SUSTAINABLE FOOD PRODUCTION WITH HORTICULTURE LEDS

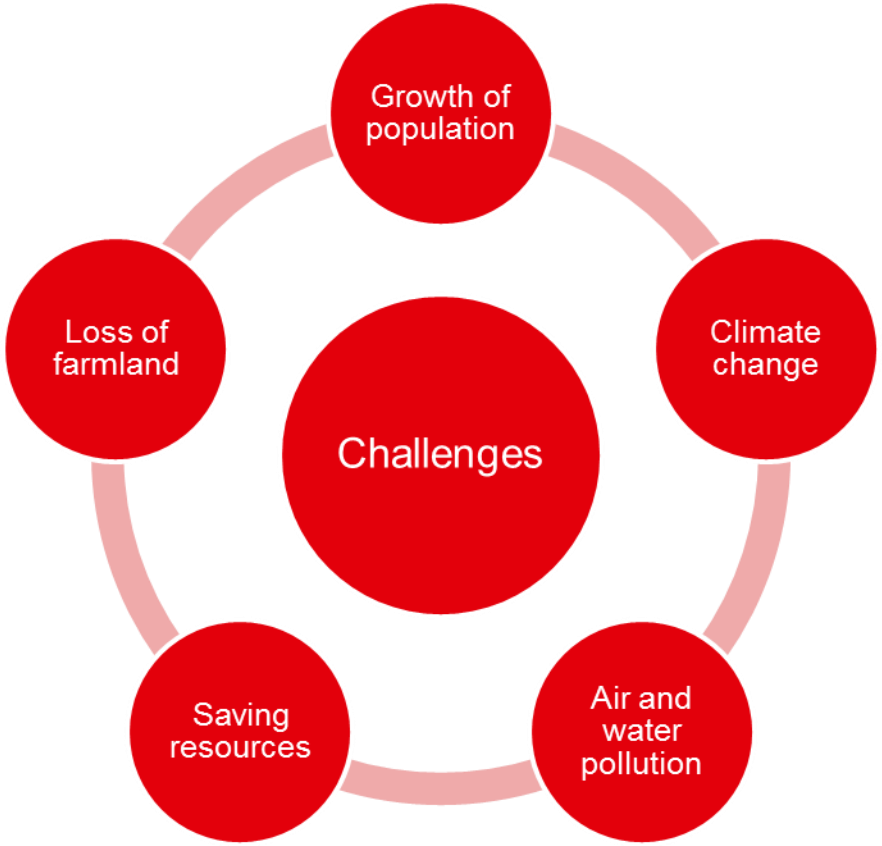
Johann Waldherr
Business Development Manager

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

AGENDA

- Challenges of humanity
- Controlled Environmental Agriculture – Vertical Farming
- Why Horticulture LEDs? Characteristics and Benefits
- Why Würth Elektronik - More than you expect
- Q&A

CHALLENGES OF HUMANITY



Higher world population in combination with less usable farmland under unpredictable weather conditions
How can we secure food supply?

All these impacts and challenges needs solutions

Horticulture LEDs can contribute to be a part of the solution

CONTROLLED ENVIRONMENTAL AGRICULTURE (CEA)

Indoor Farming

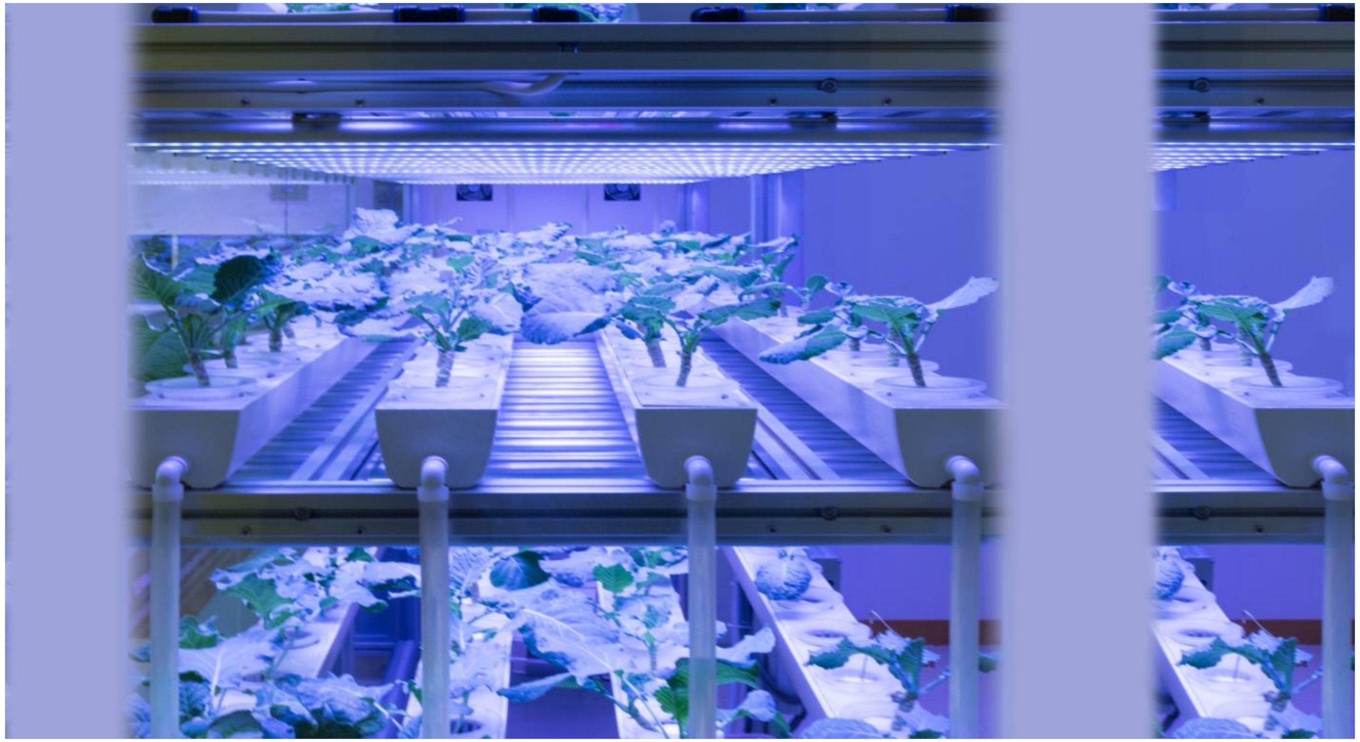
Vertical Farming

Greenhouse

→ Cultivation of plants under optimal growing conditions

→ CEA is a chance, not a competitor to traditional farming

VERTICAL FARMING



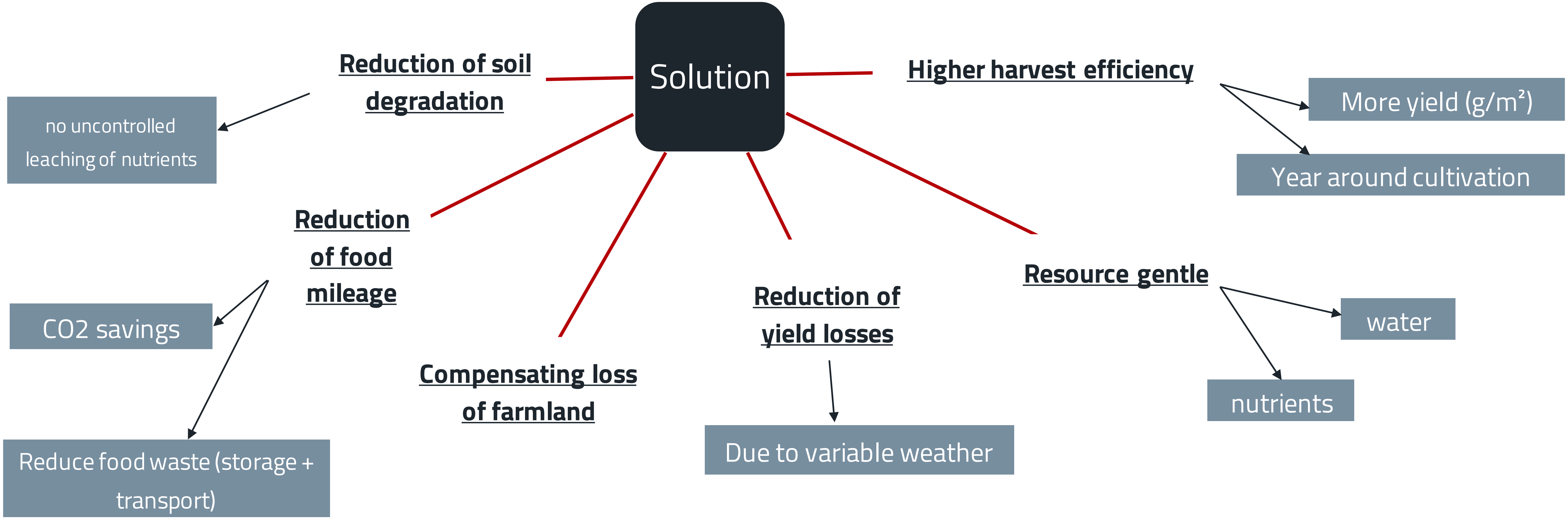
The farm of tomorrow: agriculture in the middle of the city, close to the customer

- Use of a multilayer cultivation system – minimum growing area
- Use of hydroponics (closed water and nutrient cycle)
- No long transportation of food
- Optimization of growth conditions – app control/AI
- Consistency of products – same quality
- Growing all over the world is possible – challenging places
- Harvest on demand – 100% local, higher nutritional value

Vertical Farming was made possibly by LEDs

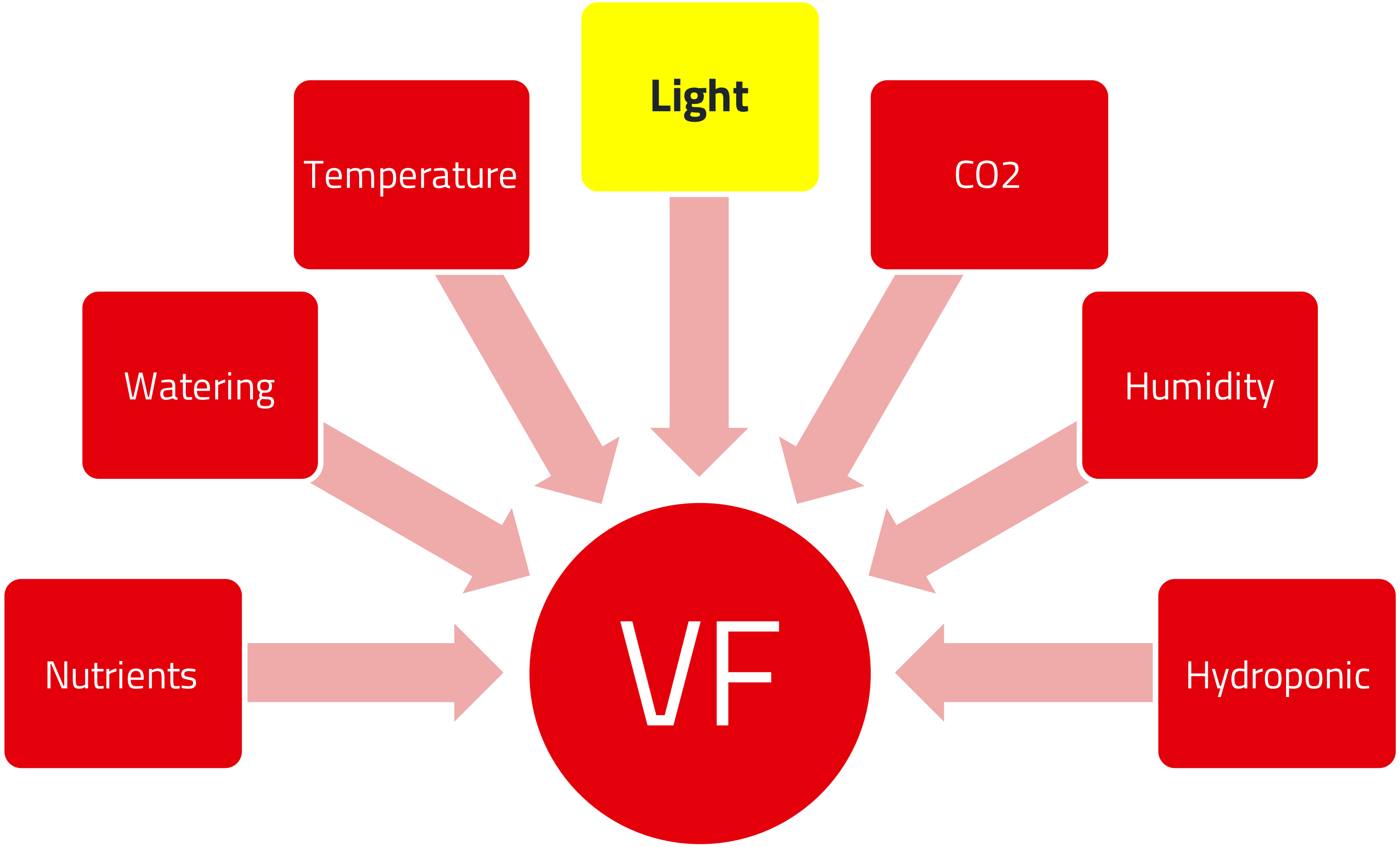
SOLUTION:

Vertical Farming is one part, which has the potential to contribute to help against the challenges of humanity:



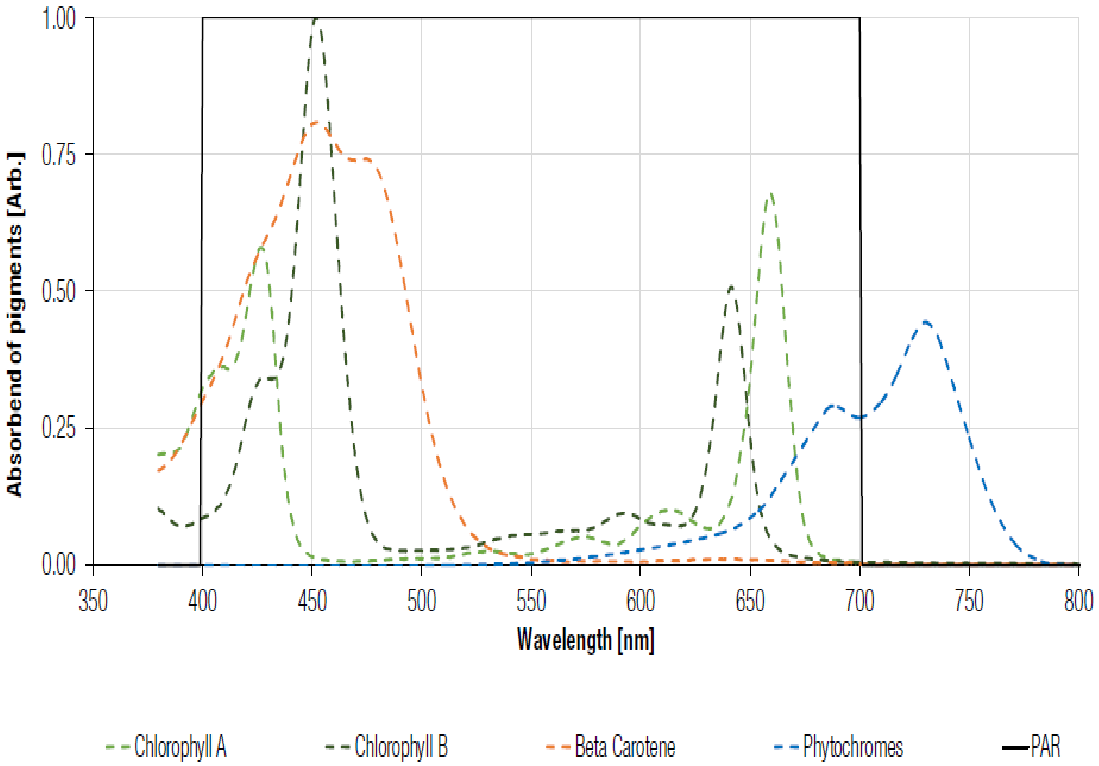
→ Vertical Farming can be used to improve food security and ensure nutrient rich food, while reducing carbon footprint and food miles.

WHAT ARE INFLUENCING FACTORS IN A VERTICAL FARM (VF)



CHARACTERISTICS OF HORTICULTURE LIGHTING

Biological Basics



What does a plant need?

→ light is essential for plant growth

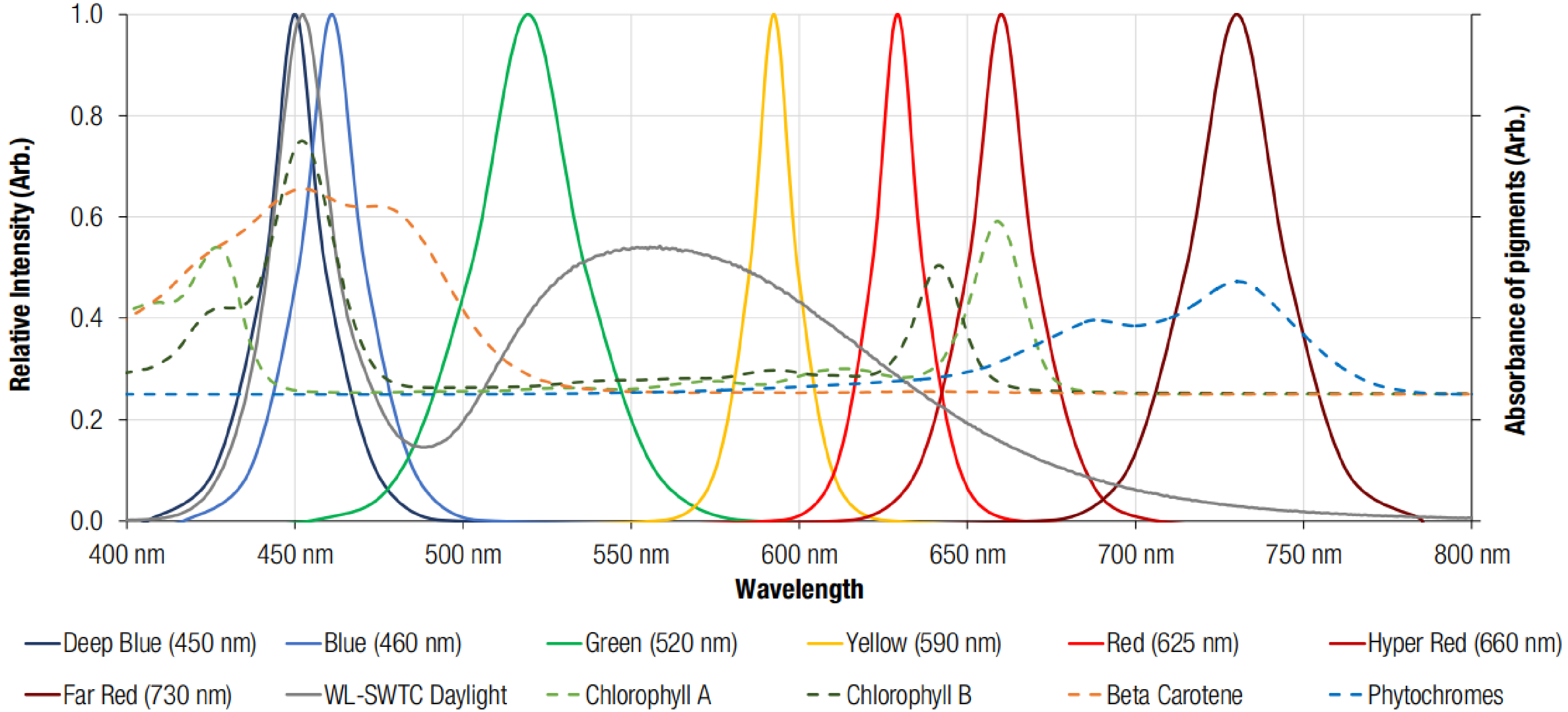
- **PAR (Photosynthetic Active Radiation)**
  region from 400nm to 700nm in which the plants are able to use photosynthesis

- **PBAR (Plant Biological Active Radiation)**
  region from 280nm to 800nm in which the plants recognize light

→ light can control: photosynthesis, morophology, flowering secondary metabolites, flavor, etc…

CHARACTERISTICS OF HORTICULTURE LIGHTING

Optical Basics

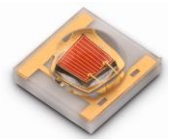


We developed our LEDs for customized light solutions for different Qualityparameter of the plants.
Suitable for all Horticulture Lighting Applications

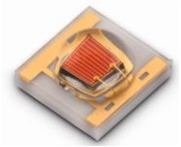
WÜRTH ELEKTRONIK HORTICULTURE LEDS

High Power Products

Horticulture



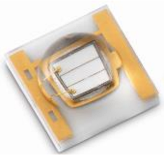
Order Code	Color	λ_P
150353DS74500	Deep Blue	**450** nm
150353HS74500	Hyper Red	**660** nm
150353FS74500	Far Red	**730** nm



Order Code	Color	λ_P
150353RS74500	Red	635 nm
150353YS74500	Yellow	593 nm
150353GS74500	Green	520 nm
150353BS74500	Blue	460 nm

Visible

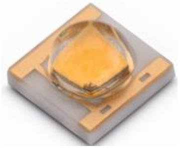
WL-SMDC



Order Code	Color	λ_P
15335338AA350	Ultraviolet	385 nm
15335339AA350	Ultraviolet	395 nm
15035340AA350	Ultraviolet	405 nm

UV

WL-SUMW



Order Code	Color	CCT
158353027	Sunrise	2700
158353030	Warm White	3000
158353040	Moonlight	4000
158353050	Daylight	5000
158353060	Cool White	6000

White

WL-SWTC

- **Advantages**
  - adjustable spectrum
  - plant adapted spectrum
  - full spectrum
  - low thermal resistance
  - high efficacy

more Information on www.we-online.com/leditgrow

WÜRTH ELEKTRONIK HORTICULTURE LEDS

Mid Power Products

WL-SMTW

Horticulture

Order Code	Color	λP
150283DS73103	Deep Blue	**450** nm
150283HS73103	Hyper Red	**660** nm
150283FS73103	Far Red	**730** nm

Visible

Order Code	Color	λP
150283RS73103	Red	635 nm
150283YS73103	Yellow	593 nm
150283GS73103	Green	520 nm
150283BS73103	Blue	460 nm

more Information on www.we-online.com/leditgrow

WL-SWTP 3030

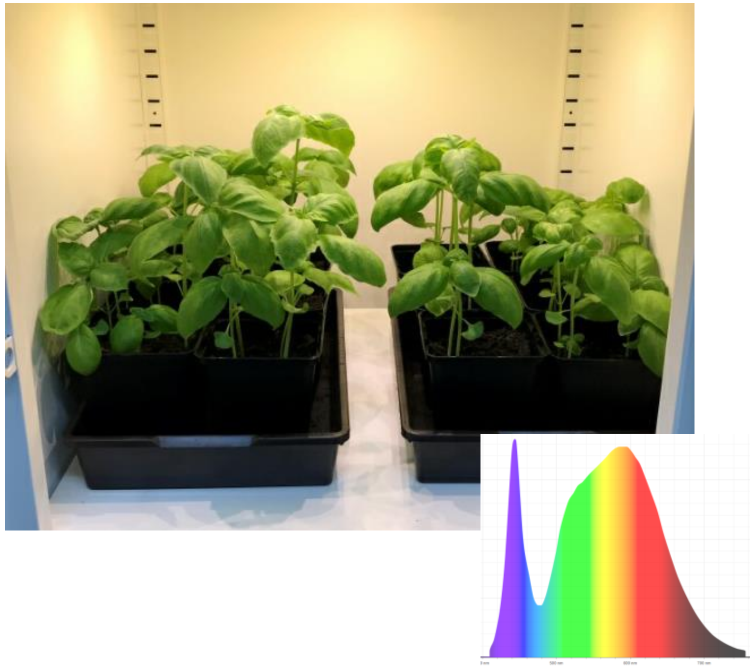
White

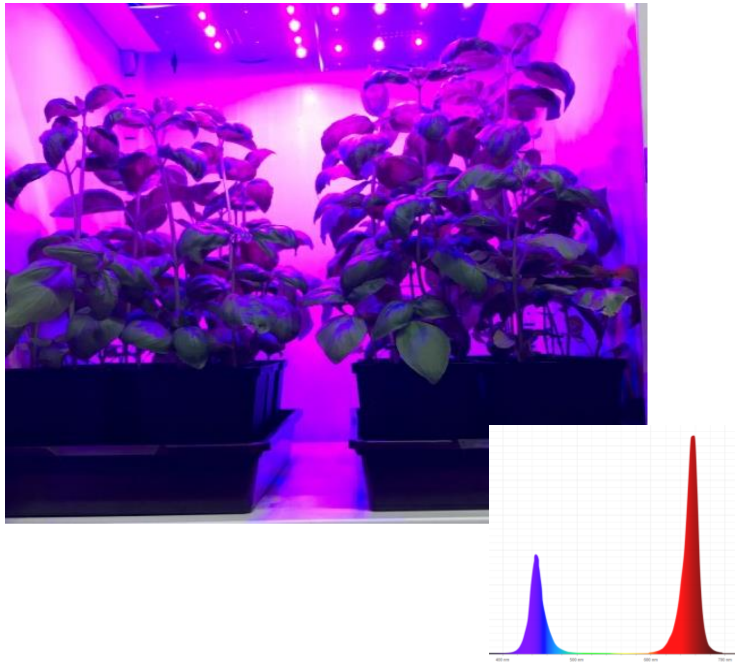
Order Code	Color	CCT
158303227A	Sunrise	2700
158303230A	Warm White	3000
158303240A	Moonlight	4000
158303250A	Daylight	5000
158303260A	Cool White	6000

- **Advantages**
  - low power Solution
  - adjustable spectrum
  - plant adapted spectrum
  - low thermal resistance
  - no need for expensive cooling solution
  - full spectrum & homogeneous illumination
  - size 2835 for color and 3030 for white LEDs
  - very high efficacy

CHARACTERISTICS OF HORTICULTURE LIGHTING

Optical Basics



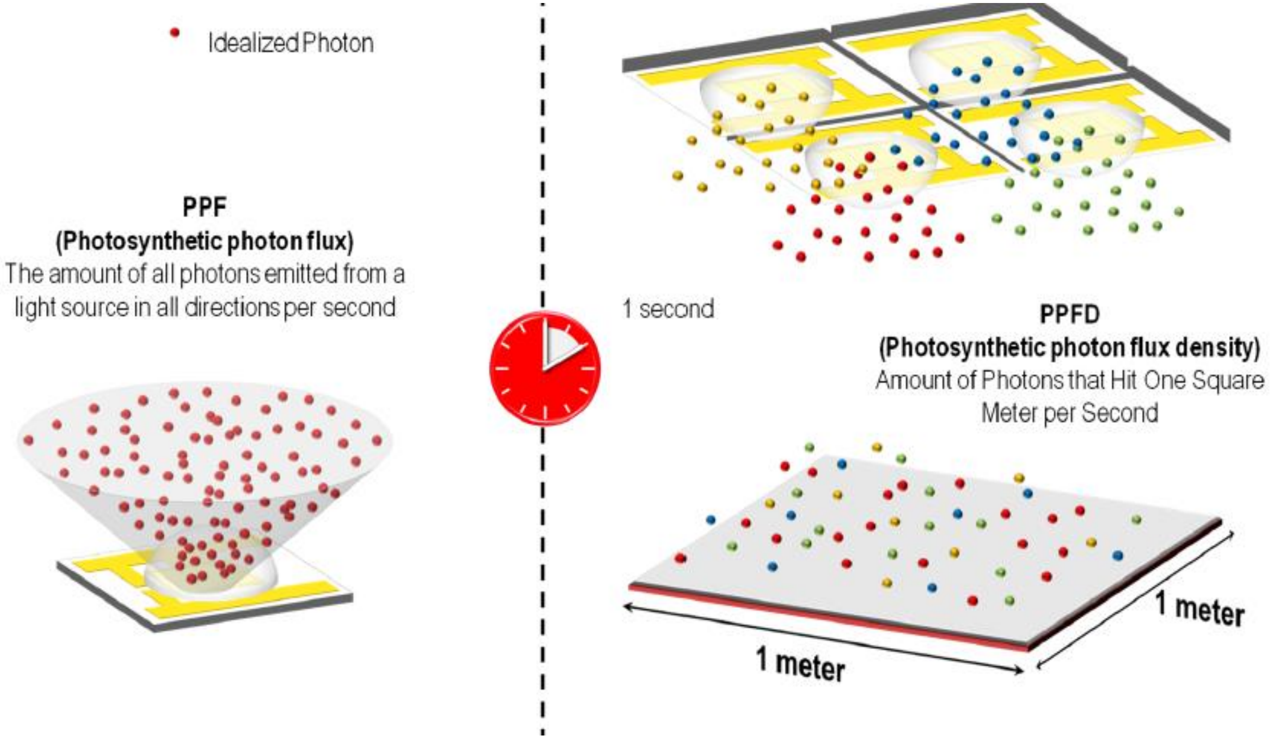


adjustable spectrum → effective light recipes to obtain optimal plant growth, development and quality

dynamic Lighting → e.g. vegetation stadium

CHARACTERISTICS OF HORTICULTURE LIGHTING

Electrical Basics



Source: Würth Elektronik eiSos

- **PPF (Photosynthetic Photon Flux)**
  amount of all photons emitted from lightsource in all directions per second
  - Unit: $\frac{\mu mol}{s}$
- **PPFD (Photosynthetic Photon Flux Density)**
  amount of Photons that hit one square meter per second
  - Unit: $\frac{\mu mol}{m^2\ s}$
- **Photon Efficacy**
  refers to how efficient a lighting system is at converting electrical energy into photons of PAR
  Unit: $\frac{\mu mol}{J}$

BENEFITS OF HORTICULTURE LEDS

Biological Advantages

- year around cultivation
- weather independent
- increase of plant quality parameter
- high harvest efficiency

Electrical Advantages

- high lifetime of LEDs
- high efficacy of LEDs
- lower maintenance costs
- lower operating costs

Environmental Advantages

- resource gentle
- space savings
- harvest on demand

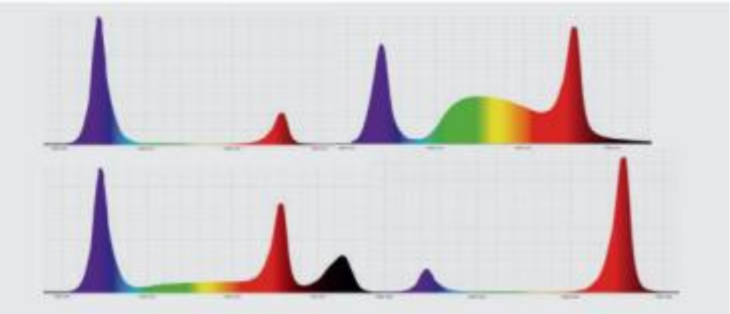
more yield + **less energy costs** → **fast return of investment and more profit for the grower**

the green revolution already started - vertical framing grows 24% every year

WHY WÜRTH ELEKTRONIK ?

- Our LEDs have a very high PPF Output
- We deliver the whole necessary spectrum, for all Horticulture Lighting application
- We help you to find the right LEDs (Mid Power/ High Power, Fullcolor/ Monocolor) for your unique application and target plant "qualityparameter"



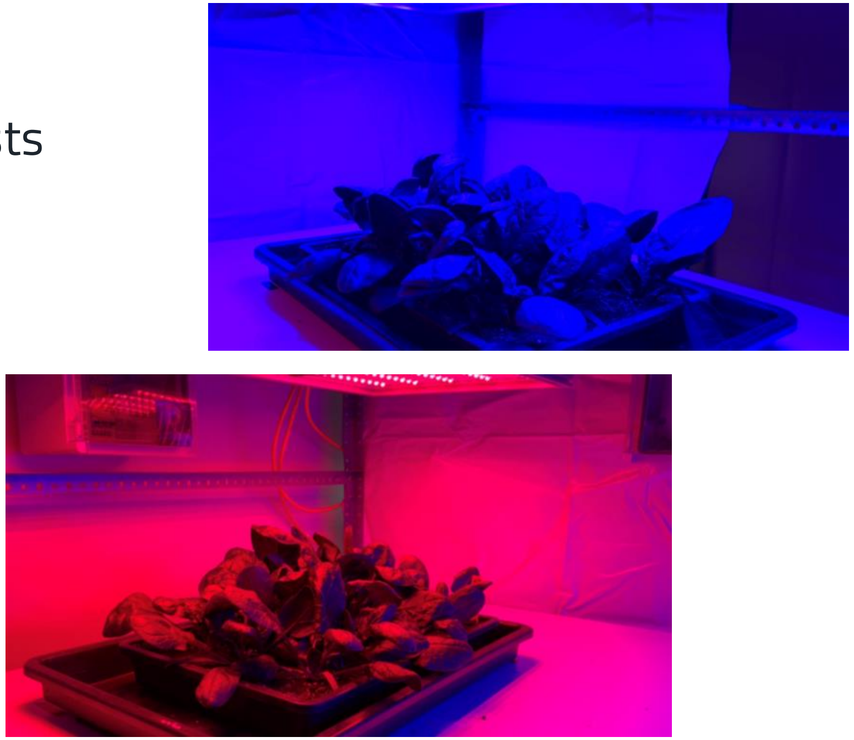


- Beside our already existing excellent service, we provide many more special Horticulture application support:

MORE THAN YOU EXPECT – WÜRTH ELEKTRONIK HORTICULTURE LEDS

- own plant scientists in team
- cooperation with universities
- know-how through own biological tests

basil under different light conditions



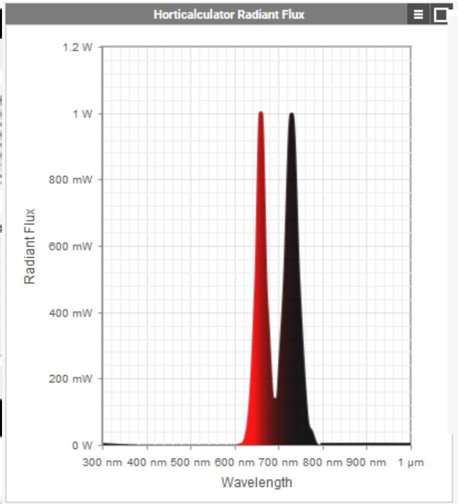
more than twice amount of flavonols after 8 days

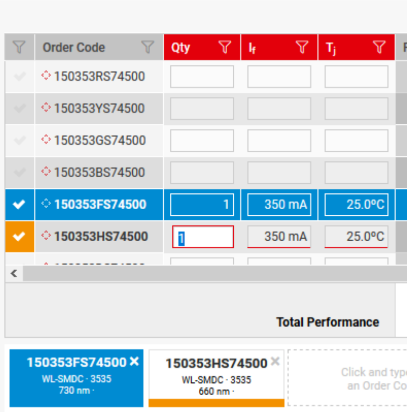
induction of flowering in the winter/14% more flowers compared to other light sources

we do research to find optimum light recipe for different quality parameter of the plant

MORE THAN YOU EXPECT – WÜRTH ELEKTRONIK HORTICULTURE LEDS

- Spectrum Design Tool Horticulator
- Horticulture Application Notes
- Lighting Development Kit





Source: Würth Elektronik eiSos

Order Code 150001

WEillumination App

Source: Würth Elektronik eiSos

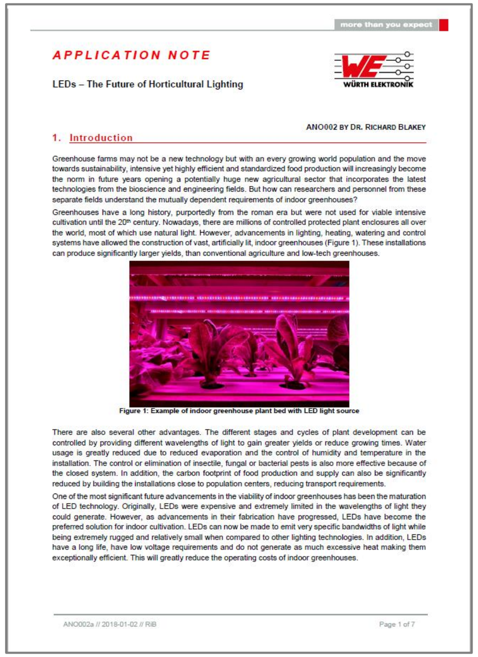
APPLICATION NOTES

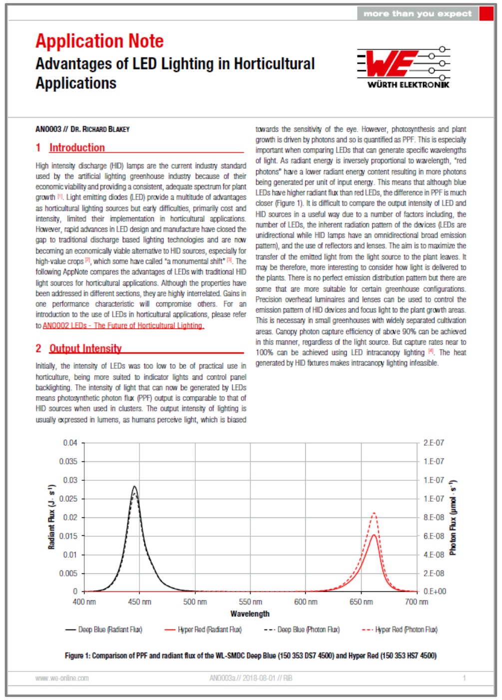
- **Three different Application Notes**

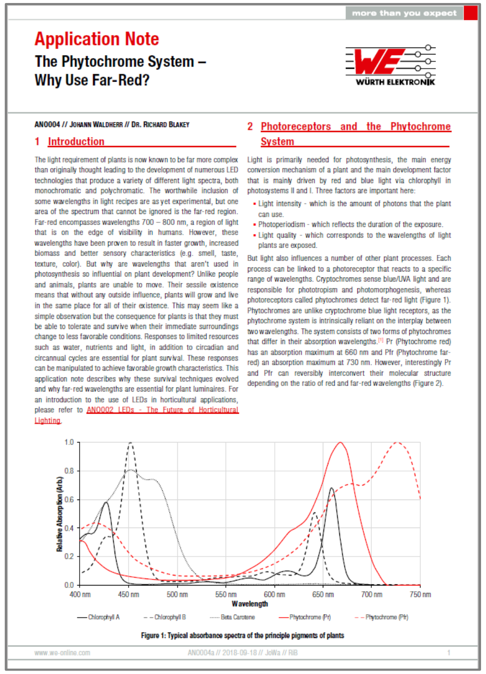
ANO002
LEDs- The Future of Horticultural Lighting

ANO003
Advantages of LED Lighting in Horticultural Applications

ANO004
The Phytochrome System
Why use far-red?







Source: Würth ElektronikeiSos

www.we-online.com/leditgrow

SUMMARY

- We are faced with more and more challenges. climate change, growing world population, loss of farmland and the need for a better use of resources - to solve these challenges, Würth Elektronik is actively accelerating the green revolution by supporting the development of the farm of tomorrow to ensure sustainable food production.