



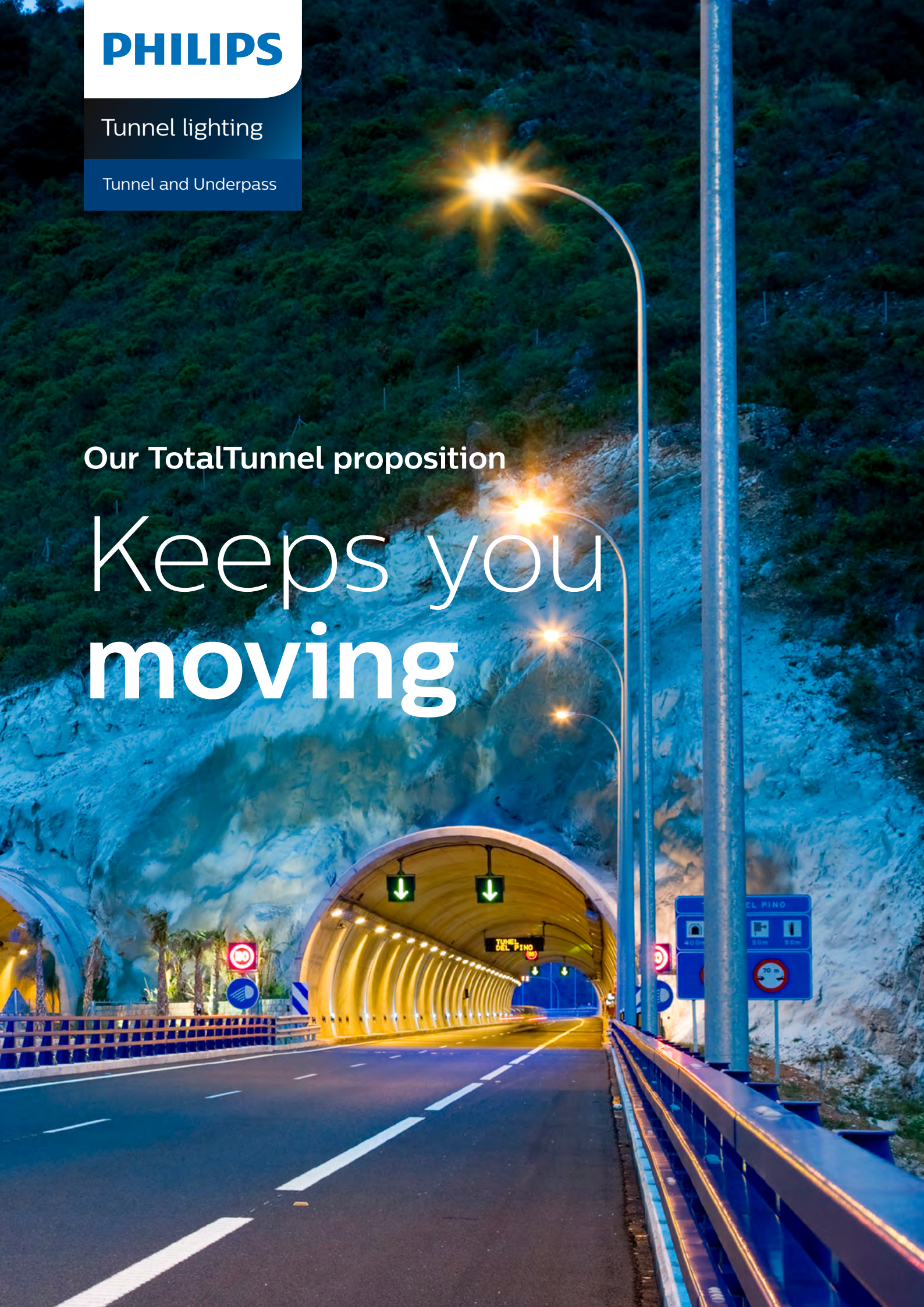
PHILIPS

Tunnel lighting

Tunnel and Underpass

Our TotalTunnel proposition

Keeps you
moving



Keeping the traffic **moving** with tunnels



Valik Tunnel, Czech Republic

The more crowded our road networks become, the more tunnels are needed to keep the traffic moving, offer quicker connections between places by tunnels through mountains or under waters and protect urban areas from exposure to the dangers of cars and fumes. Lighting is essential for traffic in a tunnel, but tunnel lighting is a complex and demanding field. Not only is the lighting performance key for the safety and comfort of road users, maintenance of the system is critical due to the physical restraints of tunnels and limited access. What is more, energy and efficiency are also important.



Tunnel &
Underpass lighting



With a long history of experience and expertise in road and tunnel lighting, Philips has unrivalled expertise in more complex lighting installations. We can offer a rich portfolio of tunnel lighting products with a dedicated LED approach, extended with a complete range of service packages. So you can trust a single source partner for a totally integrated, intelligent lighting solution from concept to completion with exceptional levels of after-sales care.

Our world is changing, so the needs

The environments that we live in are growing at an unprecedented rate. Large, heavily populated cities will become ever-more reliant on underground travel to improve infrastructure, logistics and free up valuable space.

This in turn will bring its own demands in terms of tunnel lighting, safety and driver comfort. Demand for new white light solutions that improve visibility, reduce accidents and prevent costly roadblocks will therefore increase.

With rising concerns over the costs, availability and environmental impact of high energy consumption, tunnel lighting solutions that use less power and result in fewer carbon emissions will also be in demand.

Financial constraints will put pressure on authorities and municipalities to reduce energy and maintenance costs, but they are likely to have little or no budget to invest. New business models will be required to satisfy their changing infrastructure demands.

Why do we need tunnel lighting?

With increasing urbanisation, authorities need to invest in tunnels to keep congestion on road networks to a minimum. But to ensure those tunnels provide a safe passage for motorists, lighting must recreate the same levels of safety, confidence and comfort that motorists experience on roads to tunnels – whatever the time of day or night.

Inside the tunnel, safety is paramount. The lighting should illuminate the presence and movement of other road users or objects, as well as helping to describe the tunnel's geometry to guide drivers quickly through the tunnel without any problems.

Lighting your way

Every tunnel has a range of stakeholders. Each will have their own list of requirements when it comes to the value and benefits that any lighting installation should demonstrate. We are at the forefront of the industry and can address all the key issues regarding tunnel lighting and systems. With our expertise and experience we can create the best possible tunnel solution; one that fits the requirements of your tunnel project in terms of cost, comfort and care.

Valik Tunnel, Czech Republic





Tunnel owners and operators

Owners and operators need reliable lighting solutions that are safe for road users. Ours are efficient, reliable and easy to control and maintain. With clear information on health of the lighting system and its service life time and maintenance it is easy to optimize and protect your investment.

The long, reliable and efficient service lifetime also helps to reduce your maintenance and energy costs. State-of-the-art LED technology provides the high levels of comfort that tunnel users demand. What is more, our solutions come with the reassurance that you are dealing with a reliable partner that will be there for you for decades to come.

Tunnel users

Drivers need a high quality lighting solution for safe and comfortable passage. Ours provide good color rendering and color rated temperature to improve their vision and perception. They also offer excellent uniformity and can aid guidance through LED lighting. To optimize traffic flow and minimize traffic disruption, our solutions come with a guaranteed performance and lifetime, taking the needs of different drivers into account. Less bluish light can avoid scattering in the eye for elderly people and white light improves spacial perception for those who fear confined spaces.

Tunnel installation companies

Some installers have a limited knowledge of tunnel lighting and prefer to focus on electrical works. Our lighting solutions are available as a completely integrated system with clearly defined responsibilities on system integration. There is no need to worry about the control and monitoring side of things. The system keeps that completely separate so the installation team can concentrate on the electrical and mechanical work. With one knowledgeable partner for the entire lighting system, you also benefit from just one contact from design and compliance to delivery and commissioning.

Tunnel maintenance companies

Maintenance is a key consideration in any lighting installation. Our solutions are long lasting and easy to maintain, with service packages and predictable expenses to help you estimate your Total Cost of Ownership (TCO). The control and monitoring system provides information on the health of your installation, so you can also plan for routine maintenance. What is more, our solutions have the longest available lifetime, reducing the need for tunnel closures and minimising downtime and disruption, thereby reducing maintenance costs significantly.

The principals of tunnel lighting

Tunnel lighting contributes to road safety by helping motorists to adapt from daylight to the light level in the tunnel interior. At night the opposite is true, as the tunnel interior can be up to three times as bright as the access road. Between these two extremes, lighting must provide the right degree of comfort and safety for road users.

Entrance lighting

As motorists approach a tunnel at daylight the entrance will appear black (black hole effect). This is because of light levels inside the tunnel are much lower than those outside. Our eyes cannot adapt to extreme differences in lighting levels and will automatically adjust to the brighter light and therefore will limit the visibility of obstacles in the entrance. To compensate this effect, adequate lighting must be provided at the tunnel entrance. This will ensure that drivers can see objects within the correct stopping distance before the tunnel. It will also give them the vision and confidence that the tunnel is safe to enter without slowing down, which is important to maintain optimal traffic flow.

The amount of light required to avoid the black hole effect will depend on how bright the light levels are outside the tunnel (e.g. sunny or clouded). The L20 portal luminance measurement is normally used as input to regulate the different stages in light levels that are required. It takes time for our eyes to adapt from entrance lighting level to interior lighting level. To enable drivers to proceed through the tunnel without slowing down, the entrance lighting level must be reduced gradually over time, when driving through the tunnel according the CIE curve at the so called transition zone lighting (see Figure 1).

Interior lighting

Once the eyes have adapted to the lower levels, sufficient lighting is needed in the tunnel interior for safe passage. This is usually provided by luminaires, spaced at regular intervals, throughout the full length of the tunnel.

During the day, typical luminance levels of 2-12 Cd/m² are required, depending amongst others on the speed and density of traffic. At night, lighting levels should be approximately twice as high as the levels on adjoining roads.

Tunnel exits

Although the tunnel exit zone is less critical, since the eye adapts more quickly to increased brightness, additional lighting may be desirable for the longer tunnels. Exit lighting mainly is applied to provide drivers, when leaving the tunnel, with sufficient visibility looking back in their rear-view mirror. Exit lighting is only activated during the day.

Long versus short tunnels

Tunnel lighting principals will also vary according to the length of the tunnel. Short tunnels (< 25 m) with the exit fully visible, or those with good daylight penetration, high wall reflectance (> 0.4) and limited traffic, normally do not require lighting. Light technically, tunnels in between the short and long tunnel definition (25-200 m), can either be lit according "long tunnels" or with limited daytime lighting (e.g. 50%). Long tunnels (> 200 m) always require tunnel lighting.

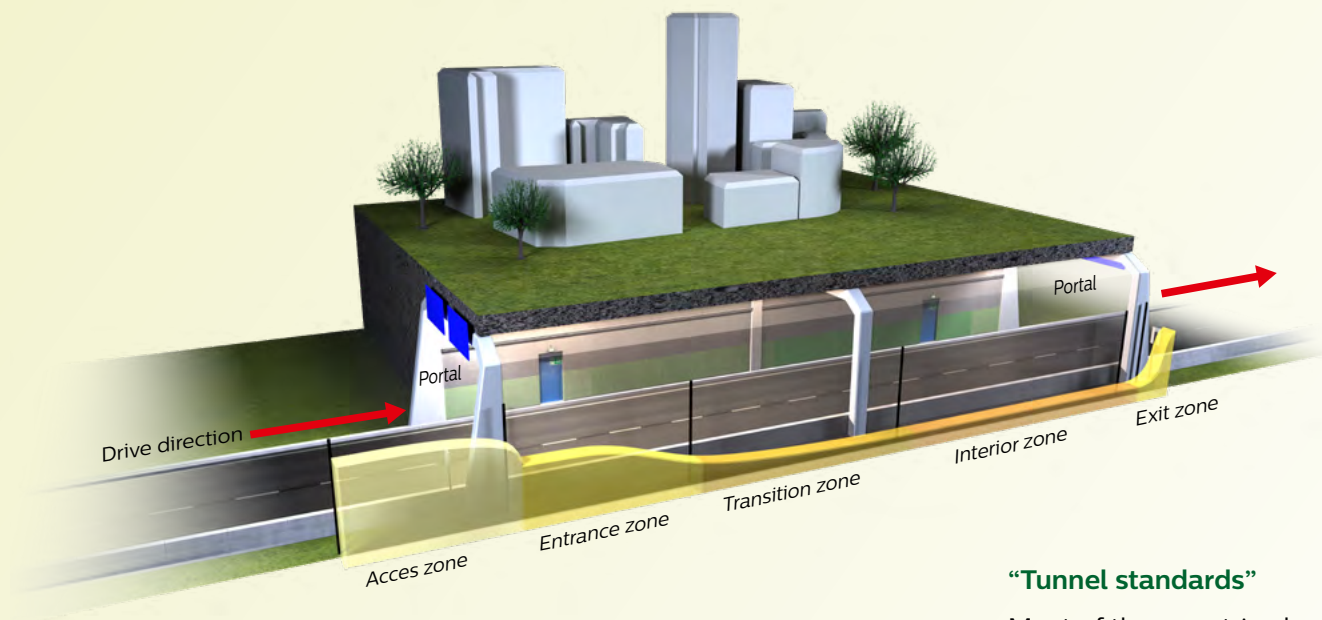


Figure 1

“Tunnel standards”

Most of the countries have their own standards and requirements. Therefore Tunnel consultancy is a very local business. We endeavor to be a partner of global scale, but with local experience and support.

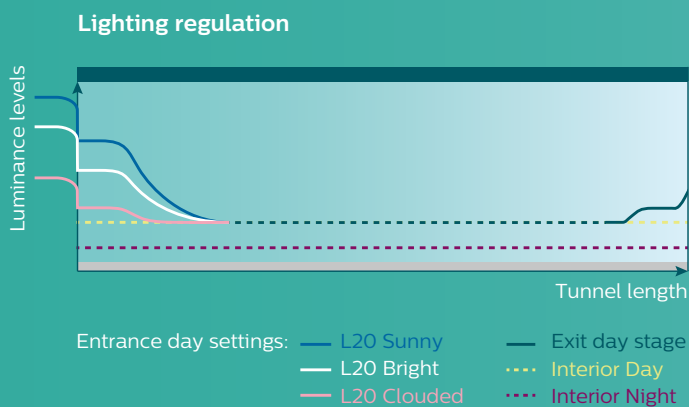
Lighting concepts and light distributions

Each tunnel zone has its own criteria in terms of lighting design and performance. Different concepts and light distributions have been developed to create the right balance between visibility, safety and costs.



Entrance versus interior lighting

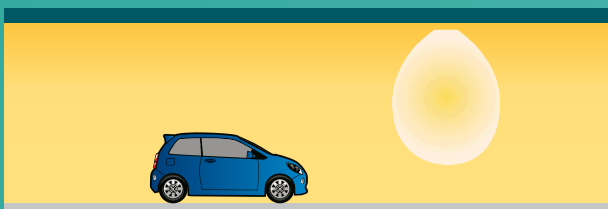
Tunnel entrances need high levels of light, luminaire spacing can be discontinuous and multiple lighting stages will be required. In contrast, interior lighting has lower levels, luminaire spacing is continuous and only a day and a night stage will be required.



Entrance light distributions

The two most commonly used distributions are symmetrical and counterbeam.

Symmetrical lighting provides lower contrast but often is perceived to be more comfortable (less glare). Symmetrical luminaires can be mounted centrally over the carriageway or cornice mounted.

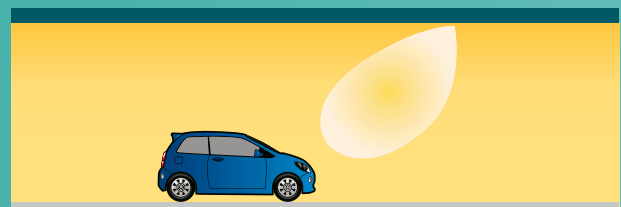


symmetrical lighting

Counterbeam lighting projects the lighting towards the traffic flow. This results in a high object contrast, so showing up as a dark object against a light background. Due to the high contrast often lower entrance lighting levels are accepted. Although compliant to the standards, they can result in higher glare. This type of lighting is not suitable for cornice mounting in the tunnel.

Counterbeam lighting is only suitable in combination with more specular road surfaces. In case of concrete road surface (diffuse), counterbeam lighting cannot be used.

The choice for counterbeam or symmetrical lighting is among others determined by the balance between comfort for the driver and costs.



Counterbeam lighting

Interior light distributions

Interior lighting uses symmetrical lighting. There are two options for interior lighting schemes: point source lighting or linear lighting.

Point source lighting, traditionally created with high pressure sodium lamps, requires fewer luminaires, but gives a lower lighting uniformity and it will produce a restless flickering effect while driving through the tunnel (dynamic behavior).

Linear lighting, traditionally created with fluorescent lamps, requires more luminaires, but gives a higher lighting uniformity and will not produce any flickering effect.

Various light distributions are available to allow the interior lighting to be positioned at any location in the tunnel: centrally or cornice. The position of the lighting (both entrance and interior) can be determined either by creating the best guidance, by maintenance considerations or by the available traffic structure.

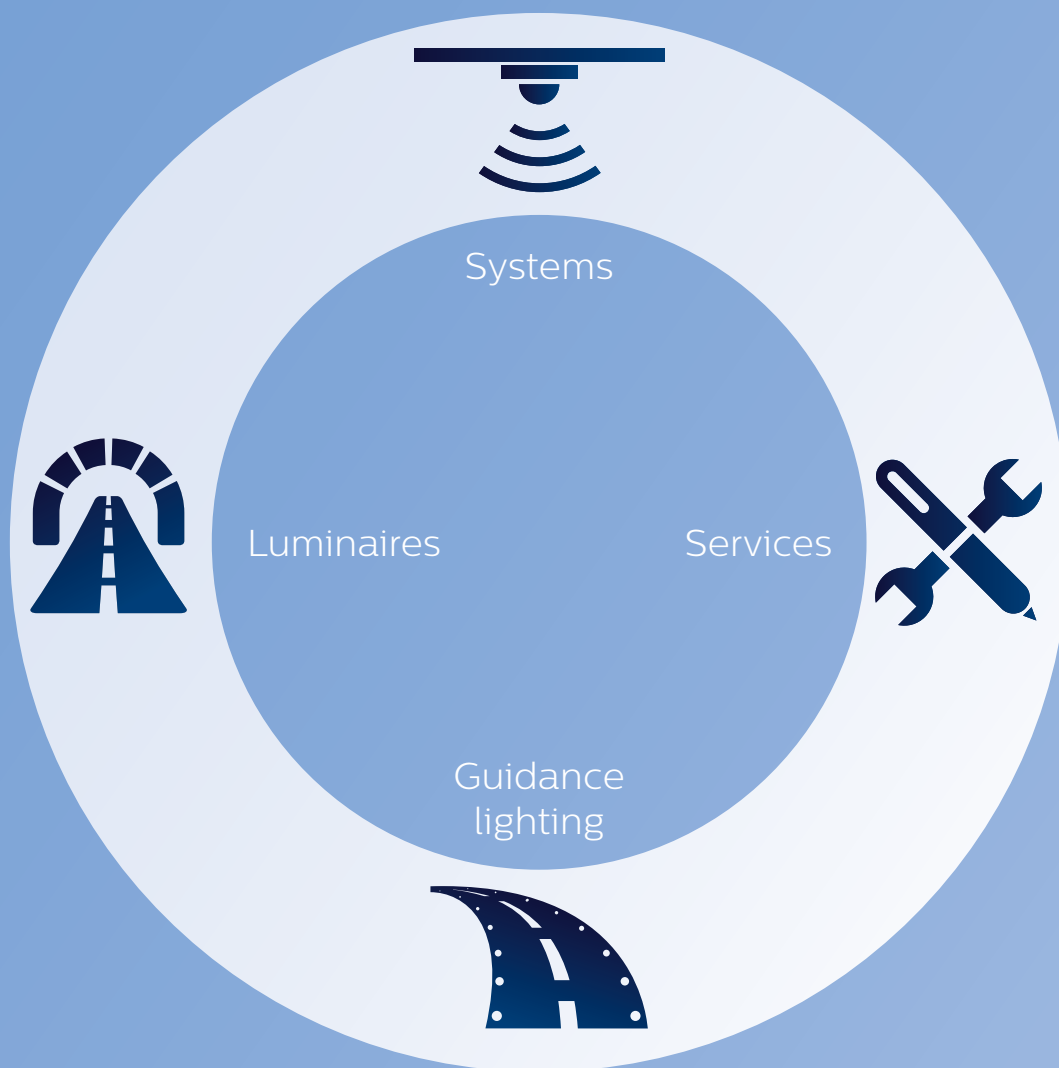


Our TotalTunnel **proposition**



Valik Tunnel, Czech Republic

TotalTunnel is our connected system approach for tunnel lighting



Luminares

To support tunnel specific lighting techniques.



Guidance lighting

To guide the traffic and to secure a safe exit.



Systems

From basic systems to elaborate monitoring systems to give you full control over the lighting system.



Services

From concept design and commissioning to lifecycle services, so that we can relieve you in delivering the complete project while protecting your investment.

It enables us to channel our expertise in tunnel lighting into bespoke solutions for our customers. By combining our four building blocks for success we can create lighting solutions that offer precise levels of quality, guidance, control and service support. And because our focus is dedicated to LED, our four building blocks are designed specifically with that technology in mind.

Balancing needs

Tunnel lighting is a highly specialist application and every project is unique. It is only by focusing on our customers needs that we can gain the insights we need to create truly meaningful solutions. After all, there is no such thing as one global market – or customer. Each country has its own lighting standards and requirements. So although we are a global company, we think and act local. Equally, no two customers share exactly the same challenges. Whilst comfort may be the priority for one client, another may be more concerned with costs. Whatever is driving your project, we are here to listen before we act.

Long term support

Tunnel lighting is a long term commitment that demands project excellence from start to finish. For example, it does not always make financial sense to base your choice of lighting on the cost of the initial investment. Because that could prove to be more expensive in the long run. Philips has the experience and expertise you need from the minute that you agree working with us. You can also rely on our full commitment for the total lifetime of your tunnel installation. We can offer all the help and guidance you need to make the right choice, and provide the after-sales support to ensure your project is a long term success.

Building blocks for success

The key building blocks for a TotalTunnel lighting proposition are:

- Luminaires
- Guidance lighting
- Systems
- Services

Within each building block Philips offers a range of products from simple solutions that deliver unbeatable value to high performance alternatives. We co-select the components with you according to your specific needs, and then combine them to create a total lighting system that is unique to your project. So whether your focus is on the cost of the initial investment, or the Total Cost of Ownership over the entire lifetime, Philips can build the right solution for you.

An attractive Total Cost of Ownership

TotalTunnel also offers an attractive proposition in terms of Total Cost of Ownership compared with conventional lighting solutions. Not only does the superior system efficiency reduce energy costs, maintenance and installation are also minimized, while the robust design extends the lifetime of your installation.



Tunnel lighting luminaires

Each zone within a tunnel has its own requirements in terms of lighting design and performance. For example, tunnel entrances require high levels of light with little or no luminaire spacing. In contrast, the lighting in the tunnel interior should be a low level with or without luminaire spacing. With our extensive portfolio of luminaires we can create any lighting concept to provide exactly the right balance between visibility, safety and costs.

Dedicated LED design

With our uncompromized focus on LED luminaire design, our solutions are optimized to deliver the best performance in every tunnel application. We have dedicated solutions that are specifically designed for each lighting concept and configuration. We also have a wide range of high quality optics to ensure that your project is lit with the optimum efficiency, taking into account the tunnel geometry and materials.

Maintenance concepts

By their very nature, tunnels have limited possibilities for closure without causing major disruption. With our easy installation and maintenance concepts we can maximize the serviceability of your lighting scheme and minimize maintenance time. And because tunnels present a particularly harsh environment, all our solutions are designed for best-in-class longevity too.

Light your way

At the luminaire level, we can light your tunnel to provide the highest standards of comfort and safety, from linear solutions to point source options. Our range also includes a comprehensive range of optics to support different mounting arrangements from central to cornice layouts. You can also expect the ultimate in intelligent control, including digital control and monitoring to support the unique dimming features of the LED luminaires.

What is driving your project?

Within our program we have a balanced choice of luminaires designed for all tunnel applications. This ranges from any basic solution to high performance luminaires that can offer significant benefits in terms of efficiency and TCO. So whatever your focus or budget, we have the right solution for you.



Tunnel &
Underpass lighting

System approach

Although each zone within a tunnel has its own specific lighting requirements, we design all our LED luminaires with the entire system in mind. That means you can expect each luminaire to have a similar lifetime expectancy whether it is intended to be used at the tunnel entrance or the interior. By focusing on system design in this way, we can minimize the inconvenience of replacements and streamline routine maintenance to make life easier for everyone.

Local knowledge and support

We have a comprehensive portfolio of tunnel lighting solutions, all of which can be adapted to the requirements of your project in your market. We also have a dedicated local support team available for you. By working closely with you from the specification stage, we can understand what is viable in your tunnel project and ensure you get the solution that is right for you. Ask your local Philips representative for more details.



FlowStar

- Stainless steel point source luminaire for extreme corrosive environments
- Alternative for HPS 400 W applications
- Dedicated design for high flux: high efficiency and long lifetime
- Modular sealed build supported by lifecycle service packages
- Fully compliant with TunneLogic intelligent control

TubeLine

- Interior linear lighting: alternative for fluorescent interior lighting
- High comfort lighting: low glare, good guidance, no flicker effect
- Smooth and shallow design, allowing maximum overhead space
- Remote driver concept: driver outside traffic envelope or mounted in line with the LED module
- Dedicated LED design for optimal LED performance
- Fully compliant with Philips tunnel controls

TubePoint

- Modular, highly adaptable Point source tunnel luminaire
- Cost effective LED alternative for HPS
- Wide application range (optics/lumen packages)
- Fully serviceable with integrated driver
- Fully compliant with Philips tunnel controls
- Dedicated LED design for optimal LED performance

For our complete global portfolio you can visit our online product catalogue [here](#).



Tunnel guidance lighting

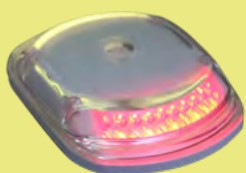
Both EU Directives and CIE stipulate that guidance markers are mandatory in tunnels for pedestrian evacuation, road edge marking and illumination around exit doors. Additionally road markers provide greater safety for guidance and traffic separation.

Inductive power

The markers make use of the inductive power transfer technology which makes it very simple to use and install, with minimum components. A key benefit of inductive power transfer is its reach: a single power supply can power up to 200 markers over a distance of 2.5 km, allowing markers to be completely sealed with no wiring entry points, they are corrosion-free and more resilient than hard wired products.

Installation

Our tunnel markers can be installed into new build, refurbishment and retrofit tunnels. The system is complete with a range of markers, power supply and built in control functions. Installing the markers is also quicker and cheaper than installing hard-wired lights. Electricity is delivered by magnetic induction, meaning the markers need to be in close proximity to a node, but not in physical contact. Replacement of markers is therefore as simple as removing a faulty one from the road and fixing a new one in its place.



Guidance markers

- A sidewalk LED marker system can efficiently and effectively direct drivers/passengers towards emergency exits
- Improves driver guidance
- Markers are IP69 rated (water and dust resistant)
- System can run over long distances – 200 markers over 2.5 km from one power supply
- Markers are individually powered and individually programmable
- Quick and affordable installation
- Spark free and no electrocution danger
- Low TCO



Lane markers

- Improves driver guidance
- Maintains lane separation and enforces lane discipline
- Markers are IP69 rated (water and dust resistant)
- System can run over long distances – 200 markers over 2 km from one power supply
- Markers are individually powered and individually programmable
- Quick and affordable installation
- Spark free and no electrocution danger



Systems

- Long range: 100 up to 2500 m of marker system
- Safe/contact free power and communication transfer (IPT-ICT)
- Flexible integration with other system systems (digital and serial I/O's available)
- Fully programmable: standard or at project specification
- Robust power supply for reliable operation

Tunnel intelligent lighting systems

Historically, traditional lighting control system designs have been the responsibility of the maintenance contractor. Through our extensive experience and integrated solution design, including intelligent lighting systems, we have reduced the burden on the installer to minimize complicated electrical designs and significantly reduce labor, and for tunnel authorities enable better traffic management and minimize the capital expenditure for the life time of the tunnel infrastructure.





End-to-end solution

Whatever your project requirements, whether it be new build, refurbishment, retrofit of a short underpass or a tunnel of many kilometers, Philips offers an end-to-end lighting system for any type of tunnel project.

Intelligent control systems offer a dynamic approach to realize the project objectives and meeting client specifications. From the lighting design output and support from our application engineers, the lighting control system design is configured and programmed off site and installed ready for use.

Delivering

Installation timescales are critical. With minimal system components and plug-and-play methodology, on-site installation is quick and simple, affording the installer cost efficiencies over many other systems.

The user friendly interface for the lighting control software allows operators and maintainers easy navigation menus for monitoring lighting system status as well as providing operational control either locally or via a scada network. System data is easily accessible for luminance photometer trending, system faults and burning hours providing the operator complete information to suit specific requirements.

High performance and system longevity is crucial to ensure your tunnel network is operational and keeps traffic moving. With our expertise and project experience across many countries, partnering with Philips provides the best of both worlds for the project related to costs, comfort and care.



BaseLogic

Easy and cost-effective control of LED tunnel lighting



BaseLogic is a basic monitoring and step dim adaptive tunnel lighting system targeted mainly at existing tunnels needing a higher quality lighting system. It requires limited CAPEX and offers low OPEX, while maintaining Signify's traditional high-quality performance.

For refurbishment projects, BaseLogic removes the need for a new control infrastructure because it uses the existing mains cables to the luminaires for communication of dimming commands. This significantly reduces installation time and costs. The luminaires are pre-programmed and do not require additional control gear. You can thus install BaseLogic without in-depth knowledge.

Highly modular, BaseLogic can be a standalone control system or fully driven by a schedule and/or sensors. It can easily be integrated into a SCADA tunnel management system for remote monitoring and control.

Reduce

operating and maintenance costs

To ensure a tunnel operates optimally, tunnel owners, operators and maintenance companies need to be quickly informed about the real-time condition of the lighting system. BaseLogic provides basic active health monitoring and fault notification, allowing corrective actions to be taken immediately. The tunnel's safety and comfort levels are maintained, while operating and maintenance costs are reduced.



Requires limited capital expenditure



Offers low operating expenses



Easy installation no new cabling needed





Underpasses



Tunnels

Applications

BaseLogic is ideal for all tunnels and underpasses. These range from standalone short underpasses driven by day or night schedules, to multi-zone road tunnels driven by the brightness of the environment. In all these applications, integration with a tunnel management system is possible.

BaseLogic is specifically targeted at existing tunnels with aging lighting that needs to be made more efficient, cost-effective and environmentally friendly. Built-in flexibility and modularity make BaseLogic suitable for all types of underpasses and tunnels.



Multi-zone tunnels



BaseLogic TCU unit

Specifications

BaseLogic system specifications

System feature	Specification
System control	DIN-rail mounted components, IP2x
	110 – 277 V 3 phase mains compatible
	RS-485 L20 photometer driven input
	Digital input for Emergency Service Override
	12 step Coded Mains dimming output
	Programmable night schedule
System monitoring	Current monitoring to detect luminaire outages
	Controls failure monitoring and redundancy
	Warning and alarm available via SCADA interface
	SCADA integration required
SCADA integration	Ubuntu (virtual) server, 2x 2 core 4Gb RAM
	Ethernet network connectivity to tunnel controls required
	SOAP XML interface for SCADA integration

TunneLogic

Scalable and easy to integrate,
tunnel lighting control and
monitoring system



Easy configuration and commissioning

TunneLogic is specifically designed to provide a control system solution that is easy to configure, install and commission. Using the PC-based configuration wizard tool, we can easily build your tunnel project's profile and configuration parameters off site. Once completed, upload of the data file is via a USB memory device onto the Master Control Unit (MCU) during the commissioning stage. Furthermore, with minimal system components and plug and play methodology, the system architecture is simple to design and install ensuring optimal benefits and flexibility for reducing installation costs. Integration for SCADA systems is easy using a standard Modbus interface (serial or ethernet).



Extensive monitoring and control (system health)

The TunneLogic graphical user interface provides simple navigation for ease of control and monitoring functions. Structured tabs allow access for extensive data logging management on photometer status, system faults and stage burn hours and control functions. Local and remote access provides the benefit of monitoring system performance and technical support to efficiently plan system maintenance and repair, reducing functional closures and lowering traffic disruption.



Lighting performance

Optimum performance is achieved as a system solution with luminaries and controls. Since TunneLogic is fully dedicated for LED technology, continuous dimming and L20 control of the lighting system provides the exact level of light needed at any given time to provide significant energy savings over other switched stage solutions. In addition to communication redundancy and failsafe configuration options, TunneLogic is a safe, robust solution for increasing system longevity and maintaining operational performance.



Cost savings

Next to all the benefits already mentioned, the entire system is a low cost, feature rich system. Not only is the system inexpensive to buy, you save costs in other ways post-purchase. As explained, the continuous dimming ensures the right lighting levels at every moment by precise L20 control. Additionally, the easy commissioning reduces design and engineering time, which also reduces costs and provides the opportunity to open the tunnel earlier.



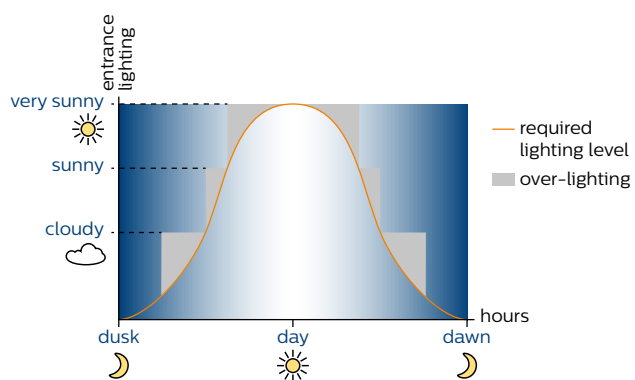


Short underpasses



High-speed road tunnels

Applications



Graphical representation of the energy saving benefits of dynamic digital control over conventional switched systems when using Philips TunnelLogic solution



Long tunnels

Specifications

System feature	Specification
System control	Stainless Steel Cabinet mounted control components, IPx4/IP66
	RS-485 L20 photometer driven input
	RS-485 or ethernet based topology
	DALI Interface
	Continuous Dimming
	Digital IO
	Local and remote Emergency Service Override
	Various night schedule options
System monitoring	Group level monitoring to detect luminaire outages
	Controls failure monitoring and wide range of redundancy options
	Warning and alarm available via dashboard and/or SCADA interface
SCADA integration	Modbus over serial or TCP/IP interface
	Standardized array of data registers

Tunnel services

Tunnel lighting is a very technical application where the client or installer sometimes do not have the in-house capability and therefore need to be reliant on external partners. With this in mind Philips offers a complete services package that will help and relieve you in delivering the project and protecting your investment.



Services

Advisory Services

Often, complete project design criteria information is not available, which can result in non-compliance and misinterpretation of design requirements. As part of our service program, we offer advisory services to maximize the benefits of the installation design and specification compliance.

- Maintenance, operational and life expectancy performance analysis
- Structural geometry and portal luminance evaluation
- Energy calculations and annual consumption advice
- Compliance checks to current lighting standards
- Lighting design criteria and product specifications advice
- Full lighting design proposals in accordance with client specification
- Periodic inspections

Project Services

With our turnkey project supply approach, we are able to deliver projects from concept to completion to meet the demands of the project stakeholders. The scope of our involvement can be requirement specific or taking complete responsibility of an end-to-end solution. Realization of the key areas of the project is important. We can provide several project services.

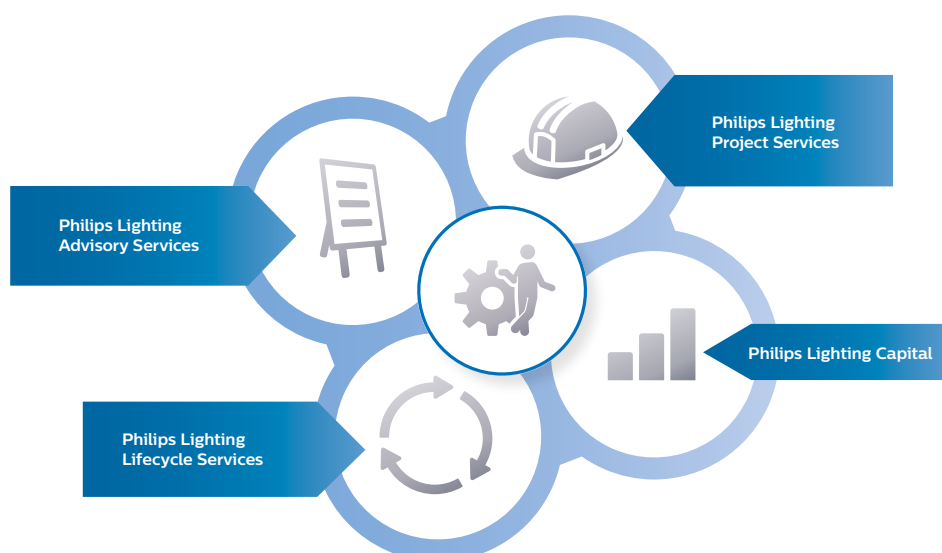
- Project management
- Application engineering
- Contractor liaison
- Factory acceptance testing
- Logistic support
- Installation and commissioning
- System integration
- Site acceptance testing

Lifecycle Services

With our lifecycle services our customers and channel partners are covered by a variety of contracts that guarantee long-lasting, cost-effective, warranty and hassle-free performance from our lighting solutions.

Lighting Capital

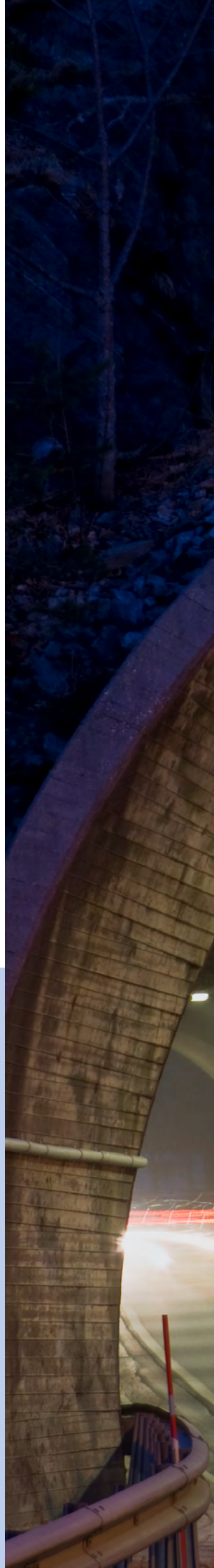
Philips Lighting Capital links financing to the costs savings that your lighting installation will deliver. That means you can acquire a state-of-the-art solution now, with little or no upfront capital investment. So your cash flow stays positive from day one.



Sørnes Tunnel

East to Sweden's capital city Stockholm, a new road tunnel was constructed to connect the city of Kvarnholmen to the center of Nacka. With Philips' TotalTunnel system, the Kvarnholmen tunnel became one of Sweden's first road tunnels to implement connected LED lighting that is remotely controllable and delivers up to 75% energy savings.

For more inspiration you can visit our case study browser [here](#).



“

The Philips TotalTunnel approach saved us installation time as the cables were already fitted with plugs. We only had to mount the luminaires and connecting these in the mains.”

Bjørnar Korsnes Andersen,
Project Manager at Caverion





© 2020 Signify Holding. All rights reserved. The information provided herein is subject to change, without notice. Signify does not give any representation or warranty as to the accuracy or completeness of the information included herein and shall not be liable for any action in reliance thereon. The information presented in this document is not intended as any commercial offer and does not form part of any quotation or contract, unless otherwise agreed by Signify.

Philips and the Philips Shield Emblem are registered trademarks of Koninklijke Philips N.V. All other trademarks are owned by Signify Holding or their respective owners.

www.lighting.philips.com