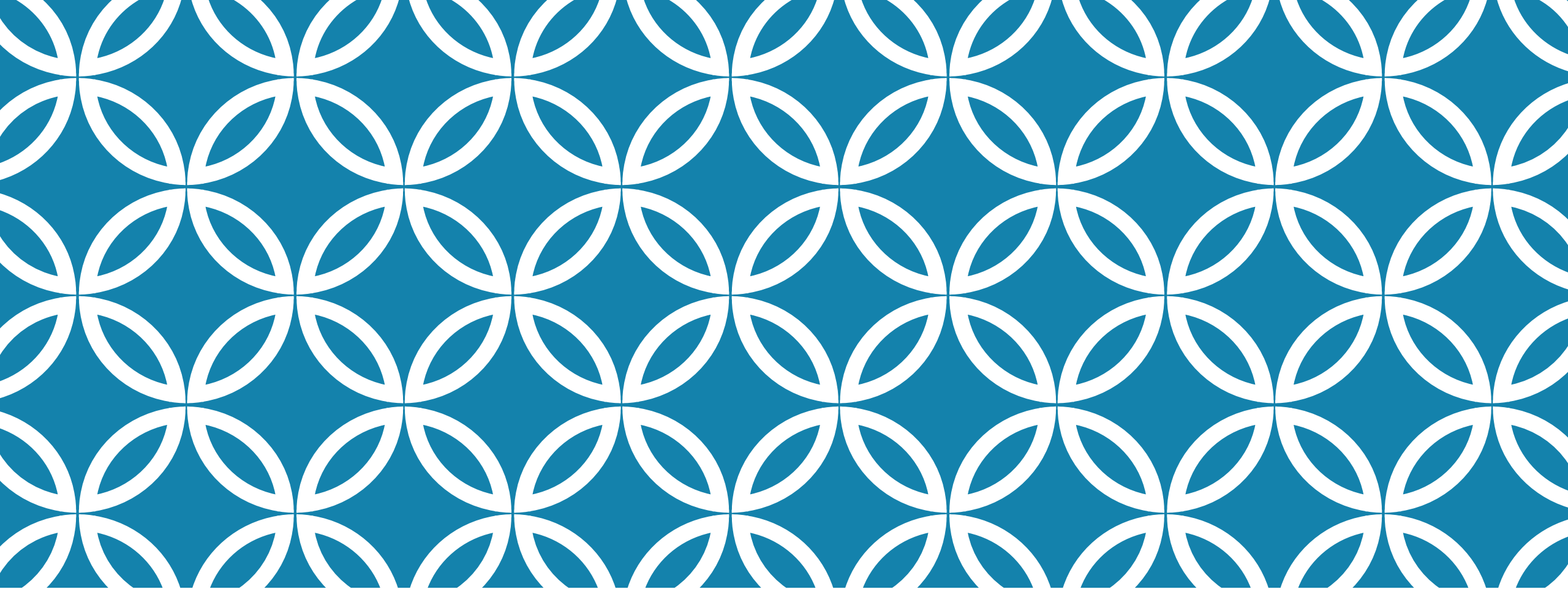




LIGHTING DESIGN IN HEALTHCARE

MEL BUSS, Buss Lighting LLC, LC, IES, IALD

KANDICE COHEN, Acuity Brands Inc.

MIKE SKURLA, Acuity Brands Inc., LEED AP O+M & BD+C MIES ASHRAE



LEARNING OBJECTIVES

1

Articulate the **wide variety of lighting needs for a healthcare environments**.

2

Explain how **energy savings** are possible using **lower illuminance levels** than has been traditional in healthcare environments.

3

Define how **system based lighting infrastructure can improve the stakeholder experience beyond simple financials** while still being simple to understand and operate.

4

Define new technology and terms that are **entering the lighting conversation** which impact design conversations about facility lighting and personal well-being to a wide array of stakeholders within a clinical environment.

Traditional Lighting Controls

Stand-Alone Controls

Low-Voltage Relay Panel Systems

New Types of Lighting Controls

Stand-Alone Fixture-Integrated Sensors

Room-Based Controls (Room Controllers)

▶ Simplified Networked Systems

▶ Comprehensive Networked Systems



CENTRAL VERMONT MEDICAL CENTER - LIGHTING DESIGN

We all accept the practical importance of light, but we must also appreciate its creative potential.

Lighting design for a retrofit/renovation project doesn't have to be 1-for-1 replacement of fixtures

A good lighting design will enhance functionality, ambiance and ultimately the enjoyment of the interior and exterior spaces.

- Less of the traditional blanketing of a space with uniform illumination
- Varying the levels of illumination to create interest
- Use of personal controls for both patients and staff

CENTRAL VERMONT MEDICAL CENTER — LIGHTING DESIGN

A professional lighting designer's primary goal is to properly illuminate the project's built environment including:

- An energy efficient and aesthetically pleasing lighting system
- Proper illumination for a given task
- Improve the environment for patients and staff
- Safety and security concerns

Data is presented on the actual CVMC case study.

TOTAL ENERGY USE IN HOSPITALS – EUI(ENERGY USE INTENSITY) = 250 KBTU/SF.FT

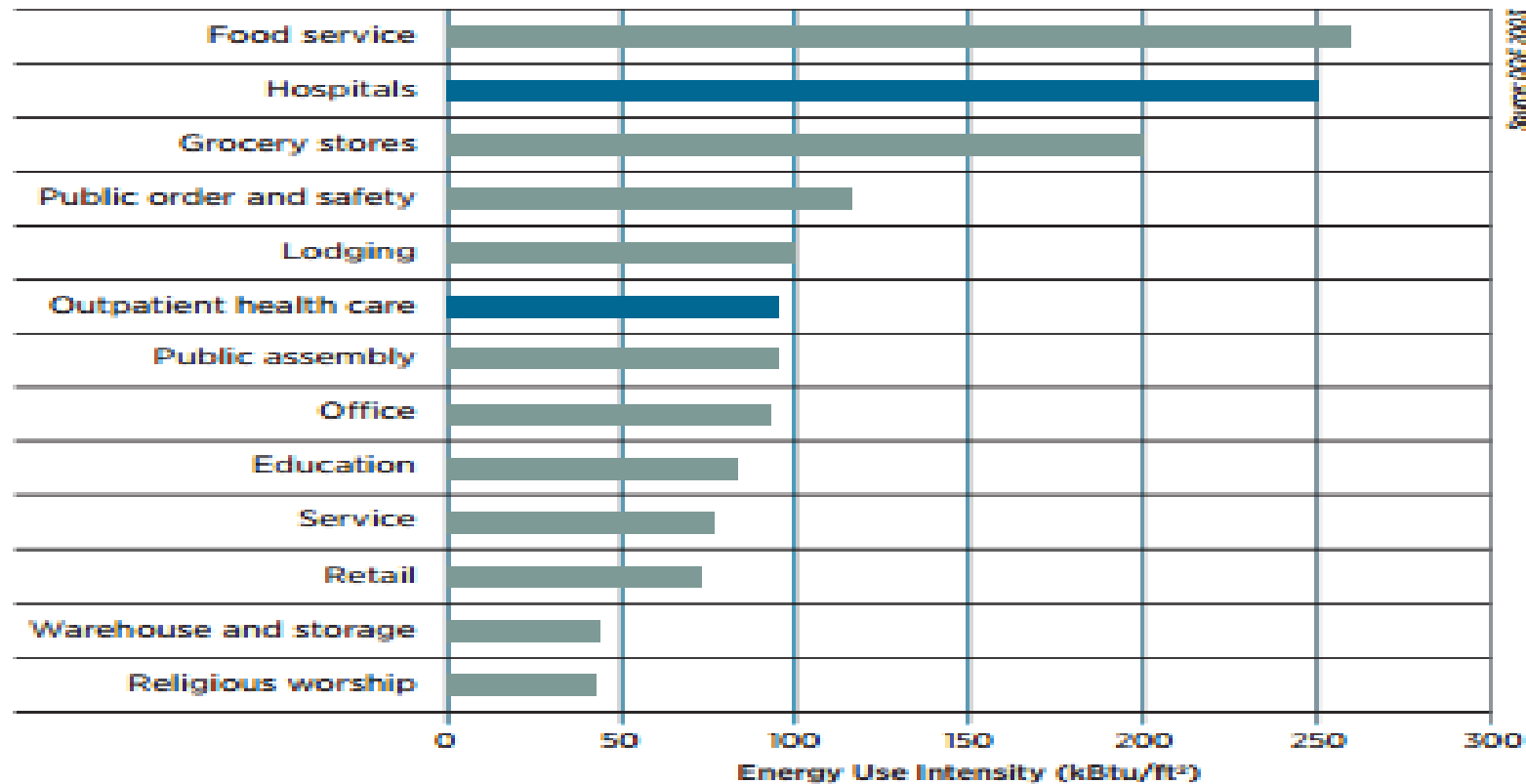


Figure 1–1 EUI for common commercial building types

TOTAL ENERGY USE IN HOSPITALS BY BUILDING TYPE (MMBTU)

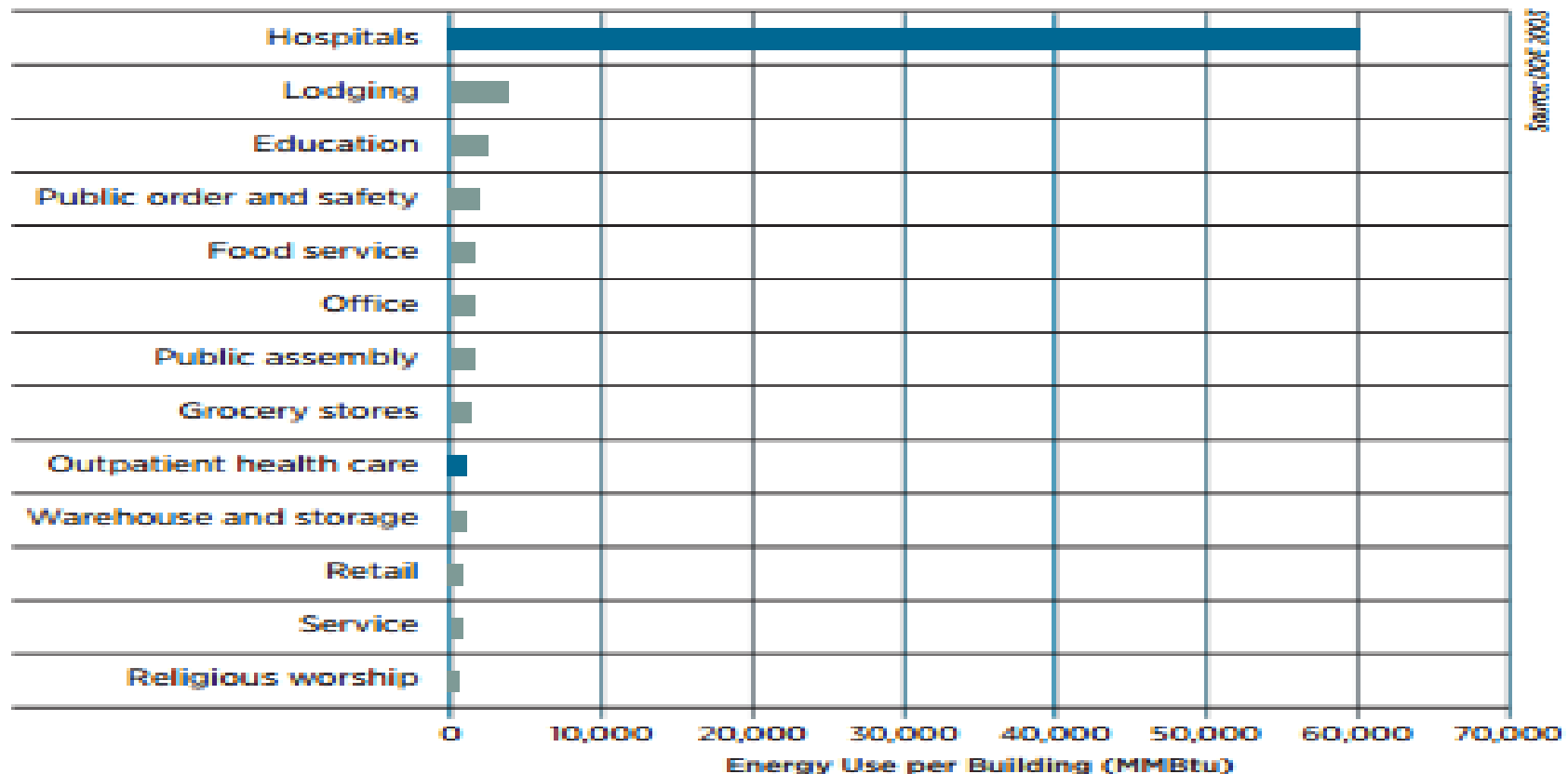


Figure 1-2 Energy use per building for common commercial building types



CVMC

University of Vermont Health Network - Central Vermont Medical Center has earned the U.S. Environmental Protection Agency's (EPA's) coveted ENERGY STAR certification, which signifies the facility performs in the top 25 percent of all hospitals nationwide for energy efficiency and meets strict energy efficiency performance levels set by the EPA.

“We are pleased to accept the ENERGY STAR certification, in recognition of our efficiency efforts,” said CVMC Vice President of Support Services Richard Morley. “Through this achievement, we have demonstrated our commitment to environmental stewardship, lowered our energy costs and provided a healing environment for our patients, where spaces are lit and conditioned to industry best practice”

ENERGY STAR SCORE FOR HOSPITALS

- The ENERGY STAR Score for Hospitals applies to general medical and surgical hospitals, including critical access hospitals and children's hospitals.
- The objective of the ENERGY STAR score is to provide a fair assessment of the energy performance of a property relative to its peers, taking into account the climate, weather, and business activities at the property.
- To identify the aspects of building activity that are significant drivers of energy use and then normalize for those factors, a statistical analysis of the peer building population is performed. The result of this analysis is an equation that will predict the energy use of a property, based on its experienced business activities.
- The energy use prediction for a building is compared to its actual energy use to yield a 1 to 100 percentile ranking of performance, relative to the national population.



CENTRAL VERMONT
MEDICAL CENTER

A Member of The Hitchcock Alliance

→ Main Entrance

→ Patient Parking 

→ Exit

← Emergency Entrance

CVMC — ENERGY SAVINGS INITIATIVE (ESI) TEAM MEMBERS

Richard Morley (CVMC)

Leo Martineau (CVMC)

Greg Liebert (Liebert Engineering)

Mel Buss (Buss Lighting LLC)

Tim Perrin (EVT)

Maribella Ibarra (EVT)



CVMC

Five years ago, when the CVMC Energy Savings Initiative team began meeting, the facility ranked in the bottom quartile of hospitals nationally for energy performance

A hospital-wide energy audit was followed by an energy master plan that addressed interior and exterior lighting, heating, ventilation, air conditioning, and information technology systems.

CVMC

In total the medical center has reduced energy consumption by 28 percent, unprecedented for a Vermont hospital.

The project has reduced greenhouse gas emissions by 6.3 million pounds of carbon dioxide a year, which is equivalent to taking 604 passenger vehicles off the road for a year. The use of new and innovative technologies has also led to **an annual savings** of:

Over 2.2 million kilowatt-hours of electricity

110,000 gallons of fuel oil

\$750,000 per year in energy costs, including a 37 percent return on investment (an average 2.7 year payback on all investments)

CVMC

Major projects implemented by UVM Health Network - CVMC include:

- Upgrade of hospital lighting to more efficient technologies using a comprehensive lighting design
- Installation of a templifier (heat recovery from chillers for summer hot water needs)
- Optimized performance for hospital-wide heating, ventilation, and cooling systems
- Conversion of boilers from fuel oil to compressed natural gas
- An employee engagement campaign for staff to identify energy reduction opportunities across their departments and areas of focus

CVMC — LIGHTING UPGRADE/RELOCATION CONSTRUCTION

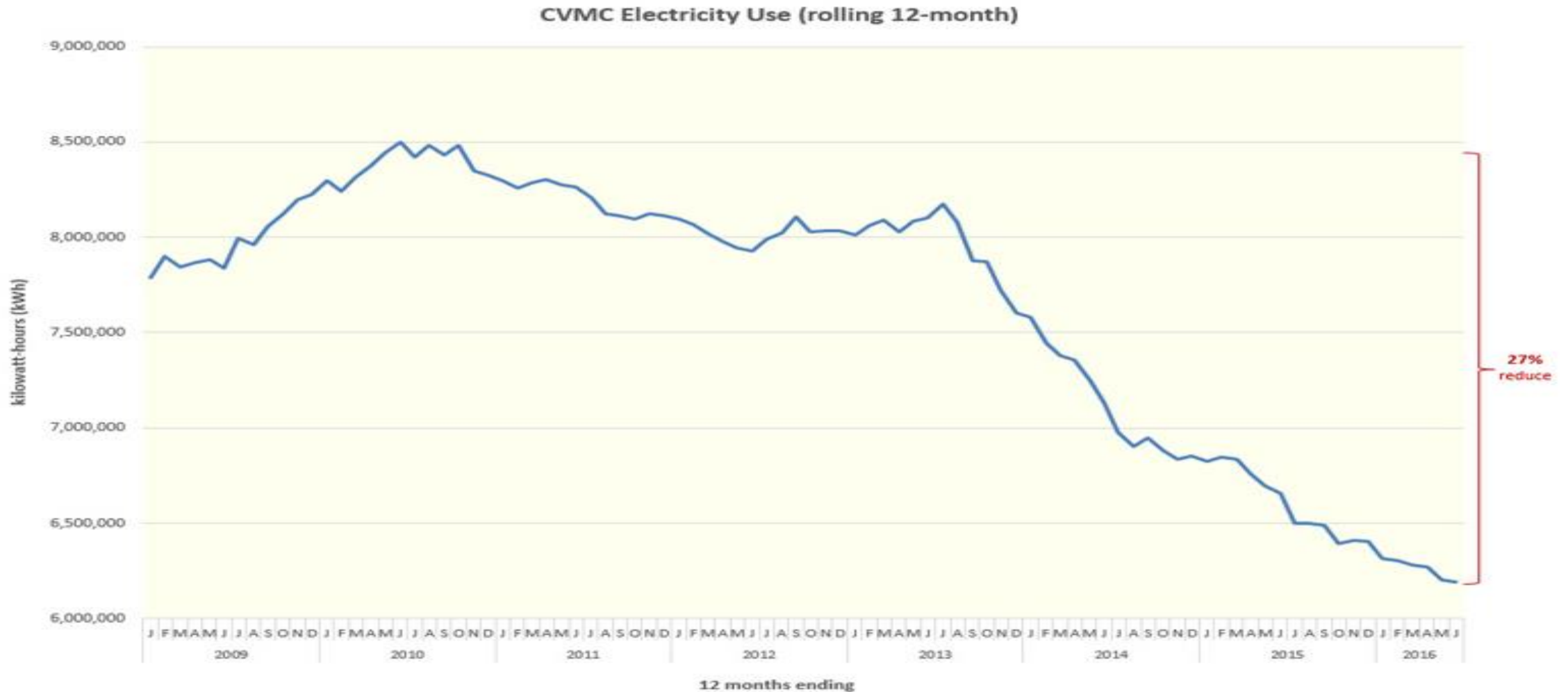
Major projects implemented by UVM Health Network – Central Vermont Medical Center include:

Upgrade of hospital lighting to more efficient technologies

Working with Buss Lighting LLC , a comprehensive lighting audit and design for the hospital and campus medical office buildings was conducted to identify opportunities to improve the quality, controllability, and energy performance of lighting systems.

- Existing T8 fluorescent lighting was converted to LED troffers with integrated controls, with many existing fixtures eliminated due to improved light distribution by new LEDs.
- When all lighting upgrades are complete (expected at end of 2016), CVMC will have cut electricity use for lighting systems by over 60 percent, while dramatically improving light quality and adding controls through the process.

CVMC ELECTRICITY USE (ROLLING 12 MONTH)



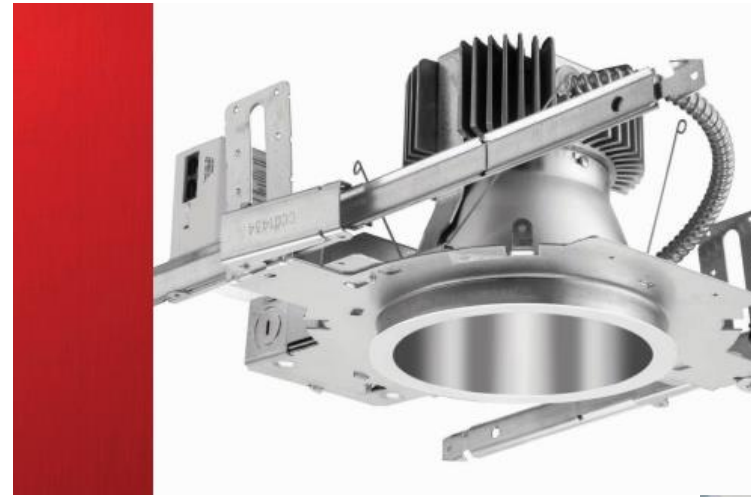
LUMINAIRES

Specification of luminaires requirements

A design goal was to have a consistent look through the hospital.

Another design goal was to have a small number of fixture types to provide this uniformity and to build strong facility staff knowledge of these specific fixtures and how they interface with the control systems.

LUMINAIRES



SURFACE VOLUMETRIC



CONTROLS

CVMC – limited previous use of controls in various spaces:

Occupancy and Dimming



South Entrance

DO NOT
ENTER

CVMC — INTERIOR LIGHTING UPGRADE INCLUDED

- Dimming
- Multi-level Dimming
- Daylight Harvest
- Personal Tuning
- Task Tuning
- Institutional Tuning
- High-End Trim
- Low-End Trim
- Lumen Maintenance

CONTROLS — ENERGY SAVINGS BY CONTROL TYPE

Control Type	Peer-Reviewed	Not Peer-Reviewed	Two-tailed <i>p</i> -Value*
Occupancy	24% (n=20)	23% (n=18)	0.8493
Daylighting	29% (n=20)	26% (n=12)	0.4687
Personal tuning	33% (n=12)	24% (n= 4)	0.4934
Institutional tuning	42% (n= 8)	26% (n= 5)	0.1268
Multiple types	43% (n=20)	30% (n=14)	0.0428

TABLE 7.
Comparison of Savings for
Peer-Reviewed and Nonpeer-
reviewed Papers

*Values <0.05 considered statistically significant.

CVMC — CONTROL TYPES USED

Single space solutions — 0-10v dimmer sensor switch

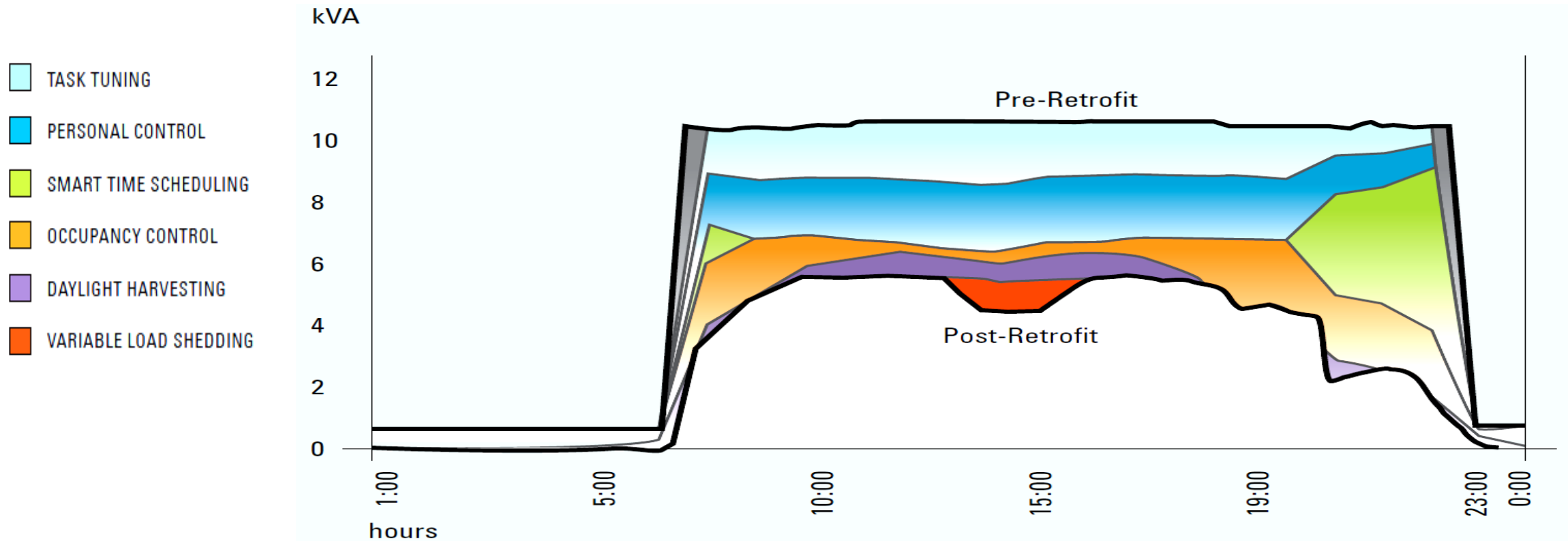
Wireless Dimming Power Packs 0-10v with wireless occupancy and daylight sensors, and wireless remote dimmer switch (>2 fixtures)

Wireless Dimming Power Pack 0-10v with local wired occupancy/daylight combined sensor and wireless remote dimmer switch for 2 fixtures (offices and exam rooms)

AVERAGE PORTFOLIO SAVINGS = 64%

Energy Management Strategies	Lighting energy savings due to Addressable Lighting Controls				Average Savings by Strategy *
	Multi-Tenant office bldg 300K ft²	HQ of Fortune 100 firm 400K ft²	Hospital Admin Building 175K ft²	Major sports complex 1.3 M ft²	
Smart Time scheduling	13.91%	8.91%	22.2%	24.01%	15 - 25%
Daylight Harvesting	0.60%	3.96%	8.15%	3.4%	20 - 50%
Task Tuning	9.0%	10.95%	13.24%	5.32%	10 - 25%
Occupancy Control	31.3%	24.94%	25.38%	37.21%	20 - 43%
Personal Control	6.12%	10.64%	1.8%	2.1%	7 - 23%
Variable Load Control	0.03%	4.65%	3.2%	5.1%	0 - 5%
Cumulative Savings due to Addressable Lighting Controls	60.96%	64.05%	73.97%	77.14%	

HOSPITAL ADMINISTRATION BUILDING



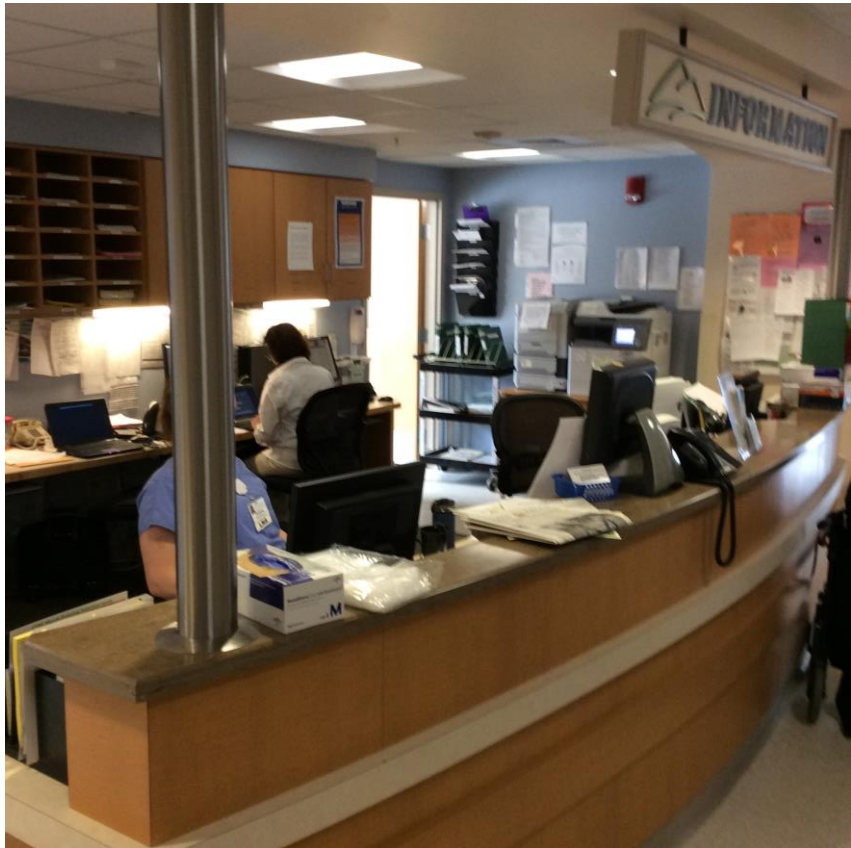
CMVC — PAYBACK PERIOD

Although the blended payback period is higher than CVMC's normal 3-year threshold, we have quantified only the energy impacts for this analysis.

As CVMC replaced existing fixtures with new LEDs, they also reduced/avoided the need to replace lamps and ballasts periodically and future fixture replacements.

Also on the cost side, there are spaces CVMC was renovating—and upgrading to new LED fixtures anyway and we still quantified in terms of full cost of replacement instead of incremental cost for going LED versus fluorescent.

“O&M Costs” & Fluorescent tube recycling costs have not be quantified.



CVMC DATA

The “Target kWh” is modeled on a simple

1-for-1 replacement from existing fixtures for LEDs.

By pursuing a more robust lighting design and controls, CVMC was able to cut that target in half again (130,000 kWh Actual versus 270,000 kWh Target).

This represents another \$15K in annual electricity savings that likely would not have been realized until the next time these new fixtures were replaced again (maybe 10-15 years in the future).

CVMC DATA

Replacing all of the fixtures across the hospital was partially driven by aesthetic needs of uniformity and equity, even when some of the spaces didn't necessarily have long enough operating hours to justify based on energy savings alone.



CVMC PROJECT COSTS & ENERGY SAVINGS

PROJECT NAME	PROJECT COSTS	EVT INCENTIVES	NET COST	BEFORE	TARGET	AFTER
	<u>Design, Materials, and Installation</u>	<u>Design, Materials, and Installation</u>	<u>Design, Materials, and Installation</u>	<u>kWh</u>	<u>kWh</u>	<u>kWh</u>
Conference Rooms	\$ 7,000	\$ 2,935	\$ 4,065			
Cafeteria & MOB A	\$ 2,000	\$ 1,161	\$ 839			
Stairwells	\$ 20,985	\$ 3,260	\$ 17,725			
Lobby	\$ 18,500	\$ 3,805	\$ 14,695			
reLIGHT Project I	\$ 84,409	\$ 22,450	\$ 61,959	174,707	125,538	68,640
reLIGHT Project II	\$ 55,295	\$ 15,000	\$ 40,295	86,054	54,259	22,164
reLIGHT Project III - MOB B	\$ 61,433	\$ 20,800	\$ 40,633	68,928	37,250	16,865
reLIGHT Project IV	\$ 36,516	\$ 9,900	\$ 26,616	39,883	27,918	13,417
reLIGHT Project V	\$ 36,966	\$ 14,265	\$ 22,701	36,504	25,599	11,229
TOTALS:	\$ 323,104	\$ 93,576	\$ 229,528	406,076	270,564	132,315
					33% reduce	67% reduce

CVMC ENERGY SAVINGS

PROJECT NAME	COST/BENEFIT	
	<u>Payback</u>	<u>ROI</u>
Conference Rooms	4.7	21%
Cafeteria & MOB A	0.9	114%
Stairwells	9.3	11%
Lobby	6.5	15%
reLIGHT Project I	5.5	18%
reLIGHT Project II	6.0	17%
<i>reLIGHT Project III - MOB</i>	7.4	14%
<i>reLIGHT Project IV</i>	9.5	11%
<i>reLIGHT Project V</i>	8.5	12%
TOTALS:	6.6	15%

CVMC — LPD (W/SQ.FT)



INTERIOR LIGHTING POWER ALLOWANCES

INTERIOR LIGHTING POWER ALLOWANCES	LPD (watts/sq.ft)		
BUILDING AREA METHOD			
BUILDING AREA TYPE			
Health Care Clinic	0.9		
Hospital	1.05		
Office	0.82		
BUILDING TYPE SPECIFIC SPACE TYPES			
health care facility			
In an exam/treatment room	1.66		
In an imaging room	1.51		
In a medical supply room	0.74		
In a nursery	0.88		
In a nurses's station	0.71		
In an operating room	2.48		
In a patient room	0.62		
In a physical therapy room	0.91		
In a recovery room	1.15		
COMMON SPACE TYPES			
LOBBY - In a Healthcare facility	0.92		
from Table C405.4.2 Interior Lighting Power Allowances, Vermont CBES 2015			

CVMC LPD (W/SQ.FT)

Project Summary	LPD (W/sf)		
	Existing	EVT Target	Lighting Designer
		1 for 1 retrofit	Redesign, Controls
Women's Health Center	1.3		0.5
Neurology	0.8	0.5	0.3
Cardiology, Kitchen	1.3	0.9	0.5
Neurology, Central Sterile Purchasing, and MOB-A corridors(partial)	2.0	1.4	1.0
MOB-B 2nd floor	1.5		0.4
MOB-D Human Resources	0.5		0.2

CVMC PROJECT IV – NEUROLOGY

Project: **Central Vermont Medical Center - CVMC - Project IV**
Lighting Designer: **Mel Buss, Buss Lighting LLC**

November 17, 2016

RELIGHT Project Summary

Design Energy Savings beyond RELIGHT Target: **144%**

Enter Design Estimates			ANNUAL USE / COST			ANNUAL SAVINGS *		
	LPD (W/sf)	VT Code	kW	kWh	\$ Cost	kW	kWh	\$ Savings
Existing	0.8	1.2	4.3	13,569	\$1,934			
RELIGHT Target	0.5	1.2	3.0	9,498	\$1,353	1.3	4,071	\$580
Design	0.3	1.2	1.7	3,636	\$518	2.7	9,933	\$1,415

Existing LPD less than code LPD. Confirm Project Area = 5600 sf

* The actual energy & cost savings may change depending on electric rate analysis, air conditioning savings and/or increased heating costs.

PROJECT II KITCHEN - CARDIOLOGY

RELIGHT Analysis Tool

Version 2014c (2014.09.25)

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Project: **Central Vermont Medical Center - CVMC - Project II**

November 17, 2016

Lighting Designer: **Mel Buss, Buss Lighting LLC**

RELIGHT Project Summary

Design Energy Savings beyond RELIGHT Target: **145%**

Enter Design Estimates			ANNUAL USE / COST			ANNUAL SAVINGS *		
	LPD (W/sf)	VT Code	kW	kWh	\$ Cost	kW	kWh	\$ Savings
Existing	1.3	1.2	19.6	86,054	\$12,263			
RELIGHT Target	0.9	1.2	13.8	60,238	\$8,584	5.9	25,816	\$3,679
Design	0.5	1.2	7.2	22,896	\$3,263	12.4	63,157	\$9,000

* The actual energy & cost savings may change depending on electric rate analysis, air conditioning savings and/or increased heating costs.

NEUROLOGY, CENTRAL STERILE, PURCHASING, MOB-CORRIDORS(PARTIAL) (CBES 2015 LPD TARGET NOT ACHIEVABLE WITHOUT LIGHTING DESIGN)

RELIGHT Analysis Tool

Version 2014c (2014.09.25)

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Project: **Central Vermont Medical Center - CVMC - Project IV**
Lighting Designer: **Mel Buss, Buss Lighting LLC**

January 5, 2017

RELIGHT Project Summary

Design Energy Savings beyond RELIGHT Target: **117%**

Enter Design Estimates			ANNUAL USE / COST			ANNUAL SAVINGS *		
	LPD (W/sf)	VT Code	kW	kWh	\$ Cost	kW	kWh	\$ Savings
Existing	2.0	1.2	12.8	39,883	\$5,683			
RELIGHT Target	1.4	1.2	8.9	27,918	\$3,978	3.8	11,965	\$1,705
Design	1.0	1.2	6.4	13,956	\$1,989	6.4	25,927	\$3,695

* The actual energy & cost savings may change depending on electric rate analysis, air conditioning savings and/or increased heating costs.

CVMC - POSSIBLE FUTURE LIGHTING IMPROVEMENTS - TECHNICAL

Centralized Control and integration

New expandable zones – Wireless Hubs – Scalable (large areas, entire floors, entire building)

Wireless hubs communicate with sensors, dimming power packs and remote dimming switch

Wireless hubs communicate via WIFI to a smart device

BACnet Integration to Wireless Hubs by wired Ethernet

- Demand Response – Load shed – connect to Wireless Hubs by wired Ethernet
- Scheduling - Programmable timeclock
- Lighting Energy Use Monitoring and Reporting

FUTURE LIGHTING IMPROVEMENTS — HUMAN-CENTRIC

- Variable Color Temperature
- Future consideration & evaluation of CRI used
- Connected Lighting Systems

SUMMARY OF KEY POINTS FOR CVMC PROJECT

We focused on human-centric lighting for healthcare recognizing that illumination levels need to vary widely and be appropriate and there is no one solution for all areas in healthcare.

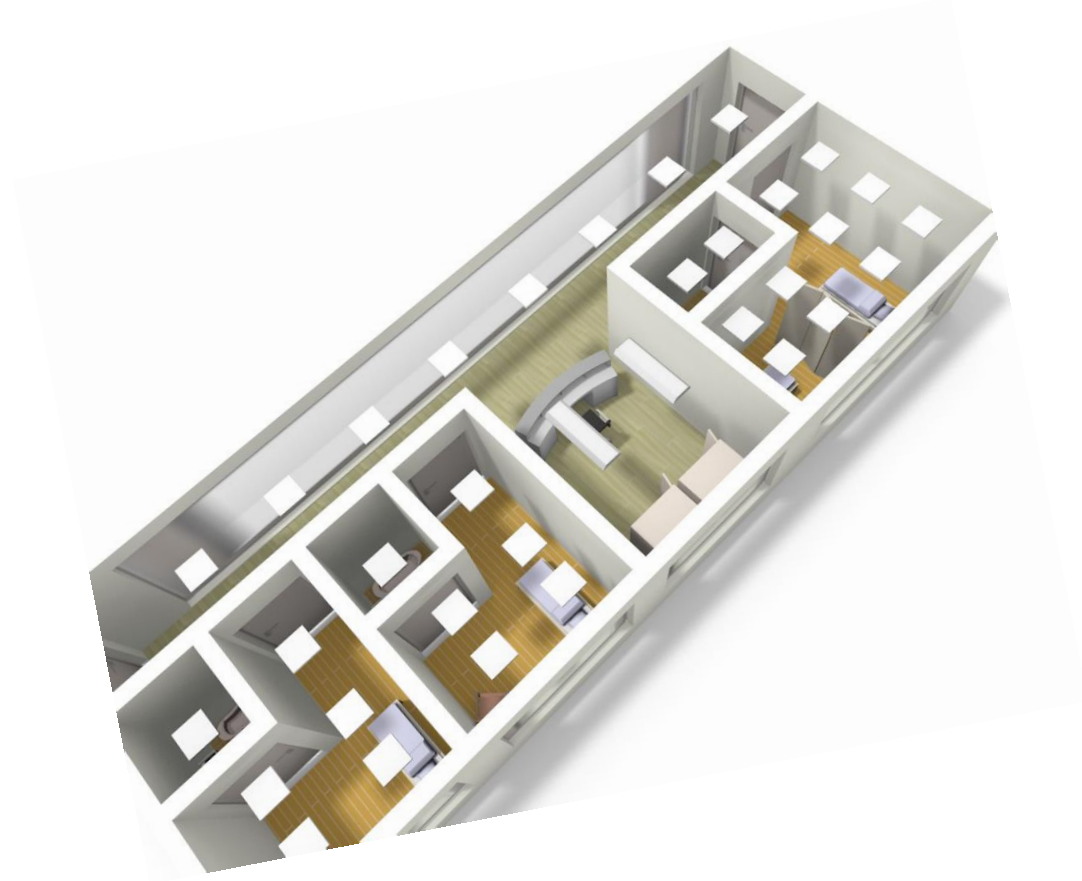
Good lighting design will enhance functionality, ambiance and ultimately your enjoyment of your interior and exterior spaces.

Good design includes a high level of attention to the illumination levels and to the ease of use of lighting controls

CLINICAL LIGHTING OF YESTERDAY

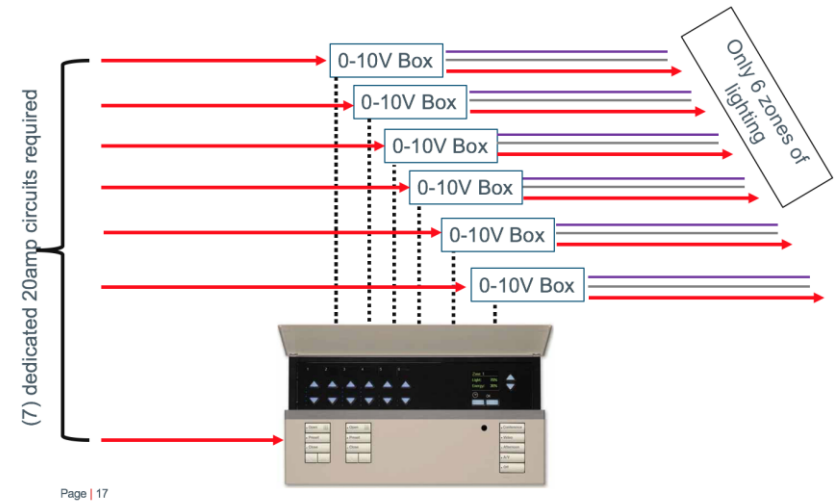
LIGHTING IN HEALTHCARE SPACES NOW

- Traditionally very similar to office lighting layouts. (e.g. Often just 2x2 fixtures covering open space).
- 42% of electricity is consumed in Healthcare spaces by lighting
- Still.... Little thought goes beyond first cost or at the most simple payback



TRADITIONAL TAKE ON CONTROLS

- Switching controls
- Dimming controls
- Motion sensors controls
- Photo sensors controls
- Timer controls



Lots of Wire – Lots of expense to just turn lights on and off. Zero insight or flexibility.

THE PERCEPTION OF LIGHTING UNTIL VERY RECENTLY

- All about ROI
- Bare minimum to meet code and safety
- Seen as complex in design



WHERE WE CAME FROM (THE WORLD INTO EFLO)

Old School - Energy Efficient Lighting was awesome!

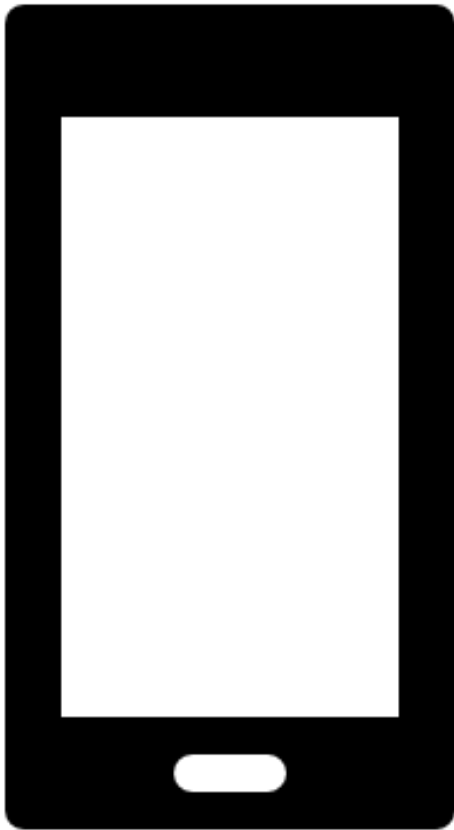
- Included ballasts (magnetic and eFLO), HID, transformers, etc.
- Goal was to reduce operation cost 30-60%
- Replacing 100W Lamp yielded about 75% savings with eFLO
- 6 pack replacement would yield about \$550 a year in savings (at 0.12\$ kWh)

Not a great solution really

- Fluorescents were ecologically nasty. (use of rare Earth materials including Mercury)
- Quality of light, generally was pretty poor
- Terrible control options (Dimming and color)
- Longer life, but not fantastic, hence maintenance was more complex because of ballasts
- Thermal Gain Still existed

Lighting was a ROI play.... With some pretty terrible tradeoffs. It also operated autonomously from the rest of the building

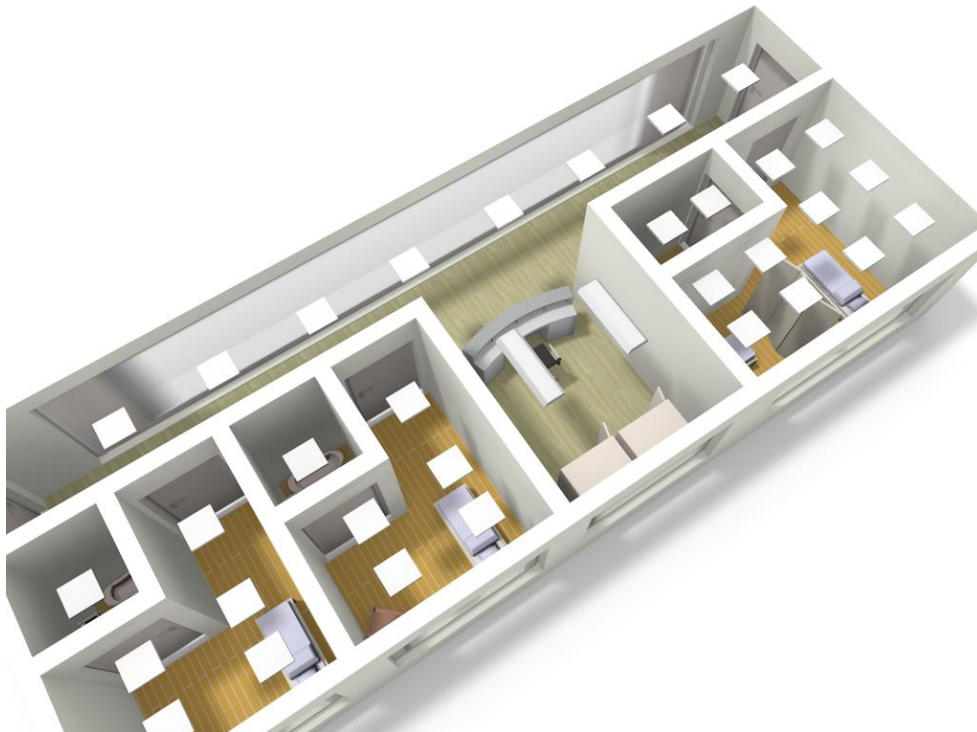
WHAT CHANGED IN ~2007?



- Clinical Trends
- SSL Digitalization
- IoT

Interconnected
expectations

TRENDS IN CLINIC SPACES



- Residential warmth in design
- Personalization of Patient Spaces
- Incorporate natural views daylight
- Recognition of the impact of light
- Integration of sub-systems creates value for patient, staff while lowering effective operational costs.
- Asset and staff tracking
- Digital Inclusion



NOW SOLID STATE LIGHTING (SSL)

Newer School - Energy Efficient Lighting was awesomer!

- Quality of light is reasonably good in modern LED array technology.
- Significantly less energy consumed over eFLO.
- Significantly less heat.
- Insanely long life. (And getting longer)
- Rugged (No Filament, or lamp to break, not affected by cold temperatures)
- Dimmable/controllable by design.
- Fewer nasty ecological problems.
- Prices are now on-par with eflo.
- Directional or wash without significant expense
- Compact by nature (Space Efficient)
- Far superior color rendering compared to eFlo

The Bads

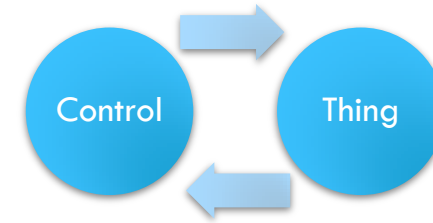
- ~~Fluorescents were ecologically nasty. (use of rare Earth materials including Mercury)~~
- ~~Quality of light, generally was pretty poor~~
- ~~Terrible control options (Dimming and color)~~
- ~~Longer life, but not fantastic, hence maintenance was more complex because of ballasts~~

Lighting replacement as low hanging fruit.... Is done. Where do we go from here?

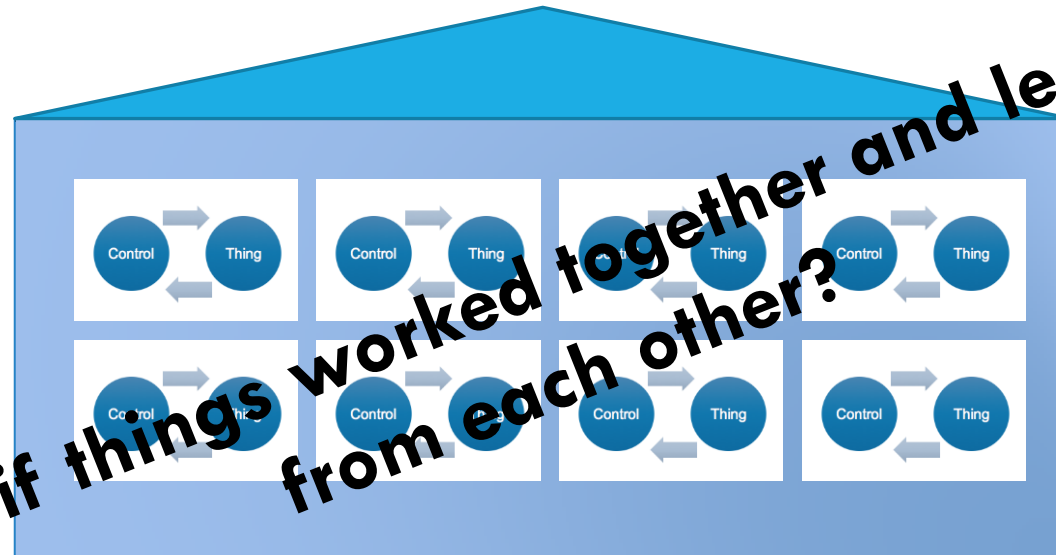
~~LIGHTING~~ ENERGY ENVELOPE EFFICIENCY — EMERGING IOT

Quandary

- Squeezed dry the light fixture as a source of savings
- So has:
 - Air Conditioning
 - Heating
 - Fresh Water
 - Waste Water
 - Water treatment / Heating
 - Structural Envelope
 - Lighting

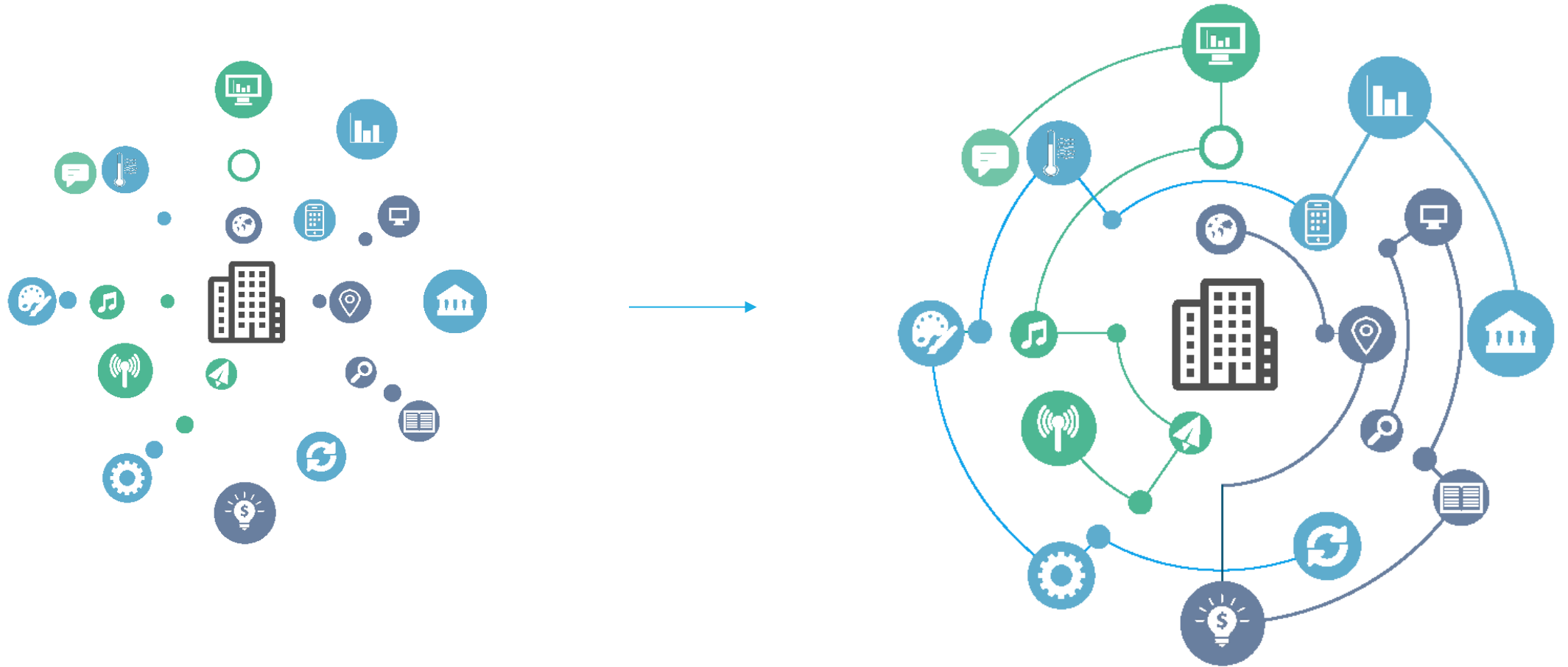


What if things worked together and learned from each other?



THE UNIFIED/SYNERGISTIC SOLUTION

DISJOINTED BECOMES UNIFIED



UNIFIED APPROACH

Environmental - Intelligent management of air conditioning, heating, air quality, and airflow balancing to maximize comfort and efficiency.

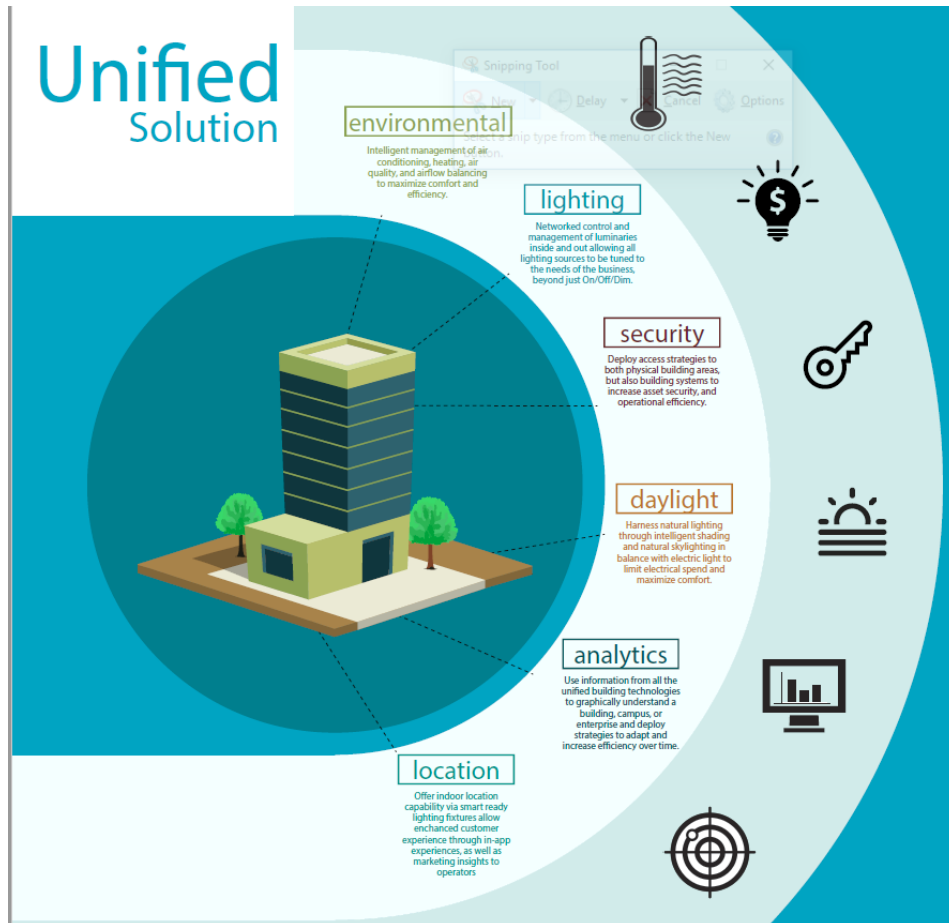
Lighting - Networked control and management of luminaries inside and out allowing all lighting sources to be tuned to the needs of the business, beyond just On/Off/Dim.

Security - Deploy access strategies to both physical building areas, but also building systems to increase asset security, and operational efficiency.

Daylight - Harness natural lighting through intelligent shading and natural skylighting in balance with electric light to limit electrical spend and maximize comfort.

Analytics - Use information from all the unified building technologies to graphically understand a building, campus, or enterprise and deploy strategies to adapt and increase efficiency over time.

Location – Indoor positioning technology for tomorrow.



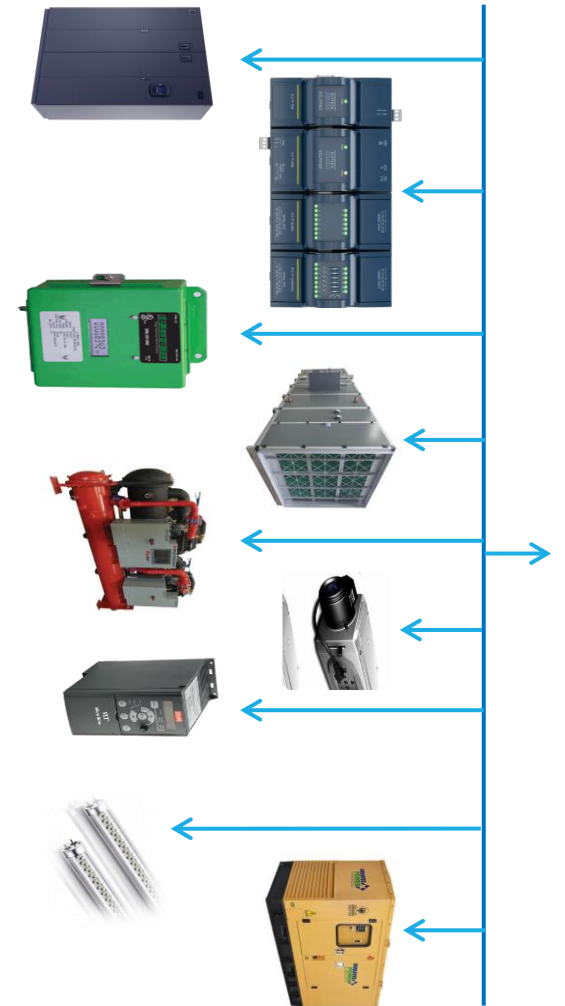
WHAT MAKES A SYNERGISTIC SOLUTION

- Recognizing Subsystem Theory

- Air Conditioning
- Heating
- Fresh Water
- Waste Water
- Water treatment / Heating
- Structural Envelope
- Lighting
- Chiller monitoring
- Energy Meters
- Switchgear
- Air Handling Units
- Security

- Harnessing sub-system recipes

- Application based thought interconnectivity



NOT — ALL OR NOTHING

Analog Systems



Compliance
built to comply
little connectivity
often proprietary
limited upgradability
no insight

Wired for Now

01
OPTION

Smart Ready



Future Proofing
communication native
software upgradable
investment protected
adapt over time

Digitally Ready for Tomorrow

02
OPTION

Unified Solution



Synergy, Savings, Simplicity
cooperative systems
enterprise insight
open connectivity
scalable architecture
adaptable to change
unified experience
insight driven

Collective Performance

03
OPTION

EVOLUTION OF TECHNOLOGY

Traditional lighting **controls** are used to turn on, off or dim connected light sources.

Modern day **lighting systems** free designers of hard electrical circuiting while offering management centralized control and 'now' status.

Synergistic Solutions empower sub-systems to work together to increase comfort, avoid redundancy, and leverage efficiency through shared strength while adapting over time.



ECONOMIC BENEFITS

TRADITIONAL SSL STORY

- Lumens per Watt
- Lifetime rating / 50,000 hours / Maintenance
- Lifetime cost is much lower when all of this is brought together

**But this is a traditional (sub-system) story if its
only about lighting**

SSL ENABLED LEDS

This is probably the last lighting upgrade you will ever do

The days of energy retrofit are over.

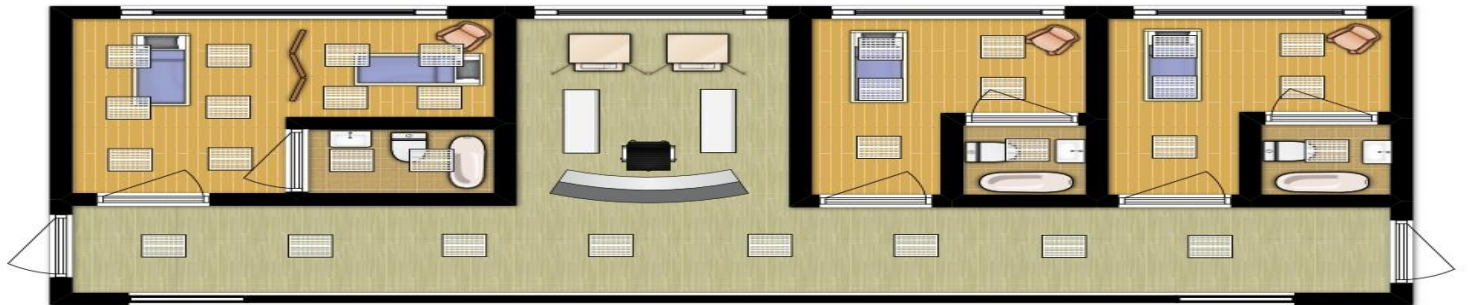
- Asset Tracking
- Indoor Positioning and Navigation/Wayfinding (IPS)
- Building connectivity to environment for business application
- Analytics and number crunching
- Vastly more comprehensive controls to support things like tunable lighting used in Circadian Rhythm
- Greater Security aspects (from IPS)

SYNERGISTIC ROI STORY

- First cost reduction of 6-8%
- Installation labor reduction of 12-15%
- Energy savings of 6-12% year over year
- One thing to understand... Not 12....
- Enterprise analytical, not per building

BEYOND THE ROI STORY

- 24hr daylight matching to foster circadian rhythm
- Single source in-room patient/provider environment control.
- In-room air quality monitoring/adjustment
- In-room air safety trending, alarming (Smoke, CO2, others based on sensing)
- Color temperature tuned lighting control based on clinical application.
- Centralized management, analytics, traffic recording, and asset monitoring.



STAKEHOLDER CONNECTION (BEYOND MONEY)



Communities



IMPACTING COMMUNITIES

DEFINING COMMUNITIES

*noun, plural **communities***

A social group of any size whose members reside in a specific locality and often sharing a common cultural heritage

- Facility Manager
- Patient
- Doctor, nurses, clinicians
- Visitors & Family
- Healthcare Administrators

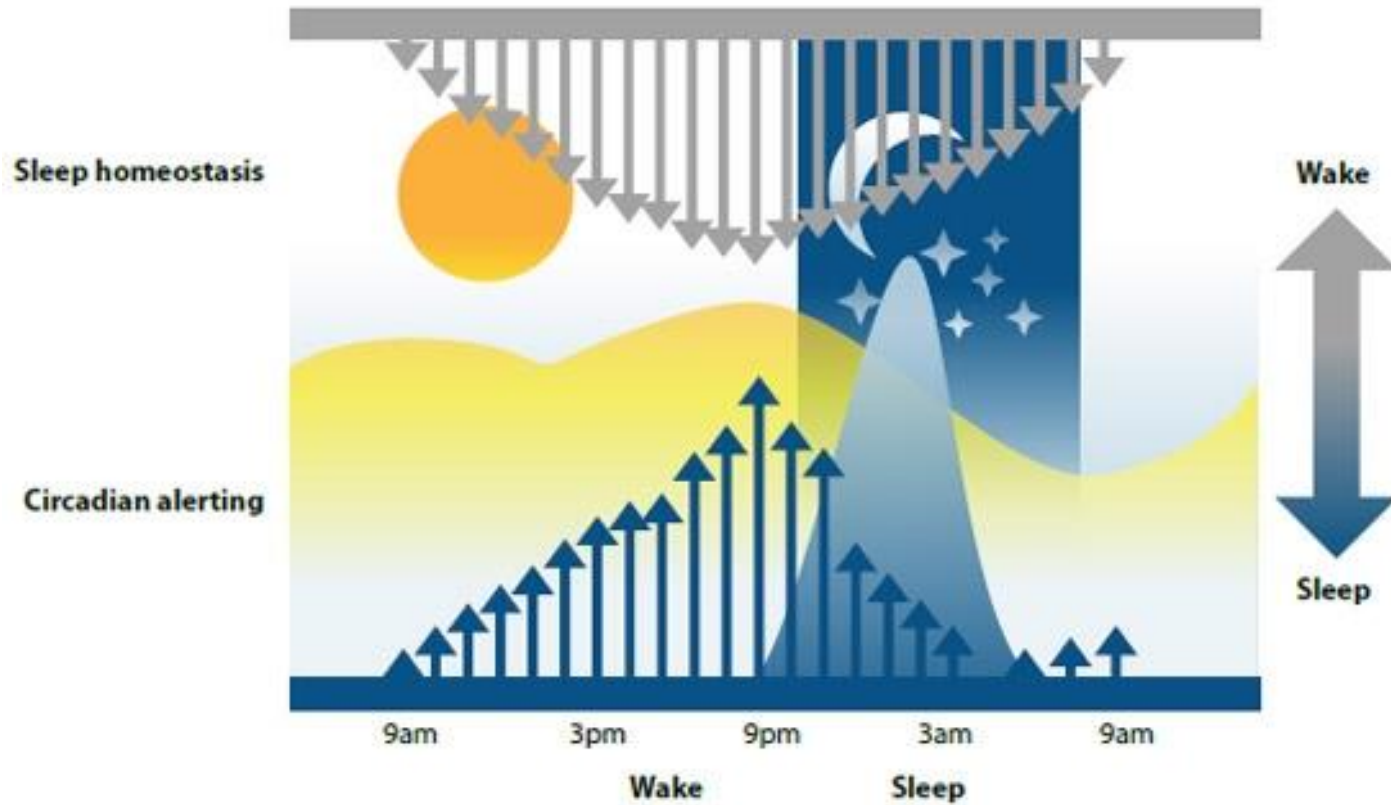
SETTING THE STAGE — LIGHT IN THE HEALTHCARE SPACE (CIRCADIAN ENTRAINMENT)



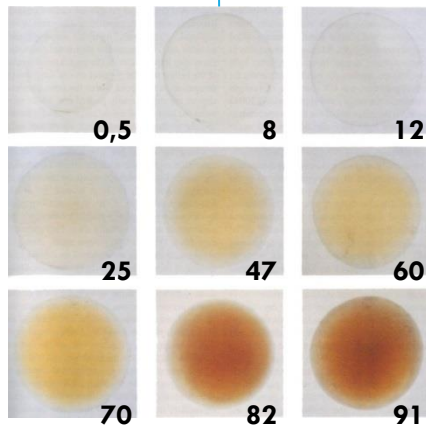
**“EVERYONE WANTS MORE, BUT NOBODY IS
GETTING ENOUGH...”**

- ANONYMOUS

SLEEP...THE PERFECT STORM.



THE EYE... AND THE IMPORTANCE OF LIGHTING FOR A BETTER LIFE



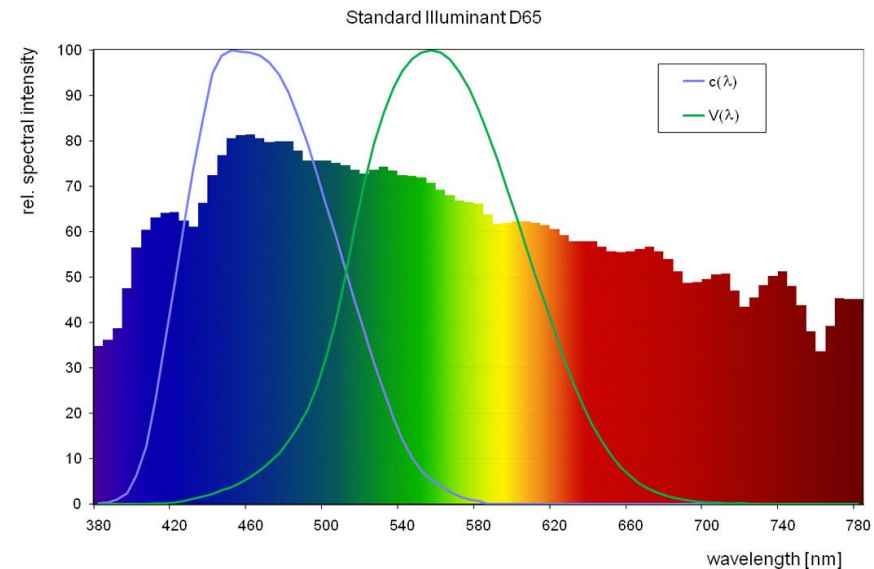
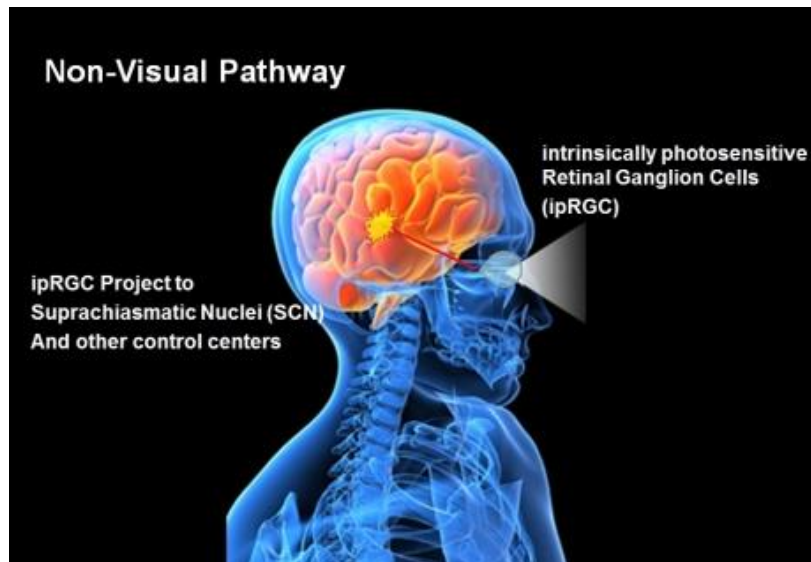
The Aging Eye



Regulating Circadian Rhythm

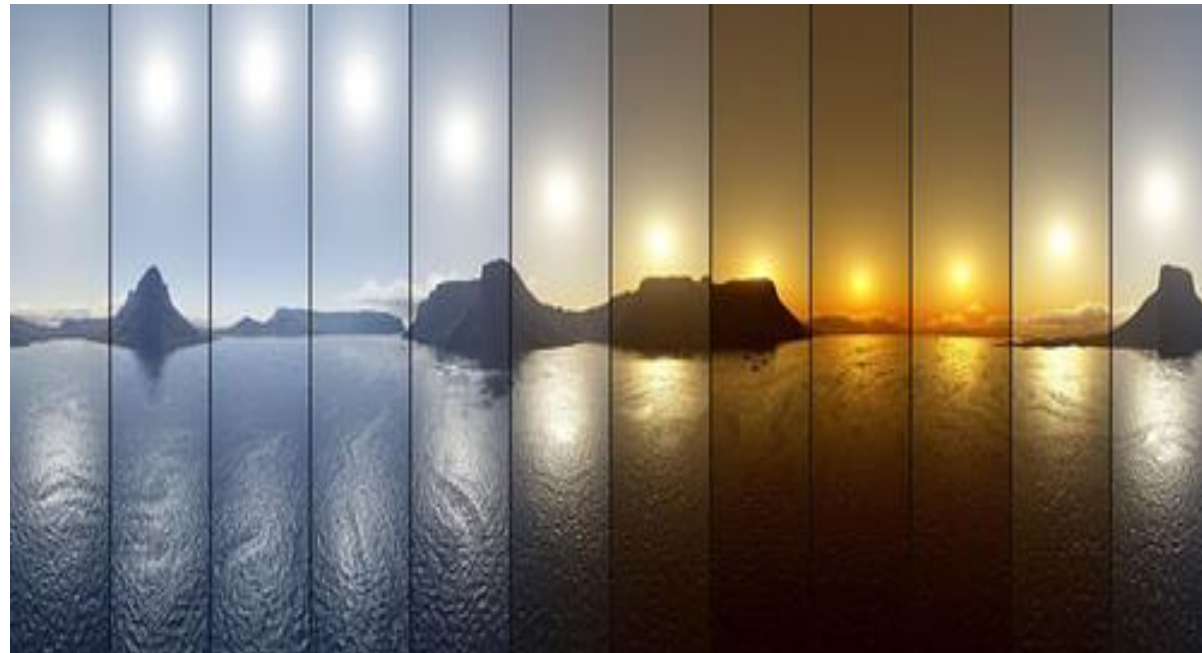
Lighting Impacts Our Visual & Biological Systems

- +Rods and cones are photoreceptors for our visual system
- +The **3rd photoreceptor**, the intrinsically photoreceptive retinal ganglion cell (IPRGC), impacts our circadian systems (peak sensitivity at 460-480nm, seeks blue light during the day)



CIRCADIAN ENTRAINMENT

- + Early morning exposure to higher light levels, especially in the short wavelength region of the visible spectrum (460-480 nm)
- + Warmer, long-wavelength light in late afternoon and evening
- + Dark at night to allow for melatonin production



SLEEP DEPRIVATION IS THE “EPIDEMIC OF THE 21ST CENTURY”

Obesity	• Higher BMI with insufficient sleep • Disruption of appetite hormone secretion (leptin & ghrelin)
Diabetes	• Slower processing of glucose
Hypertension	• Elevated blood pressure • Link to heart disease & stroke
Mood Disorders	• Sadness, irritability, negative outlook, reduced sociability
Immunity	• Increased susceptibility to infection
Self-Medication	• Potential for increased alcohol consumption, dependence on sleep aids
Life Expectancy	• Sleeping 5 hours or less increases mortality risk by 15%

Source: Division of Sleep Medicine at Harvard Medical School



FACILITY MANAGER

HOW LIGHTING AFFECTS THE FACILITY MANAGER

Responsible for keeping a facility running, and from a lighting perspective, is literally responsible for keeping the lights on.

Uses their budget to maintain the facility and focuses on:

- ROI
- Maintenance
- Safety
- Security

SUSTAINABLE DESIGN & ENERGY USAGE

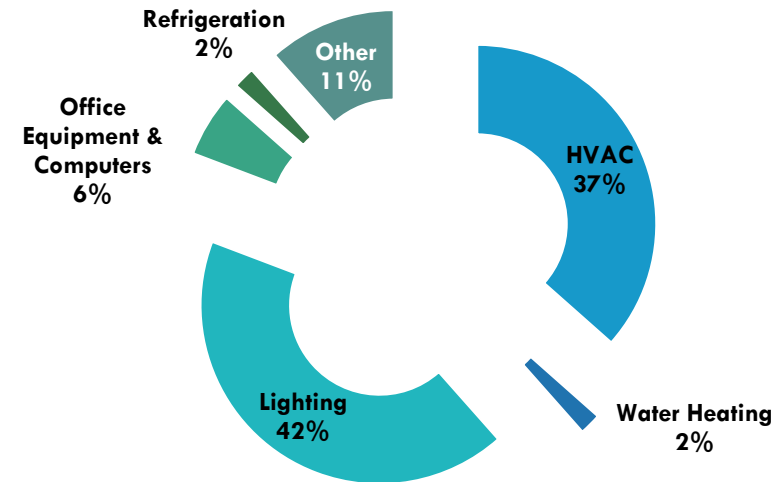
- + Based on 2008 data from the US DOE's Energy Information Administration, lighting accounts for a large portion of overall health care electricity use:

—Inpatient: 42%

—Outpatient: 40%

- + Healthcare buildings account for 7 percent of electricity use by all commercial and industrial buildings... and GROWING (aging population)

US Electricity Consumption (kWh),
2008 - Inpatient Health Care
Facilities



“The lighting upgrade improved the quality of the illumination and made our campuses feel safer and more inviting...Color rendering improved, contrast ratios decreased and visitors and staff find it easier to navigate our night environment.”

— Paul Gerner, Dignity Health Area Director

Dignity Health Hospitals selected an LED Lighting Solution for their campus exteriors as an opportunity to increase sustainability and safety.

- **D-Series LED** Area, Bollards, Floods, Parking, Garage, and Wall Pack **luminaires** were installed
- Dignity Health Hospitals can save up to **90% in energy** when replacing comparable HID luminaires with LEDs
- Dignity Health Hospitals have the potential to reduce greenhouse emissions by 5,824 metric tons
- Dignity Health Hospitals exterior lighting installation is estimated to save \$505,000 across all 38 facilities
- The LED system provides all 38 hospitals with maintenance-free lighting over the next 10 years



PATIENT

HOW LIGHTING AFFECTS PATIENTS IN HEALTHCARE

Flexibility:

- Provide light levels that support the needs of doctors, nurses, and clinicians for exams and procedures
- Offer lower light levels for patients and guests

Comfort:

- Lighting levels between just on and off give the patient and guests the ability to set the lights to levels appropriate with their needs throughout the day

Empowerment:

- Empower the patient (who often feels helpless) through control of their light level of even the color temperature or color of their lighting

HOW LIGHTING AFFECTS PATIENTS IN HEALTHCARE

Health:

- Mimic the outdoor environment
- Deliver “doses of light”
- Consider applications such as in a NICU or long term care

MAJOR VALIDATED RESEARCH CONNECTING LIGHTING TO HEALTH



DOE Gateway Study for long-term care facility in Sacramento, CA

- + Yelling, agitation and crying reduced by 41%
- + Reduction of falls in corridors
- + 68% energy savings over incumbent lighting



Source: DOE Gateway Report, Tunable Lighting – Light Therapy – “Doses of Light”

“ACC will be incorporating many of the lighting solutions piloted in this project as best practices in terms of fall risk, sleep enhancement and non-pharmacological approaches for behaviors related to dementia.”

ACC Administrator



Tailored lighting intervention improves measures of sleep, depression, and agitation in persons with Alzheimer's disease and related dementia living in long-term care facilities

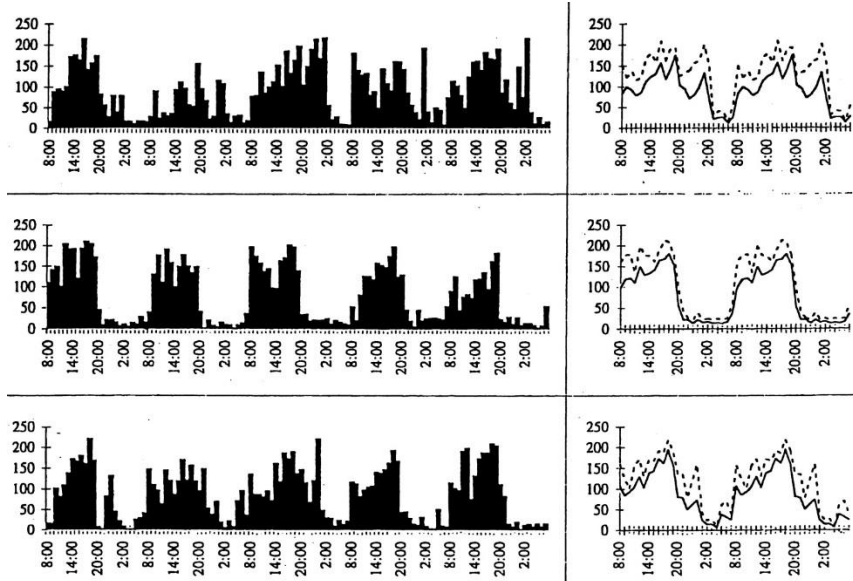
Source: Lighting Research Center, RPI

Background: Light therapy has shown great promise as a nonpharmacological method to improve symptoms associated with Alzheimer's disease and related dementias (ADRD), with preliminary studies demonstrating that **appropriately timed light exposure can improve nighttime sleep efficiency, reduce nocturnal wandering, and alleviate evening agitation.**

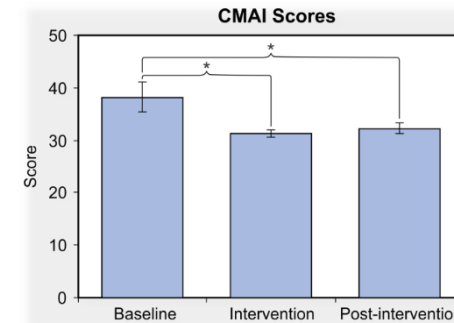
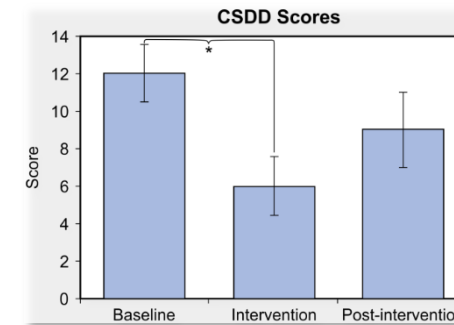
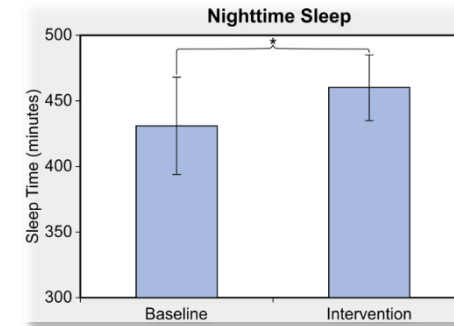
MAJOR VALIDATED RESEARCH CONNECTING LIGHTING TO HEALTH

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IMPROVED OUTCOMES: SELECTIVE PROOF POINTS



Van Someren et al. 1997. Indirect bright light improves circadian rest-activity rhythm disturbances in demented patients. *Biol Psychiatry* 1;41(9):955-63.



PATIENT ROOM: OCCUPANT NEEDS

Patient

- +Reading/writing
- +Watching TV
- +Visiting with guests
- +Sleeping
- +Restroom

Caregiver/Staff

- +Routine nursing
- +Observation of patients
- +Night lighting
- +Patient examination

PATIENT ROOMS: ADDITIONAL CONSIDERATIONS

+ Dynamic Features

- Warm dimming
- Tunable white
- Circadian optimization
- Color for positive distraction

+ Nighttime Modes

- Patient safety
- Elimination of circadian stimulus



DOCTORS, NURSES, CLINICIANS

HOW LIGHTING AFFECTS DOCTORS, NURSES, & CLINICIANS

Proper lighting

Provide enough light for the task necessary whether exams or procedures

Wayfinding:

Offering easy ways for patients and visitors to navigate the hospital allows staff to spend time saving lives and not being a tour guides

HOW LIGHTING AFFECTS DOCTORS, NURSES, & CLINICIANS

Alertness:

Keep second and third shift staff alert to reduce errors and mistakes

Circadian stimulus:

Lighting can be used to provide light levels and color temperatures that keep staff alert, maintain their circadian rhythms as closely as possible, and allow patients to sleep and maintain their own circadian rhythms

VISITORS & FAMILY

HOW LIGHTING AFFECTS VISITORS IN HEALTHCARE SPACES

Control:

Offer guests individual control over lighting that does not disrupt the patient, allowing everyone in the space a more comfortable time during their stay.

Wayfinding:

In a rush, it's important for visitors to be able to navigate to their destination quickly and seamlessly.

HEALTHCARE ADMINISTRATORS

BETWEEN A ROCK AND A HARD PLACE? TODAY'S HEALTHCARE ENVIRONMENT IS MORE CHALLENGING THAN EVER...



+ Improving the quality of care delivered

- Outcomes
- Experience & Comfort
- Safety

HOW LIGHTING AFFECTS HOSPITAL ADMINISTRATORS

“Textbook” Economics:

Energy Savings

Financial savings associated with energy savings from controlled LED lighting is a win to the bottom line where margins are tight in the healthcare space and every dollar counts.

Maintenance

Long lifetimes of LEDs lead to saved operational costs associated with not having to replace lighting as frequently.

Visibility

An understanding of building operations and building systems across an aggregated system wide building portfolio and down to the individual fixture, room, floor, or building

“THE MATH IS FUZZY BUT IMPORTANT” ECONOMICS

1. **Safety:** Protecting people from things including safe working conditions, safe passage and identification of hazards or obstructions
2. **Security:** Security lighting is intended to protect people and property from criminal activities.
3. **Wayfinding:** Illuminating one's location, destination and means to get there from your current location.
4. **First Impression:** Designers raise the attractiveness of a design and assess what kind of emotions the lighting should evoke.

SECURITY — HOMELAND SECURITY REPORT

- “Over the past decade, hospitals across the nation have been subject to an alarming increase in violent incidents and in the last five years alone, there as been nearly a 300% increase in the number of reported homicides, assaults, and rapes compared to the previous five years.”
- A safe campus (or lack thereof) can have a strong impact on attracting doctors, nurses, staff, and patients
- Thoughts to consider:
 - Brand Equity
 - Cost to replace doctor/nurse/staff
 - Insurance
 - Legal liability



FIRST (AND LAST) IMPRESSIONS MATTER...

Seniors (age 65+):

"Parking" ranked second behind "lobby" and before "building exterior" and "grounds" as factors impacting first impression of a hospital.

(Source: Parking BOXX survey, 2015)



BORROW FROM THE IOT ECOSYSTEM



HOW LIGHTING AFFECTS HOSPITAL ADMINISTRATORS

Asset Tracking:

Now let's really get crazy... what if we could use the “grid” of the lighting infrastructure to provide information on how a space is used? And make smart decisions based on that information?

How much would it save the hospital if the lighting system could not only do:

- **Asset tracking** (where is the closest wheelchair or medical equipment?)?
- **Asset management** (where are the best places to locate wheelchairs so that they are quickly and easily accessible?)

HOW LIGHTING AFFECTS HOSPITAL ADMINISTRATORS

Asset Tracking:

What are other uses for this?

- Dialysis Clinic: wait times, schedule appointment, direct patient to room, send clinician to room along with patient information, instructions, and medical file
- Long Term Care: Monitoring safety of Alzheimer's and dementia residents
- Using asset tracking to maximize efficiency of staff



SUMMARY



SO WHAT'S THE TAKEAWAY?

Lighting is no longer “just lighting:”

What are the benefits of lighting (outside of providing light) in the healthcare space?

- Positive impacts to sleep/health (patients & night staff)
- Reduced errors, mistakes, and falls
- Comfort, flexibility, control, EMPOWERMENT
- Enhanced safety, security, first impressions
- Improved wayfinding
- Asset tracking and management could have hugely positive impacts in the space



SO WHAT'S THE TAKEAWAY?

And???

Is that all?

- System integration will enable the “smart buildings” of the future
- Don't discount the importance of good lighting design!
- Don't forget to consider energy savings and the benefit of hassle free maintenance/operations

Questions?



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