



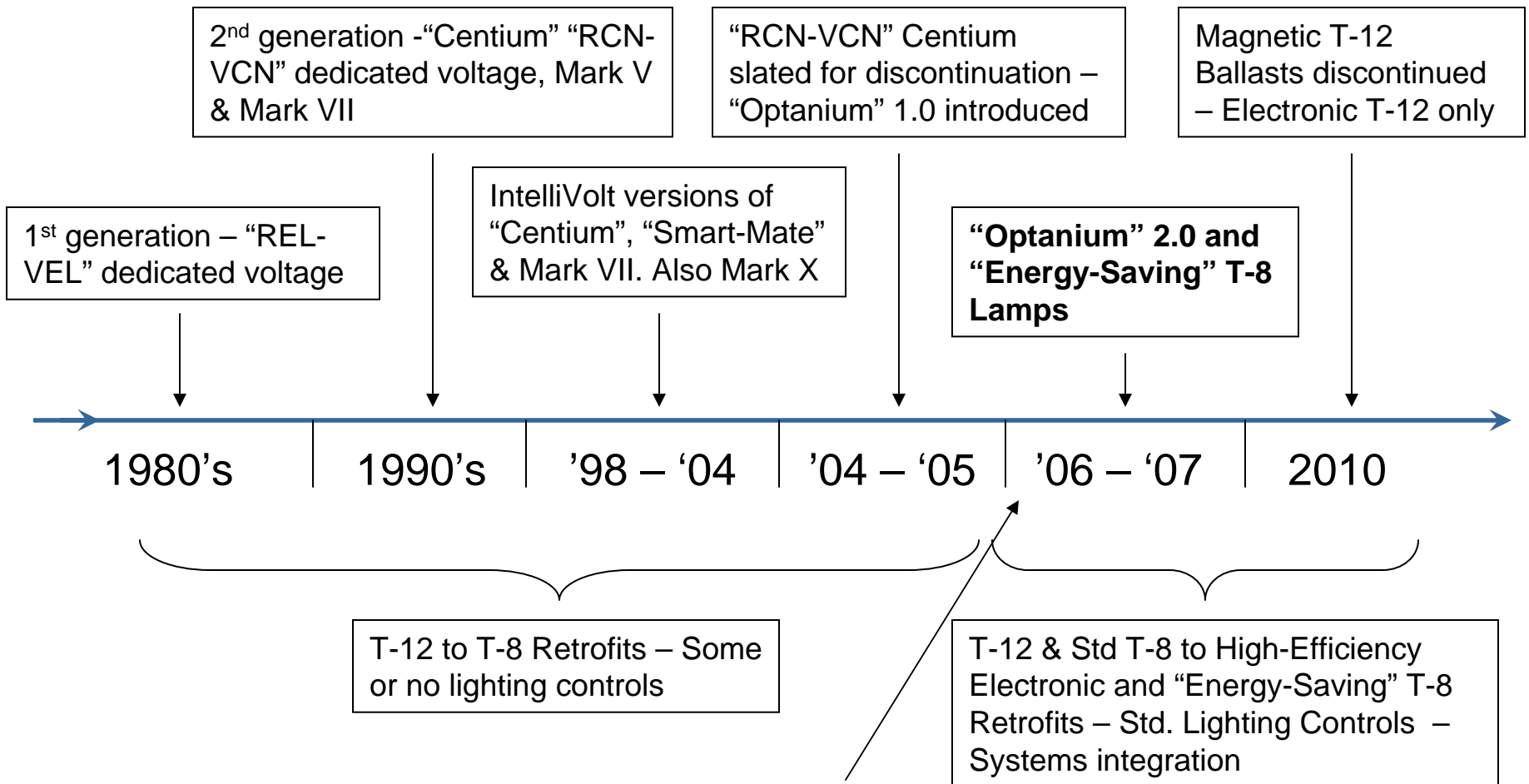
# Electronic Ballast Update

Schaedler/YESCO – EXPO 2008

**Presented by Rock Weinrich,  
Joseph E. Biben Sales Corporation**

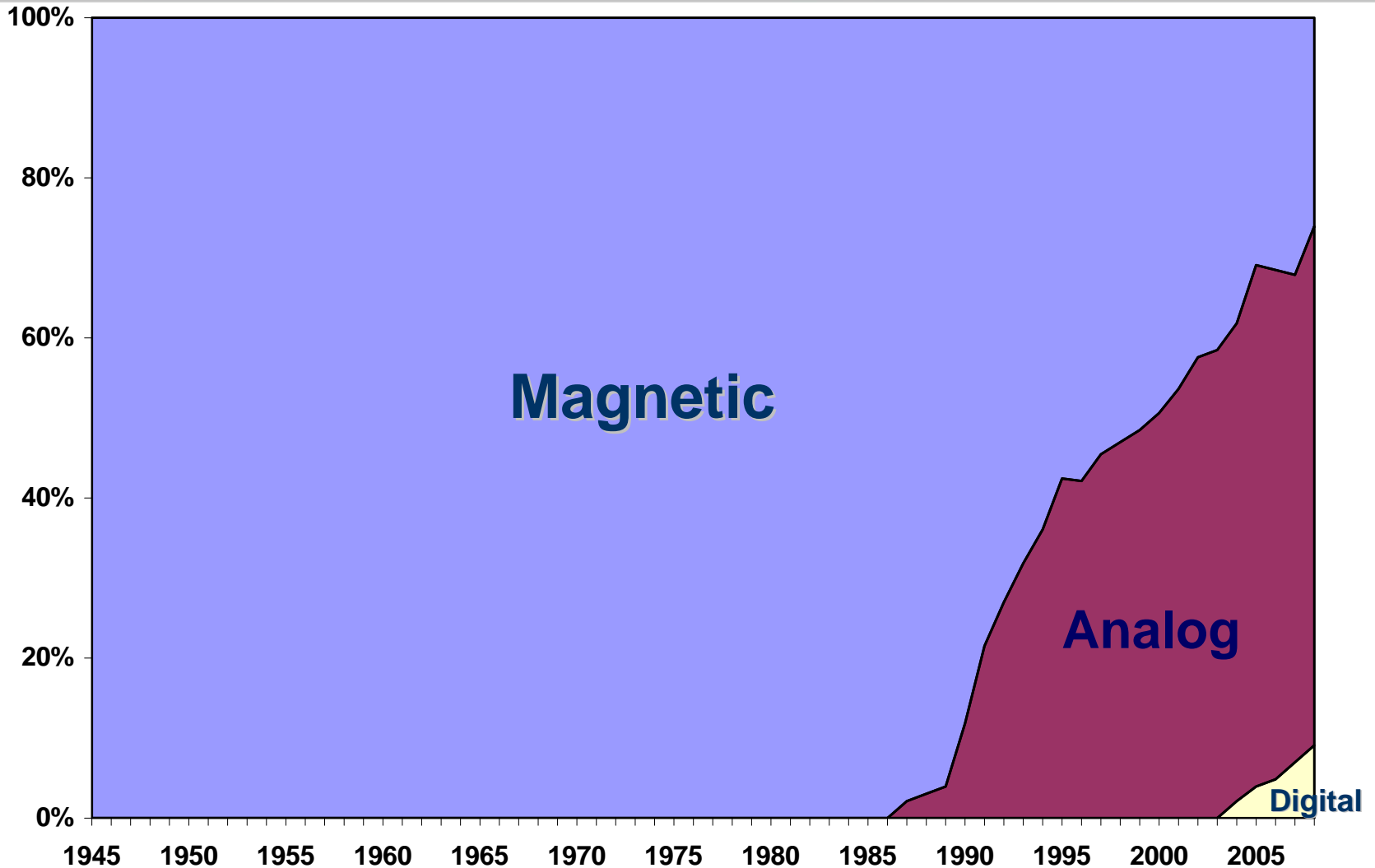


# Electronic Ballast Timeline



**2005 EPA Act takes effect**

# Advance Fluorescent Product Sales History 1945 – 2008



# Current Status of Electronic Ballasts

- ⊕ **Electronic T-12 ballasts replacing magnetic T-12 ballasts per D.O.E. and “EPAct”**
- ⊕ **High-efficiency electronic ballasts replacing standard electronic ballasts**
- ⊕ **High-efficiency T-8 electronic ballasts and energy-saving T-8 lamps replacing standard electronic ballasts and T-8 lamps**
- ⊕ **Fluorescent lighting is replacing HID in some low-bay applications using current electronic ballast technology and lighting controls**



# Ballast Technology

A Quick Review...



# The Ballast and the Emitter

*Three types of Electronic Ballasts:*

1. Instant Start
2. Rapid Start
3. Program Rapid Start



# Starting Methods

## ✦ Instant Start

- Instant On
- Maximum Energy Savings
- 10-15K Switch Cycles
- Lamps wired in parallel
- Most economical and most common starting circuit

# Starting Methods

## ⊠ Rapid Start

- Low Voltage Applied Prior to Lamp Ignition
- 1.5-2W Loss Per Lamp
- 15-20K Switch Cycles
- Lamps wired in series
- Typical for 4-foot T-12 magnetic and electronic ballasts



# Starting Methods

## ⊠ Programmed Start

- Pre-heats Cathodes to 700 Degrees C
- Maximum Lamp Life
- Up To 50,000 Switch Cycles
- Lamps wired in series or series-parallel
- Used in dimming and lighting control applications

# Ballast Wiring

## ⊠ Series Operation

- ⊕ Lamps start in sequence, dependent upon each to provide light
- ⊕ If one lamp becomes inoperative, the other will not operate properly, if at all.

## ⊠ Parallel Operation

- ⊕ Lamps operate independently of each other
- ⊕ If one lamp becomes inoperative, it will not affect the operation of the other lamp

# Ballast Factor

$$\text{Ballast Factor} = \frac{\text{Commercial Ballast Light Output}}{\text{Laboratory Ballast Light Output}}$$

**Ballast Factor ~ 'Multiplier'**

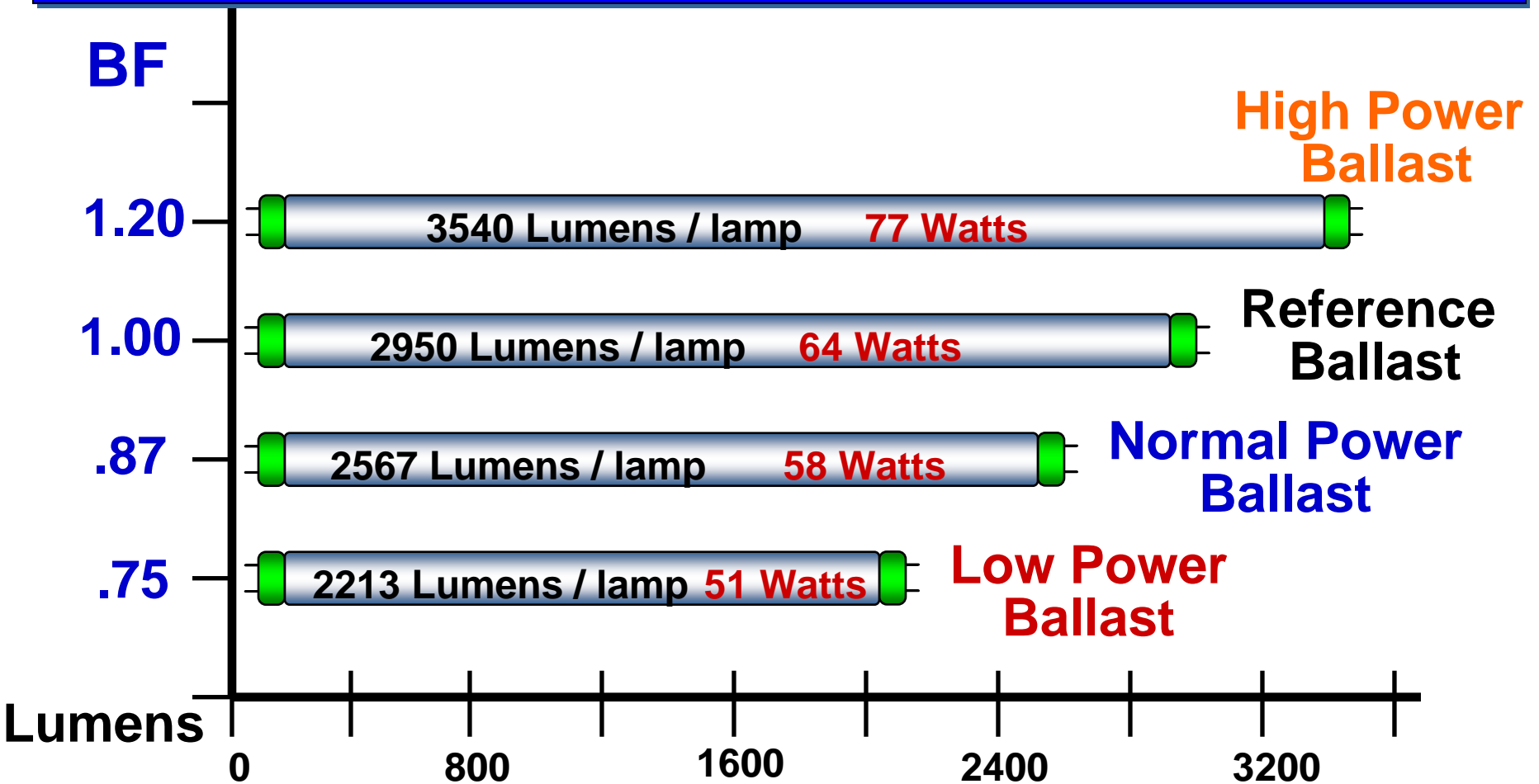
# Ballast Factor & Light Output

- ⊕ **Ballast Factor enables the adjustment of lighting levels through ballast factor selection**
- ⊕ **3 ballast factors are available in high efficiency electronic ballast designs**

<b>Ballast Type</b>	<b>Ballast Factor</b>	<b>Light Level</b>
<b>LW</b>	<b>.75</b>	<b>Low</b>
<b>Standard</b>	<b>.87</b>	<b>Standard</b>
<b>HL</b>	<b>1.20</b>	<b>High</b>

# Ballast Factor & Light Output

## Performance Comparison of 2 – F32T8 Lamps





# Advance High-Efficiency Ballasts





# The Optanium™ Family

The most  
**COMPREHENSIVE** family  
of **HIGH-EFFICIENCY**  
ballasts  
**IN THE INDUSTRY...**  
**PERIOD.**

# The Optanium Advantage

## FEATURE

- ⊠ **High Efficiency: ~ 3 watt reduction in ballast losses**
- ⊠ **Instant AND Programmed start models**
- ⊠ **IntelliVolt operation: 120-277V**
- ⊠ **Operate all standard AND energy saving T8 lamps**

## BENEFIT

- ⊠ **Lower energy bills**
- ⊠ **Maximized lamp life AND energy savings for every application**
- ⊠ **Simplifies energy-audits, reduces installation and maintenance costs**
- ⊠ **Elimination of system restrictions maximizes user choice**

# The Optanium Advantage

## FEATURE

- # Lamp auto re-strike
- # -20 °F Minimum Starting Temperature
- # Meet new NEMA/CEE BEF standards for high-efficiency ballasts
- # Leads exit on “correct side” of the ballast

## BENEFIT

- # Reduced maintenance costs
- # Creates new T8 system opportunities
- # Qualify for utility “Super T8” rebates
- # Reduced installation and maintenance costs

# The Optanium Advantage

## FEATURE

- ⊞ **Lamp anti-striation circuitry to eliminate flicker**
- ⊞ **UL Type CC anti-arc rating**
- ⊞ **Operating frequency between 42-50 kHz**

## BENEFIT

- ⊞ **Improves visual comfort in open (parabolic) fixtures**
- ⊞ **Protects system components in the event of damaged sockets or poorly seated lamps**
- ⊞ **No interference with Infrared or Article Surveillance Systems**

# 25W / Advance Optanium System

## The “Optimized” System Solution

### Lamp Comparison (12hrs/start)

Lamp Type	Initial Lumens	Design Lumens	CRI	Lamp Life	Lumen Maintenance
34 Watt	2650	2300	62	20K	87%
32 Watt	2850	2710	86	25K	95%
30 Watt	2900	2750	84	25K	95%
28 Watt	2725	2560	86	26K	94%
<b>25 Watt</b>	<b>2400</b>	<b>2280</b>	<b>86</b>	<b>25K</b>	<b>95%</b>

### Ballast Comparison

Ballast Type	ANSI Watts	Ballast Factor	Ballast Efficacy Factor	Starting Method	Lumens Per Watt
34 Watt	144	0.88	0.61	Rapid Start	56.2
32 Watt	112	0.88	0.79	Instant Start	85.2
30 Watt	104	0.87	0.84	Instant Start	92.0
28 Watt	95	0.87	0.92	Instant Start	93.8
<b>25 Watt*</b>	<b>85</b>	<b>0.88</b>	<b>1.04</b>	<b>Instant Start</b>	<b>94.4</b>

\*25 watt lamp with Optanium ballast. Other lamps with standard ballast

# System Solutions At-A-Glance

<b>Ballast(s)</b>	<b>Lamps</b>	<b>Input Watts</b>	<b>Relative Light Output</b>	<b>Savings</b>
<b>(2) Magnetic</b>	(4) 34 Watt T12	144	<b>100%</b>	N/A
<b>(2) Electronic</b>	(4) 34 Watt T12	120	<b>97%</b>	<b>17%</b>
<b>(1) Low-watt ELE</b>	(4) 32 Watt T8	98	<b>100%</b>	<b>32%</b>
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<b>(1) High-efficiency ELE</b>	(4) 25 Watt T8	85	<b>98%</b>	<b>41%</b>
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# Dimming Technology

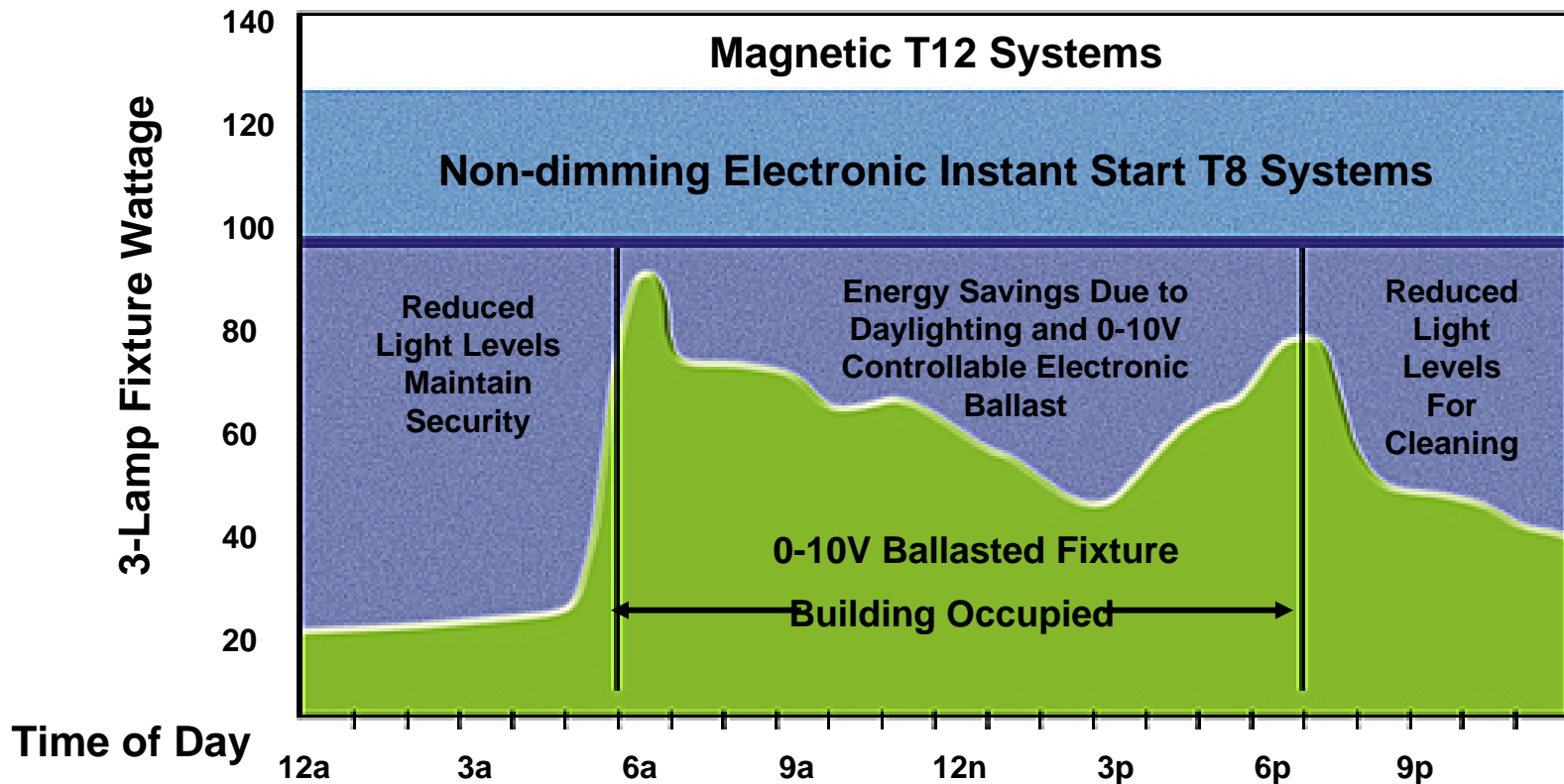
## Available dimming methods?

# Line voltage **Mark 10**  
**POWERLINE** <sup>TM</sup>

# Low voltage **Mark 7**  
**0-10 VOLT** <sup>TM</sup>

# How can dimming save you energy?

*Typical savings when dimming ballasts are tied to daylight harvesting/building management systems.*



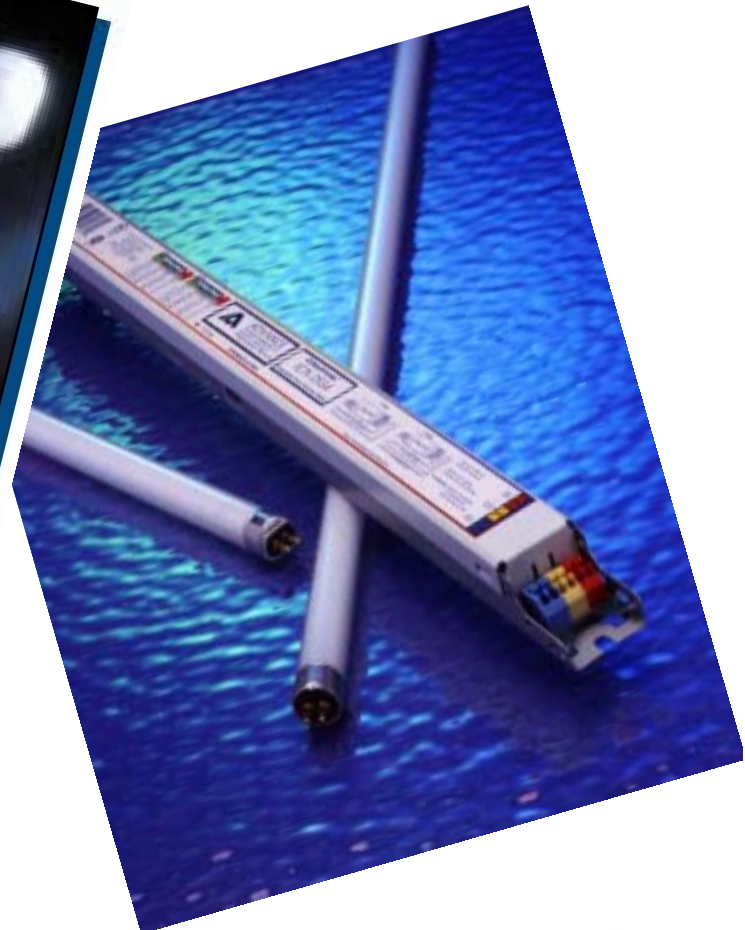
# Dimming Ballasts Available

# CFL

# TT5

# T8

# T5/HO



# Dimming Technology

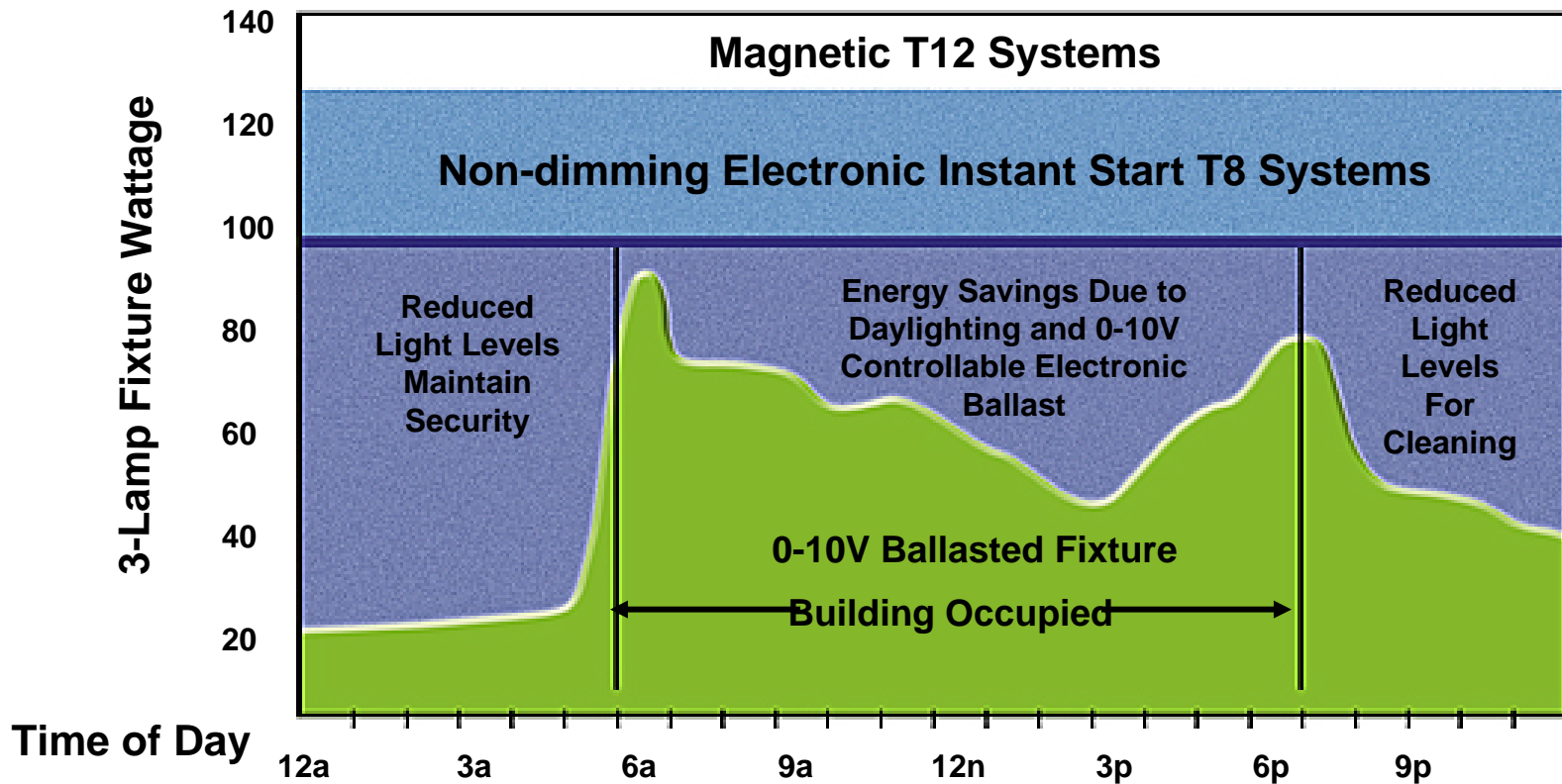
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# Dimming Ballasts Available

# CFL

# TT5

# T8

# T5/HO







# Business Opportunities Under “EPAct 2005”

Presented by:

Biben Sales  
Corporation



# Changes Create Opportunities

New energy laws and other government legislation along with continuing new product development and the discontinuation of older, outdated lighting products is creating many business opportunities for contractors, energy service companies, engineering firms and those engaged in the manufacture and sales of lighting products.

Any commercial/industrial business entity can benefit from a lighting system upgrade and the addition of lighting controls.

# Components Of Change

- ✦ **Energy policy act of 2005 – “EPAct”**
- ✦ **Department of Energy legislation (DOE)**
- ✦ **Revised standards (“ASHREA” & “ISENA”)**
- ✦ **New lamp and ballast technologies**
- ✦ **Advanced lighting control products**
- ✦ **State building codes**
- ✦ **Discontinued lighting products**



# Energy Policy Act Of 2005 ("EPAct 2005")



# EPAct 2005 Specifics

- ✦ **Signed into law by President Bush on August 8, 2005**
- ✦ **Took effect on January 1, 2006**
- ✦ **“Into Service Date” extended to December 31, 2008**
- ✦ **Provides tax credit incentives for energy efficient designs and upgrades**
- ✦ **ASHREA 90.1-2001 is the basis for comparison**

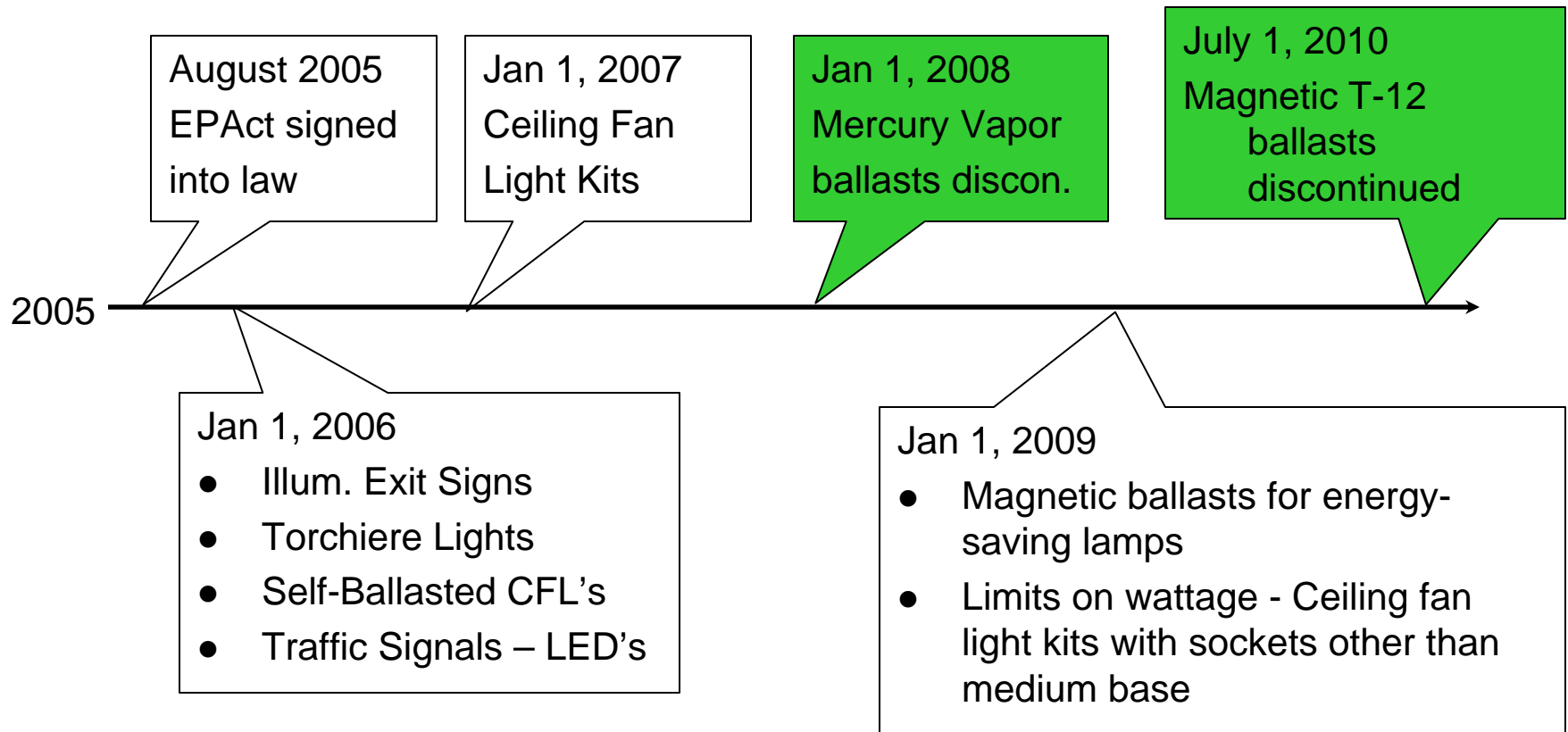


# “EPAct” Specifics

- ⊠ **New efficiency standards for products manufactured on or after January 1, 2006:**
  - ⊠ Energy-saving magnetic fluorescent lamp ballasts
  - ⊠ Medium screw base CFL’s
  - ⊠ Mercury Vapor ballasts cannot be manufactured or imported after January 1, 2008
  - ⊠ Low voltage dry-type distribution transformers
  - ⊠ Exit signs
  - ⊠ Other products



# Timeline Of Changes Under "EPAct"



# Specifics - continued

- ⊞ **Commercial building tax deductions to reward the use of energy-efficient technologies**
- ⊞ **New energy efficiency goals for federal buildings**
- ⊞ **Development of standards for electric-powered devices using standby power**
- ⊞ **Interstate transmission grid components**

# Specifics – continued

- ⊞ **Rate incentives to assure the recovery of investments in new transmission facilities**
- ⊞ **Accelerated depreciation for transmission and distribution assets.**
- ⊞ **Far-reaching impact on the awareness and use of lighting technology and the manufacturers who make up the lighting industry**

# Impact On Lighting Users

- ⊕ **The D.O.E. estimates that lighting accounts for:**
  - ⊕ 25% of the nation's energy cost
  - ⊕ 40% of a typical commercial building's energy bill
- ⊕ **Lighting users benefit from “EPAct” by reducing their energy consumption and costs by utilizing a broad range of available energy-efficient technologies**

# Types Of Buildings That Qualify

## ⊕ **Energy efficient commercial buildings defined as:**

- ⊕ On or in any building located in the United States that is within the scope of Standard 90.1-2001
- ⊕ Installed as part of:
  - ※ Interior lighting
  - ※ HVAC systems
  - ※ Building envelope

# Qualification continued

- ⊕ **Certified as being part of a plan designed to reduce total annual energy and power costs of interior lighting systems, HVAC systems, and hot water systems of the building by 50% or more when compared to a reference building, which meets the minimum of Standard 90.1-2001**



# **Tax Deductions - Commercial Bldgs.**

- ✦ **Supply-side incentives favored**
- ✦ **\$243M in tax deduction provisions for building owners to encourage investment in energy-efficient products**
- ✦ **Estimated to result in ~\$500M in incremental sales of lighting systems**
- ✦ **The tax deduction is equal to energy-efficient commercial building property expenditures made by the tax payer, subject to a cap**

# Tax Deductions - continued

## ⊕ How Tax Deduction Works

- ⊕ Up to \$1.80/sq. ft. for “Energy Efficient Property” used for new construction or renovation
  - ※ \$0.60/sq. ft. each for lighting systems, HVAC, and building envelopes
- ⊕ Qualifying property must reduce total annual energy consumption by 50% beyond ASHRAE 90.1-2001
- ⊕ Qualifying property must be placed in service (ready for its intended use) from 1/1/06 – 12/31/07

# Individual Systems

## ⊕ Buildings that do not meet 50% savings

- ⊕ Partial deduction allowed for with respect to each separate building system
- ⊕ Certified by qualified professional
- ⊕ Applicable savings targets resulting in a total annual energy savings of 50% for the whole building
  - ※ Interior lighting
  - ※ HVAC & Hot Water
  - ※ Building envelope

# Interim Rules For Lighting Projects

⊕ **Building owners are encouraged under the law to focus first on lighting systems for two reasons:**

⊕ Their ease of and availability of upgrading

⊕ Known achievements in energy efficiency that will be gained

# Interim Rules - continued

- ⊠ **\$0.30 to \$0.60/sq. ft. deduction if lighting power densities (w/sf.) are reduced from 25-40% beyond the minimum requirements in ASHRAE 90.1-2001. (Table 9.3.1.1 or 9.3.1.2)**
- ⊠ **For warehouses, the LPD must be 50% lower than the minimum requirements**
- ⊠ **Controls Provisions: bi-level switching, automatic light shut-off, tandem ballast wiring**
- ⊠ **Minimum requirements for light levels per IESNA**

# EPAct 2005 – Interim Tax Breaks

% LPD Reduction beyond ASHRAE 90.1-2001	<25%	25%	26%	27%	28%	29%	30%	31%	32%	33%	34%	35%	36%	37%	38%	39%	40%	>40%
Eligible Tax Deduction Per Sq. Ft	\$0.00	\$0.30	\$0.32	\$0.34	\$0.36	\$0.38	\$0.40	\$0.42	\$0.44	\$0.46	\$0.48	\$0.50	\$0.52	\$0.54	\$0.56	\$0.58	\$0.60	\$0.60





# Window of Opportunity

- ✦ **Building must be placed into service between January 1, 2006 and December 31<sup>st</sup>, 2008 inclusive**
- ✦ **Congress may, at its discretion, extend the window of opportunity by an act of legislation**
- ✦ **Tax deductions must be claimed in the year in which the building is placed into service**

# Who Gets The Tax Deduction?

- ✦ **Tax deductions for private buildings goes to the building owner**
- ✦ **Where there are governmental entities who are owners of the building, the tax deduction goes to the person who is responsible for the design of the lighting upgrade**
- ✦ **When building tenants are involved, whoever carries the lighting fixtures as an asset on their books is considered the owner for tax reasons**

# Counting Fixture Watts

- ⊕ **“System wattage” must be used**
  - ⊕ Total input watts of lamp and ballast
  - ⊕ Fluorescent systems using T-8 “energy-saving” lamps – assume energy saving lamp is installed in socket
  - ⊕ Energy-saving T-8 lamp must be specified for purchase, listed on quotations and actually installed
  - ⊕ Line voltage track lighting – assume 30 watts/linear foot

# Who Can Certify Compliance

- ✦ **An individual who is not related to the person claiming the deduction**
- ✦ **An engineer or contractor who is properly licensed in the jurisdiction where the building is located**
- ✦ **Has represented to the taxpayer in writing that he or she has the requisite qualifications to provide the certification**

# Software Programs For Compliance

- ⊠ **Must use an approved software program when doing all three areas of the buildings**
- ⊠ **Can use the “interim rules” for lighting only**
- ⊠ **approved software**
  - ⊠ **[http://www.eere.energy.gov/buildings/info/tax\\_credit\\_2006.html](http://www.eere.energy.gov/buildings/info/tax_credit_2006.html)**

# Information Required By Certifier

- ⊕ **Name, address & telephone number of the qualified person**
- ⊕ **Address of the building**
- ⊕ **Prescribed statement for energy efficient lighting property that satisfies the requirements of the rules**
- ⊕ **Statement that reduced energy has been determined under the IRS rules**
- ⊕ **Statement that field inspections were conducted and that the building has – or will – meet the energy saving targets contained in the plans and specifications**
- ⊕ **Statement that the building owner has received an explanation of the energy efficiency features of the building and projected annual energy costs**
- ⊕ **Statement that qualified computer software was used, if applicable**
- ⊕ **List of components of the interior lighting system installed in the building**
- ⊕ **Prescribed statement declaring the certifier believes the facts presented to be true, correct and complete**



# Other Notable Implications (cont.)

- ⊕ **Tax deduction provisions are intended to allow credit for alternate design methods:**
  - ⊕ **Daylighting**
  - ⊕ **Automatic lighting controls**
  - ⊕ **Improved fan motor efficiency**
  - ⊕ **Variable speed controllers**
  - ⊕ **Fuel cells**
  - ⊕ **Low loss wire for building power distribution**
- ⊕ **Accelerated depreciation for transmission and distribution assets from 20 to 15 years**

## Forces weighing on the building upgrade decision...

ROI Uncertainty  
Acceptance of Outdated Systems  
Nominal Cost Per Kilowatt Hour  
Lower Legislative Pressures  
Low Tenant Expectations

EPAct 2005 Tax Deductions  
Higher Efficiency Technologies  
Rising Cost Per Kilowatt Hour  
Energy Compliance Laws  
High Tenant Expectations  
Sustainability/LEED

**EPAct 2005**



Tax deductions and heftier-than-ever returns on system investments are creating an environment for building upgrades.

# Department of Energy

⊕ **This regulation only covers the following high power factor ballast types.**

⊕ 120V or 277V ballast for (1) or (2) F40T12 (40 Watt) lamps

⊕ 120V or 277V ballast for (2) F96T12 (75 Watt) Slimline lamps

⊕ 120V or 277V ballast for (2) F96T12/HO (110 Watt) lamps

**The following ballasts cannot be manufactured on or after April 1, 2005 or sold to Distributors on or after July 1, 2005.**

Obsolete Ballasts	Replacement ballast options			
	T12 Magnetic	T12 Electronic	T8 Magnetic	T8 Electronic
<b>RC-1P40-TP</b> <b>RC-2SP40-TP</b> <b>RS-2S110-TP</b> <b>VC-1P40-TP</b> <b>VC-2SP40-TP</b> <b>VS-2S110-TP</b>	<b>NA</b> <b>NA</b> <b>R-2S110-TP</b> <b>NA</b> <b>NA</b> <b>V-2S110-TP</b>	<b>NA</b> <b>NA</b> <b>REL-2S110</b> <b>NA</b> <b>NA</b> <b>VEL-2S110</b>	<b>NA</b> <b>NA</b> <b>R-2S86-TP</b> <b>NA</b> <b>NA</b> <b>V-2S86-TP</b>	<b>ICN-1P32-SC</b> <b>ICN-2P32-SC</b> <b>ICN-2S86</b> <b>ICN-1P32-SC</b> <b>ICN-2P32-SC</b> <b>ICN-2S86</b>

**The following ballasts, manufactured on or after April 1, 2005, will continue to be available for sale to Distributors until July 1, 2010 with the changes noted below.**

Catalog Number	The following changes apply to ballasts manufactured on or after April 1, 2005
<p> <b>R-140-TP</b>  <b>R-1U40-TP</b>  <b>R-2E60-S-TP</b>  <b>R-2E75-S-TP</b>  <b>RC-2E75-S-TP</b>  <b>R-2S34-TP</b>  <b>R-2S40-TP</b>  <b>RK-2S34-TP</b>  <b>V-140-TP</b>  <b>V-1U40-TP</b>  <b>V-2E60-S-TP</b>  <b>V-2E75-S-TP</b>  <b>VC-2E75-S-TP</b>  <b>V-2S34-TP</b>  <b>V-2S40-TP</b>  <b>VK-2S34-TP</b> </p>	<ol style="list-style-type: none"> <li><b>1. Ballasts will only be available as IC – Individual Carton</b></li> <li><b>2. Ballasts will only be available with short leads - typically 12”</b></li> <li><b>3. Ballast will be marked “FOR REPLACEMENT USE ONLY”</b></li> </ol>

# Obituary - Mercury Vapor Ballasts



January 1, 2008 - Mercury Vapor ballasts passed away quietly everywhere. They are no longer be available for sale due to Department of Energy regulations. May they rest in peace.





# Energy Saving Products

**Advance Electronic Ballasts**





# Advance Optanium™ Ballasts

- ⊕ **High efficiency ~ 3 watt reduction in ballast losses**
- ⊕ **IntelliVolt Operation – 120 to 277 volt applications**
- ⊕ **Normal, low, and high ballast factors**
- ⊕ **Instant and Programmed Start models**
- ⊕ **Operates all standard and energy saving T-8 lamps**
- ⊕ **- 20 deg. “F” starting temperature**

# Optanium™ Ballasts - continued

- ✦ **UL “CC” rating**

  - ✦ Anti Arc protection

- ✦ **Lamp auto-restrike capability**

  - ✦ Lower maintenance costs

- ✦ **No interference with security systems**

- ✦ **Correct lead placement ensures easy installation**

# System Solutions Comparison

Ballast(s)	Lamps	Input Watts	Relative Light Output	Savings
<b>(2) Magnetic</b>	(4) 34 Watt T12	144	<b>100%</b>	N/A
<b>(2) Electronic</b>	(4) 34 Watt T12	120	<b>97%</b>	<b>17%</b>
<b>(1) Low-watt ELE</b>	(4) 32 Watt T8	98	<b>100%</b>	<b>32%</b>
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<b>(1) High-efficiency low-watt ELE</b>	(4) 25 Watt T8	76	<b>88%</b>	<b>47%</b>

# Ballast Factor Defined

- ⊕ **“Measure of light output from lamp operated by commercial ballast, as compared to laboratory standard referenced ballast specified by ANSI.”**
- ⊕ **There are 3 nominal ballast factor choices when selecting electronic ballasts:**
  - ⊕ Normal ballast factor ~ (.88)
  - ⊕ High ballast factor ~ (1.20)
  - ⊕ Low ballast factor ~ (.75)

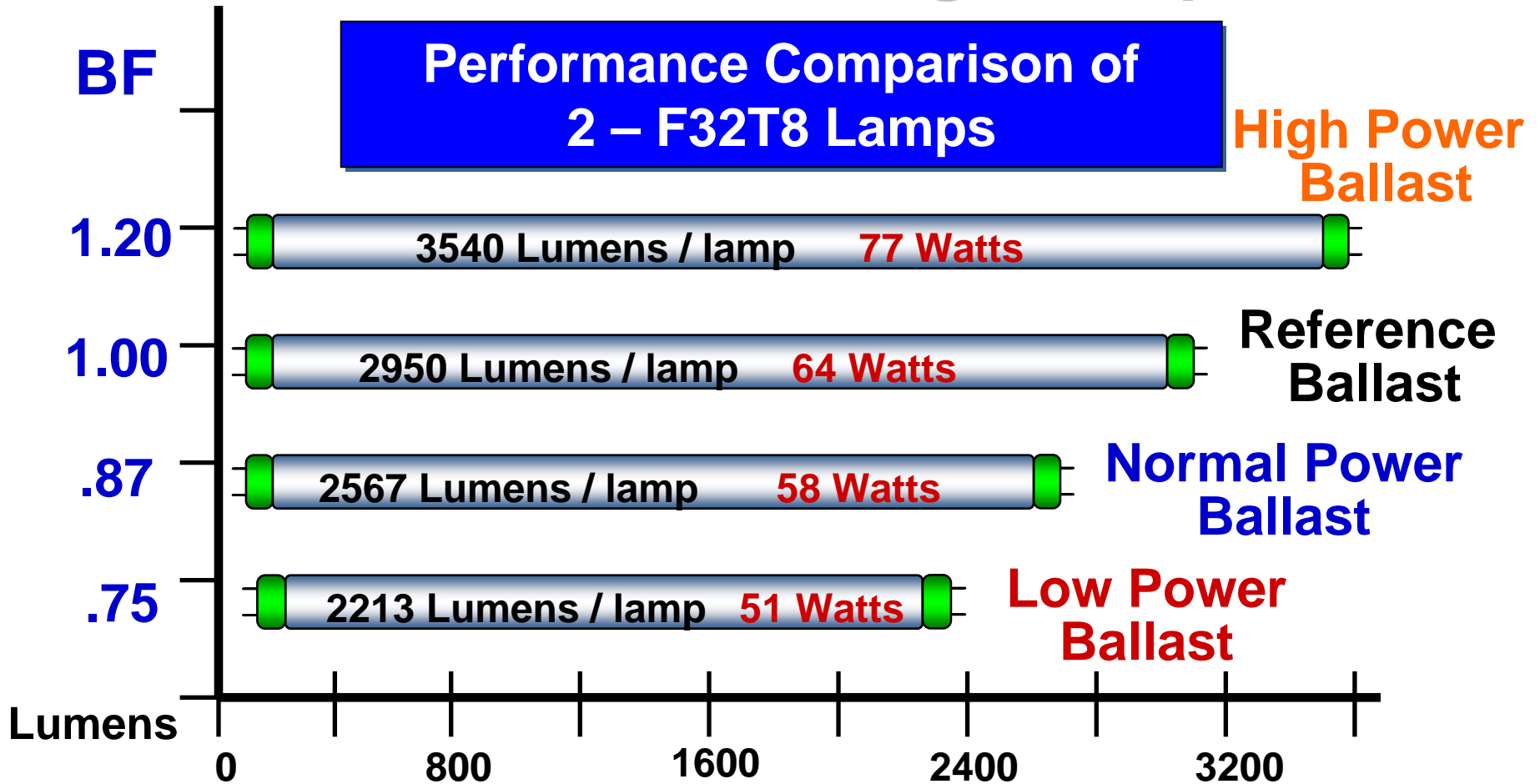
# Ballast Factor In Terms of Control

- ⊞ **Electronic ballasts are offered with different ballast factors (refer to Advance catalog)**
- ⊞ **Selection and application of ballast factor can act as a form of lighting control**
- ⊞ **Reducing the ballast factor reduces light output and saves energy**
- ⊞ **Reduced light output cannot be below minimum requirements**

# Ballast Factor Is Important

- ✦ **You can control the amount light you need by selecting the correct ballast factor**
- ✦ **Low ballast factor = less light and saves energy**
- ✦ **High ballast factor = more light and less energy efficient**
- ✦ **Know when and where to use the different ballast factors**

# Ballast Factor & Light Output







# Fluorescent Dimming

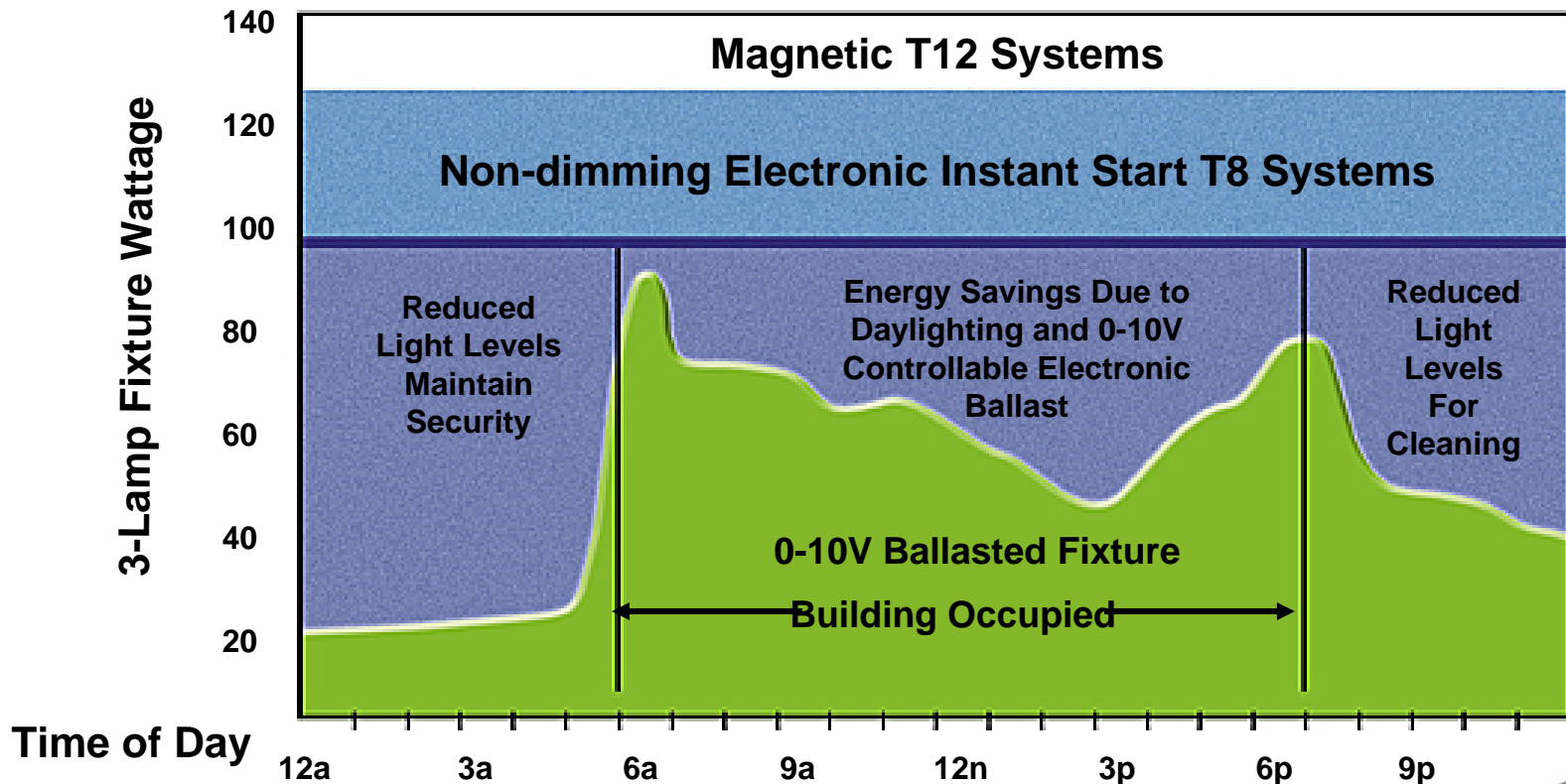
Added Energy Savings



# Fluorescent Dimming

- ⊕ **An excellent method of control resulting in exceptional energy savings**
- ⊕ **Varies ballast factor to create 100 % to 5 % light output**
- ⊕ **Advance offers 2 types:**
  - ⊕ **Mark X® – Powerline 2-wire**
  - ⊕ **Mark VII® – 0-10 Volt D.C. Control**
- ⊕ **Multiple compatible control manufacturers including Leviton Mfg.**

# How can dimming save you energy?



# Advance Mark X® Powerline

## ✦ Applications

- ✦ Linear Fluorescent
  - ✦ 4-Pin Compact Fluorescent
  - ✦ T5-HO
- ✦ **100% to 5% full-range continuous dimming (down to 1% in T5/HO models)**
- ✦ **Delivers up to 65% energy savings over standard Fixed Output T8 ballasts**

# Advance Mark X® Powerline

- ✦ **Standard Wiring – no special control leads**
- ✦ **Programmed Start Ignition**
- ✦ **Lamp ignition at any light setting, including the 5% level (1% in T5/HO models)**
- ✦ **Uses:**
  - ✦ Atriums, Auditoriums, Classrooms, Conference Rooms, and Dining areas

# Advance Mark VII® 0-10 VDC

- ⊕ **100% to 5% full-range continuous dimming (down to 1% in T5/HO models)**
- ⊕ **Direct operation from a 0-10V DC control device**
- ⊕ **IntelliVolt® multiple-voltage technology enables operation at any input voltage from 120 to 277 volts, 50/60Hz**

# Advance Step-Dim Ballasts for T-5

- ⊠ **Designed to operate (2) 28 watt T-5 lamps**
- ⊠ **Controlled by any line voltage switching device**
  - ⊠ Separate line voltage leads for operation of each lamp
- ⊠ **IntelliVolt™ design**
  - ⊠ Operates on any voltage between 120 and 277 VAC
- ⊠ **Programmed-Start for use with occupancy sensors and other control devices**





# New Fluorescent Technology

T-5 HO and T-8 VHO



# Advance Centium® T5-HO

- ⊠ **Programmed rapid-start lamp ignition**
  - ⊕ Allows the use of lighting controls and occupancy sensors
- ⊠ **IntelliVolt™ -120 through 277V operation at 50/60 Hz**
- ⊠ **Standard and 90° C models for use in spaces with untreated air**
- ⊠ **0°F cold starting capability**
  - ⊕ Suitable for cold temperature applications

# Advance Centium® T5-HO

- ⊕ Multi-lamp capability with consistent ballast factor
  - ⊕ Operates (1) or (2) lamps at same full-light output
  - ⊕ Further reduces SKU's required in inventory
- ⊕ Auto-Restrike
  - ⊕ Eliminates the need to reset power mains after failed lamps are replaced
- ⊕ Color-coded, poke-in wire connectors
  - ⊕ Ensures wiring accuracy
  - ⊕ Minimizes fixture assembly and ballast installation time

# Optanium® for F48T8-VHO

- ⊕ Operates (1) or (2) F48T8VHO lamps
- ⊕ Programmed-start circuitry
  - ⊕ Suitable for on/off cycle operations
- ⊕ IntelliVolt High Technology (277V-480V, 50/60Hz)
  - ⊕ No need to rewire 480 volt systems



# F48T8-VHO Applications

## ⊕ High and low temperature environments

- ⊕ Minimum starting temperature of  $-20^{\circ}\text{F}/-29^{\circ}\text{C}$ , a maximum case temperature rating of  $194^{\circ}\text{F}/90^{\circ}\text{C}$
- ⊕ UL Type HL (Hazardous Location) rating
- ⊕ Ballast is designed to thrive under the most extreme conditions.

## ⊕ Lamp EOL protection circuit

- ⊕ Removes power from the lamp at end-of-life