world connect
- Industrial Equipment natively speaks IoT protocols
- Voltages & currents available to the cloud
- REST, HTTP, MQTT, node.js, JavaScript



Opportunity Size

- In the absence of analyst data...
- I'm in the industrial space
- We make input/output (I/O) modules—over 100 million shipped by just Opto 22
- Consider many other manufacturers
 - Rockwell, Siemens, GE, Schneider
- Maybe you can change the world?



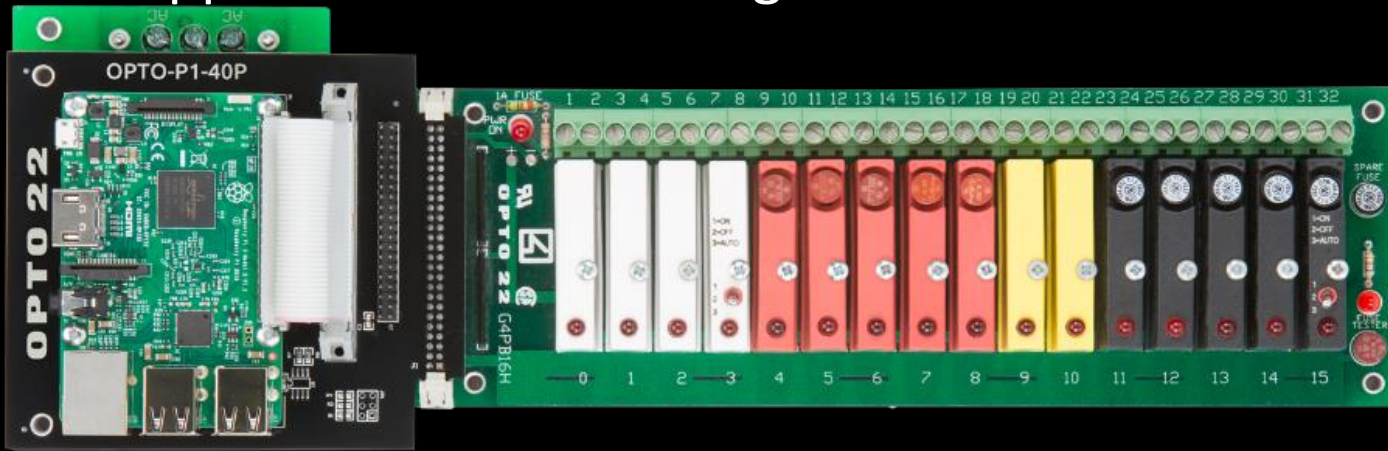
IIoT Development Platform

- Industrially hardened interface
- Bridges physical and digital gap
- Translates voltages and current into languages of IoT
- Survive harsh industrial environments
- I/O for sensors, transmitters, relays
- IoT Communication & programming capabilities
- node.js, JavaScript, HTTP, RESTful APIs



But Just In Case...

- Not a mission critical application?
- Raspberry Pi > GPIO > Industrial I/O
- Switch 5-60 VDC, 120/240 AC – From your Pi
- Your app scaled to industrial grade



Recap

- The market opportunity is huge
- The tools exist today to start building and rolling out these applications
- It's up to the developer community