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Smart Lighting with D4i-enabled Luminaires: Energy Reporting, Asset Management, Predictive Maintenance and more

L22EP4

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Sree Venkit – Signify
Kevin Fitzmaurice – Georgia Power
Michael Davidson – Synapse Wireless

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Smart Lighting with D4i-enabled Luminaires: Energy Reporting, Asset Management, Predictive Maintenance and more

L22EP4

Overview of the course:

D4i brings long-awaited plug and play standardization for smart luminaires. This course will demonstrate the benefits of D4i data using real-world application examples. A key capability in use today is power monitoring for energy savings. D4i also stores asset information, diagnostics data, and identifies failure modes of the power source, LED driver and LED array. The D4i standard, which is part of DALI-2, provides the required DC power for controllers (NLCs) and sensors. Attendees will understand how D4i simplifies compliance with NLC specifications from DLC. The course will feature real-world examples from utility Georgia Power using D4i.

Smart Lighting with D4i-enabled Luminaires: Energy Reporting, Asset Management, Predictive Maintenance and more

L22EP4

At the end of this course, participants will know:

1. Understand the capabilities of D4i luminaires for smart lighting applications
2. Assess the value of energy monitoring and compliance with DLC specifications
3. Explore applications of asset management using D4i
4. Explain the benefits of using D4i diagnostics data for predictive maintenance
5. Discover the benefits of D4i in area and street lighting installations

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Sree Venkit

System Architect for Connected Lighting, Signify

What is “Connected Lighting”?

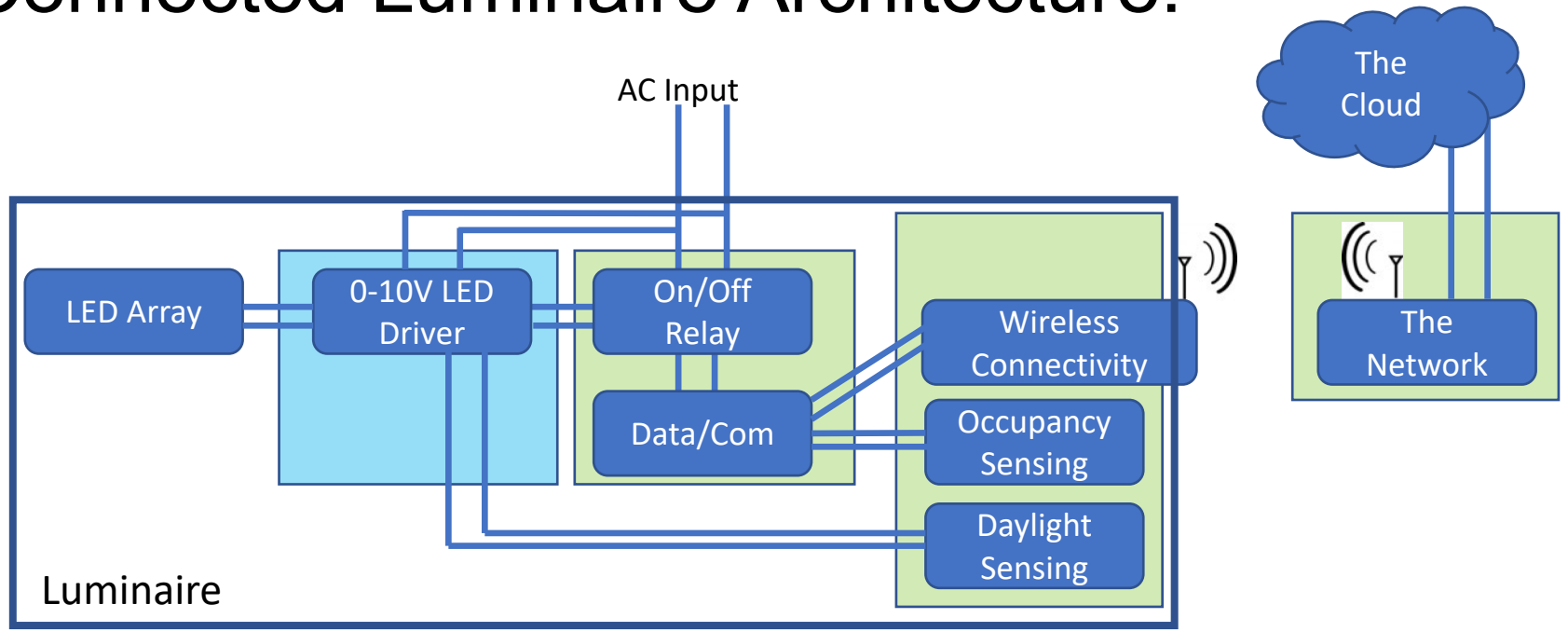
Smart lighting fixtures will drive enhanced energy saving and make Lighting a key driver in the “Internet of Things”

- **Lighting is everywhere where people are**

- **Focus will gradually shift from energy savings to data insights leading to new uses**:
  - Occupancy/space management
  - Building automation / control (HVAC, security, elevators)
  - Retail engagement

- **Lighting provides an opportunity for human centric data collection**
  - Luminaires become the collecting points for local information…..data nodes…….Luminaire OEMs uniquely positioned to be the carrier

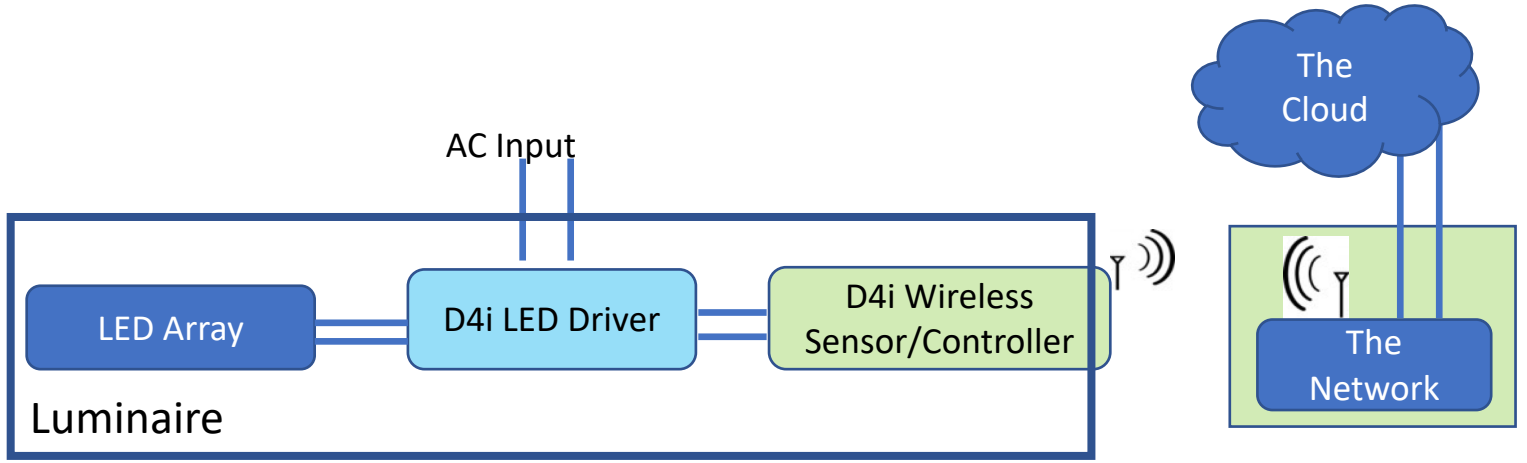
Connected Luminaire Architecture:



Analog 0-10V:

- Complex with many components
- Limited standardization
- No data capability from LED driver
- Reduced reliability - AC mains connection to multiple components

0-10V Dim2OFF with Aux is in between, but still no data from LED driver.



Digital D4i:

- Simple with few components
- Standardized connection for power and digital data from LED driver
- High reliability – AC mains to the LED driver only

D4i – Overview

- D4i is a certification program for interoperable DALI devices that enable smart, connected luminaires
  - D4i is an extension of DALI-2 certification
- D4i components have a compulsory set of features
  - Based on power-supply and data specifications from DiiA
- All D4i LED drivers provide luminaire, energy & diagnostics data
- D4i enables intra-luminaire DALI
  - Other D4i implementations are also permitted
- D4i luminaires are smart and IoT-ready
  - D4i simplifies addition of sensors and communication devices (NLCs) to luminaires
- D4i enables plug-and-play interoperability when combined with a connector system
  - e.g. Zhaga Book 18 & 20 or NEMA/ANSI C136.41

DiiA Specifications – Published

- The following specifications can be downloaded from the DiiA website

Specification	Name	Version	Certification?
Power supply specifications			
DALI Part 150	AUX Power Supply	v1.1, Oct 2019	✓
DALI Part 250	Integrated Bus Power Supply	v1.1, Oct 2019	✓
Data specifications for LED drivers & other control gear			
DALI Part 251	Luminaire Data	v1.1, Oct 2019	✓
DALI Part 252	Energy Data	v1.1, Oct 2019	✓
DALI Part 253	Diagnostics Data	v1.1, Oct 2019	✓
Specifications for control devices			
DiiA Part 351	Luminaire-mounted Control Devices	v1.0, Oct 2019	✓

DiiA power-supply specifications

DALI Part 250 – Integrated Bus Power Supply

- For control gear (e.g. LED drivers) with an integrated DALI bus power supply (PSU)
  - Suitable for powering some devices – such as sensors – on the bus

- PSU can be enabled or disabled – allowing use in systems with multiple bus PSUs
- For D4i certification, Part 250 must be included, with the bus PSU enabled by default

DALI Part 150 – AUX Power Supply

- 24V DC power supply
- Can be built into control gear, or designed as a stand-alone product
- Suitable for devices with higher-power requirements
  - e.g. City-wide wireless transceivers
- Provides 3W average, 6W peak

DALI data specifications for control gear

- Data for enhanced asset management & performance monitoring
- Data storage in DALI memory banks, with standardized format & locations

Luminaire Data

DALI Part 251 – Luminaire Data

- Information about the luminaire (e.g. ID code, light output, CCT & CRI, light distribution etc) can be stored in the control gear
- Enables asset management

Energy Data

DALI Part 252 – Energy Reporting

- Provides real-time power & energy usage for control gear

Diagnostics Data

DALI Part 253 – Diagnostics & Maintenance

- Operating data for control gear and lamps, including failure conditions, run-time data
- Enables predictive maintenance

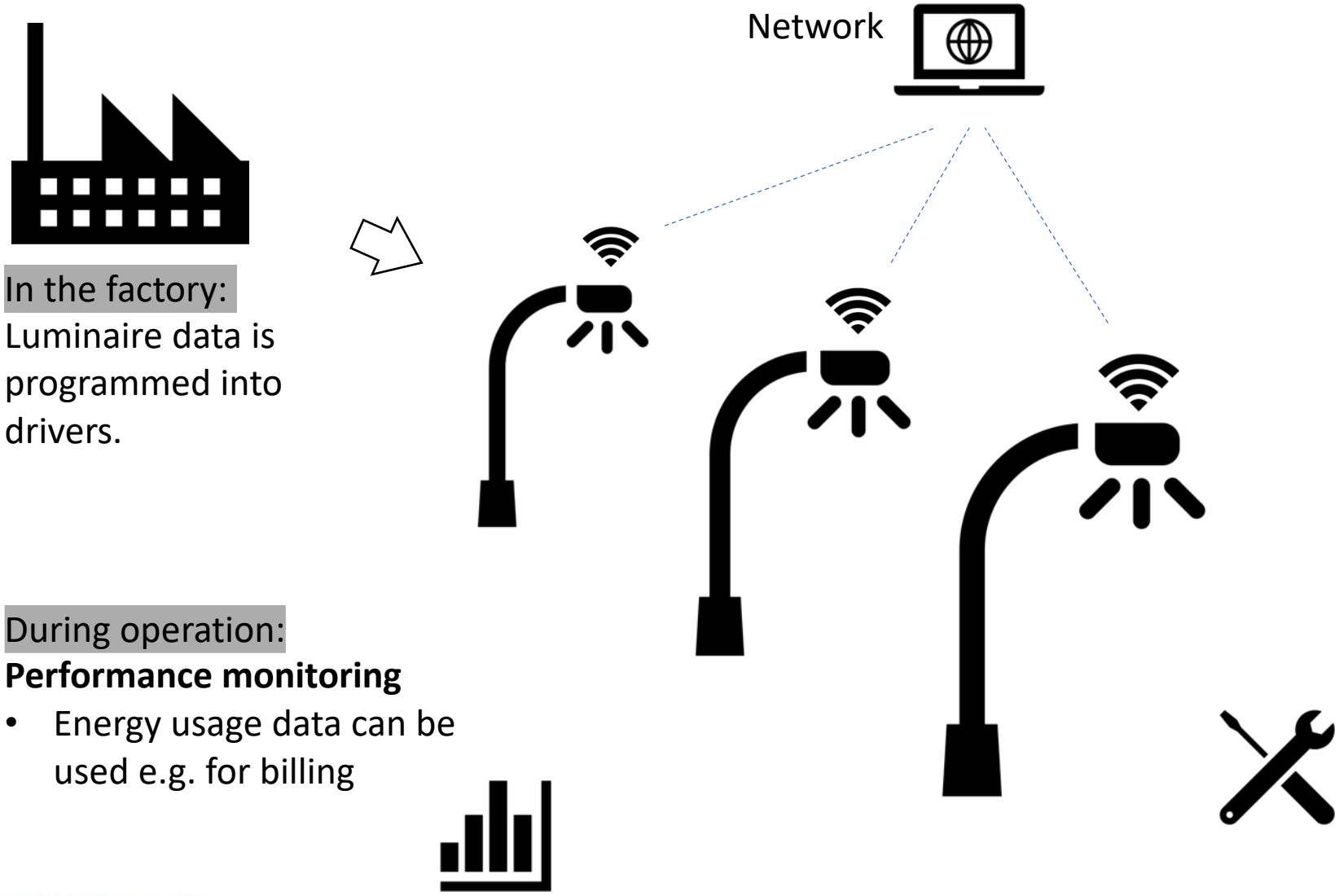
Benefit Summary – D4i Drivers vs 0-10V

Benefit	Driver Feature	Feature Description	0-10V	0-10V Dim2OFF w/Aux	D4i
Ease of maintenance and Asset Management	Asset management via DALI scenes	Use limited space in DALI scenes for unique vendor code and manual lookup tables to correlate to specific fixture			✓
	Asset management via MB1	Standardized method for storing vendor specific information in the driver; No lookup table required.			✓
	Memory Banks with Diagnostics Data	Data such as voltages, surges, currents and thermals made available back through NLC for analysis			✓
Ensure/monitor energy savings	Memory Banks with Power/Energy metering Data	Measured power and energy data. Supports DLC NLC QPL listing and thus qualify for utility rebates.			✓
High reliability	Integrated switching, and Low Voltage power supply	Eliminates mains protection and relay. No need for separate low voltage supply for the NLC.		✓	✓
Easy integration	Built-in DALI Bus Power Supply	Simple two wire connection from the driver to the NLC node to supply power and data			✓
System interoperability assurance	D4i Certification program	Testing assures DALI communication protocol robustness and D4i specified power and data availability to NLC.			✓

Part 351 for control devices

- **DiiA Part 351 – Luminaire-mounted control devices**
  - Examples: Sensors, wireless communication nodes
- Control devices can be bus-powered or externally powered (e.g. by AUX supply).
- Part 351 specifies four types of control device (types A-D)
  - Covering both indoor and outdoor applications
  - Including devices such as wireless network lighting controllers (NLCs), photocells (light sensors), movement sensors and timers
- Specification includes:
  - Requirements for power consumption
  - A mechanism to arbitrate between multiple application controllers
  - A memory bank definition for multi-master devices
- Part 351 is mandatory for D4i certification

DALI data: An outdoor lighting example



In the factory:
Luminaire data is programmed into drivers.

During operation:
Performance monitoring
- Energy usage data can be used e.g. for billing

In the field:
Automated commissioning
- When installed, luminaire can automatically transfer data to remote network
- Reduces human error, saves installation time and cost
- Operator has a full map of asset information

During operation:
Predictive maintenance
- Diagnostics data allows network operator to anticipate need for maintenance
- Repair team has knowledge of location and type of fixture

Technology standards driving connected lighting adoption

Introduced **North America standard** for *energy reporting, diagnostics,* and *asset management* for LED drivers (C137.4)

Defined **global requirements** for *energy reporting, diagnostics,* and *asset management* for LED drivers (D4i)

Energy monitoring is a *required* interior/exterior NLC system capability (V5.0)

- Standardize luminaire data format (e.g. luminaire asset data)
- Encourage new usage of data
- Accelerate adoption of connected lighting
- Greater design flexibility in lighting control

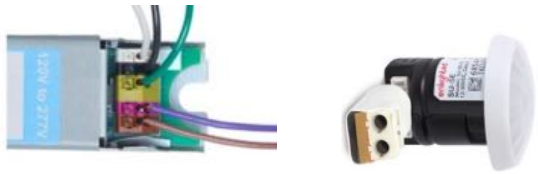
Application Examples : Benefits of D4i/DALI-2 Data

- *Next few slides show application examples from several Lighting Control system manufacturers*
- *Some of the controllers/systems are still under development as noted.*
- *All products may not be D4i/DALI-2 certified.*

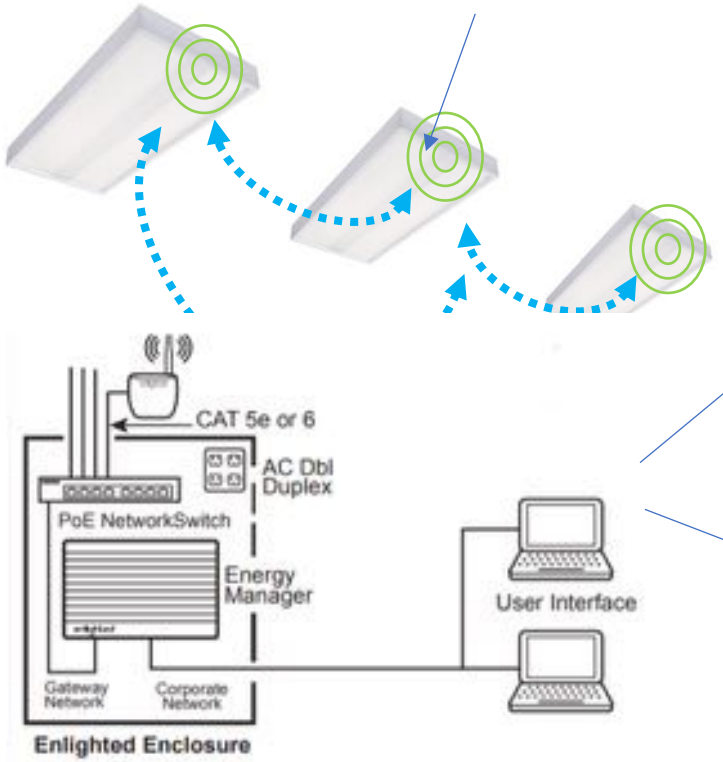
Indoor Application: Philips EasySense with Energy Report for a Room

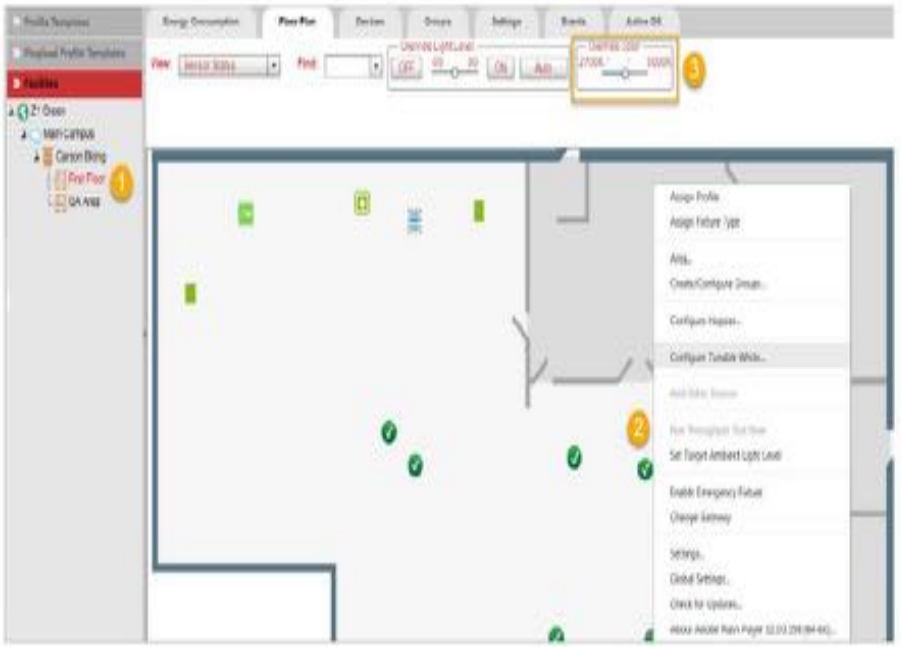
Philips EasySense &
Advance Xitanium SR - D4i LED Driver

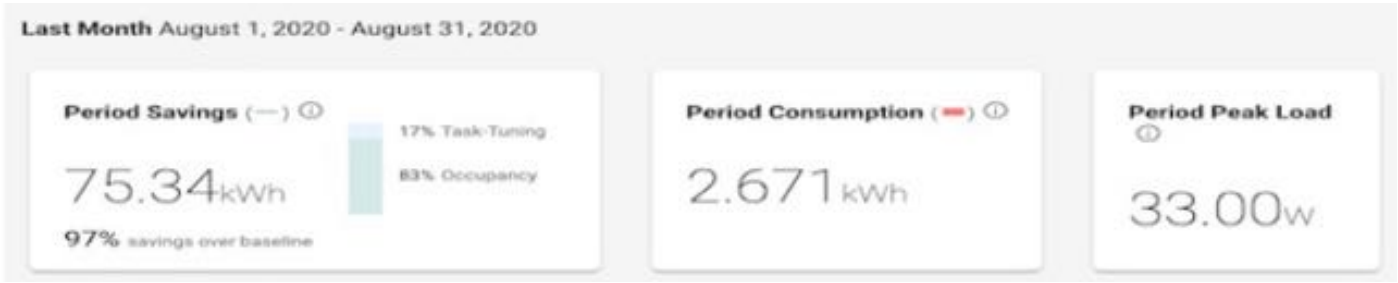
Indoor Application: Enlighted System featuring Energy Reporting & Human Centric Lighting



Enlighted 2-wire Sensor &
Advance FlexTune SR **LED Driver**



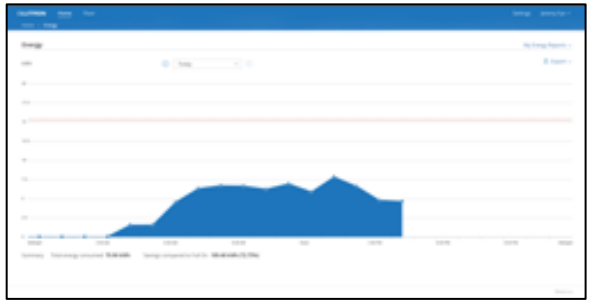




Indoor Application: Vive System featuring Energy and Occupancy Reports

Vive Integral
Fixture Control

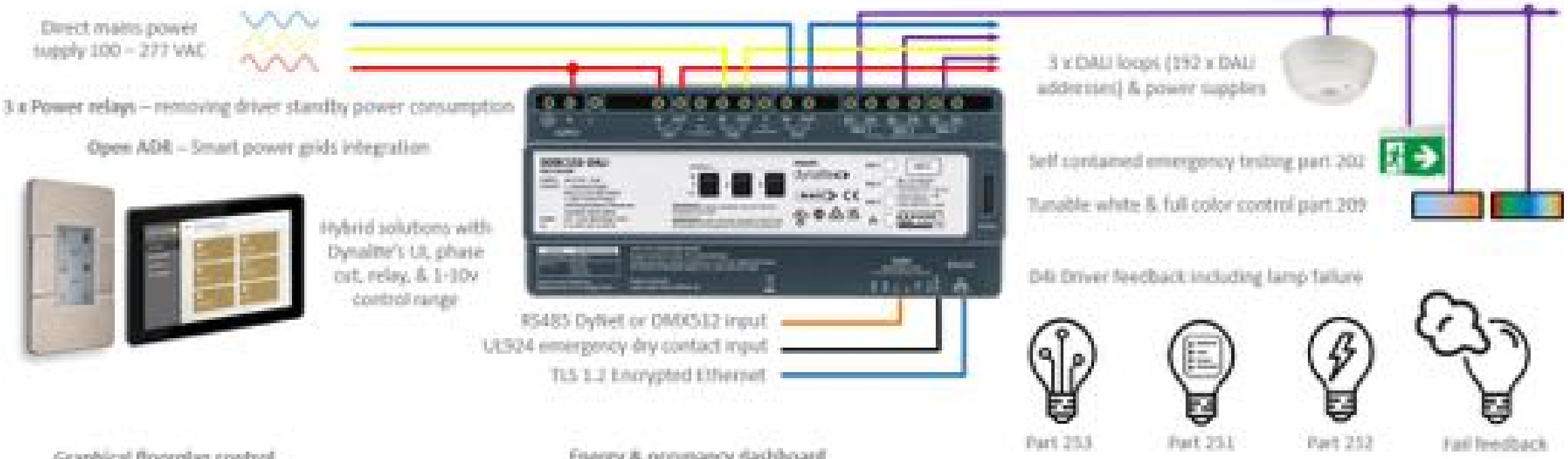
Advance Xitanium SR –
D4i LED Driver



Vive Vue Energy Report

Vive Vue Occupancy Report

Indoor Application: Philips Dynalite system accessing D4i data



Graphical floorplan control
- Edit scene lighting levels
- Change sensor time out and target lux levels

Energy & occupancy dashboard
- Historical & area comparison reporting
- Insights to different control strategy results

Console over view of lighting performance
- Driver status feedback
- maintenance reports

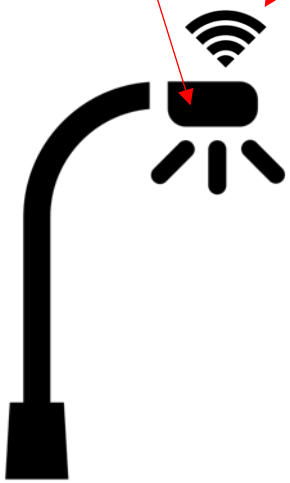
Outdoor Application: Luminaire Asset data using SELC/Itron System

Itron System:
Dashboard* with map showing
Luminaire asset data

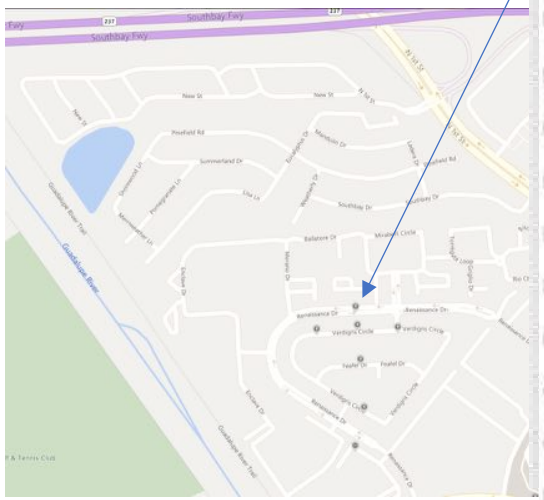
D4i Part 251 –
Luminaire asset data
entered & stored in the driver

SELC D4i Wireless
Fixture Controller

D4i LED Driver



Content format ID:	Luminaire info - v3 (DALI Part 251/ANSI C137.4)	
Luminaire manufacturer GTIN (EAN13):		
Identification number:	16141547696627796868	
Additional info (13S):		
Luminaire identification (60):	GCM3-603-MV-30K-2R-GY-160-LPCR-LEOTEK	
Luminaire date of manufacture:	22 YY 15	WW
Luminaire color (24):	Grey	
Nominal input power:	111	W
Nominal minimum AC mains voltage:	120	V
Nominal maximum AC mains voltage:	277	V
Power at minimum dimlevel:	20	W
Nominal light output:	15790	lm
CRI:	70	
CCT:	3000	K
Light distribution type:	2	



** Dashboard under development*

Outdoor Application: Comprehensive set of Luminaire data using McWong Wireless System

D4i LED Driver

McWong DALI Wireless Fixture Controller*

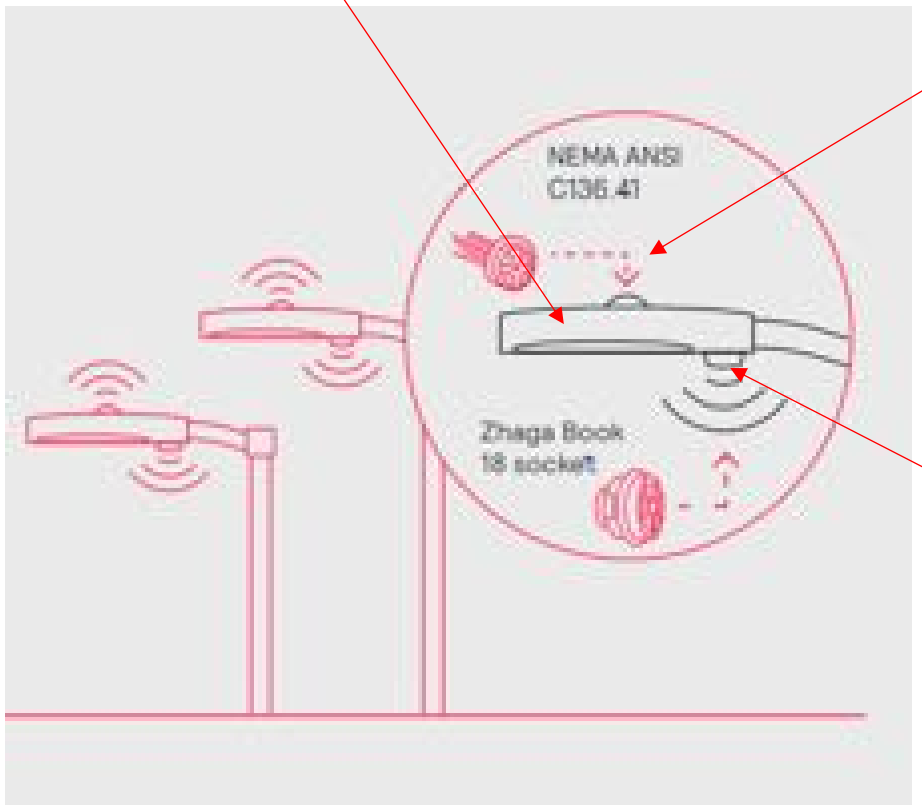
** Product under development*

< Back	DALI details
DALI address	A0
DALI status	04, ON
GTIN	[illegible]
Serial	[illegible]
Device manufacturer	Signify
Device model	[illegible]
Device type	6:50:51:52
FW Version	1.0
HW Version	1.0
Manufacture Time	–
Last update (energy)	2021-04-13 13:15:39
Energy Total	0.18 kWh
Active Power	30.5 W
System Starts	68
Operating Time	332:39 hours
Lamp On Time	3:23 hours
Operating Temperature, C°	36 C°
Power Factor (%)	–
Output Current	1094 mA
Output Voltage	24.0 V
Lamp Starts	147
Gear Failure Counter	10
Gear Status TS:TD:PL:OV:UV:OF	000000
Lamp Failure Counter	12
Lamp Status TS:TD:OC:SC:LF	00000
Input Voltage	116.0 V

Outdoor Application: interact City - Central management system with local sensing

D4i LED Driver

D4i Communication Node



D4i Multisensor

interact City

- Central management functions (scheduling, energy metering, asset management..) using RF communication node on NEMA receptacle.
- Local sensing and light control using Multisensor node on Zhaga receptacle.

Outdoor Application: Asset & Diagnostic data using Synapse system

D4i LED Driver

Synapse
ZHA-S1 Zhaga D4i
controller

** Dashboard under development*

D4i is Changing the World

Kevin Fitzmaurice, LC

Principal Engineer,
Lighting and Smart Services, Georgia Power

Lighting & Smart Services

Georgia Power

Earning customer loyalty by delivering exceptional value through lighting and smart services.

Future Proofing Outdoor Luminaires
— End User Perspective —

Kevin Fitzmaurice - Principal Engineer
Lighting & Smart Services - Georgia Power

Georgia Power

Lighting & Smart Services

Vision

To be the most valued and trusted utility lighting and smart solutions provider.

Mission

To earn customer loyalty by delivering exceptional value through lighting and smart services.

Guiding Principles

- Guided by CULTURE
- Lead by STRATEGY
- Focused on CUSTOMER
- Informed by DATA
- Enabled by TECHNOLOGY
- Optimized for RESULTS

DALI® Alliance

Georgia Power – a Summary of Services

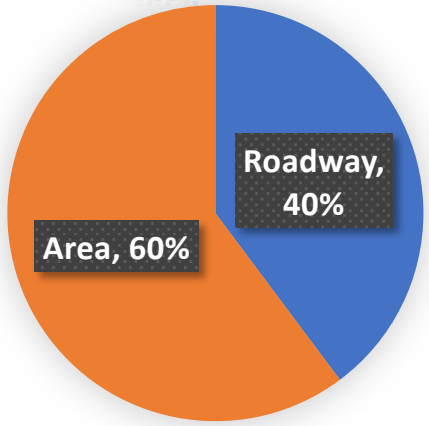
Investor owned utility (IOU) providing electricity to 2.6 million customers

Own, operate and maintenance 930,000 outdoor luminaires

- 370,000 roadway luminaires (40%)
- 560,000 area luminaires (60%)

Provide “Smart Services” such as:

- Monitoring and control of outdoor luminaires
- Video and license plate recognition (LPR) systems
- Gun shot detection and ambient noise level monitoring
- Environmental monitoring (e.g., air quality, CO_2, RH)
- Pedestrian and vehicle counting
- Small cellular (4G/5G) transceivers and antennas on lighting poles



What is Georgia Power currently doing?

- Converting 930,000 luminaires to LED with networked lighting controllers (NLC)
- Monitoring LED luminaires with wireless networks and central management systems
- Utilizing digital communication protocols (e.g., DALI, DALI-2, D4i) in our LED luminaires
- Using sensors for additional functionalities
- Actively participating on lighting standards committees (e.g., ANSI, IES)

Why does Georgia Power use DALI, DALI-2 and D4i digital communication protocols?

To provide two-way communications between LED drivers, sensors and networked lighting controllers (NLCs)

They are established protocols with published standards and provide the desired functionalities

What about sensor interfaces?

- Georgia Power needs standardized sensor interfaces
- These interfaces need to be locking type for easy installation or removal of sensors
- These interfaces are needed so Georgia Power can “future proof” its luminaires
- Georgia Power selected the 7-pin ANSI C136.41 control receptacle on the top of the luminaire for NLCs or PCs
- Georgia Power selected the 4-pin ANSI C136.58 (Zhaga Book 18) interface on the bottom of the luminaire for sensors

Do these standardized control and sensor receptacles meet Georgia Powers' needs?

Yes!

- It provides a standardized environment for digital communication between our digital drivers, sensors and networked lighting controllers (NLCs)
- It allows Georgia Power to "future proof" its luminaires
- It allows easy installation and removal of controls and sensors
- It provides a standard framework for manufacturers of drivers, sensors, controllers and luminaires to use for design and production of the tools the lighting industry and Georgia Power need today

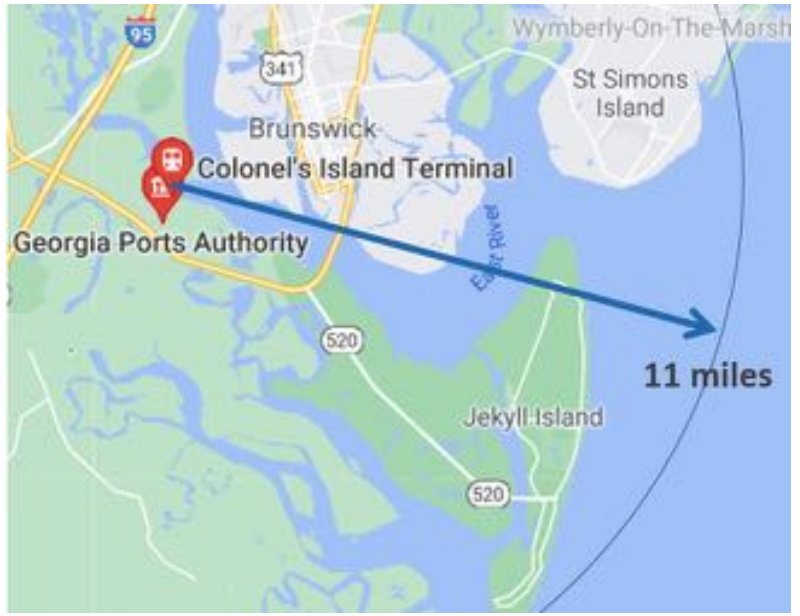
Let’s conclude with a case study

Georgia Ports Authority - Port of Brunswick, GA

This port specializes in roll-on/roll-off (RORO or ro-ro) ocean vessels normally holding between 4,000 and 5,000 vehicles

Photo by Georgia Ports Authority

The port on Colonel's Island is less than 11 miles from turtle sanctuaries on Jekyll Island



Google Maps

Case Study: Georgia Ports Authority

Georgia Power installed 600 DALI enabled roadway and area LED luminaires with networked lighting controllers (NLCs) at this site. Approximately 500 with presence sensors to detect activity and 100 without presence sensors on roadways.

This configuration with presence sensors provides low lumen output (30% of full) during nighttime hours unless activity (presence) is detected. Activity triggers 100% lumen output until there is 15 minutes of inactivity when the power reduces back to low output (30%)

This assembly provides automatic low or high lumen output, remote monitoring, energy metering and remote operational control

The customer reduces sky glow near a sea turtle nesting area and reduces energy usage

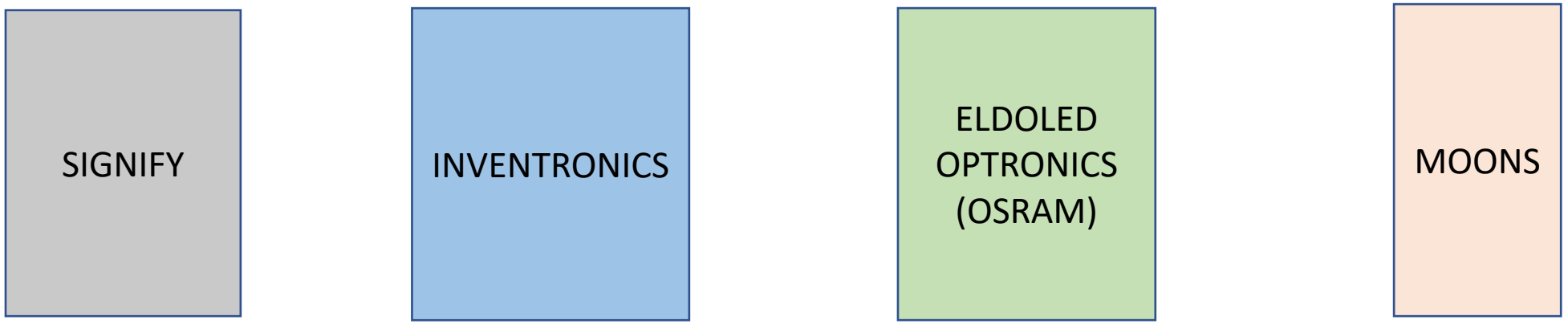
Georgia Power

D4™

Michael Davidson

System Architect, Synapse Wireless

Before DALI-2/D4i - Things were a bit Primitive



- Different Wiring Diagrams
- Different Software

Guess What? PLUG AND PLAY IS HERE

SIGNIFY

INVENTRONICS

ELDOLED
OPTRONICS
(OSRAM)

MOONS

- CERTIFIED D4i LED Drivers – Gets rid on the inconsistency in Hardware and Data

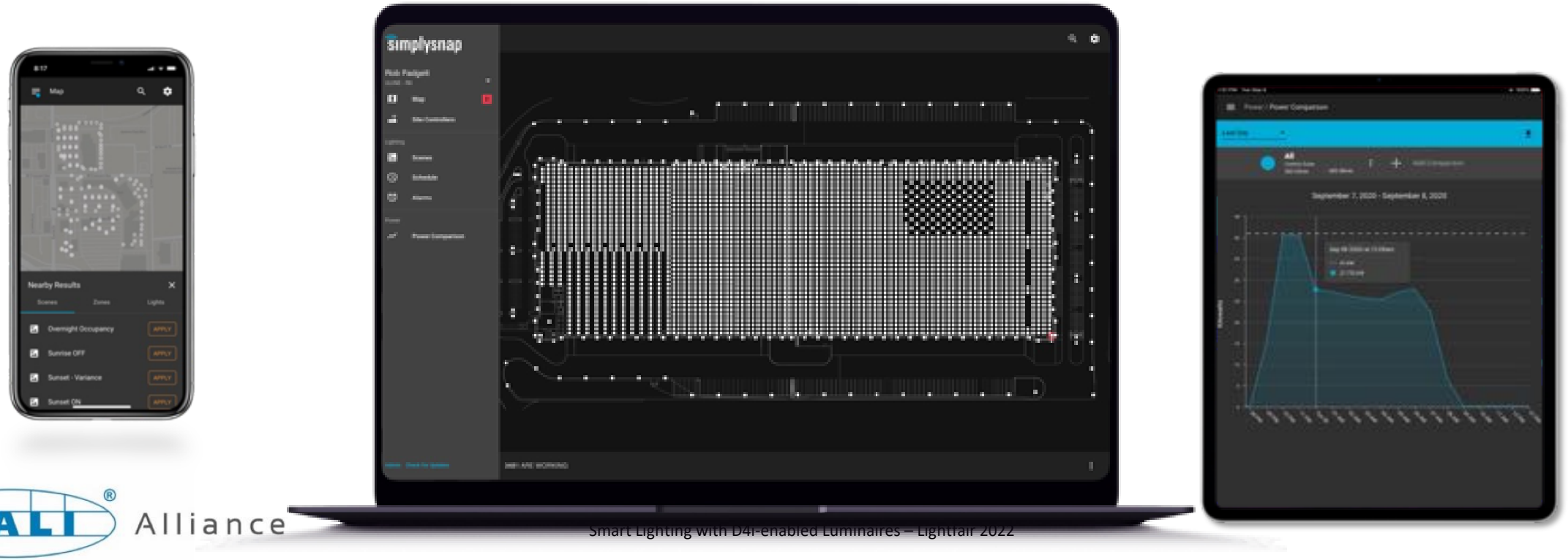
PLUG & PLAY

- ZHAGA INTERFACES FOR NLC (Networked Lighting Controls) and Sensors

PLUG & PLAY

D4i Brings the Information that lives on the DALI-2/D4i LED Driver Front and Center

Asset Info, Power Info, Power Saving Strategies, Temperature, Voltage Spikes, and Diagnostics



COMPLETE CONTROL

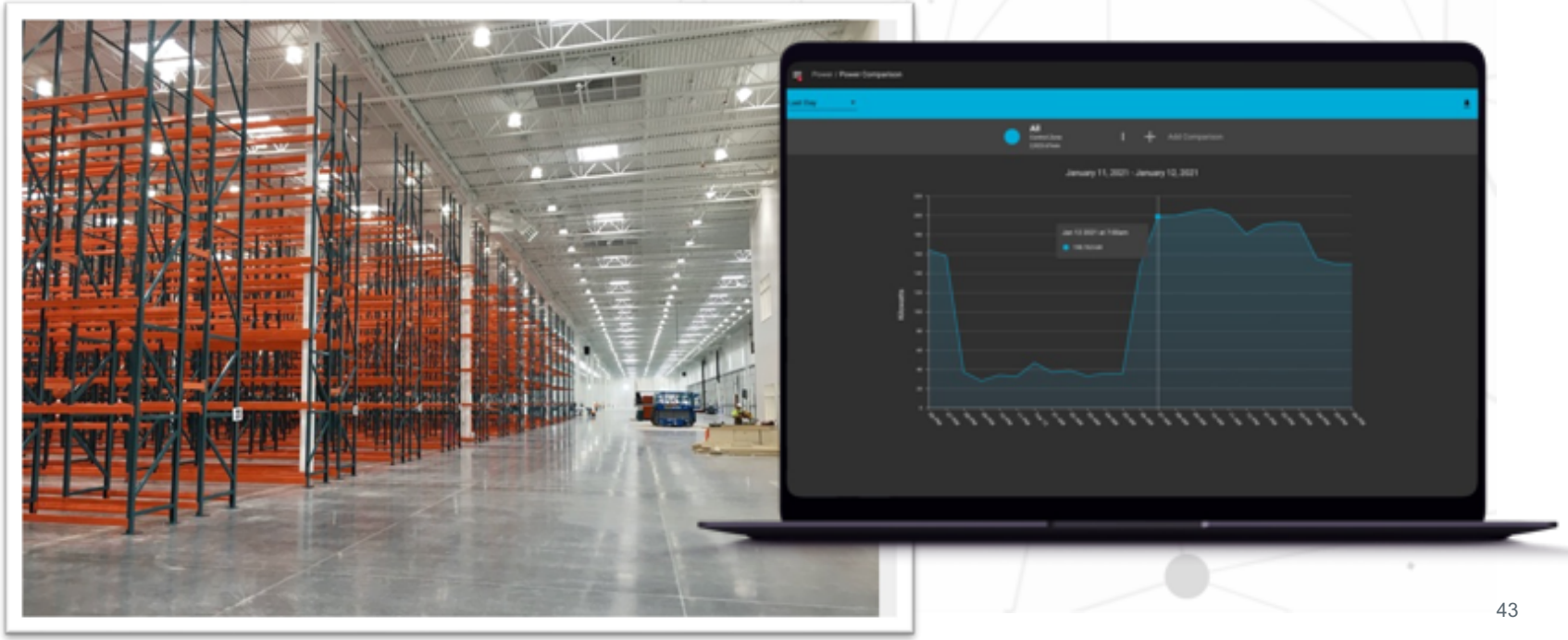
- Zoning
- Task Tuning
- Flexible Schedules

ENERGY SAVINGS

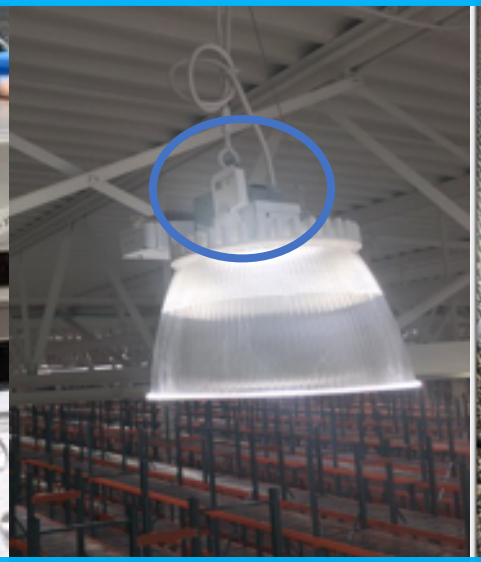
- Daylight Harvesting
- High-end Trim
- Scenes and Lighting Behaviors

MONITORING

- Fault Detection
- Notifications
- Power and Cost
- Power Saving Strategies



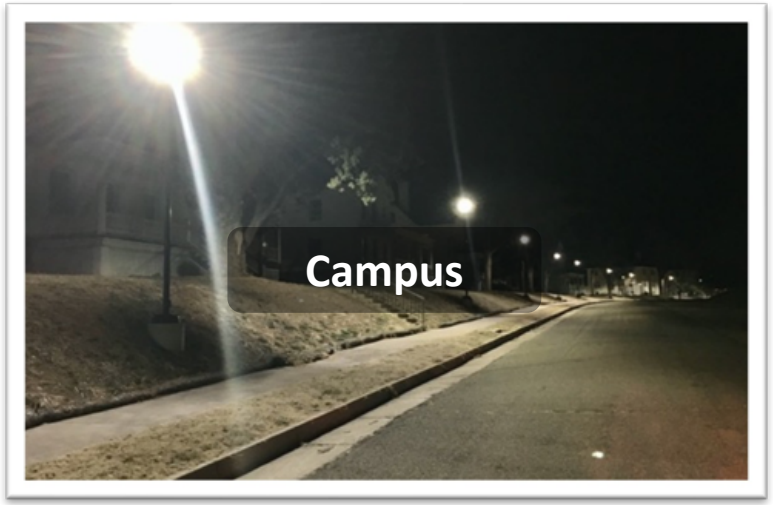
DALI® Alliance

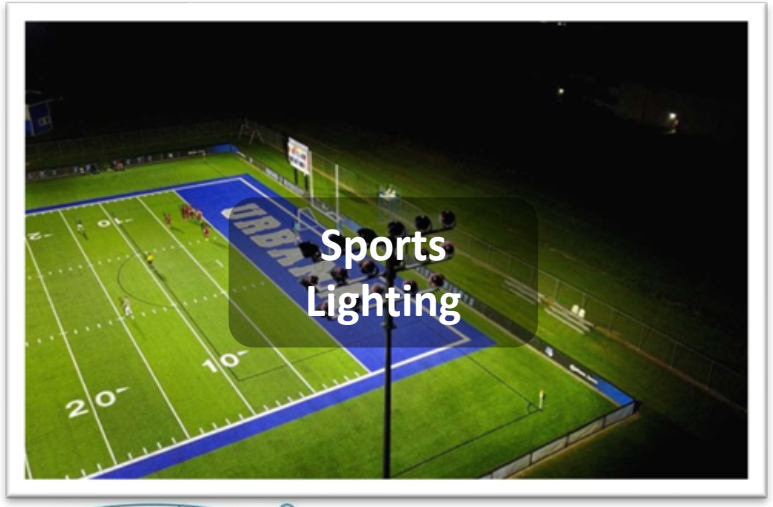


D4i AVAILABLE WITH OVER 50 LUMINAIRE MANUFACTURES

D4i comes in Different Shapes & Sizes

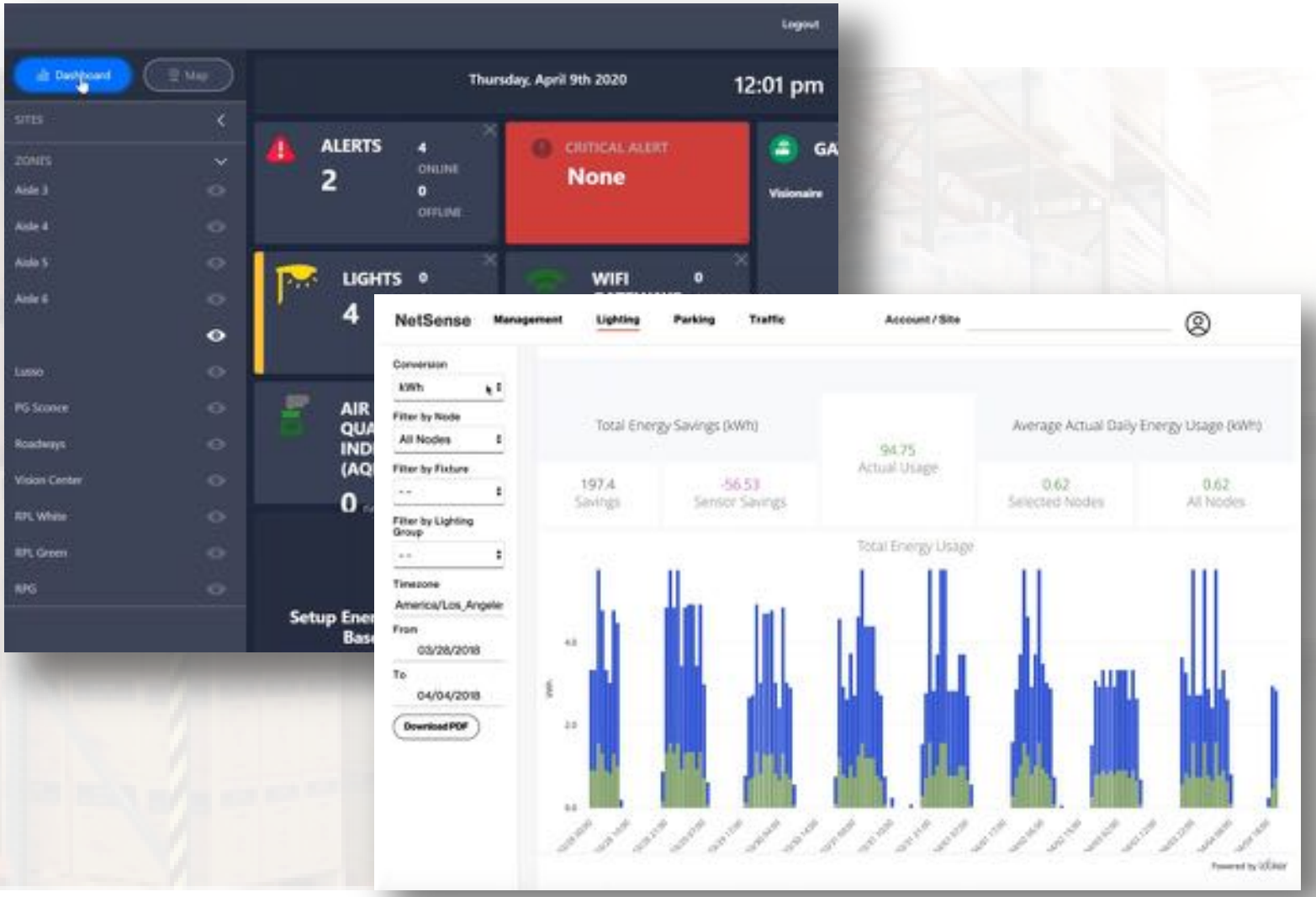
APPLICATIONS





INTEROPERABILITY

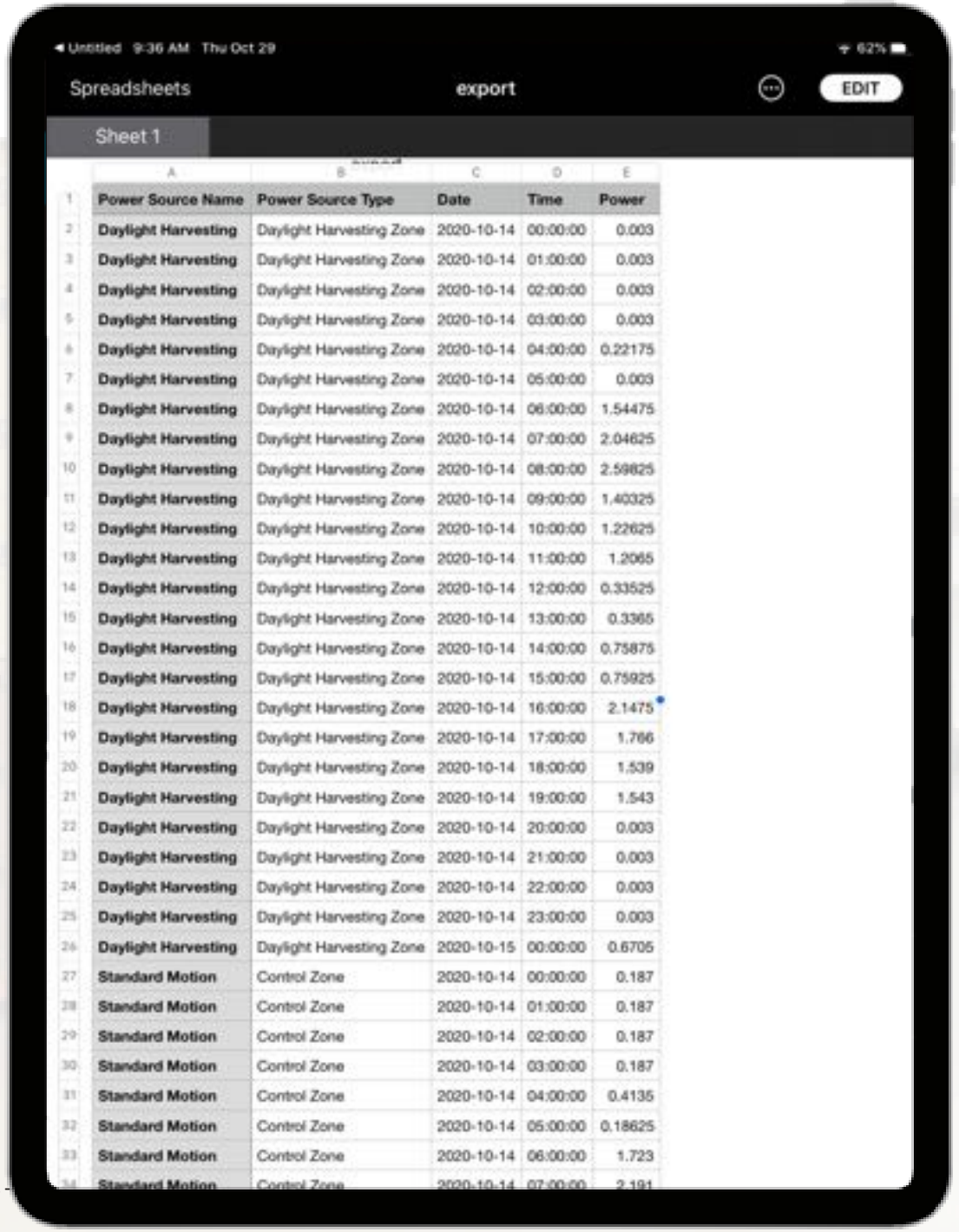
- Standard interface at the lighting layer (DALI2/D4i, AC/DC Power, Sensor input)
- Connect to existing IT infrastructure
- BACNET or Modbus
- Standard interfaces at Cloud layer (GraphQL API)



D4I ENERGY REPORTING

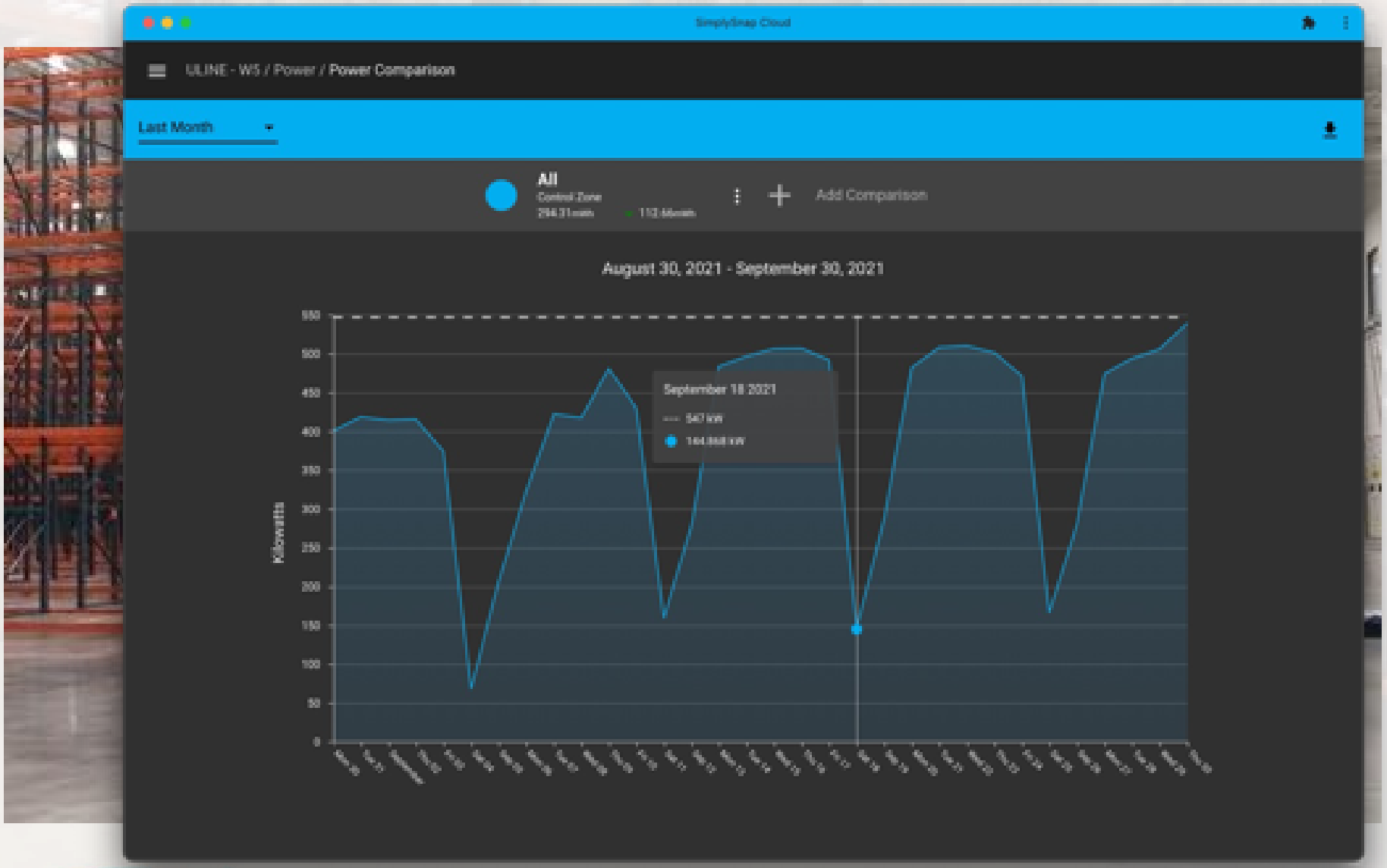
- Compare zone power against baseline
- Generate reports in real-time
- Use data for rebates and controls optimization

DALI® Alliance

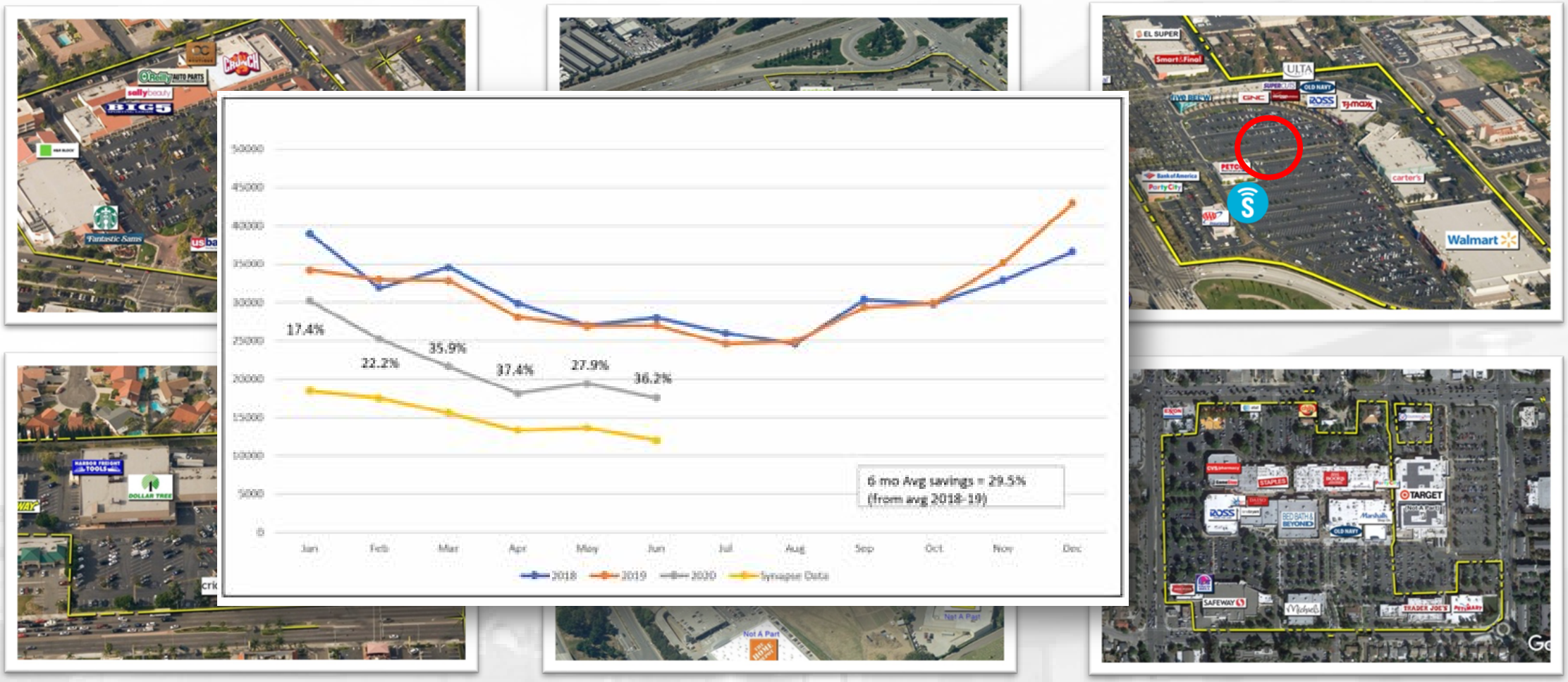


	A	B	C	D	E
1	Power Source Name	Power Source Type	Date	Time	Power
2	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	00:00:00	0.003
3	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	01:00:00	0.003
4	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	02:00:00	0.003
5	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	03:00:00	0.003
6	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	04:00:00	0.22175
7	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	05:00:00	0.003
8	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	06:00:00	1.54475
9	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	07:00:00	2.04625
10	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	08:00:00	2.59825
11	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	09:00:00	1.40325
12	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	10:00:00	1.22625
13	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	11:00:00	1.2065
14	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	12:00:00	0.33525
15	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	13:00:00	0.3365
16	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	14:00:00	0.75875
17	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	15:00:00	0.75925
18	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	16:00:00	2.1475
19	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	17:00:00	1.766
20	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	18:00:00	1.539
21	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	19:00:00	1.543
22	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	20:00:00	0.003
23	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	21:00:00	0.003
24	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	22:00:00	0.003
25	Daylight Harvesting	Daylight Harvesting Zone	2020-10-14	23:00:00	0.003
26	Daylight Harvesting	Daylight Harvesting Zone	2020-10-15	00:00:00	0.6705
27	Standard Motion	Control Zone	2020-10-14	00:00:00	0.187
28	Standard Motion	Control Zone	2020-10-14	01:00:00	0.187
29	Standard Motion	Control Zone	2020-10-14	02:00:00	0.187
30	Standard Motion	Control Zone	2020-10-14	03:00:00	0.187
31	Standard Motion	Control Zone	2020-10-14	04:00:00	0.4135
32	Standard Motion	Control Zone	2020-10-14	05:00:00	0.18625
33	Standard Motion	Control Zone	2020-10-14	06:00:00	1.723
34	Standard Motion	Control Zone	2020-10-14	07:00:00	2.191

ENERGY SAVINGS VERIFIED

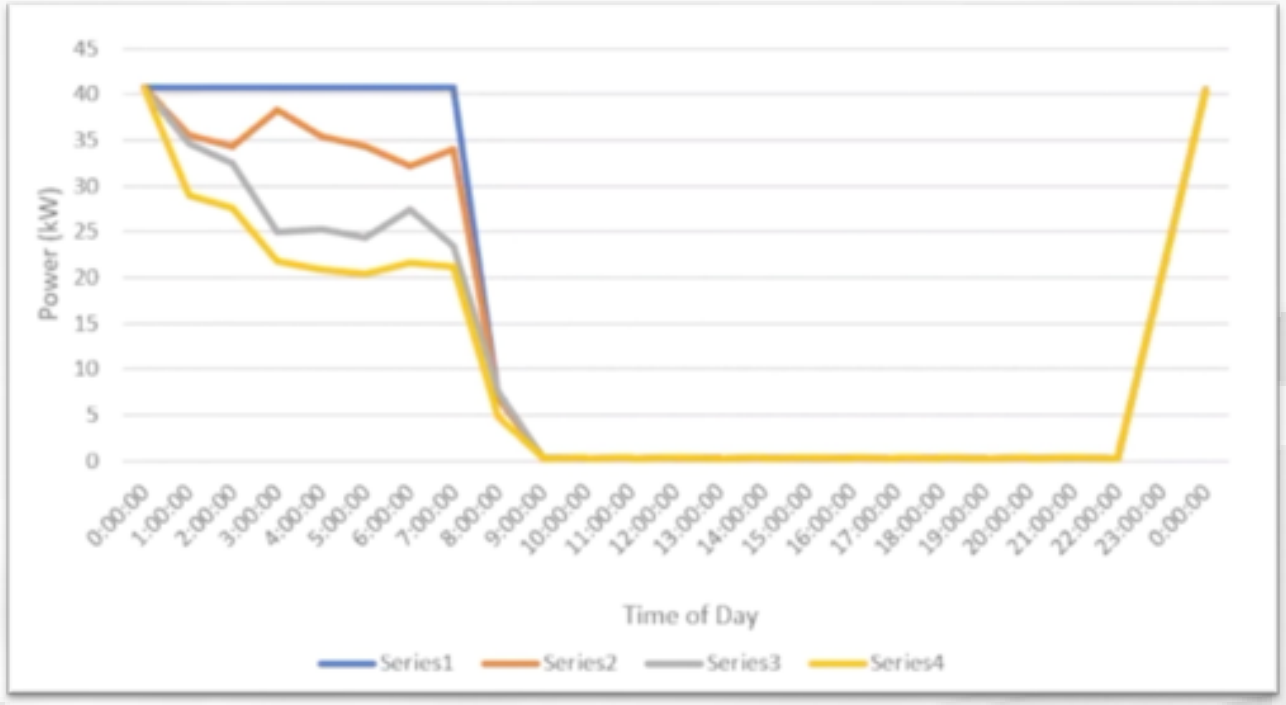


ENERGY OPTIMIZATION



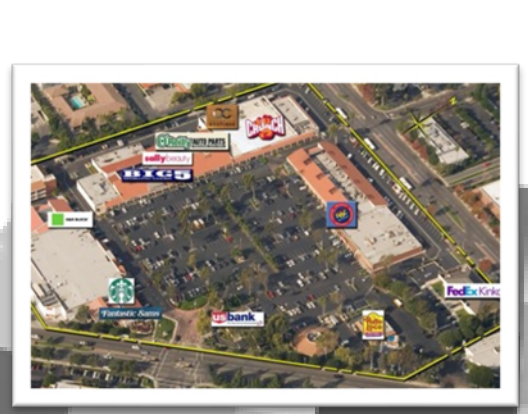
Site A	Site B	Site C	Site D	Site E	Site E
30%	34%	29%	36%	27%	24%

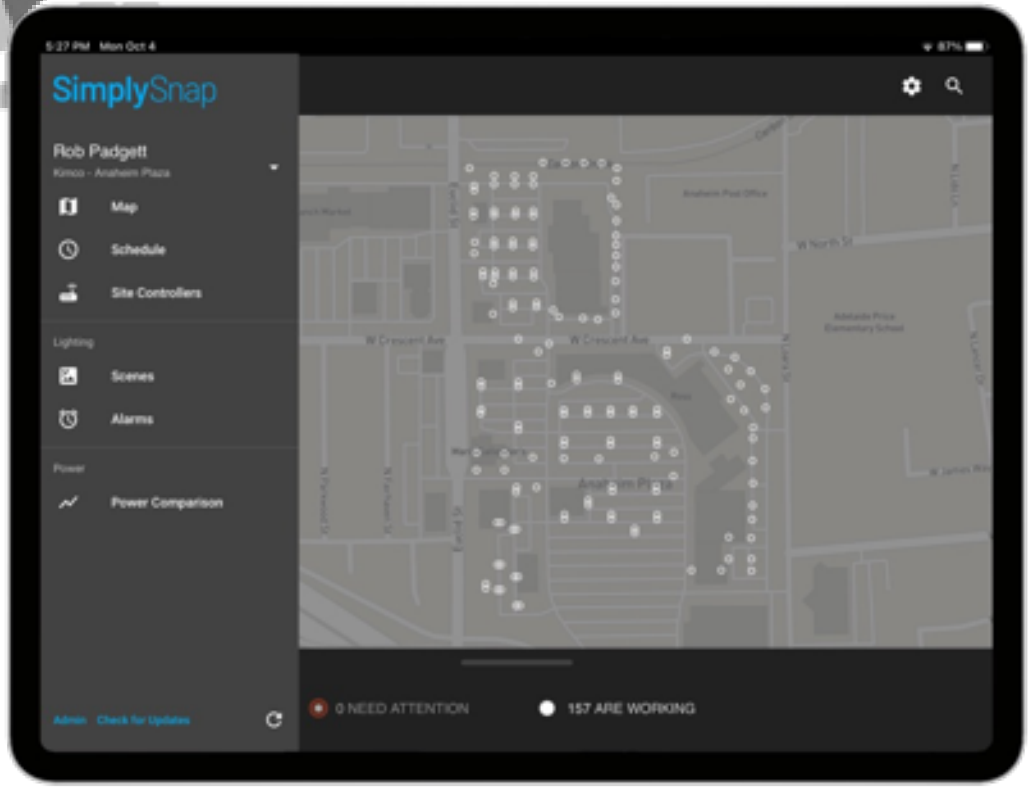
ENERGY OPTIMIZATION



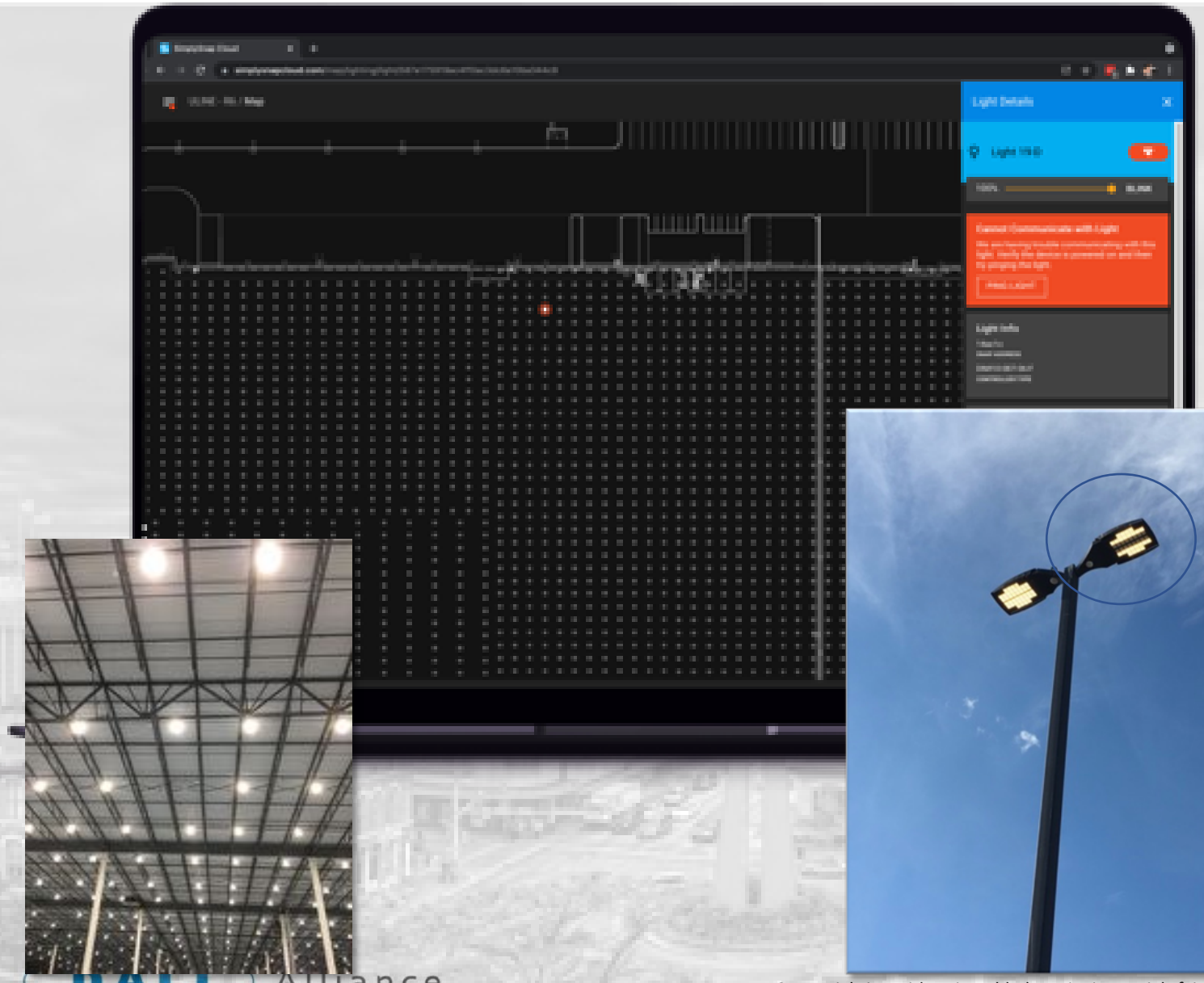
Site A	Usage (kWh)	Usage (kWh)
1. Baseline with No Occupancy Detection	397	0%
2. Initial Synapse Deployment	356	10%
3. Improved Occupancy Detection Zone	305	23%
4. Optimized Setback	273	31%

MANAGE MULTIPLE LOCATIONS USING DALI-2/D4I LUMINAIRES AND A NETWORKED LIGHTING CONTROL SYSTEM



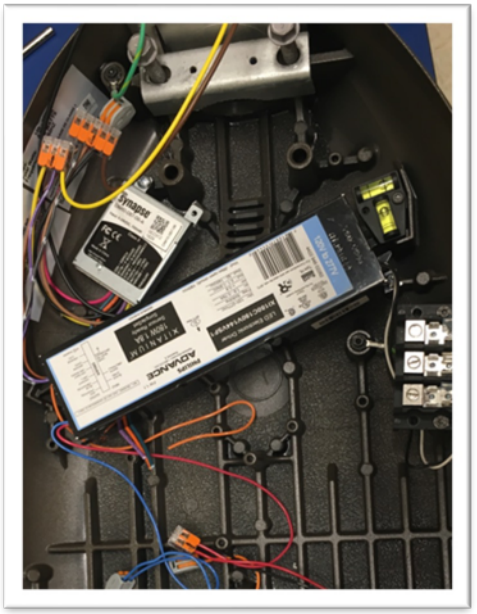


PROACTIVE MONITORING

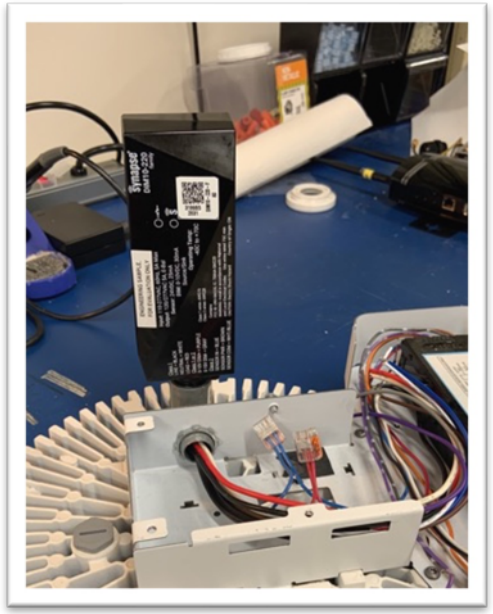


DALI-2 / D4i Brings **Plug and Play** to the Lighting Market
Mix and Match Luminaires from any OEM with D4i Ready Luminaire.

1. Specify DALI-2 / D4i Luminaires
2. Pick Controls: Zigbee – Bluetooth – SNAP – Thread
3. Mix and Match Luminaires for OEMs

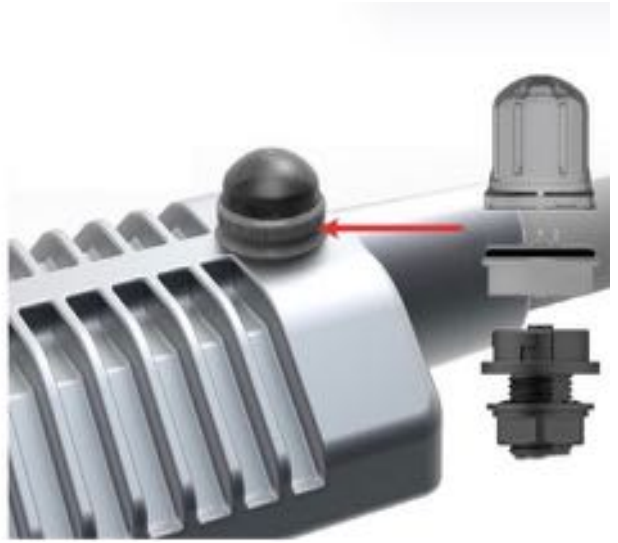


Embedded D4i



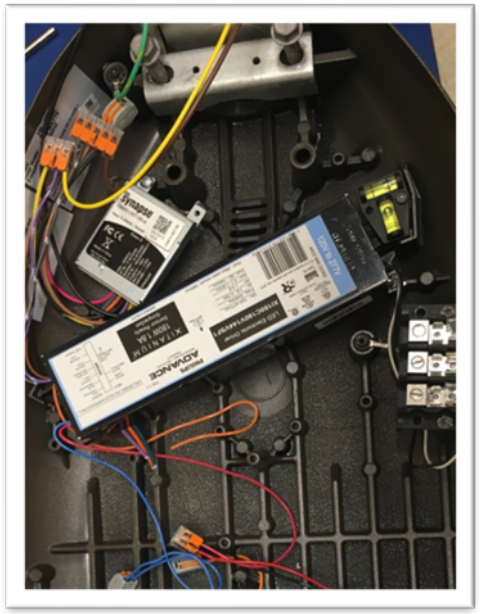
Bolt-on 0-10V Retrofit

Twist Lock 0-10V



Zhaga D4i Controller

MIX & MATCH TECHNOLOGIES



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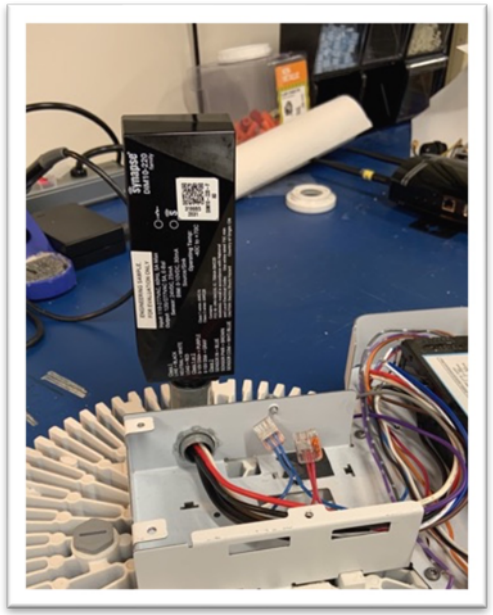
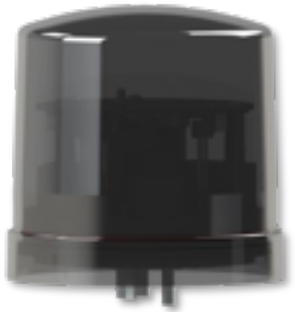
DIM10-87-06-A



Bolt-on Retrofit
DIM10-220



Twist Lock
TL7

Zhaga Controller
ZHA-S1

WHY DO WE CARE ABOUT ENERGY MONITORING?

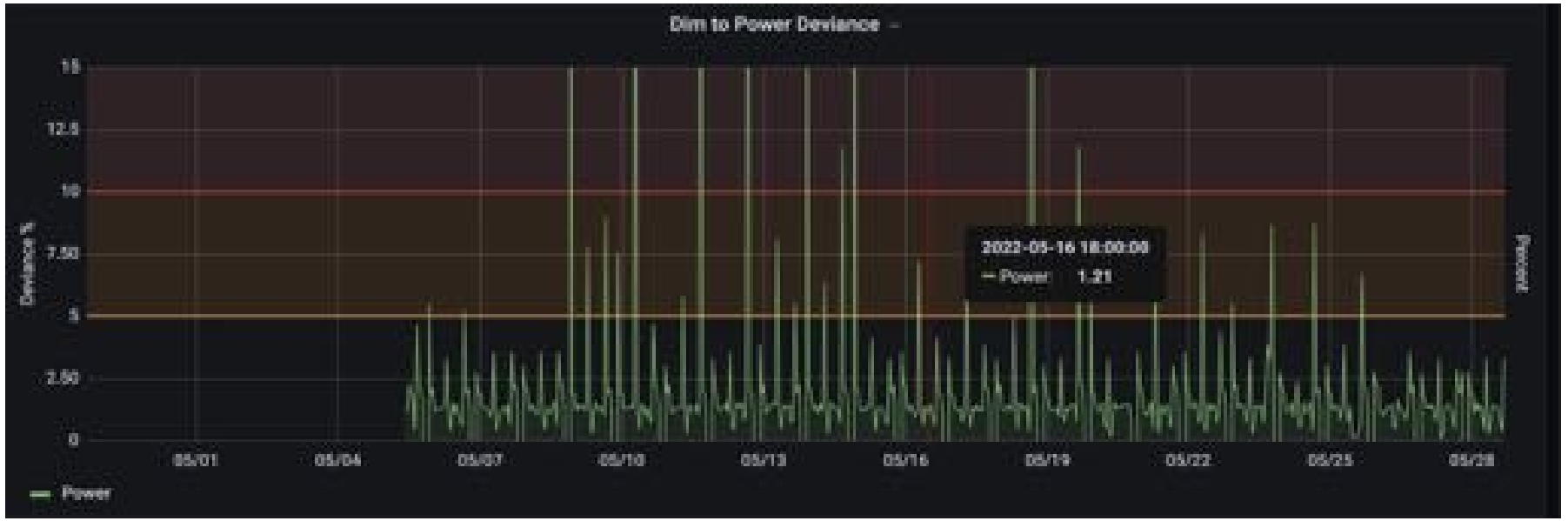
- VALIDATE SAVINGS
- REBATES
- ENERGY CODES
- DLC CERTIFICATION
- ESG STORY
- SUSTAINABILITY
- CASH TO THE BOTTOM LINE

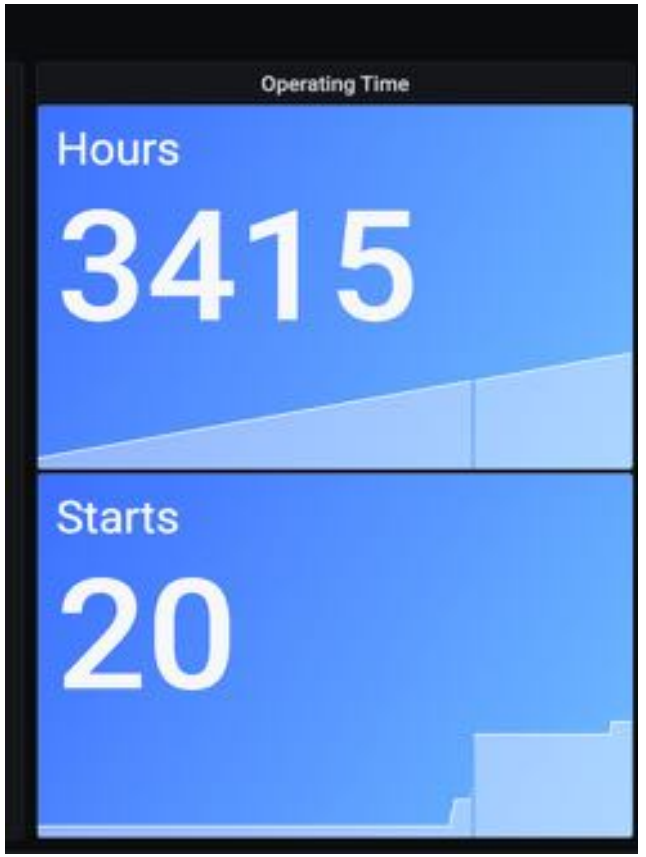
WHAT IS NEXT?

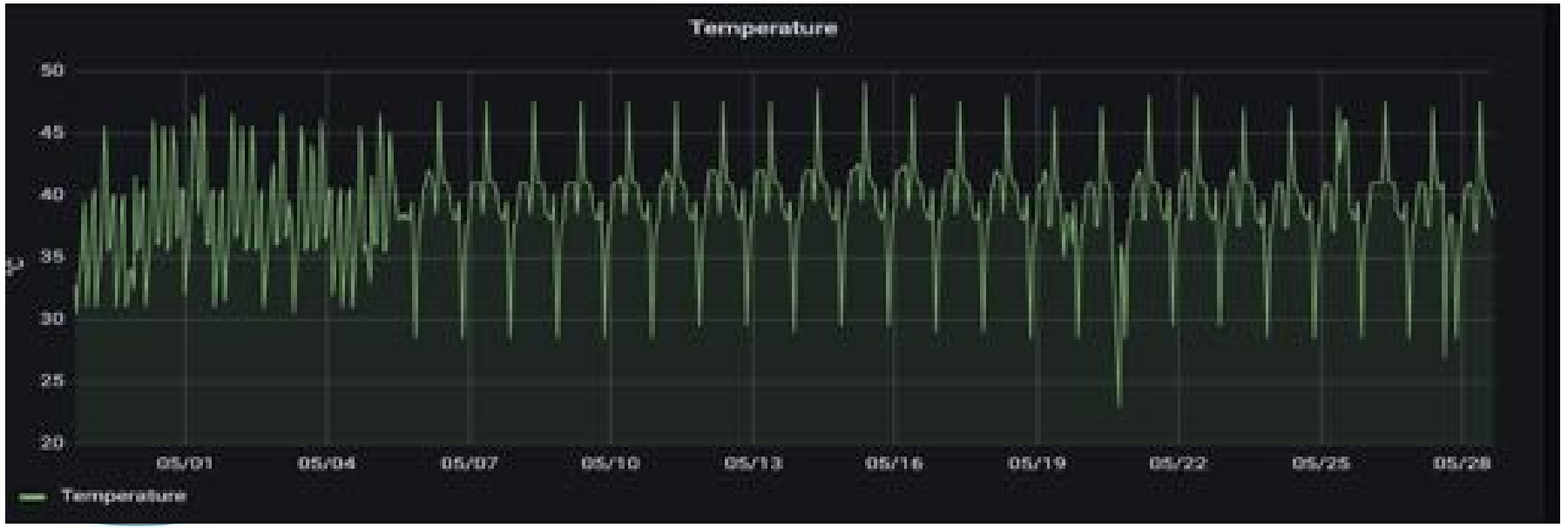
Driver Information	
Field	**Value**
Manufacturer	Signify
GTIN	781087167397
Product ID	1614154786628379
Firmware Version	1.0
Hardware Version	1.0

GTIN	123456789012
Serial Number	164722
Manufacturing Year	16
Manufacturing Week	51
Input Power	50
Power at Min Dim	2
Min AC Mains	120
Max AC Mains	277
Light Output	3500

WHAT IS NEXT?


Dim to Power Deviance
15
12.5
10
7.50
5
2.50
0
Deviance %
2022-05-16 18:00:00
Power 1.21
05/01
05/04
05/07
05/10
05/13
05/16
05/19
05/22
05/25
05/28
Power


Operating Time
Hours
3415
Starts
20


Temperature
50
45
40
35
30
25
20
°C
05/01
05/04
05/07
05/10
05/13
05/16
05/19
05/22
05/25
05/28
Temperature

Thank you!

Remember to complete your course evaluations.

Sree Venkit
Signify

Kevin Fitzmaurice
Georgia Power

Michael Davidson
Synapse Wireless