

# CLEAR ADVANTAGE FOR LAMP-FREE PROJECTORS :

Benchmarking Cost, Performance,  
and Capability for the Panasonic  
PT-RZ/RW range



## Executive summary

1. Assess the performance of LED/Laser projectors against historic lamp-lit projectors against the following fields

Lifetime Total Cost of Ownership – Financial Cost  
Lifetime Carbon Consumption – Environmental Impact

2. Contention: A new brightness rating system based on Cumulated Light Output

The current ANSI system for assessing the brightness rating of projectors has been overtaken by the emergence of a new class of projectors that do not have a bulb, but instead use LED/Laser as their light source. The decay curve for this new generation of projectors is very different to that of a lamp-lit projector, and the differences are not accommodated by the ANSI system. Therefore we propose a new brightness rating system based on **Cumulated Light Output**.

3. Superior Total Cost of Ownership of the Panasonic RZ Series in Education and Museum applications

Higher brightness stability of the LED/Laser in combination with the long life light source which makes lamp changes obsolete decreases the operating cost for the end user. Additional maintenance cycles and cost for filter cleaning and filter changing are eliminated.

ROI Team analyzed the market with the target to benchmark the performance of LED/Laser projectors against conventional lamp lit models. ROI Team made initial contact with 90 AV dealers from 7 different territories. Subject of the survey included the number and cost of maintenance visits - Information received from this source was averaged.

This project was commissioned by Panasonic Systems Communications Company Europe (Panasonic SCEU), configured and delivered by ROI Team with input from Dr Joyce Tsoi, ROI Team Associate and Subject Expert, and scrutinised by UL.com ([www.ul.com](http://www.ul.com))

## Section 1

### Demand for Visual Communications – the projector comes of age

For this study we have considered two sectors where projectors are widely used:



#### Higher Education

..... where projectors are a required tool to assist teachers and lecturers to enhance their subjects by visual stimulus. The value of the projector as an aid to teachers has been balanced by tendency of historic lamp-lit projectors' inability to provide projection-on-demand, because of the need to warm up/cool down the machine to prevent serious damage and/or sudden lamp burn out, imply darkened room, and often uncomfortably hot from heat dissipated by the projector.



#### Museums and Galleries

..... where projectors are sometimes used in combination to convey key background information to support exhibitions, and more and more to recreate an 'experience' of an era or location to bring alive an exhibition. Projectors in this setting need sophisticated features to enable them to be used in combination to create a concerted effect.

#### 20th Century – Lamp-lit projector:

- Limited bulb life
- Periodic bulb changes
- Filter cleaning / changing
- Warm-up/warm-down time

Until very recently the performance and maintenance requirements of projectors have been framed by a number of factors that have limited their performance and flexibility.

#### 21st Century Panasonic LED/Laser Projectors PT-RZ470/RW430/RZ370/RW330

First lamp-free projector with professional installation features such as Digital Link, Full-HD resolution or Edge-Blending (exact feature set is model dependant).

- 20,000 hours maintenance-free lifetime
- Quick ON/OFF capability with full brightness instantly
- Reduced operating costs
- Reduced environmental impact.

2012 has witnessed the launch of **Panasonic's PT-RZ series**, the first projectors with professional features such as edge blending and Digital Link connectivity to dispense with a lamp, achieving higher brightness stability by way of a combination of LED and laser lighting technology.

This series represents a huge step forward for the capability of the projector, with immediate gains in durability, immediacy, performance, and maintenance. Importantly the LED/laser technology implies reduced overall power consumption and reduction of toxic metals, and is therefore more environmentally friendly.



## Section 2

### Advantages of LED/Laser as a light source

**The use of the projector as a tool for visual communication and teaching has been restricted by performance limitations of the conventional lamp-lit projector including:**

#### Lamp life

A projector requiring a lamp is subject to the decay curve associated with the conventional bulb. Projector bulbs have a limited life expectancy varying, according to manufacturers' recommendations, between 1,500 hours to 6,000 hours. Manufacturers recommend that a bulb is no longer functional and must be replaced when its brightness falls to 50% of its initial output.

If we assume that in a university setting a projector might be in use for 48 hours per week for 40 weeks a year, it can be seen that the university must budget for a lamp-change approximately yearly – or face deterioration and possible failure of essential teaching equipment. It is also relevant to consider that, as the PT-RZ Series has a life of 20,000 hours, this university would need to budget for as many as 13 lamp changes to keep their projector operational.

#### Warm-up/Cool-down time

Projectors need to be operated within a very specific temperature range. In case of conventional lamp projectors a carefully engineered airflow system is essential to avoid catastrophic damage to the lamp. In addition, the lamp requires over 30 minutes to reach a stable state, consequently frequent on/off cycle will deteriorate the lamp faster.

For this reason a conventional projector needs a warm-up time of up to 2 minutes before it can achieve operational brightness; it's also essential that on closing down it must remain connected to the power supply during cool-down time to ensure its fans continue to cool the bulb.

Not surprisingly these requirements make the conventional projector cumbersome in the context of a fast-moving teaching session. The tutor must either keep the projector switched on throughout his lecture, and accept an uncomfortably hot and possibly

darkened room – or accept a pause of 2 minutes before he can respond to a student's question. Either way he must switch off the projector 5 minutes before the end of the lecture to ensure it can be fully cooled before he locks up the lecture room.

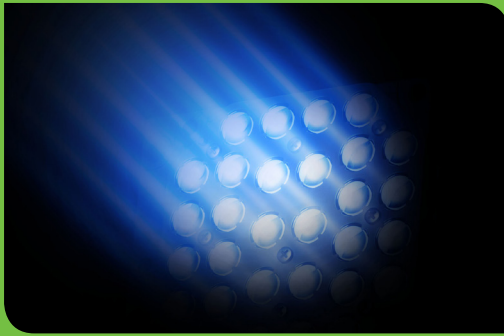
The Panasonic LED/Laser projector on the other hand operates at a much lower temperature and provides a quick on/off technology.

#### Power consumption adjustment

Conventional projector lamps run at 100% of their power requirement, which means producing 100% of the brightness, regardless of the brightness of the image they are projecting. For darker contents additional technology reduces the amount of light projected to the screen by either absorbing the additional brightness within an LCD panel, or reflecting it away from the light path. Both systems produce additional heat which has to be dissipated from the projector.

LED/Laser diodes on the other hand are dimmable light sources. They will use 100% power only when full brightness is called for. In dynamic mode or with the EcoSave feature when projecting a typical mixed output of darker pictures the Panasonic LED/Laser light source will automatically reduce its power consumption – and its heat output.

It can rapidly be seen that the LED/Laser projector represents a major advance in terms of operational efficiency and flexibility.



#### LED/Laser light source

- Light source life span: 20,000 hours
- 20,000 maintenance free lifetime
- Optical parts not air-cooled, so filter is not needed

- Operates at a much lower temperature, requiring less energy

- Quick-on/off technology reducing power consumption and making projector instantly usable
- More eco-friendly
- Adjusts power consumption and heat output according to brightness of the image.



#### Lamp as light source

- Bulbs no longer functional after brightness falls to 50%
- Lamp-life range: 1,500 to 6,000 hours
- Needs up to 13 lamp changes during 20,000 hours lifespan
- Need to change or clean filter to keep optical parts free of dust
- Needs up to 20x costly maintenance visits during 20,000 hours lifespan

- Warm-up time up to 2 mins
- Cool-down time 5 mins or more
- Remains connected to power supply during cool-down time, increasing power consumption

- Bulb contains mercury and other toxic materials
- Runs at 100% power requirement at all times, causing additional heat output

## Section 3

### Projector Maintenance: Bulbs and Filters

**Conventional projectors have tended to be ‘maintenance heavy’ requiring regular attention by skilled technicians to keep them operating at full efficiency. These maintenance visits are costly, and also add to the environmental impact of the projector because of the need for technicians to travel by van to the site.**

#### Bulbs

As we have observed above, all types of light source (car headlights, household bulbs etc.) are consumable items with a limited lifetime. Manufacturers of lamp-lit projectors recommend that a bulb has reached the end of its useful life when its brightness has fallen to 50% of its initial rating. Of the range of models that we have evaluated, manufacturers recommend the bulb should be replaced after anything between 1500 to 6000 hours of use. Therefore during the 20,000 hours assumed lifetime of a projector, some models will require as many as 13 bulb changes – which, owing to the delicate nature of the equipment, must be carried out by a professional technician.

There is a charge for these ‘maintenance visits’ which we investigated to be charged at an average of €98 in European territories.

Nor is the bulb itself a cheap item. Of the basket of 9 models most purchased by the Higher Education Sector, best price for a replacement bulb ranges from €145 to €348. For most conventional models it is clear that the cost of replacement bulbs and maintenance will exceed the purchase price of the projector across its lifetime.

Regular bulb changes are also an environmental burden as bulbs cannot be recycled, and all contain amounts of hazardous metals such as mercury.

#### Filters

For conventional projectors a number of parts, including lamp, sensitive optical components, require constant cooling, usually with air which is drawn into the projector from outside. As air is drawn into the projector, dust particles collect inside and start to degrade picture quality by sticking to optical components.

To avoid this development, many conventional projectors are equipped with a filter, which requires periodic cleaning and/or changing by a skilled technician. If filter cleaning / changing do not correspond with a bulb change visit, there will be charges for an additional maintenance visit.

With the Panasonic LED/Laser series optical parts are cooled by a heat sink, so do not need to be located within the airflow. Therefore there is no need for a filter. The DMD chip which creates the image is sealed away and a special heat sink device housed away from the LED/Laser diodes cools the light source.

## Section 4

### Brightness Decay

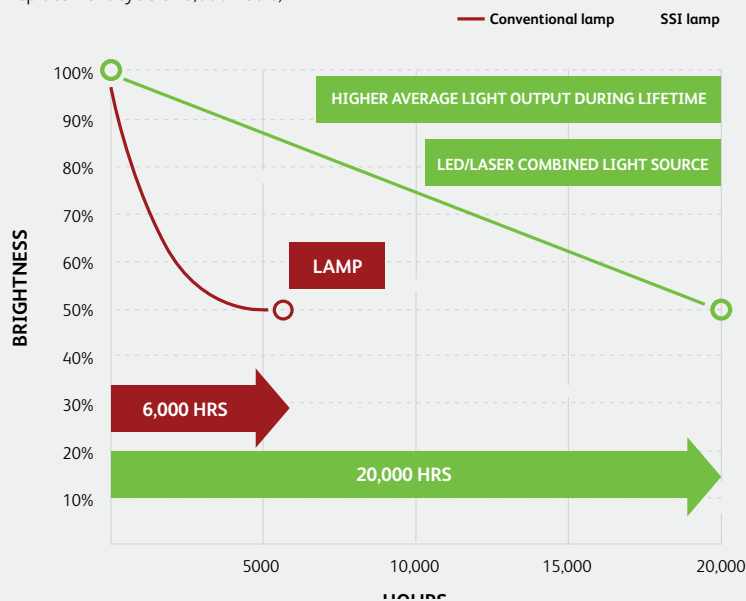
All types of light source (car headlights, household bulbs etc.) show brightness decay and a limited lifetime. They are consumable items.

Conventional projector lamps show a **Regressive Decay**. This means that a lot of initial brightness is lost in the early hours of operation. The decay curve then flattens out before finally reaching 50% of initial brightness, at which point the bulb is no longer functional and must be changed. This means that a conventional projector bulb will spend as much as half of its life operating at close to half of its full capacity.

LED/Laser light sources on the other hand when engineered and cooled properly, display a **Linear Decay** – so the projector loses operational brightness much more slowly and in a steady decline. This means that soon after starting its lifetime an LED/Laser projector will be providing more brightness than its equivalent lamp-lit projector.

#### Regressive Decay (bulb) Vs Linear Decay Solid State Illumination (SSI)

(Comparison with a projector that has a lamp replacement cycle of 6,000 hours)

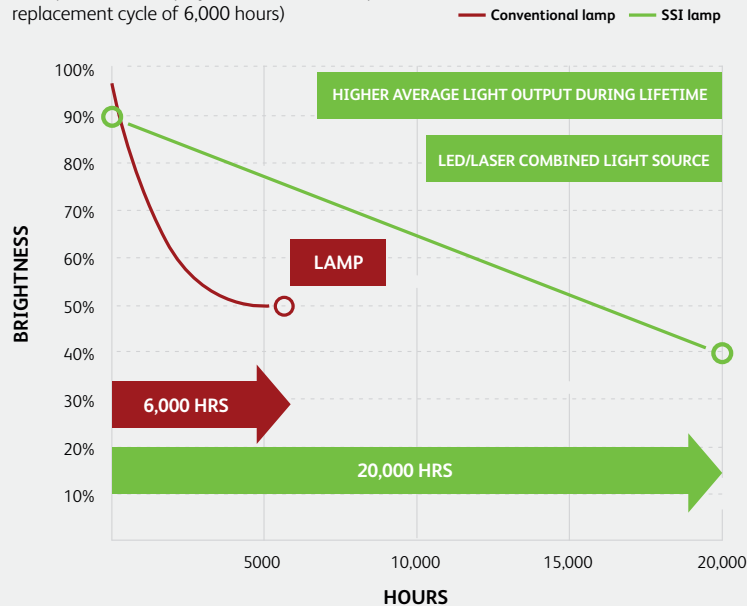


The graph above shows the brightness output of two projectors, both with an initial rating of 3,500lm: one a conventional lamp-lit projector with 6000 hrs lamp life, the other an LED/Laser projector. It can be seen that the brightness of the lamp-lit model rapidly falls below the SSI model. Even after an expensive bulb change, the conventional model matches the performance of the SSI model only for a short time.

Even where we compare the performance of a conventional projector rated at 4,000lm against that of an SSI model rated at 3,500lm it can be seen that, because of the Regressive Decay pattern of the lamp-lit projector, after only a short period of use, the SSI model is operating at a superior level of brightness. In the graphic below, the brightness of the lamp-lit 4,000lm projector falls below that of the 3,500 lm SSI model after just 1,000 hours of use – after approx 6 months as used in a typical Higher Education location.

### Brightness output – 4,000lm lamp Vs 3,500lm SSI

(Comparison with a projector that has a lamp replacement cycle of 6,000 hours)



Referring to this graph, we see that over its lifetime of 20,000 hours an SSI projector rated at 3,500lm ANSI produces 10% greater light output than a conventional lamp-lit model rated at 4,000lm ANSI, considering that the lamp will be repetitively replaced with a new one after its end of life.

This encourages us to make a bold assertion which we intend to prove in the course of this paper:

*In spite of their different initial ratings, the true competitor for a 3,500lm SSI projector is a 4,000lm conventional projector especially if application and lifetime brightness are considered.*



## Section 5

### New Basis for Comparison: Cumulated Light Output

**The best known and most widely accepted method to measure projector brightness is the ANSI Lumen specification devised by the American National Standards Institute (IT7.227-1998) which considers not only brightness, but also the uniformity of brightness as projected on a screen.**

However brightness ratings following the ANSI model or any other specification are time-coded measurements which cannot track differences in brightness decay. Historically, this limitation has been acceptable because all projectors have used similar technology and so follow a similar pattern of brightness decay i.e. the **Regressive Decay** path.

However, as observed above, the development of the LED / Laser projector now introduces alternative technology and an entirely different decay path i.e. a **Linear Decay** path. This means that an LED/Laser projector delivers a higher level of brightness for a greater proportion of its operational life.

To make a meaningful comparison between projectors using these different light sources, we need to evaluate brightness output over the lifetime of the projector. The cumulated light output can be expressed by the equation:

“

**Brightness (ANSI lm) x Hours of Operation = Cumulated Light Output**

”

The **Panasonic PT-RZ370/PT-RW330 & PT-RZ470/PT-RW430** with initial brightness of 3500lm ANSI produces 22% more brightness than a conventional projector of the same initial brightness, that requires 4 lamp changes within its 20,000 hours operating lifetime.

When benchmarked against a conventional projector with ANSI rating of 4,000lm, the **Panasonic PT-RZ370/PT-RW330 & PT-RZ470/PT-RW430** (brightness rating of 3500lm) still produces **10% more brightness across the same period.**

**Additionally built-in colour sensors inside the optical system will make sure that no colour shifting occurs during the product life.**

A projector is chosen for a specific application (seminar room, class room, digital signage) according to the brightness required to run the application. This includes comfortable and stress free attention to teacher presentations in daylight light conditions, or maybe crisp and clear reproduction of content in a museum or exhibition context.

The **PT-RZ370/PT-RW330 & PT-RZ470/PT-RW430** projectors **with an initial brightness of 3500lm** ANSI produce more brightness over the same period than a conventional projector measured initially at 4000lm. Depending on room condition, content and brightness requirement both are suitable for the same applications.

## Section 6

### Power Consumption

**Conventional projector lamps run at 100% of their power requirement, which means producing 100% of the brightness, regardless of the brightness of the image they are projecting.**

For darker contents additional technology reduces the amount of light projected to the screen by either absorbing the additional brightness within an LCD panel, or reflecting it away from the light path. Both systems produce additional heat which has to be dissipated from the projector.

LED/Laser diodes on the other hand are dimmable light sources. They will use 100% power only when full brightness is called for – i.e. a 100% white picture. With the EcoSave feature when projecting a typical mixed output of darker pictures the Panasonic LED/Laser light source will automatically reduce its power consumption – and its heat output.

Presentation content and video vary in brightness. While the conventional projector will always run at maximum power consumption, the LED/Laser projector consumes power according to the content being projected.

IEC 62087 Ed.2 is a recognized standard for measuring power consumption of TV's, displays and video equipment, issued by the International Electrotechnical Commission (IEC). The IEC's 'Test Pattern Video' is an edit of material of differing

brightness calculated to replicate typical video output in different territories around the world. This method has been developed to measure the power consumption of devices with content related power consumption capability – **like the Panasonic PT-RZ370/RW330 & PT-RZ470/PT-RW430 series.**

Using this test sequence the **Panasonic PT-RZ370/RW330 & PT-RZ470/PT-RW430** projectors show an average power consumption of 271W in Standard Mode, or 193W using EcoSave2.

As part of their work to benchmark the performance of the **Panasonic PT-RZ370/RW330 series** against conventional lamp-lit projectors ROI Team analysed the power consumption of the **PT-RZ370/RW330 series** against consumption of the 8 projectors most purchased by the Higher Education Sector over the last three years (source : [www.futuresource-consulting.com](http://www.futuresource-consulting.com)). Power consumption data was sourced from manufacturers' published product data, and analysed by Dr Joyce Tsoi to assess a weighted average for the basket. The outcome is:

<b>Panasonic PT-RZ370/RW330 series</b>	<b>250W</b>
<b>Basket of conventional projectors</b>	<b>350W*</b>

\* average operating power consumption of 8 conventional projectors in Watts

	Projector brand	Projector model number	Brightness in ANSI	Lamp life	Power consumption
1	Epson	EB-1925W	4,000 Lumen	2,500 hrs	341W (Normal Mode), 0,3W (Standby)
2	Infocus	IN5124	4,000 Lumen	3,000 hrs	254W (Normal Mode)
3	Infocus	IN5316HD	4,000 Lumen	1,500 hrs	330W (Normal Mode), < 1W (Standby)
4	Mitsubishi	FL6900U	4,000 Lumen	2,000 hrs	430W (Normal Mode)
5	Mitsubishi	WD3300U	4,000 Lumen	2,000 hrs	430W (Normal Mode), < 1W (Standby)
6	NEC	NP3250W	4,000 Lumen	2,000 hrs	490W (Normal Mode)
7	Optoma	EH2060	4,000 Lumen	2,000 hrs	380W (Normal Mode), < 1W (Standby)
8	Optoma	EW766	4,000 Lumen	3,000 hrs	233W (Normal Mode), < 1W (Standby)

**If we assume the effective operating lifetime of a modern projector to be 20,000 hours, then the lifetime power consumption is:**

<b>Panasonic PT-RZ370/RW330 series</b>	<b>5,000 KW</b>
<b>Basket of conventional projectors</b>	<b>7,180 KW</b>

By this measure the PT-RZ370/RW330 series uses only 70% of the power consumed by a conventional projector of equivalent brightness, whilst in fact producing 10% more light output across its lifetime.

## Section 7

### Projector Distractions: Output of heat and noise

**Historically use of a projector in a closed room has implied unwanted distractions associated with heat and noise generated by lamp-lit projectors, which is an unavoidable feature of the technology they use.**

An increase in room temperature can be uncomfortable and can cause loss of concentration and drowsiness. Noise too can become an irritant and cause fatigues as voices are raised to overcome ambient noise in the room. It can immediately be seen that both of these factors are unwanted in a Higher Education teaching environment.

#### **Output of heat and light**

Projectors need to be operated within a very specific temperature range. In case of conventional lamp projectors a carefully engineered airflow system is essential to avoid catastrophic damage to the lamp.

For this reason a conventional projector needs a warm-up time of up to 2 minutes before it can achieve operational brightness; it's also essential that on closing down it must remain connected to the power supply during cool-down time to ensure its fans continue to cool the bulb.

LED/Laser light sources switch on instantly with full brightness, there is no cool down time needed so the projector can be switched off and disconnected from power supply immediately after the end of the presentation.

Conventional projectors always operate at 100% brightness, regardless of the image they are projecting. Much of the time a conventional projector needs to absorb much of the light which is produced, but not wanted when the projector is projecting darker images. The excess light is converted to heat which is then dissipated into the room, with the effect of raising the room temperature, leading to discomfort.

With an LED/Laser light source in Dynamic or EcoSave picture mode, as with the power consumption, generation of light and heat are dependent on content shown. 100% brightness is required only by a blank white screen, with all other image styles demanding less than 100% light output. This means a significant reduction in the heat output by the projector, and therefore a reduced change in room temperature.

## Section 8

### LED/Laser vs. Lamp-lit: Benchmarking projector performance and lifetime costs

#### ROI Team's brief:

Benchmark the performance /consumption of the **Panasonic PT-RZ370/RW330** series of projectors against a basket of historic lamp-lit projectors against the following fields:

- Lifetime Total Cost of Ownership – Financial Cost
- Lifetime Carbon Consumption – Environmental Impact

#### Market Sector:

Higher Education Organisations - universities, colleges, training schools etc.

#### Models for comparison:

SSI model: Panasonic PT-RW330 – 3,500lm ANSI

Basket of 9 models identified by Europe wide sales returns as most purchased by Higher Education Organisations during the last 12 months (source : [www.futuresource-consulting.com](http://www.futuresource-consulting.com)) selecting models rated between 3,500 and 4,000lm ANSI

#### Projector Lifetime:

Assumed to be 20,000 hours

Usage pattern, Higher Education organisations:

10am to 6pm, 6 days pw, 40 weeks per year = 48 hours pw = 1,920 hours per year

#### Sources of performance metrics:

- a) Resellers/dealers independent of Panasonic, and actively selling into the Higher Education Sector. ROI Team made initial contact with 90 from 7 different territories. Information received from this source was averaged
- b) Manufacturers' published product data sheets
- c) Aggregated Cost Calculator built for this project by ROI Team Associate, Dr Joyce Tsoi

#### Research Approach

Work undertaken by project team from ROI Team, London, UK ([www.roiteam.co.uk](http://www.roiteam.co.uk)), Project Director, Andrew McCall, with expert input by Subject Expert Dr Joyce Tsoi

Research approach and method adopted has been scrutinised and endorsed by UL.

## Section 9

### Conclusions

**Sector professionals such as resellers/dealers and experienced end-users welcome the user-friendly qualities of Panasonic's new lamp-free projectors:**

- 20,000 hours maintenance-free lifetime
- Always ready for use, never in the repair workshop
- Instant ON/OFF capability
- Reduced environmental impact
- Heat sink means cooler and quieter running
- Flexible projection position

**ROI Team's evaluation over the second half of 2012 demonstrates clear advantages for the Panasonic PT-RZ370/RW330 series against the projectors most purchased by the Higher Education sector :**

- Brighter better projection: Cumulated Light Output 22% greater
- Environmental Stewardship: Carbon Consumption reduced by 37%
- Lifetime Cost of Ownership between 30% to 80% lower.

### Lifetime Power Consumption

**If we assume the effective operating lifetime of a modern projector to be 20,000 hours, then the lifetime power consumption is:**

- Panasonic **PT-RZ370/RW330 series** 5,000KW
- Basket of conventional projectors 7,180KW.

By this measure the **PT-RZ370/RW330** series uses only **70% of the power** consumed by a conventional projector of equivalent brightness, whilst producing **10% greater Cumulated Light Output** across its lifetime.

### Lifetime Cost of Ownership

Taking into account all costs associated with the purchase and effective operation of a projector for Higher Education use we see again a clear advantage for the **PT-RZ370/RW330 series** compared with a basket of most-purchased lamp-lit projectors:

- Panasonic **PT-RZ370/RW330 series** Euros 3301 to 4551 (dependent on model selection)
- Basket of conventional projectors Euros 5934
- Although the initial purchase price may be higher, lifetime freedom from maintenance calls and lamp-changes gives the **PT-RZ370/RW330 series** a Lifetime Cost of Ownership between **30% to 80%** lower than a basket conventional projectors of equivalent brightness.

### Lifetime Carbon Consumption

**In terms of Carbon Consumption the lifetime comparison between the two projectors shows :**

- Panasonic **PT-RZ370/RW330 series** 2.65 tonnes
- Basket of conventional projectors 4.24 tonnes
- Across its lifetime the **PT-RZ370/RW330 series** produces only **63% of the Carbon Consumption** of a conventional projector of equivalent brightness.

### LED/Laser Projectors

- LED/Laser Light Source with 20,000 hours life expectancy
- No light source maintenance for 20,000 hours performance
- Power efficient, energy-friendly, operates at a much lower temperature, requires less energy
- Instant-on/off technology – no warm-up or cool-down required which reduces power consumption
- Consumes power according to the content being projected
- Power consumption: 271w in standard mode, or 193w using EcoSave2
- Brightness decay: Linear – projector loses operational brightness slowly and in steady decline
- More stable and long lasting brightness
- Generation of light and heat are dependant on content shown. Do not use 100% light output which reduces the heat output and creates a reduced change in the room temperature

### Lamp-lit projector

- Traditional Projector Lamp as light source with life expectancy between 1,500 to 6,000 hours
- 13 lamp changes for 20,000 hours performance
- Runs at 100% of their power requirement all the time which causes additional heat
- Warm-up and cool-down time required. Remain connected to the power supply during cool-down time, all increase power consumption
- Always run at maximum power consumption
- Power consumption: 271W in standard mode, or 193W using EcoSave2
- Brightness decay: Regressive – initial brightness is lost in the early hours of operation
- Bulb operates half of its lifetime at half of its full capacity
- Always demands 100% light output, which creates excess light when projecting darker images which is converted to heat and raise the room temperature
- Constantly cooled by a fan which produces noise
- Regular bulb and filter changes, cause high costs and environmental burden

## Appendix I

### Credentials and Biographies



**Andrew McCall,**  
Managing Director,  
ROI Team

ROI Team is a research consultancy that works to understand clients objectives, strategies, and challenges, devising and managing programmes of research to provide the hard evidence to enable well informed strategies and commercial decisions.

Clients include retailers such as **Harrods**, **Flying Brands**, and **Best Direct**; owners of retail property like **The Mall Corporation**; the **NHS** and **Department of Health**; and media companies such as **Thomson Reuters**, **TV New Zealand** and community TV operator **CAN Media**.

Directors of ROI Team have also led projects to benchmark performance of key products for leading companies such as **3M**, **JCDecaux**, and **Media Zest plc**.

ROI Team has a close working relationship with Brunel University. With academics from **Brunel**, ROI is developing **Greenscope**, the first tool for the measurement of sustainable marketing strategies in the world of retail with the benefit of a development grant from the **London Development Agency**

ROI Team is wholly owned by its founding directors and does not have any financial arrangements or obligations within its fields of operation. Our aim is to provide sound information, impartially interpreted, to provide a basis for informed business decisions.

#### **Dr Joyce Tsoi, Environmental Program Manager**

Dr. Tsoi is an Environmental Engineering Professional with over 10 years of extensive environmental management fields. She is a Fellow member of the Royal Institute of Minerals, Mining and Materials, UK. She has extensive experience in leading and managing sustainability projects for large international and Fortune 500 clients especially in the areas of environmental auditing; waste management; sustainable supply chain solutions; energy and carbon footprint auditing; corporate environmental/ sustainability reporting and sustainable technologies. She has managed a wide range of international environmental business activities,



**Dr Joyce Tsoi,**  
Environmental  
Program Manager

including supply chain operations; construction and operations, industrial and commercial management, due diligence EHS projects and consultancy services worldwide. She has been developing solutions for environmental liability issues, managing projects to prevent and control environmental risks. She has been developing and implementing realistic and achievable environmental management plans for clients; help clients improve overall

environmental performance, and minimize environmental impacts and liabilities; reducing long-term liabilities by improving environmental compliance; implementing sustainable solutions that address a wide range of environmental challenges, including chemical hazards; waste handling and disposal; energy efficiency and greenhouse gas emissions; and air, water and wastewater management.

She has delivered environmental management trainings for a wide range of clients United Nation Environmental Programme (UNEP); European Commission; ERM (UK); HSBC; Gammon Skanska; Cisco; Media Zest; Deloitte Touche Tohmatsu, Kenan Institute Asia, Global Standards and many others. She is trained as an ISO 14001 EMS lead auditor; approved EICC EHS lead auditor; SA 8000 auditor and is a certified carbon auditor with the UK Energy Institute. She plays a leading role in the industry. She is a co-founder of the UK Negowaste initiative.

## UL : a name you can trust.

UL is a global independent safety science company offering expertise across five key strategic businesses: Product Safety, Environment, Life & Health, Knowledge Services and Verification Services. Our breadth, established objectivity and proven history mean we are a symbol of trust and enable us to help provide peace of mind to all.

### Global conformity Unparalleled breadth. Unmatched expertise:

#### UL's global conformity work in 2011 :

- 22.4 billion UL Marks appeared on products
- 67,798 manufacturers produced UL certified products
- 86,972 product evaluations were conducted by UL
- 563,862 follow-up services inspection visits were conducted by UL
- 19,909 types of products were evaluated by UL
- 160 satellite and inspection centers in service (97 UL inspection centers and 63 UL-STR satellite locations)
- 104 countries with UL customers
- 3.1 billion consumers were reached by UL with safety messages in Asia, Europe and North America
- 1,464 current standards for safety published by the UL family of companies (1,158 for UL; 306 for ULC)
- 95 laboratory, testing and certification facilities in the UL family of companies
- 8,956 employees in the UL family of companies ready to serve UL customers
- 6,461 products certified for Energy Star
- 46 countries with UL employees

Further information from [www.UL.com](http://www.UL.com)



## Appendix II

Introducing the Panasonic PT-RZ370/RW330 series  
– the world's first lamp-free projector with professional  
installation features



NO MAINTENANCE FOR 20,000 HOURS



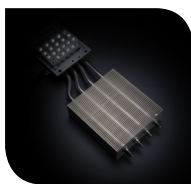
INSTANT ON/OFF



PORTRAIT MODE COMPATIBILITY\*



ECO FRIENDLY

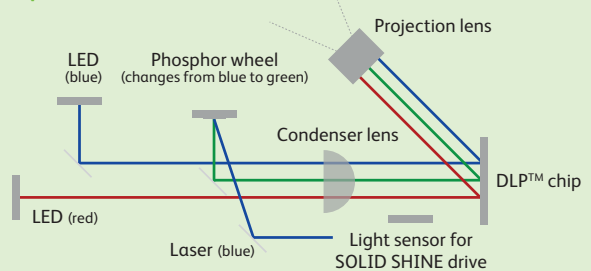


Heat pipe cooling system  
maintains stable operation  
up to 45°C (113°C)



The LED/Laser-combined  
light source enables  
approx. 20,000 hours of  
continuous operation

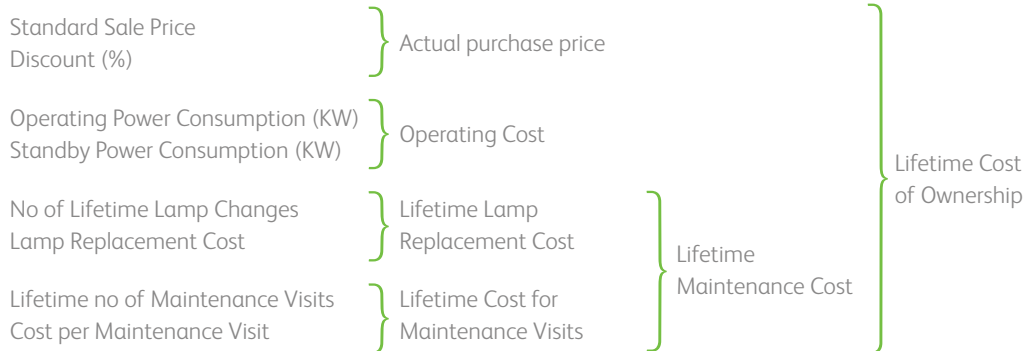
### PT-RZ370/RW330 Optical Structure



## Appendix III

### Anatomy of the Cost /Carbon Consumption Calculator

#### Lifetime cost of ownership



#### Carbon Consumption

