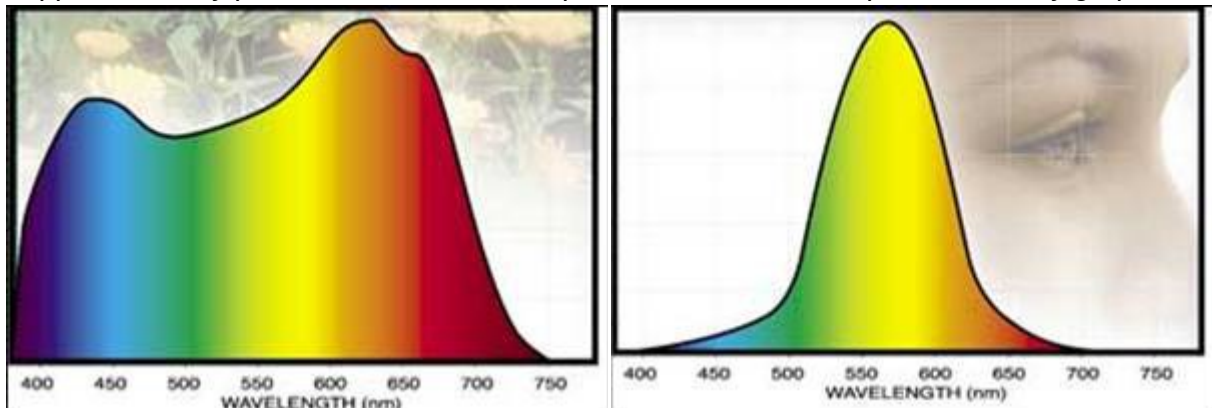


Double-ended Lamp technology

Light and plants

Plants have a different sensitivity response than humans to light of various wavelengths. For green plants, the sensitivity to red light is highest and it is lowest for green light. For this reason, the 'lux' unit is not the right measure for the lighting of green plants. Light sources may be regarded as sources of energy particles; these are called light quanta or photons. Most lighting products are developed for applications with human beings at center stage. The units 'lumen' and 'lux' are relevant for these. The unit lux has its origins in photometry and is based on the average sensitivity of the human eye. The maximum sensitivity is around 555 nm (yellow-green light) and reduces in case of longer (red) and shorter (blue) wavelengths.

All photons, from blue to red (400 to 700 nm), are used for photosynthesis, but this does not happen for every photon with the same output. This is termed the 'plant sensitivity graph'.



Micromol

Studies carried out by universities and testing stations show that the speed of growth of plants is mainly determined by the number of photons between 400 and 700 nm that they absorb. The growth light is indicated by the abbreviation PAR, and is the only reliable measure to indicate whether a lamp is suitable for photosynthesis. The higher the PAR value per Watt, the more efficient the lamp. For this reason, Philips specifies the PAR value for all its 'growth lamps', expressed in micromol photons per second ($\mu\text{mol/s}$).

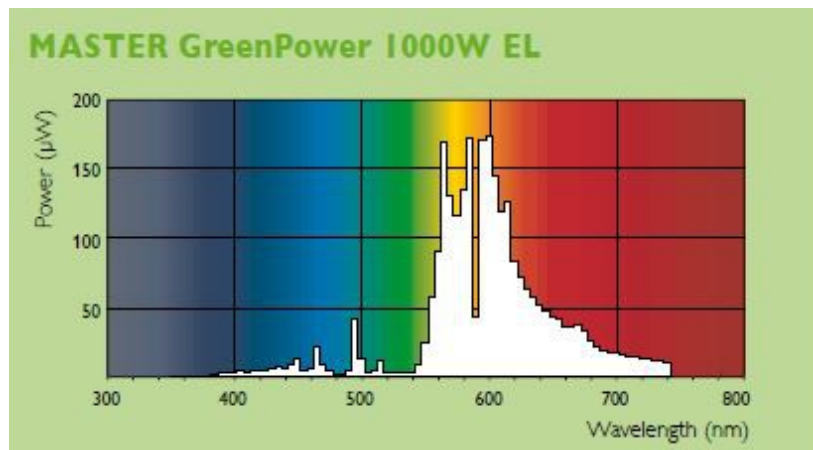
The Double-ended Lamp

HPS lamps have long been the favored light sources for plant growth, owing to the high proportion of radiation in the spectral range of greatest value to photosynthesis. Philips was an early pioneer in the development of lamps having a further optimized spectrum, for instance the original SON-T Agro 400W. This features enhanced output in the blue as well as red regions to stimulate photosynthesis with maximum efficiency.

In order to increase growing yields, there has been a continual trend to the use of higher irradiation levels, which in turn calls for higher output lamps. This resulted in the GreenPower range of HPS lamps having only the increased red component, which raises performance because growth is stimulated much more by red light than blue.



To fuel the desire for still higher light levels, Philips launched the first 1000W plant growth lamp in 2005, in the form of this GreenPower TD. The double ended construction was chosen so as to maximize optical efficiency in the luminaire, because unlike for single ended lamps there is no frame support wire running alongside the arc tube, which may cast a shadow in the beam. The position of the arc tube with respect to the pinch-seals is also tightly controlled, which permits optimal positioning within the luminaire's optics. The Philips GreenPower 1000W lamp is a gas-filled lamp rather than vacuum. This permits a reduction of arc tube length for a given wattage, further improving the degree of optical control. The high thermal conductivity of the gas filling does however make the lamp extremely sensitive to its environment in the luminaire, especially the reflector design.



Using the E-Papillon for the double-ended lamp

Optex Lighting recently introduced the Lights Interaction ePapillon fixtures into the hydroponics industry. Completely new to the hydroponics is the way the reflector is set up.



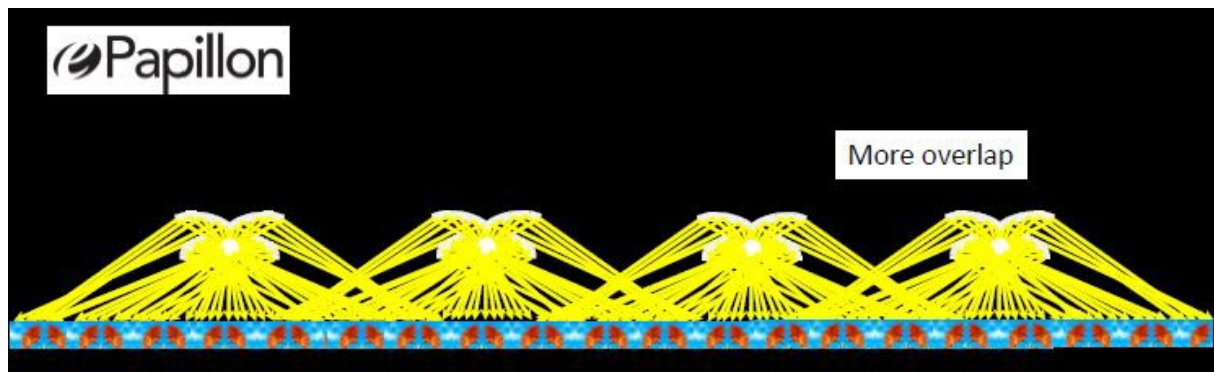
The patented reflector included with the ePapillon 1000W has a yield of 95% (certified by the British Standardization Institute). The PAR values achieved by this reflector is as much as 10% higher than comparable lighting systems, resulting in more PAR light to the plant canopy.

The reflector utilizes Open Reflector Functionality, which directs more light on the canopy while trapping considerably less heat; heat is allowed to rise away from the canopy more efficiently than other reflectors that trap the heat, resulting in higher temps in the plant canopy.

Using the open reflector means less hotspots on your plants. Also the open reflector will make sure the lamps deteriorate much less.



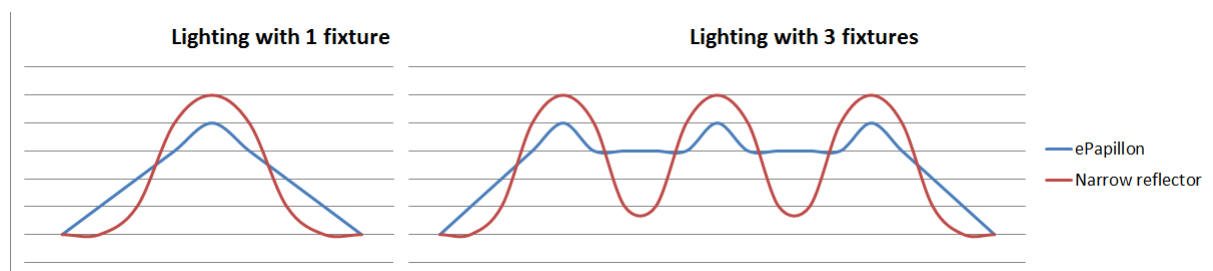
The ePapillon reflector was designed to reflect the light in different angles. The light shouldn't be only directed downwards. The light in the angles will be the light that is directed into the canopy. So every plant will get light in different angles. Take a plant and you'll see the leaves aren't all only directed upwards.



Because the light comes out of the reflector in different angles there will be more light penetrating into the canopy. But apart from the penetration of the light into the crop it is very important you get an overlap of light. Each plant should get the same quantity of light, so uniformity of light is very important.

Measuring light

For measuring light the measuring field should be a representative part of the lit growroom. In principle, the measuring field should cover three adjacent lamps.



Narrow light bundles create high lightlevels on 1 spot, but not on a surface. The ePapillon creates an even lightsread over the canopy. So it doesn't make sense to measure light only directly under the center of the fixture. Lights should be measured over a complete surface on at least 45 spots.

A measurement on just 1 single spot makes no sense. You could either measure in a peak or in a valley. Both give no representative image of the lightsread and average lightlevel.

Wall-plug efficiency of a fixture.

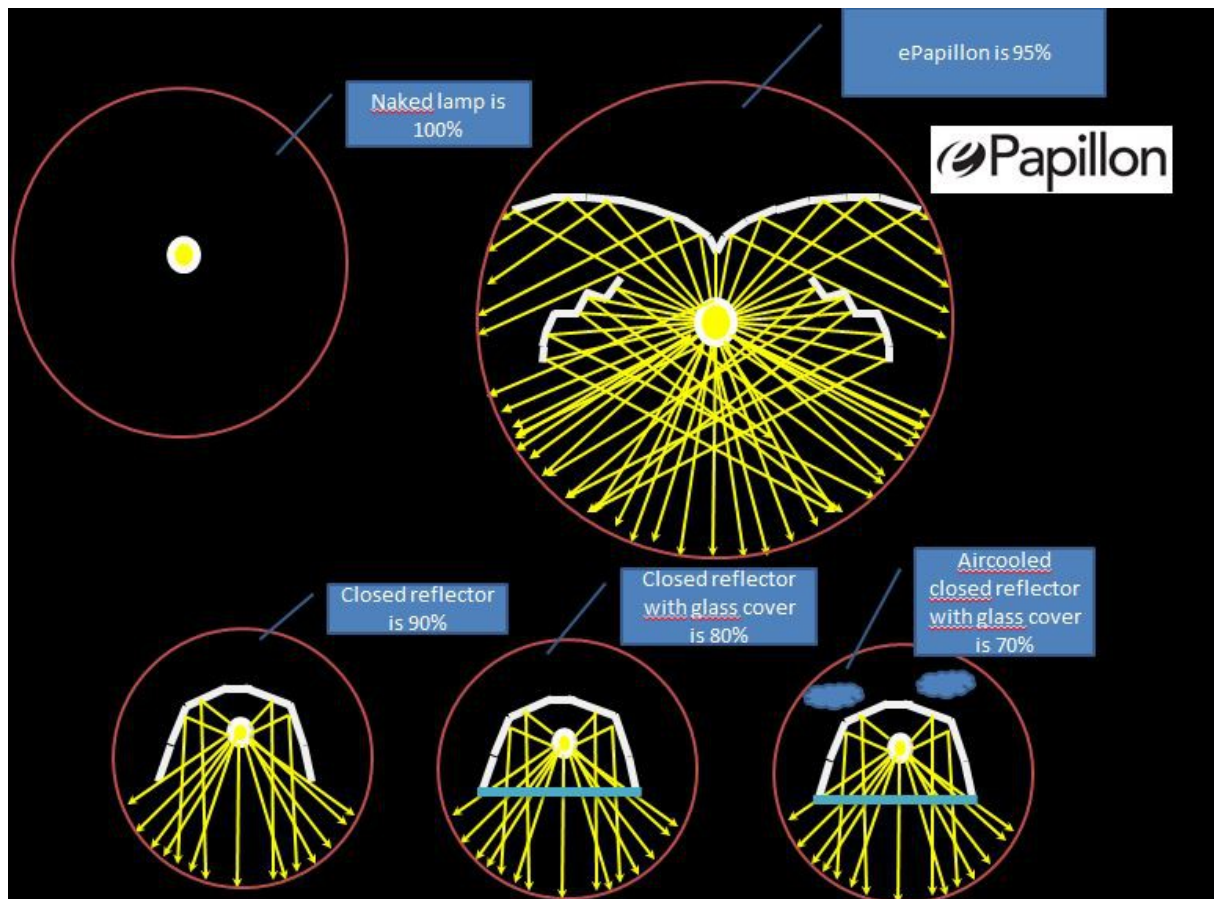
Wall-plug efficiency is the energy conversion efficiency with which the system converts electrical power into optical power.

The ePapillon 1000W is fitted with the Philips GreenPower 1000W EL Plus double-ended lamp which has a guaranteed lightoutput of 1925 $\mu\text{mol/s}$ over a period of 10.000 hours. But measurements have shown that Philips is conservative when it comes to claiming the quantity of light coming from the lamp. The Philips GreenPower 1000W lamp gives no less than 2100 $\mu\text{mol/s}$!

The ePapillon reflector has an efficiency of 95%, which means that 95% of the light coming out of the reflector is reflected to the canopy.

The power consumption of the ePapillon 1000W is 1060W.

This results in a wall-plug efficiency of $(2100 \mu\text{mol/s} * 0,95) / 1060\text{W} = 1.9 \mu\text{mol/W}$



What is clear in hydroponics is that there never has been a good design of reflectors before. Most reflectors are copies of reflectors that have been used in the 90's which only have efficiencies of about 85%.

Then the lamps that are most used aren't specified in micromoles, but still in lumens. Much of the light coming from those lamps is still in the yellow/green spectrum of which we know has little influence on plant growth.

By using a protective glass cover on the reflector you will lose about 10% of the total output of the lamp.

Don't use active cooling of a double-ended lamp

Compared to ordinary HPS lamps the Philips 1000W Double Ended lamps are gas filled, this means that the discharge tube which is inside the outer glass balloon is protected by inert gasses.

This is done because the PIA (Philips Integrated Antenna, this is the fine grey line over the length of the discharge tube) needs to be protected of the higher temperatures the 1000W lamps have.

Also gas filling the lamp gives it a longer lifetime, and the dimensions of the outer glass balloon can be much smaller which results in smaller luminaire designs.

Normal HPS lamps are vacuum lamps; the discharge tube is protected by the vacuum that exists between the outer glass balloon and the tube itself. Because of the vacuum inside the lamp the discharge tube is well insulated from moderate temperature changes from outside the lamps. The 1000W double-ended lamps on the other hand are much more sensitive to temperature changes.

Even the slightest change in airflow and temperature around the lamp will immediately have an effect on the temperatures of the discharge tube inside.

Lower temperatures on the discharge tube result in a dramatic loss of efficiency because less energy is converted into light and more into heat.

ePapillon and double-ended technology.

Most of the growers are accustomed to using two 1000w lighting systems over each 4' x 8' tray, or four 1000w systems over two trays. The ePapillon 1000w system is so bright and so efficient that you will be able to achieve the same results with only three fixtures over two 4' x 8' trays!

When you combine the cost savings of only needing three of these systems to cover what would normally require four systems, the reduced cost of not having to purchase replacement lamps as frequently and all the other features the ePapillon has to offer, it's easy to see how cost effective these systems are over the course of a relatively short period of time.

