Technical Trend

Indoor Lighting Facilities

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ABSTRACT

According to the Ministry of Land, Infrastructure, Transport and Tourism's statistical data on building construction started (floor area), the first increase in 4 years was achieved, with a total building constructed floor area of 121,460,000 m², which is a 5.2% increase from the previous year. However, 5,580,000 m² was for offices (a 10.1% decrease from the previous year), which marks the second year of decrease in a row. Since the revised Energy Saving Act was first enforced in April 2010, there has been a sudden surge of LED lighting on the market. People are beginning to take a second look at task-ambient lighting as well, for simple and effective ways of conserving energy. Light emitting diode (LED) lighting is now being used in various types of facilities, including exhibition halls, multipurpose halls, conference rooms, and religious buildings. Even in art galleries, which demand high color rendering, LED lighting has started to be used for exhibits. Even facilities that have been using halogen lamps are now converting to LED fixtures with energy conservation as an objective. Now that hospitals, schools, and other facilities are planning construction suited to LED lighting, facilities using LED lights continue to increase. Areas that use fluorescent lighting for late night illumination are also expected to completely switch to LED in the near future. As for theaters and meeting halls, there were especially a lot of self-sustained movements by local governments, with new construction twice that of the previous year, and renovation work increasing by over 60% of that in the previous year. About 20 meeting halls suffered damage in East Japan due to the Great East Japan Earthquake on March 11. Many halls that only suffered relatively minor damage are being used as safety shelters. As for new structures, 12 halls and 3 studios were built. As for shops and commercial facilities, LED lighting continues to be actively adopted. There is strong public demand for large shopping malls, shops, restaurants, and hotels to change to LED lighting, especially to avoid light sources producing infrared and ultraviolet rays. Use of light sources such as LEDs and seamless lamps are replacing conventional lighting in the lodging, restaurant, and service fields as well, in order to clearly define each area's aims. In the residential field, use of bulb-type LED lamps is starting to spread, mixed with conventional light sources, by companies specializing in housing complexes for a reduction in energy use. When using LED fixtures, an illumination plan is needed which considers light distribution properties and the brightness offered by vertical illuminance.

1. Offices and business facilities

According to statistical data announced by the Ministry of Land, Infrastructure, Transport and Tourism on building construction started in 2010^{*1)}, the first increase in 4 years was achieved, with a total building

constructed floor area of 121,460,000 m², which is a 5.2% increase from the previous year. However, 5,580,000 m² was for offices (a 10.1% decrease from the previous year), which marks the second year of decrease in a row. And the average rate of vacancy in the Tokyo Business District was 8.91% in late December 2010, a 0.82 point increase from the same month of previous year^{*2)}. In 2010, the reduction of offices had slowed down, but a lagging economy meant that office demand

*1) Ministry of Land, Infrastructure, Transport and Tourism, Website, Data of the Current Survey on Construction Statistics, Housing Starts
http://www.mlit.go.jp/report/press/joho04_hh_000205.html

*2) Miki Shoji, Co., Ltd. website: <http://www.e-miki.com/data/index.html>

had not increased.

Since the revised Energy Saving Act was first enforced in April 2010, there has been a sudden surge of LED lighting on the market. People are beginning to take a second look at task-ambient lighting (TAL) as well, for simple and effective ways of conserving energy.

In search of the next-generation low-energy office, Takenaka Corporation started a demonstration experiment in their TAK E-HVAC Shinsuna Headquarters Building (Figure 1.1)*³⁾. Lighting construction includes ceiling lighting (ambient lighting) and desk lighting for work (task lighting). The ceiling lighting consists of LED lights, set inside air conditioning ventilation film made of semi-transparent materials. Even in an area of limited illumination intensity, a wide portion of the ceiling is lit, maintaining a comfortable bright feeling throughout the room. The illumination intensity provided by this ceiling lighting is about 400 lx per desk surface, and together with the desk lighting it ensures an appropriate level of brightness needed for work. Moreover, seating sensors can determine the attendance situation, dimming lights when no one is in the seat with illumination control.

The Obayashi Corporation Technical Research Institute's Techno Station (Figure 1.2) has implemented an ecological roof for its ceiling (combining an inclined roof with high side lights), adopting TAL for maximum utilization of natural lighting. On a fine day, a luminescence intensity of more than 300 lx is ensured for the office, even when no lights are turned on. In instances when natural luminescence cannot be ensured, such as at night or on cloudy days, FHF63 W fluorescent lamps on the underside of the high side lights will turn on automatically, providing more than 300 lx of intensity. Task lighting uses small, low-consumption LED task lights.

Figure 1.1 TAK E-HVAC Shinsuna Headquarters Building (Tokyo)
(©Takenaka Corporation)

The ceiling lighting consists of LED lights, set inside air conditioning ventilation film made of a translucent medium. Even in an area of limited illuminance, a wide portion of the ceiling is lit, maintaining a comfortable bright feeling throughout the room. The illuminance provided by this ceiling lighting is about 400 lx on desk surface, and together with the desk lighting it ensures an appropriate level of brightness needed for work.

*3) Takenaka Corporation website
http://www.takenaka.co.jp/news/pr1006/m1006_01.html

the underside of the high side lights will turn on automatically, providing more than 300 lx of intensity. Task lighting uses small, low-consumption LED task lights, and a seating sensor using IC tags will turn off lights automatically when others forget to do so. As for ambient lighting, rooms are divided into 5 areas, and when no one is sitting in a particular area, the lighting will turn off automatically, thoroughly reducing the amount of energy used on lighting.

The Toyota Boshoku Sanage Development Center Nigokan (Figure 1.3) was built as an R&D center for Toyota Boshoku, with its lower level used as an experiment zone, and its upper level used as a development

Figure 1.2 The Obayashi Corporation Technical Research Institute's Techno Station (Tokyo)
(©Obayashi Corporation)

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Figure 1.3 The Toyota Boshoku Sanage Development Center Nigokan (Aichi Prefecture)
(©Panasonic Electric Works Co., Ltd.)

The office lighting utilizes a continuous light modulation lighting fixture (FHF63 W × 1), with illumination control via brightness sensors, ensuring a luminescence intensity of 750 lx on desk surfaces. Moreover, with light shelves placed in the outer periphery of the office, an ample amount of natural light can be utilized, resulting in an average energy consumption rate of about 6 W/m² on the office floor.

design zone. The office lighting utilizes continuous light modulation lighting fixtures, with illumination control via brightness sensors, ensuring a luminescence intensity of 750 lx on desk surfaces. Moreover, with ecovoids placed centrally within the office, and light shelves placed in the outer periphery, an ample amount of natural light can be utilized, resulting in an extremely low average energy consumption rate of about 6 W/m², providing energy-efficient office lighting.

The Hokuyo Odori Center (Figure 1.4) is a large multi-purpose building which houses a bank, tenant offices, and various commercial facilities. The bank's help desk has a coved ceiling area, with light fixtures attached directly with louvers (FHF32 W × 2), providing a desk surface illumination intensity of 750 lx. The louvers cut glare, while an opening is positioned at the top of the fixtures to brighten the ceiling surface, providing a bright space. This method is very effective for banks and other high-ceiling facilities.

In order to deal with the power shortages caused by the Great East Japan Earthquake, various methods of energy conservation were discussed. In many cases of urgency, the measures were thinned out, but for permanent solutions, a replacement of conventional lighting to Hf fluorescent lamps, straight tube LED lamps, and other highly-efficient light fixtures is often sought after. Straight tube LED lamps were standardized in October 2010¹⁾, with minimum performance requirements determined. Cases of delivery should be available for introduction sometime next year. Moreover, TAL is starting to get a second look for its strengths as a low-energy light source that also provides comfortable lighting. Currently the Illuminating Engineering Institute of Japan's Committee for the Promotion of TAL is drawing up guidelines, and is expected to promote this method of illumination in the near future.

Figure 1.4 The Hokuyo Odori Center (Hokkaido)
(©Panasonic Electric Works Co., Ltd.)

The bank's help desk has a coved ceiling area, with light fixtures attached directly with louvers (FHF32 W × 2), providing a desk surface illumination intensity of 750 lx. The louvers cut glare, while an opening is positioned at the top of the fixtures to brighten the ceiling surface, providing a bright space.

References

- (1) JELMA: Straight tube LED Lamp System with JEL801 L Pin Type Cap GX16t-5 (for General Lighting) (2010) (in Japanese).

2. Exhibition halls, multipurpose halls, conference rooms, and religious buildings

Due to the unprecedented economic recession experienced last year, building constructed floor area decreased a great deal, but this year a total building constructed floor area of 121,460,000 m² was reported, which is a 5.2% increase from the previous year. Although it is only a small increase, it is the first in 4 years. The private sector increased by 3% when compared to the previous year (the first increase in 4 years), while public construction increased by 3% (the third year in a row showing an increase). Although small, there is a general upward trend, which is seen as a sign of recovery.

Light emitting diode (LED) lighting is now being used in various types of facilities. Even in art galleries, which demand high color rendering, LED lighting has started to be used for exhibits. Even facilities that have been using halogen lamps are now converting to LED fixtures with energy conservation as an objective.

To relay an accurate history of the Battle of Okinawa to the next generation, and to work for lasting peace, the "Okinawa Prefectural Peace Memorial Museum" (Figure 2.1) was established. And in order to have low-energy, eco-friendly lighting for the plan exhibition room, their incandescent spotlights were changed to LED lighting. By switching to LED fixtures, they are able to consume about 70% less energy when compared to the

Figure 2.1 The Okinawa Prefectural Peace Memorial Museum (Okinawa Prefecture)
(©Panasonic Electric Works Co., Ltd.)

This direct management facility was established to relay an accurate history of the Battle of Okinawa to the next generation, and contribute to a lasting peace. LEDs are used for lighting in the plan exhibition room as spotlights and within exhibition cases. Fluorescent downlights are equipped with an ultraviolet ray cutting filter, providing a space almost completely free of ultraviolet rays.

conventional light fixtures. And with a remarkable life-span of 40,000 hours, using an LED light source has dramatically reduced maintenance costs. Not only are LED lights advantageous due to their low energy consumption, but they also contain no thermal or ultraviolet rays, protecting important wartime exhibitions from damage.

Nara Prefecture's "Nara National Museum: West Wing" (Figure 2.2) was upgraded to strengthen their buildings against earthquakes, including a renovation of the exhibit halls. Lighting for the museum's exhibition cases was converted to Ra90 high color rendering LEDs, which provide the ideal low-energy, low-maintenance solution for fine viewing. LED lighting combines white and bulb colors for a system that can freely change color temperature according to exhibition needs. Variability in color temperature depending on immediate needs is expected to become more common in various fields thanks to LED technology. Moreover, mobile operations equipment is now used for lighting control to adjust lighting according to the needs posed by certain exhibits. Ambient light has been adopted for overall exhibition space, providing an environment for guests to focus on the exhibits.

In Kyoto Prefecture, the "Ryukoku Museum" (Figure 2.3) was built as a way of celebrating Ryukoku University's 370th anniversary, and features a Buddhism-themed exhibition covering the religion's birth to its contemporary forms. Its entrance hall features dual-level ventilation, with 70 W ceramic metal halide lamp spotlights positioned between wooden louvers on the ceiling. These spotlights provide ample floor illumination, while FHF63 W fluorescent lamps and ceramic metal halide lamps provide visually pleasing wall illumination. These plans hide the actual light fixtures,

Figure 2.2 The Nara National Museum: West Wing (Nara Prefecture)
(©Panasonic Electric Works Co., Ltd.)

The museum's exhibit halls were renovated as a part of the West Wing upgrade to protect against earthquakes. FHF32 W × 2 fixtures are used for base lighting in the exhibition room as indirect lighting. In addition, lighting ducts are embedded in the ceiling for indirect lighting, and spotlights can be positioned freely for various displays.

and are careful not to interfere with the construction design.

The "Nerima Shakujiikoen Furusato Museum" (Figure 2.4) was opened in Tokyo's Nerima Ward. This museum complex is used for lifelong learning and tourism exchange, as a way to inform visitors of Nerima's history and culture, including an aging pool management facility and Ikebuchi Historic Park on the east side. Low-energy, 70 W ceramic metal halide lamps with a color temperature of 3000 K are embedded in the floor of this complex to compliment its horizontal eaves. The eaves are evenly illuminated with a soft light, adding extra appeal to the building design.

LED illumination is starting to be adopted for religious buildings as well. The Buddhist "Shingon-shu Chisan-ha Jizoji Temple" (Figure 2.5) in Sapporo has

Figure 2.3 Ryukoku University's Ryukoku Museum (Kyoto Prefecture)
(©Panasonic Electric Works Co., Ltd.)

In order to bring the "open museum" concept to life, 1st floor surrounding are constructed of glass for a feeling of transparency, and the bottom floor entrance is constructed to draw in light from the garden on the mid-level. Its entrance hall features 70 W ceramic metal halide lamp spotlights positioned between wooden louvers on the ceiling. These spotlights provide the necessary luminosity while keeping the actual lamps concealed.

Figure 2.4 Nerima Shakujiikoen Furusato Museum (Tokyo)
(©Lightscape Design Office Inc.)

This expansive building is situated in the lush green environment offered by Shakuji Park. In order to create new lighting for scenery that is fitting to the green environment, energy is used efficiently to produce a comfortable luminosity.

Figure 2.5 The Shingon-shu Chisan-ha Jizoji Temple (Hokkaido)
(©Toshiba Lighting & Technology Corporation)

Japanese-style square fixtures are used for lighting on the nave of the main temple's ceiling. A dimming feature provides flexible lighting. LED downlights are used in the inner temple, providing a low-energy, low-maintenance alternative to conventional lighting.

Figure 2.6 The Jodo-shu Misumaisan Kofukuin Daishoji Temple (Hokkaido)
(©Toshiba Lighting & Technology Corporation)

Daishoji Temple was established in 1908 through the request and cooperation of voluntary citizens of Sapporo's Misumai Area, as a temple for Jodo-shu Buddhism. The central hall has light fixtures with square covers in the center of the ceiling, designed to give it a feeling of height. The ceiling at the front far end has semi-circular lamps for indirect lighting, illuminating the "o-nai-butsum" (Buddhist altar).

adopted low-energy, long-life LED downlights in its main hall of 5 meters in height, due to their eco-friendly, low maintenance advantages.

Another religious building with an eco-friendly design is the "Jodo-shu Misumaisan Kofukuin Daishoji Temple" (Figure 2.6) in Sapporo, which primarily uses fluorescent lamps for low energy consumption.

3. Hospitals, schools and libraries

Higher medical costs due to Japan's aging society, societal changes due to a decrease in young school children, and eco-friendly energy needs to reduce CO₂ emissions as a countermeasure against global warming are some of the elements taken into consideration when designing hospitals, school, and libraries in recent years.

With hospitals in particular, a survey from the Health, Labor and Welfare Ministry shows that the number of hospitals and hospital beds reached their peak in 1990,

Figure 3.1 Kasuya-Minami Hospital Waiting Lobby (Fukuoka Prefecture)
(©Panasonic Electric Works Co., Ltd.)

LED downlights are planned to be used as a general light source. These provide an illumination intensity equivalent to FHT 32 W lamps, at approximately 600 lx for the floor surface.

and are gradually decreasing on a yearly basis. Doctors tend to become more and more unevenly distributed throughout the city on a yearly basis, with a lack of doctors in rural areas and smaller islands becoming a serious problem. On the other hand, the advancement of medical technologies has led to the construction of central regional hospitals offering high-quality medical treatment, with patients primarily concerned about improvements of medical services.

It is important for hospital illumination plans to play a role in helping patients overcome their sicknesses, in particular those who are hospitalized on a long-term basis with illnesses such as cancer, as well as providing peace of mind for their families.

The annual amount of electricity consumed by lighting is said to be 1/3 of the buildings total annual electricity consumption. Which means energy improvements for lighting is a very important issue.

Although LED lighting offers high-efficiency and long life, it is also lacking in terms of color rendering properties, glare, and cost issues. Yet LED lighting is being seriously considered for use in various facilities due to its merits. There are still very few examples of LED lighting being changed to fluorescent lamps for primary illumination. Facilities using layout plans suited to LED lighting, and taking advantage of fixture light flux improvements via technological advancements made by various manufacturers, continue to increase. In the near future, LED lighting is expected to replace fluorescent lamps as a primary light source.

Attempts at indirect lighting, and more evenly-distributed illumination, are also being considered with light sources other than LED.

The following illumination plans illustrate recent trends for hospitals, schools, and libraries.

As an example of LED lighting for hospitals, the "Kasuya-Minami Hospital Waiting Lobby" (Figure 3.1) uses LED downlights as a general light source. These

Figure 3.2 Kasuya-Minami Hospital patient rooms (Fukuoka Prefecture)

(©Panasonic Electric Works Co., Ltd.)

These rooms use LED lighting embedded in opalescent panels, which eliminate glare.

Figure 3.3 Sapporo Odori High School's Chuo Kindergarten Lounge (Hokkaido)

(©Endo Lighting Corporation)

Low-energy LEDs are used as focal lighting. Since this building is often used at night for regional PTA meetings and student communications, LED lamps with a color temperature of 3500 K are used to provide a warmly-lit space.

provide an illumination intensity equivalent to FHT 32 W lamps, at approximately 600 lx for the floor surface.

“Kasuya-Minami Hospital patient rooms” (Figure 3.2) use LED lighting embedded in opalescent panels, which eliminate glare.

As an example of LED lighting in schools, “Sapporo Odori High School's Chuo Kindergarten Lounge” (Figure 3.3) uses low-energy LEDs as focal lighting. Since this building is often used at night for regional PTA meetings and student communications, LED lamps with a color temperature of 3500 K are used to provide a warmly-lit space.

As an example of indirect lighting for libraries, “The Library at Ohori Junior and Senior High School, Fukuoka University (Fukuoka Prefecture)” (Figure 3.4) combines indirect lighting and lights embedded in

Figure 3.4 The Library at Ohori Junior and Senior High School, Fukuoka University (Fukuoka Prefecture)

(©Panasonic Electric Works Co., Ltd.)

Indirect lighting and lights embedded in opaline acrylic covers are combined for soft, evenly-distributed illumination at approximately 700 lx. This lighting plan only provides general illumination, and does not interfere with bookcase layouts.

opaline acrylic covers for soft, evenly-distributed illumination at approximately 700 lx. This lighting plan only provides general illumination, and does not interfere with bookcase layouts.

4. Theaters, halls and studios

4.1 Theaters and halls

In 2010 as well, Japan's prolonged financial crisis threatens a spate of economic disasters. This along with increasing unemployment has taken its toll on the Japanese economy. Eventually this will have an effect on our culture and its expression through building.

However, in 2010 there were a lot of self-sustained movements by local governments related to theaters and meeting halls, with new construction twice that of the previous year, and renovation work increasing by over 60% of that in the previous year. This stood out as a sign of revitalization in the midst of our nation's difficulties. And then the Great East Japan Earthquake hit on March 11 of this year. Most meeting halls located in the Tohoku region were damaged. Those such as the Rikuzentakata Community Center were badly damaged as if they were bombed. Others such as the Sendai Sunplaza Hall, public halls outside of Sendai such as in Tagajo City, assembly halls in Iwaki City, Mito City, and Kawasaki City, the Tokyo Kudan Kaikan Hall and the Tokyo International Forum were badly damaged as well by the quake, for about 20 in total.

Although no halls newly built in 2010 were used for safety shelters in the affected areas, many renovated halls were used in that manner, driving them to a temporary halt.

Of the 12 newly-built halls, the Nihon University College of Art's old buildings were torn down, a new campus was built, and a Middle Hall (theater) was opened in the North Building, which we will now examine (Figure 4.3, Figure 4.4). As a place for creative arts educa-

Figure 4.1 Shibuya Culture Center Owada (Sakura Hall) (newly constructed) (Tokyo)
(©Marumo Electric Co., Ltd.)
Audience seats viewed from the stage right.

Figure 4.2 Shibuya Cultural Center Owada (Traditional Hall) (newly constructed) (Tokyo)
(©Marumo Electric Co., Ltd.)
Audience seats viewed from the stage right.

Figure 4.3 Nihon University College of Art, North Bldg Theater, Medium Hall (newly built) (Tokyo)
(©Toshiba Lighting & Technology Corporation)
Stage viewed from audience seats right.

tion, the theater is newly-equipped so that it can amply function of presentation and training for students. The size of the theater varies from 10.8 m to 15.6 m as a variable proscenium, with stage rigging done with practical instruction in mind, using two forms - hand-pulled manual counterweight style and motorized style.

An intelligent light-dimming console is used for light modulation, with 80 faders on 3 levels offering manual or memory control, constructed with stage actuators, etc. The most fundamental light dimmers are portable, with 8 12-circuit devices, and 10 3-circuit devices as suspen-

Figure 4.4 Nihon University College of Art, North Bldg Theater, Medium Hall (newly built) (Tokyo)
(©Toshiba Lighting & Technology Corporation)
Audience seats viewed from deep center stage.

Figure 4.5 Grand Hall of Tokyo Culture Center (renovated) (Tokyo)
(©Marumo Electric Co., Ltd.)
Audience seats viewed from the stage right.

sion lights, load systems positioned in each location, and DMX patching/LAN for a highly-functional machine. There are more than 160 load illumination fixtures installed, including ellipsoidal spotlights (Source Four), with lighting/acoustic controls positioned behind audience seating for convenient practice.

The prefectural Kanagawa Arts Theatre (also known as KAAT) newly opened in Yokohama, with a goal of producing next-generation actors through a high-standard regiment of daily creativity and performance activities. An elevation device is positioned at each row of first-level seating, enabling inclination adjustment, with a maximum gradient adjacent to the second floor balcony. Illumination is wired throughout floor pockets, with adjustable wiring where circuits can be pulled out through openings wherever necessary. Tables 4.1 and 4.2 show a list of new facilities and reformed theaters and halls, and Figures 4.1 to 4.7 show the main facility examples.

4.2 Studios

Studios newly built in 2010 were three including new wings of NHK Yokohama, and a TV studio at the Nihon University College of Art (Broadcasting Department).

Only half the number of studios renovated last year

Table 4.1 Newly-built theaters and halls

Theaters/Halls (newly-built)	Prefecture	Capacity	Stage size		Capacity of Electricity	Number of stage circuits	Light control		Features of functions and mechanisms
		(seats)	Width (m)	Depth (m)	(kVA)		Number of faders (Units × rows)	Memory (scenes)	
Shibuya Culture Center Owada (Sakura Hall)	Tokyo	735	14.6 to 16.7	10.0	420	199	80 × 3	1,000	Ceiling reflector lights in shoebox style concert hall with side balconies for audience seats, LED lights in the audience seats.
Shibuya Culture Center Owada (Traditional Hall)	Tokyo	345	9.8 to 11.6	10.8	240	134	80 × 3	1,000	3 series of suspension light, 3 series of border lights, horizontal lights and others in ordinary multipurpose hall when removing reflector boarding, etc.
Nihon University College of Art, North Bldg Theater, Medium Hall	Tokyo	249	10.8 to 15.6	12.6	360	208	80 × 3	1,000	Corresponding traditional arts equipped with balcony seats and elevated runway.
SHIKI Theater Company "Natsu"	Tokyo	1,200	15.8	18.8	1,090	828	non-fader	2,000	3 Series of suspension lights, front side ceiling lights, etc.
Nihonbashi Mitsui Hall	Tokyo	678	16.4	6.0	360	188	80 × 3	1,000	Stage wing manipulation equipment, portable dimmer, 8 units of 12 circuits and 10 units of 3 circuits, respectively. Installing operation desks for lighting and acoustic equipment at the rear of audience seats considering education and teaching.
Kanagawa Arts Theater, "KAAT" Hall	Yokohama	1,300	16.4	31.0	750	106+ Removable dimmer 108	non-fader	2,000	4 Series of suspension lights, horizontal lights, front side ceiling lights, etc.
Kanagawa Arts Theater "KAAT" Large Studio, including Medium, Small Studio, and Atelier Studio	Yokohama	220	18.0	12.6	300	128+ Removable dimmer 10	non-fader	2,000	Corresponding to long-running performance by adopting non-fader dimmer desk, providing a lot of movable operation desks, and flexible mechanism and equipment (including a lot of instruments).
Tsurumi Ward Culture Center, Main Hall including Music Hall	Kanagawa	548	17.4	9.8	300	159	80 × 3	1,000	Multipurpose hall (flexible, lifting stage).
Fuji Goko Cultural Center	Yamanashi	1,016	17.0	12.0	200	133	60 × 3	1,000	3 units of tower lights, 10 series of light battens, etc.
North Ward Cultural Hall, Niigata City	Niigata	549	16.0	12.6	240	165	60 × 3	1,000	Network configuration using movable dimmers and Ethernet. Suspending equipment composed of variable speed battens of 57 pieces for stage and 4 pieces for audience seats.
Shin Kabukiza	Osaka	1,489	20.0	18.2	900	491	120 × 3	2,000	6 series of suspension lights, proscenium lights, 2 series of suspension lights for audience seats, horizontal lights, 2 series of front-side ceiling lights etc.
Kyushu Railway Company, Hakata Hall	Fukuoka	680	16.2	8.0	300	127	80 × 3	200	Movable dimmers with intelligent function etc.

Table 4.3 Newly established and renovated studios

Studio Name	Prefecture	Studio Area (m ²)	Number of light batons (Units)		Capacity of Electricity (kVA)	Number of circuits	Light control		Facility features and notes
							Number of faders (Units × rows)	Memory (scenes)	
Nihon University College of Arts, South Bldg, Broadcast & TV Studio, Including two studios (newly-built)	Tokyo	274	For lighting	26	240 and other specially installed for 100V & 200V	181	60 × 2	200	19 units of moving lights, a large number of battens because of short separation of each batten, each batten equipped with dimmer.
Broadcasting Station of NHK Yokohama (newly-built)	Kanagawa	99	For lighting	5	60	30	10 × 1	60	Custom desk for scene playback.
Broadcasting Station of NHK Yokohama (newly-built)	Kanagawa	99	For lighting	5	60	32	10 × 1	60	Custom desk for scene playback.
Studio G of Nippon Television Network Corporation (renovated)	Tokyo	approx. 600	For lighting	127	750	574	Custom wheels	200	Network system; 61 pieces of rotational lighting battens, 66 pieces of area horizontal battens etc., 41 pieces of artistic area battens, 14 pieces curtain battens, and 38 pieces of single point suspension battens.
T-1 Studio of NHK Toyama (renovated)	Toyama	208	For lighting	13	60	63	10 × 1	60	Custom desk for scene playback.
T-2 Studio of NHK Osaka (renovated)	Osaka	264	For lighting	36	390	224	40 × 2	1,000	Dimmer desk corresponding to network and drama.
Hiroshima HOME Television, Sakura Studio (renovated)	Hiroshima	approx. 200	Free Produced for 330m ²		240	122	60 × 1	1,000	Improvement of dimmer panel and operation desk.
T-1 Studio of NHK Kochi (renovated)	Kochi	208	For lighting	9	60	52	10 × 1	60	Custom desk for scene playback.
1st Studio of NHK Takamatsu (renovated)	Kagawa	198	For lighting	9	60	52	10 × 1	60	Custom desk for scene playback.
Production studio of Kagoshima Television Station Co.,Ltd. (renovated)	Kagoshima	220	For lighting	21	150	164	60 × 2	1,000	Module type dimmer desk corresponding to network.

Table 4.2 Renovated theaters and halls

Theaters/Halls (renovated)	Prefecture	Capacity (seats)	Stage size		Capacity of Electricity (kVA)	Number of stage circuits	Light control		Major renovations and features
			Width (m)	Depth (m)			Number of faders (Units × rows)	Memory (scenes)	
Nemuro City Cultural Center, Main Hall	Hokkaido	1,000	18.0	15.0	300	174	80 × 3	2,000	Operation desk for intelligent dimmers, stage wing manipulation desk, and renovation of wireless manipulators
Wakabayashi Ward Cultural Center Hall, Sendai	Miyagi	700	14.4	12.5	360	164	80 × 3	2,000	4 series of suspension lights, proscenium arch suspension, 3 series of boarder lights and others
Kawanishi Friendly Plaza Hall, Yamagata	Yamagata	717	14.0	11.9	240	122	80 × 3	1,000	Operation desk for intelligent dimmers, stage wing manipulation desk, and renovation of wireless manipulators
Aizu Fugado	Fukushima	1,758	20.0	17.0	480	292	100 × 3	1,000	3 series of suspension lights, 2 series of boarder lights, 2 series of ceiling lights etc
Saitama City Cultural Center, Main Hall	Saitama	2,006	20.0	18.0	600	412	120 × 3	1,000	Operation desk for intelligent dimmers, stage wing manipulation desk, and renovation of wireless manipulators
Fukaya Municipal Cultural Hall, Main Hall	Saitama	1,164	18.0	15.0	300	238	120 × 3	1,000	3 series of suspension lights, 2 series of boarder lights, 2 series of ceiling lights etc
Funabashi Municipal Cultural Hall	Chiba	1,106	17.0	13.5	240	184	80 × 3	500	Operation desk for intelligent dimmers, stage wing manipulation desk, and renovation of wireless manipulators
Yotsukaido Cultural Center	Chiba	1,157	17.0	15.0	300	144	80 × 3	1,000	4 series of suspension lights, 2 series of boarder lights, 2 series of ceiling lights etc
Tokyo Bunka Kaikan, Main Hall	Tokyo	2,303	18.0	24.0	900	941	—	1,000	Panel and operation desk for dimmers, partial renovation of lighting equipment
Meijiza	Tokyo	1,368	20.0	17.0	750	524	—	2,000 × 30	4 series of suspension lights, 2 series of boarder lights etc
Orchard Hall	Tokyo	2,150	16.5	15.0	1,000 + 300	472	Non-fader, Free fader × 24, and others	1,000	Renovation of operation desk for non-fader dimmers with shooting function
Katsushika Symphony Hills, Mozan Hall	Tokyo	1,318	16.0 to 19.7	16.5	600	326	100 × 3	1,000	Introduction of moving lights, additional installation of ellipsoidal spot in gallery
Fuchuro Mori Arts Theater, "Dream Hall," including Furusato Hall & "Vienna Hall"	Tokyo	2,027	20.0	19.0	600	407	120 × 3	2,000	Adopting of operation desk for non-fader dimmers with shooting function
Tokyo International Exhibition Center, Conference Tower	Tokyo	1,000	20.5	6.8	240	110	80 × 3	2,000	Corresponding to lighting for various commercial plays
West Community Hall, West Ward, Yokohama City	Kanagawa	575	12.0	6.0	100	66	40 × 2	1,000	Renovation of fly duct, replace of outlets
Togen Hall	Yamanashi	726	16.0	10.0	210	96	80 × 3	1,000	5 series of suspension lights, 4 series of boarder lights, 2 series of ceiling lights etc
Kodogo Cultural Hall, Main Hall, including Small Hall	Niigata	1,132	19.0	20.0	450	218	80 × 3	1,000	Renewal and improvement of operation desk for intelligent dimmers
The Kanazawa Theater	Ishikawa	722	30.0	15.0	360	340	100 × 3	1,000	Change to C-type connectors, additionally renewal and improvement of instruments
Takahama Town Cultural Hall, Main Hall	Fukui	790	17.4	12.6	300	163	80 × 3	1,000	Dimmer panel, renovation of lighting instruments, replace of boarder cables
Act City Hamanatsu	Shizuoka	2,336	18.0	21.7	108	727	120 × 3	1,000	4 series of suspension lights, 2 series of horizontal lights, 2 series of ceiling lights etc
East Civic Center, Komaki City	Aichi	600	14.0	9.0	150	142	60 × 3	1,000	Dimmer panel and operation desk, manipulation equipment of stage wing, renovation of wireless system
Aichi Prefectural Art Theater	Aichi	2,500	29.0	23.5	900	809	180 × 3	2,000	Replacing 2048 channels of light control and non-fader dimmer operation desk
Mie Prefectural Sun Arena	Mie	4,980	Open type		180	120	60 × 3	1,000	Large-scale renovation work, through renovation of dimmers and lighting equipment
Cultural Industry Community Hall	Shiga	1,962	17.0	8.0	240	135	80 × 3	1,000	3 series of suspension lights, 2 series of boarder lights, ceiling lights and others
Kyoto Prefectural Nagaokakyo Memorial Cultural Hall	Kyoto	1,000	17.0 to 20.0	14.7	360	206	100 × 3	1,000	Renovation of dimmer operation desk, DMX composition into 8 distributions, 15 series of lighting batters
MieParque-Osaka	Osaka	1,010	18.0	14.0	300	306	80 × 3	1,000	Improvement of dimmer panel and operation desk, renovation of DMX batch system
Osaka-Jo Hall	Osaka	16,000	21.6	12.6	Main 600	282	120 × 3	1,000	2 series of suspension lights, 5 series of truss batters and lighting batters for audience seats etc
Akashi Civic Hall, Main Hall, including Small Hall	Hyogo	1,280	18.0	15.0	360	258	100 × 3	1,000	Dimmer operation desk, DMA converter, renovation of wireless manipulator for stage wing
ASTV Tokushima, Multipurpose Hall	Tokushima	5,000	Open type		750	392	100 × 3	1,000	5 series of suspension lights, 2 series of boarder lights, 2 series of ceiling lights etc
SHIKI Theater Company, Fukuoka	Fukuoka	1,144	14.4	17.0	600	520	100 × 3	1,000	Renovation of main dimmer panel
Other than above listed 30 halls, 45 halls in large, medium and small size were renovated.	various	120 to 15,000	6.0 to 20.5	4.0 to 16.8	60 to 500	49 to 336	40×3 to 160×3	200 to 2,000	Renovation of dimmer operation desk, improvement of other equipment, 6 batters in stage A, 8 batters in stage B, 8 batters in stage C and ceiling lights, renovation of dimmer panel

Figure 4.6 Meijiza (renovated) (Tokyo)
(©Marumo Electric Co., Ltd.)
Audience seats viewed from the stage left.

Figure 4.7 ACTCITY Hamamatsu (renovated) (Shizuoka)
(©Marumo Electric Co., Ltd.)
Audience seats viewed from deep center stage.

are being done in 2010.

Special features of the three TV studios newly built at the Nihon University College of Art include short stage batons positioned so that many can be connected, while each baton is embedded with a dimmer for convenience. Newly-built and renovated studios are listed in Table 4.3.

5. Shops and commercial facilities

The market size of LED lighting in early 2010 is 61 billion yen^{*4)}, but is projected to reach 90 billion yen^{*5)} by early 2011.

Taking this data into consideration, we can safely say LED lighting is being aggressively adopted by commercial facilities in recent years. There is strong public demand for large shopping malls, many shops, restaurants, and hotels to change to LED lighting.

The Dean & DeLuca Aoyama Shop has switched from conventional lighting to LED, and compared to previous lighting, energy consumption has decreased by 67%, illustrating a clear connection to energy conservation

Figure 5.1 The Dean & DeLuca Aoyama Shop's LED lighting
(©Panasonic Electric Works Co., Ltd.)

Remarkable Ra92 color rendering properties brilliantly show the natural coloring of the food on display. Products on the counter are positioned close to the lighting, which caused problems in the past for products using chocolate, but since LEDs produce next to zero thermal rays, even sensitive food products can be lit up brightly without worry.

Figure 5.2 Seibu-Ikebukuro Main Store Liquor Department Ground Floor (Tokyo)
(©Panasonic Electric Works Co., Ltd.)

(Figure 5.1).

Moreover, the liquor department in their Seibu-Ikebukuro Main Store uses LED as primary light fixtures, successfully creating a new visual atmosphere for that department. As LED lights produce nearly zero thermal or ultraviolet rays, they prevent degradation of the more delicate alcoholic beverages, while also ensuring a basic illumination intensity of 1500 lx, which is 3 to 5 times brighter than the conventional lighting used in this department (Figure 5.2, Figure 5.3).

Large public facilities are also rapidly turning to LED, for a more efficient environment in terms of energy conservation and maintenance. Mitsui Outlet Park Shiga Ryuo has adopted an illumination plan that considers light leaks from tenants, and primarily focuses on brilliance - eliminating inefficient use of lighting wherever possible (Figure 5.4, Figure 5.5).

An "Energy Saving Lighting Design Model Project"

^{*4)} Fuji Keizai Co., Ltd.

^{*5)} Estimated from materials of Fuji Keizai Co., Ltd. and Fuji Chimera Research Institute, Inc.

Figure 5.3 Seibu-Ikebukuro Main Store, Japanese sake department ground floor (Tokyo)

(©Panasonic Electric Works Co., Ltd.)

LED lighting fixtures with brightness equal to 35 W compact ceramic metal halide lamps and 12 V 50 W small halogen lamps are used for display lighting. They are very practical way for alcoholic beverages, quite sensitive to thermal and ultraviolet rays.

Figure 5.4 Mitsui Outlet Park Shiga Ryuo Entrance Lights (Shiga Prefecture)

(©Panasonic Electric Works Co., Ltd.)

Uses an illumination plan that considers light leaks from tenants, and primarily focuses on brilliance at the front entrance - eliminating inefficient use of lighting wherever possible.

was hosted by the Ministry of the Environment, allowing clients and designers to stay current with energy-conscious and eco ideas, while advancing the use of LED illumination^{*6)}.

This is not only a pursuit of low-energy products, but also offers remarkable specs to meet client demands such as high-quality color rendering properties and selectable color temperature suitable to various spaces. In addition, it is a way attain lower costs through market expansion.

Development of high-output LEDs for high ceilings is also underway, with a primary focus on transitioning

Figure 5.5 Mitsui Outlet Park Shiga Ryuo, path lights (Shiga Prefecture)

(©Panasonic Electric Works Co., Ltd.)

5 W LED universal downlights are used to illuminate signs for tenants. This plan focuses on eliminating inefficient use of lighting.

from current lighting plans to LED illumination designs.

At the "Lighting Fair 2011," (March 8 - 11, 2011, Tokyo Big Sight), large domestic lighting manufacturers got together to exhibit straight tube LED lamps and one-core LEDs. Although safety standards were previously an issue with straight tube LEDs, they have now been specified and enacted by the Japan Electric Lamp Manufacturers Association (JELMA), and product development is now progressing based on those standards.

Other than LED, a lot of booths were introducing organic EL lighting. Although LED related exhibits were the main focus, there was an increase in companies displaying organic EL lighting, which is seen as a promising addition to next generation illumination.

Next to LED lighting, the organic EL market is said to show a lot of potential for future growth. There are also a lot of expectations for organic EL use in commercial facilities, and it can be used in many facets as a new design tool.

Lastly I'd like to go over some of the main issues related to LED illumination design, along with future challenges. One of the most important points when dealing with lighting designs for commercial facilities is color rendering properties. Whether or not LED lamps can accurately display the colors of products and commercial space has been called into question, and people are wondering how they'll be able to make colors seem more beautiful and appealing in the near future. A great deal of importance is placed on the ability of LED lamps to provide high-quality lighting with control technology.

Another problem LED lamps can't seem to break away from is the glare issue. Although the illumination intensity problem has been solved with the advance-

*6) MOE The Energy Efficient Lighting Design Model Project

ment of high-output LED development, this has led to a new problem of glare in many cases. There is now a demand for development of fixtures that will eliminate the glare problem.

From now on, eco-friendly lighting designs actively adopting next-generation lighting technologies, such as LED lighting and organic EL lighting, must be directly coordinated with efforts to preserve the earth's environment.

6. Accommodation, food and drink, and service industries

A 2010 (January to December) investigation by the Japan Food Service association of the trends of the food service industry market found that sales in all shops in all categories was 100.5% compared to the previous year,

Figure 6.1 Cafe Lighting for "Elm Forest" at Hokkaido University's Information Center (Hokkaido)
(©Mitsubishi Electric Living Environment Systems Corporation)

22.5 W LED (5,000 K) diffused downlights are used. From leaf-shaped holes underneath the double ceiling, light comes down as if sunlight shining through a forest of trees.

Figure 6.2 Lounge Cafe Hoshiyama, bar lighting (Miyagi Prefecture)
(©Panasonic Electric Works Co., Ltd.)

Cupboards behind the main service counter are illuminated by seamless lamps (2800 K) to evoke a feeling of floating. The walls of guest rooms are made of specially processed glass with embedded illumination, and the brightness can be adjusted by using a dimming device. Thin LED downlights are positioned above the counter.

indicating the first increase in 2 years^{*7)}.

As with last year, many industries continue to adopt LED lighting. "Elm Forest" at Hokkaido University's Information Center is utilizing LED properties as a point source to simulate rays of sunlight peaking through the trees (Figure 6.1). Lounge Cafe Hoshiyama bar lights are produced with wall lighting for spectacular scenery (Figure 6.2). Lighting on the 3 floor of Haneda Airport's Terminal ANA Lounge uses a lattice design suspended from the ceiling, with adjustable downlights (Figure 6.3). Tateshina Guesthouse lighting uses a dimming device capable of producing 4 scenes of LED illumination (Figure 6.4). Lighting in the Kix Refresh Cabin's rest area offers indirect lighting that simulates sunset and blue sky images as seen from an

Figure 6.3 Lighting on the 3 floor of Haneda Airport's Terminal 2 ANA Lounge (Tokyo)
(©Panasonic Electric Works Co., Ltd.)

This facility is a lounge for domestic flights, and consists of 3 floors. The 3rd floor rest area has seamless lamps (2500 K) in a lattice design suspended from the ceiling, and paths are lit with downlights embedded with 100 lx, 12 V 50 W halogen lamps, which are covered by infrared reflecting film, and provide 400 lx of illumination on table surfaces, making them ideal for business.

Figure 6.4 Tateshina Guest House, bedroom illumination (Nagano Prefecture)
(©Panasonic Electric Works Co., Ltd.)

The bedroom in this Tateshina Kogen wooden one-story guest house has 7.2 W LED downlights, LED indirect lighting, and a dimming device to produce 4 scenes. For the entire building, 82% less energy is consumed when compared to incandescent lamps, which is a very significant conservation of energy.

*7) http://www.jfnet.or.jp/data/y/data_c_y2010_reki.html

Figure 6.5 KIX Refresh Cabin, rest area illumination (Osaka)
(©Panasonic Electric Works Co., Ltd.)

This “refresh” facility newly built at the Kansai International Airport employs fluorescent lamps of 2500 K and blue for indirect lighting which evokes the image of sunsets and blue skies as seen from an airplane cabin. Downlights embedded with 12 V 50 W halogen lamps provide the light needed for floor and table illumination.

Figure 6.6 Lighting in the Auberge Uchiko's accommodations building (Aichi Prefecture)
(©Miyaji Denki Electric Company Inc.)

The hotel restaurant accommodations building takes advantage of the plentiful “washi” Japanese paper to offer an elegant yet firm luminescence.

airplane cabin (Figure 6.5). Lighting in the Auberge Uchiko's accommodations building takes advantage of the plentiful “washi” Japanese paper to offer an elegant yet firm luminescence (Figure 6.6).

7. Residential buildings

According to statistical data announced by the Ministry of Land, Infrastructure, Transport and Tourism on residential housing construction started in 2010 (from January to December), 813,126 residential buildings were constructed, a 3.1% increase compared to the previous year, although there was a decrease in the previous year. The details showed that owned houses were at 305,221 (a 7.2% increase compared to the previous year), rentals were at 298,014 (a 7.2% decrease), and houses built for sale were at 201,888 (a 19.6% increase). Among

condominiums, 90,597 apartment buildings were constructed (an 18.2% increase from the previous year), while 110,358 residential houses were built (a 20.9% increase, and the first increase in four years^{*8)}).

As for overall residential statistics, eco housing continues to draw interest among consumers for their designs which take the environment into consideration. Smart house experimental buildings for families to control their energy consumption are popping up around the country, implementing solar panels for lighting and low-energy appliances, charge stands for electric cars and more. Not only the construction industry, but the automobile, electronics, and communications industries are participating as well. This transition to smart housing is found with detached houses as well as with apartment complexes¹²⁾.

The government has adopted the slogan “From a flow society to a stock society” as a way to encourage improvements, and by moving from “creating houses that damage society” to “creating good products, and preserving them for a long time”, a “new growth strategy” is formed. By maintaining an environment in which consumers can make improvements with peace of mind while working toward a stock society, the objective is to revamp the market by 2020 from approximately 6 trillion yen to 12 trillion yen. Moreover, according to the Japan Housing Finance Agency's survey results announced in 2009, more than 40% of consumers are not concerned with whether a house is newly-built or used. This indicates that the number of consumers rivaling consumers of new homes will possibly buy a used home³⁾.

Although comfort and low-energy use can still be considered the main themes of residential lighting, a lot of focus is being put into environmental issues and energy conservation.

A lighting allocation plan is needed that can adapt to the various uses of space, and an environment that can control lighting to match the usage conditions. Multi-fixture distributed lighting is a concept of single-room, multi-fixture lighting that permits the setup of various lighting situations, while also adding energy efficiency. A big feature of this method is consideration of restrictions on total wattage during design and control of lighting conditions during use. It is believed that the coexistence of comfort and energy efficiency will become a large trend in the future.

LEDs have attracted attention as a light source because of their energy efficiency. As a result of more power, products are expanding from downlights to ceiling and bracket lighting. Products are also starting to hit the market which take advantage of LED properties such as light dimming, color matching (dealing with color temp changes from light bulb color to white), and

*8) Ministry of Land, Infrastructure, Transport and Tourism, Website, Data of the Current Survey on Construction Statistics, Housing Starts
http://www.mlit.go.jp/report/press/joho04_hh_000205.html

Figure 7.1 Housing complex A-1
(©Yamagiwa Corp.)

Features upper lights positioned on the wall surface and between vertical louvers at both sides of the entrance for visual brightness.

Figure 7.2 Housing complex B-1
(©Yamagiwa Corp.)

Features LEDs with varying color temperatures attached vertically along the entrance walls, changing color with time.

sensors to offer high functionality. In addition, manufacturers are starting to offer a wider variation of bulb-type LED lamps, such as small types compatible with E26 and E17 bases, which is expanding sales. Now that the Japan Electric Lamp Manufacturers Association (JELMA) has released and unified the “Guidelines for Bulb-type LED Lamps Performance Indication”, display of bulb-type LED lamps is no longer hard to grasp, and consumers are easily able to determine their needs⁴⁾.

Use of bulb-type LED lamps is starting to spread, mixed with conventional light sources, by companies specializing in housing complexes for a reduction in energy use. When using LED fixtures, an illumination plan is needed which considers light distribution properties and the brightness offered by vertical illumination. It is becoming more and more important to select a light source considering its use and placing areas.

Figures 7.1 to 7.4 show examples of construction in recent residential lighting.

“Residential Complex A-1” has upper lights positioned on the wall surface and between vertical louvers at both

Figure 7.3 Residence K-1
(©Panasonic Electric Works Co., Ltd.)

Features LED downlights and soft indirect lighting with scene control in the living room.

Figure 7.4 Residence K-2
(©Panasonic Electric Works Co., Ltd.)

Features indirect lighting that completely illuminates the living room and dining room, along with a architectural lighting providing bright illumination.

sides of the entrance for visual brightness. “Residential Complex B-2” has LEDs with varying color temperatures attached vertically along the entrance walls, changing color with time. “Residence K-1” has LED downlights and soft indirect lighting with scene control in the living room. “Residence K-2” has indirect lighting that completely illuminates the living room and dining room, along with a construction design providing bright illumination.

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