Light use by tomato under HPS and LED lighting systems

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Voor een bloeiende zaak

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Kas als Energiebron

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Aims

Aim:

- Increase production in tomato
- Increase energy efficiency
- Learn to grow tomato under LEDs

Experimental design

- Race Sunstream

- 4 treatments, equal light intensity,
- (170 µmol/m^2/s), optimal growth
- HPS (100%),
- LED-top (100%),
- Hybrid (50% HPS, 50% LED-top),
- Hybrid (50% HPS, 50% LED-interlighting)



Hybrid

Interlight

LED

HPS

PHILIPS
sense and simplicity

lemnis
lighting
a tendris company

Agro Energy
Hét loket voor al uw energiezaken

provincie ZUID HOLLAND

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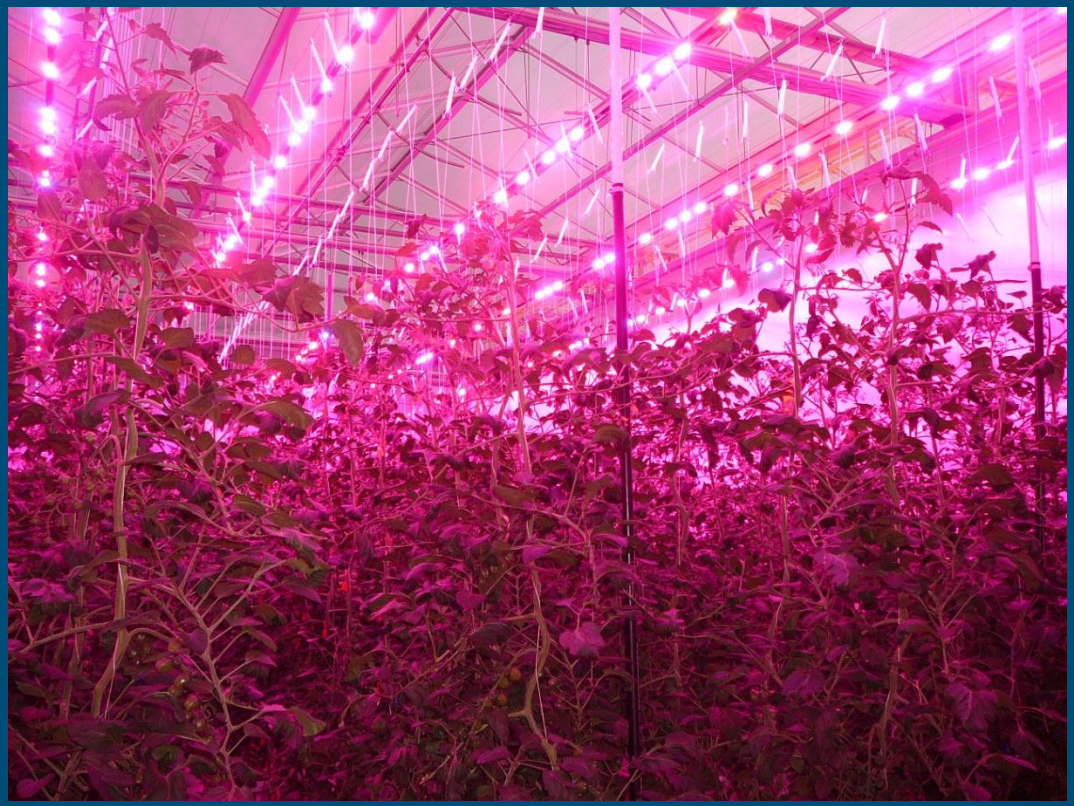
Interlighting

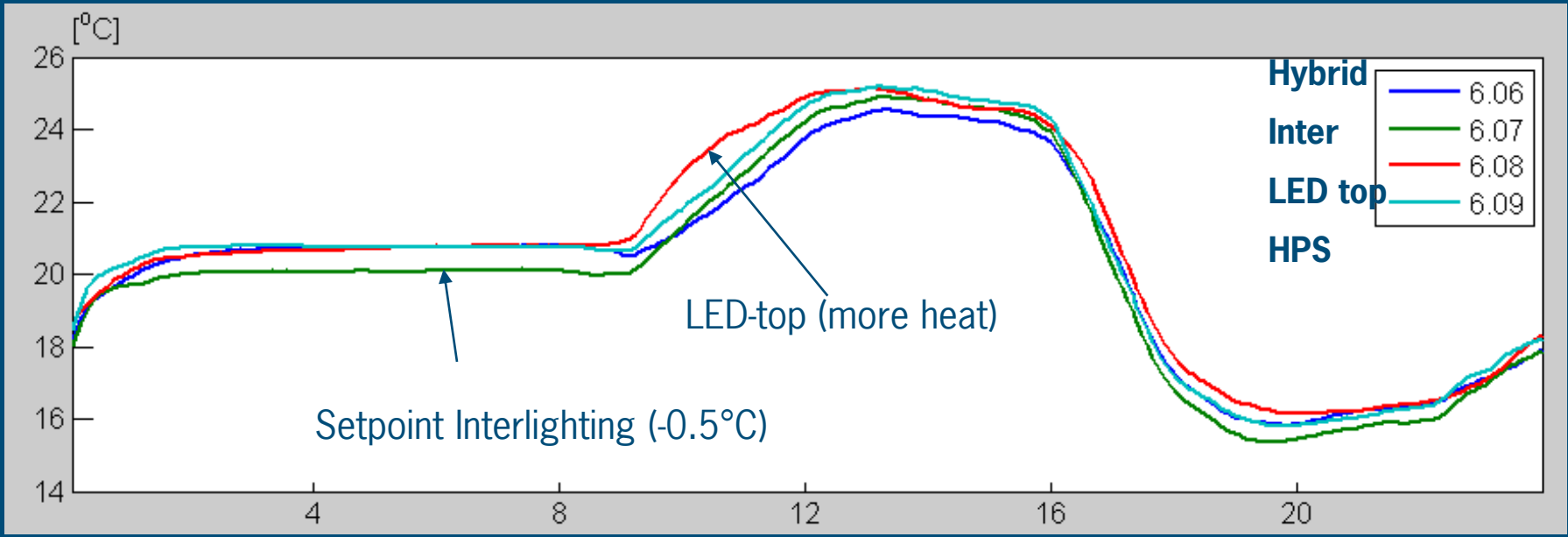
LED-top



Many measurements

- Crop grew well, weekly control growers
- Climate (greenhouse + plant temperature)
- Crop morphology (leaf) length, LAI, SLA)
- Photosynthesis and transpiration
- Production, truss flowering, setting, split truss, taste, shelf life
- Energy use

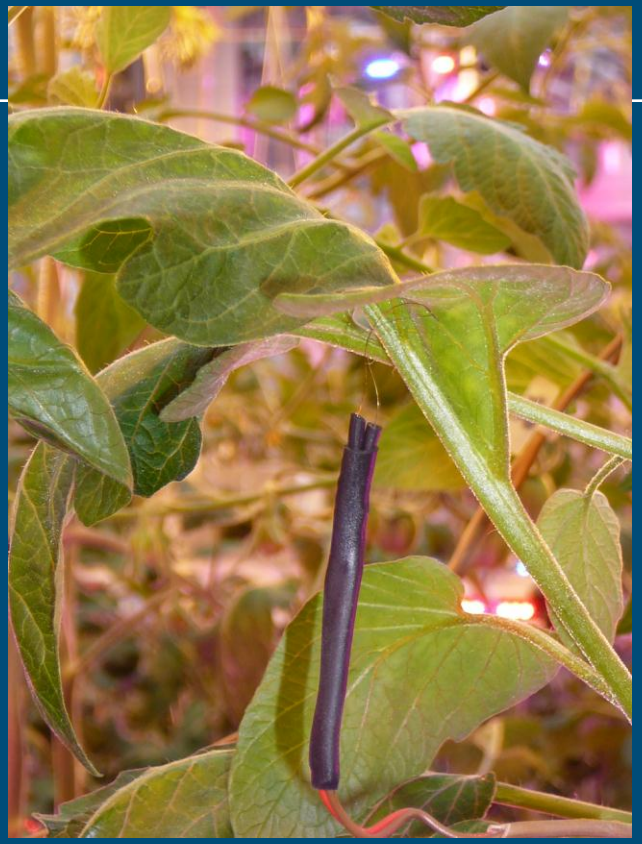
Greenhouse climate – mean day



Interlighting acts as minimum pipe (ca. 35°C), thus less heating necessary

Crop under LED-top too cold in the morning, thus more heating is necessary

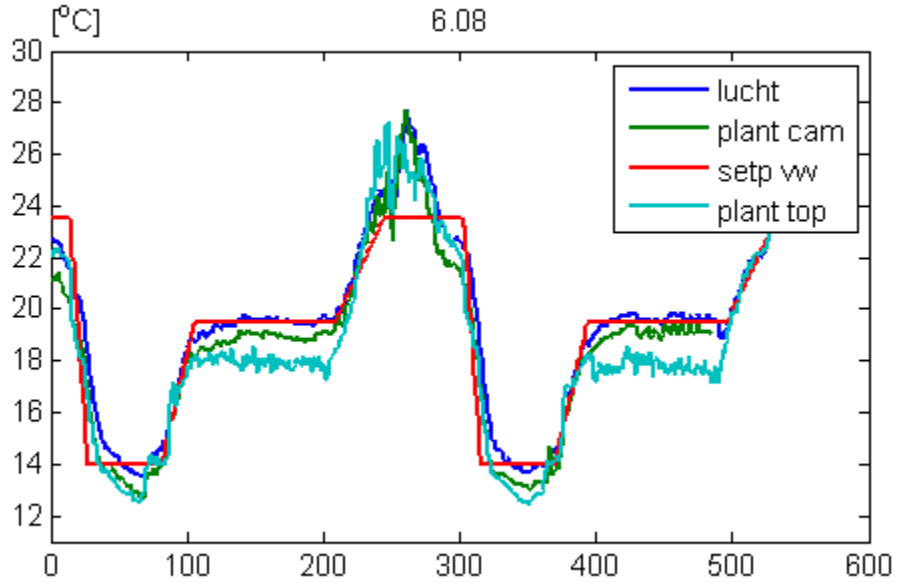
Leaf temperature



thermocouple

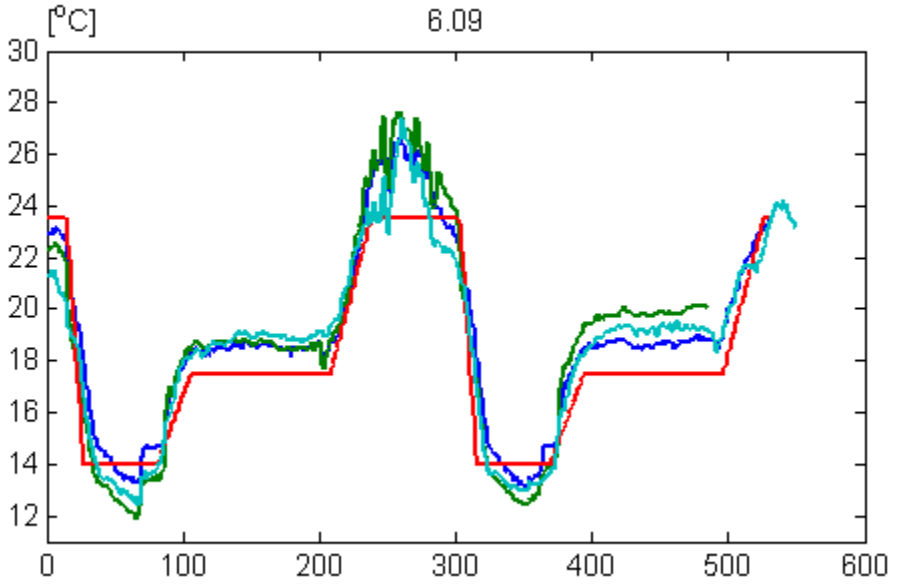
Leaf temperatuur – IR camera + thermocouples

LEDs-top



Leaf temp LED < air temp

HPS



Leaf temp HPS > air temp

Water uptake (16 jan t/m 4 febr)

	% uptake irt HPS	Daily T (°C)	Pipe T (°C)
hybrid	-22	19.5	39
interlighting	-15	19.0	20
LED-top	-17	19.4	43
HPS	-	19.2	32

Crop parameters to March (destructive)

	Leaf length (cm)	Leaf DS %	LAI (m^2/m^2)	SLA (cm^2/g)
Hybrid	43	9.6	1.8	150
Interlighting	44	9.4	2.2	158
LED-top	44	10.6	1.9	143
HPS	39	9.4	2.1	168

Spectral effects?

Spectral effects?

More movement under HPS in the afternoon:

-spectral effects?

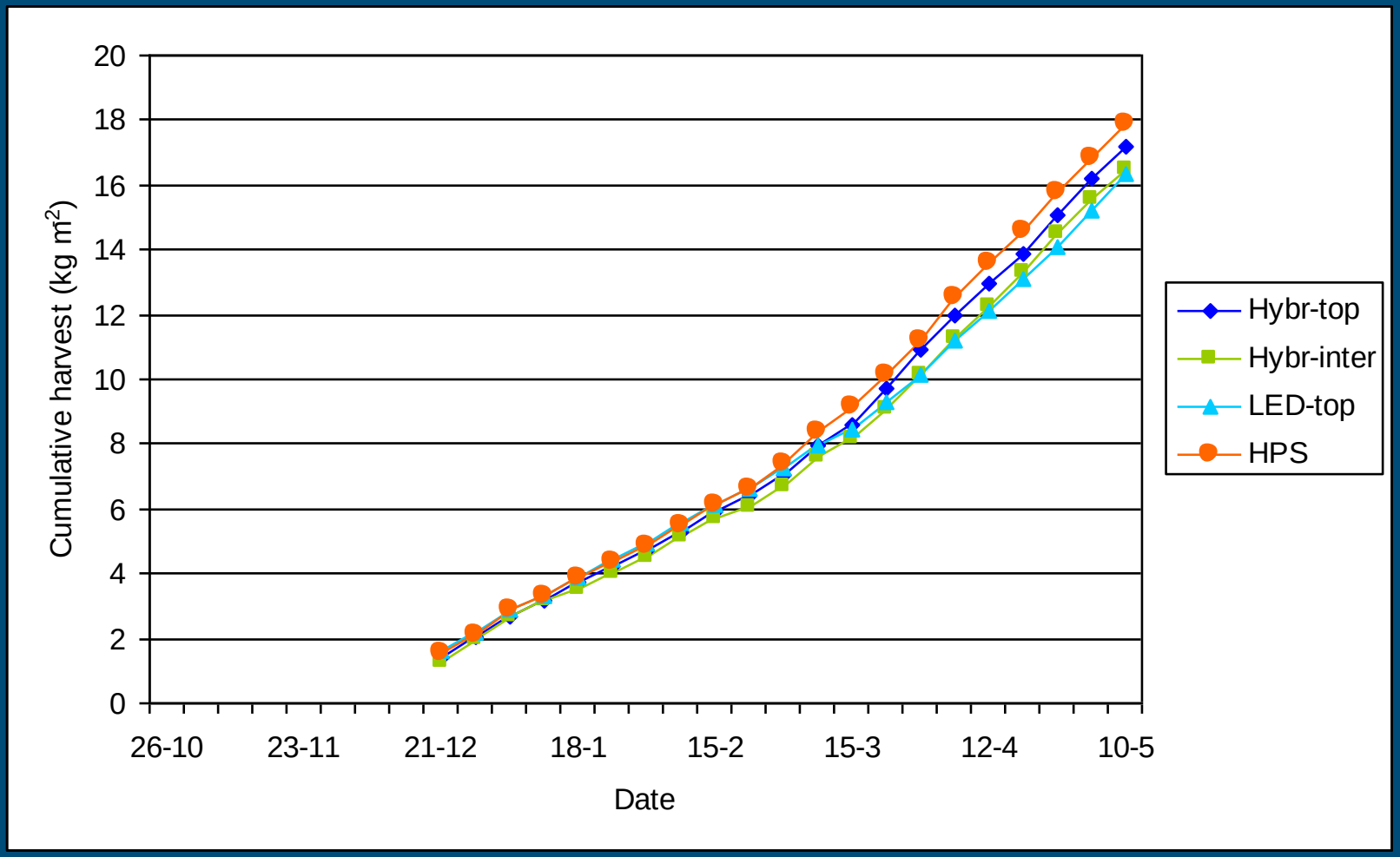
-turgor effects?

Production t/m June 21st

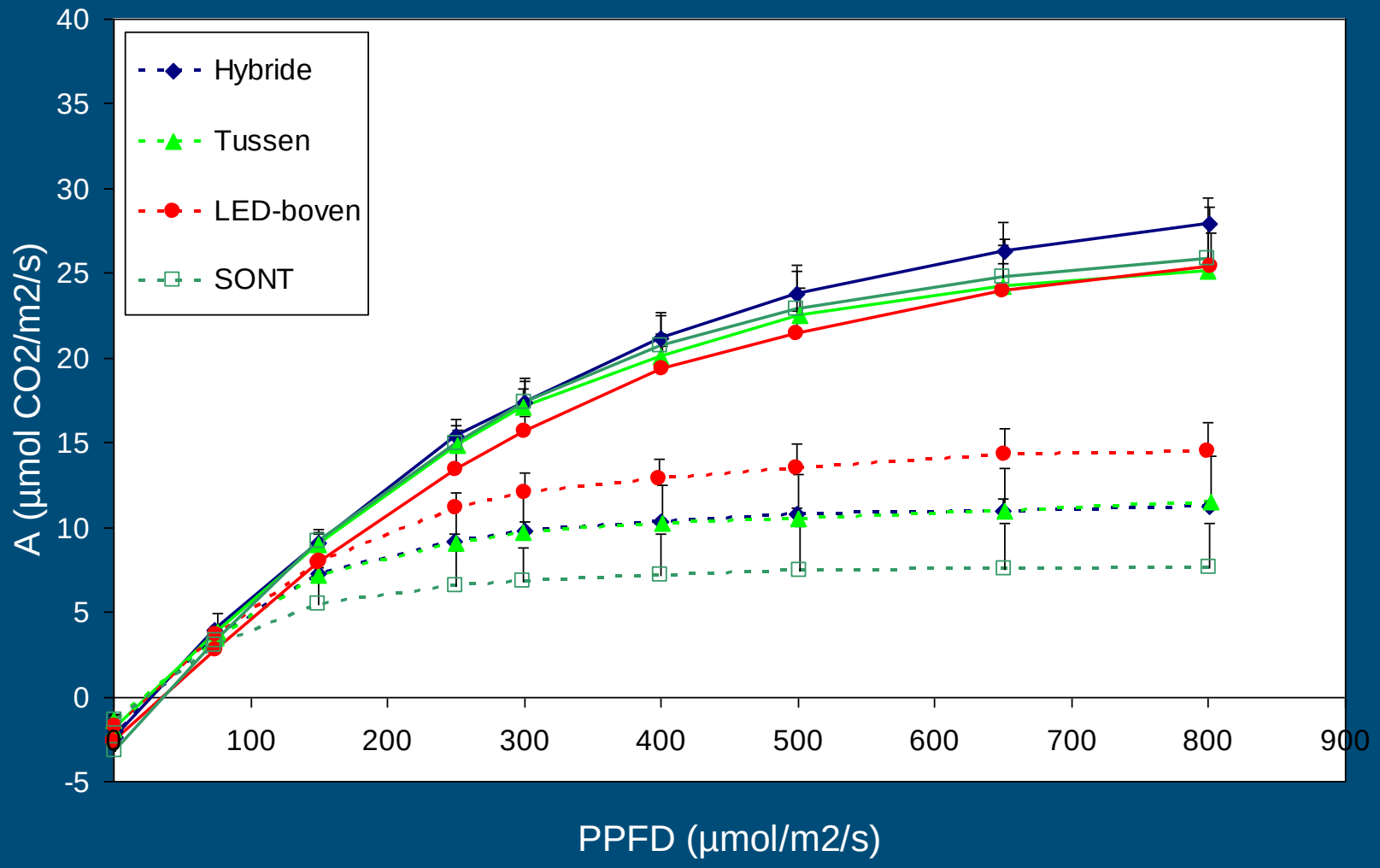
	Flowering truss	Total set fruits	Prod. kg/m^2	Prod. %	Split truss %
Hybrid	37.4	1466	25.2	- 2.7	10.5
Inter-lighting	37.3	1433	24.3	- 6.1	11.5
LED-top	36.9	1472	24.5	- 5.1	9.7
HPS	38.1	1498	25.9	-	10.4

Split truss

Cumulative production (kg/m2)



Photosynthesis capacity - winter



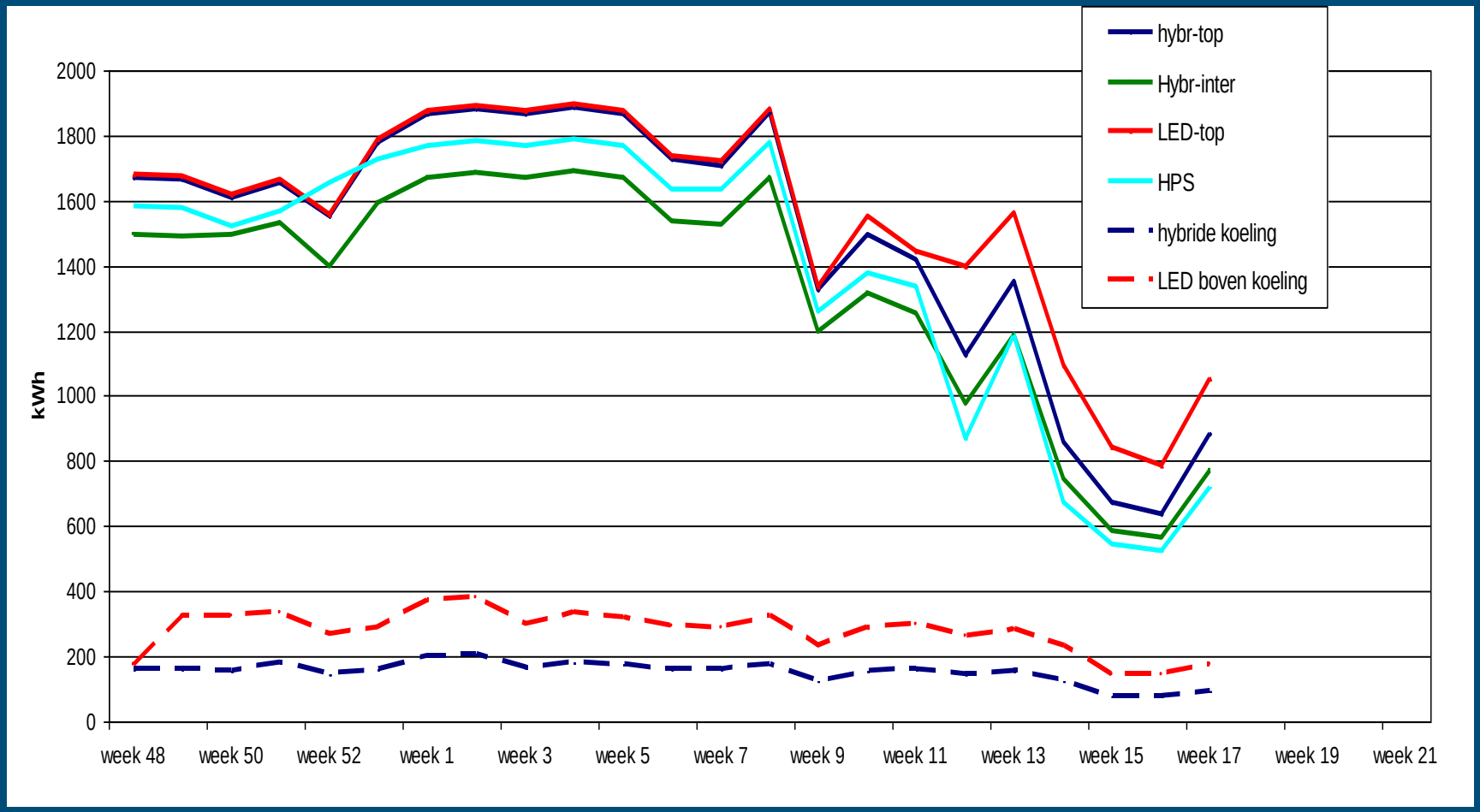
Fruit quality

- HPS: slightly higher refraction and % sap
- No clear differences in taste
- No clear differences in % dry matter
- Mean shelf life 16 days

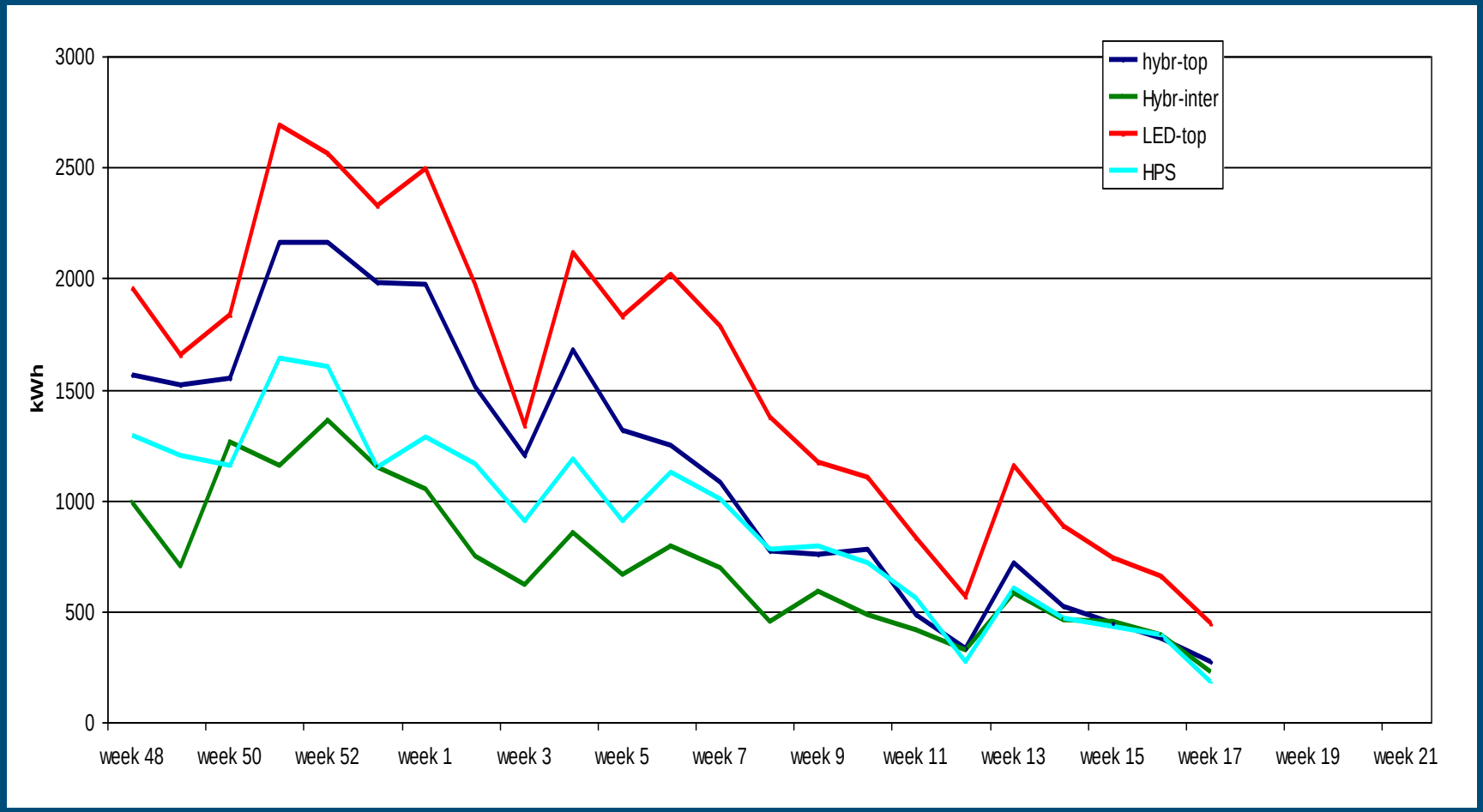
Energy en LEDs in our experiment

- 2 types of LED light systems
  - Top lighting – (water)cooling required, heat exchanger, costs extra electrical energy
  - Interlighting – (air)cooled, yields extra (heat)energy in greenhouse

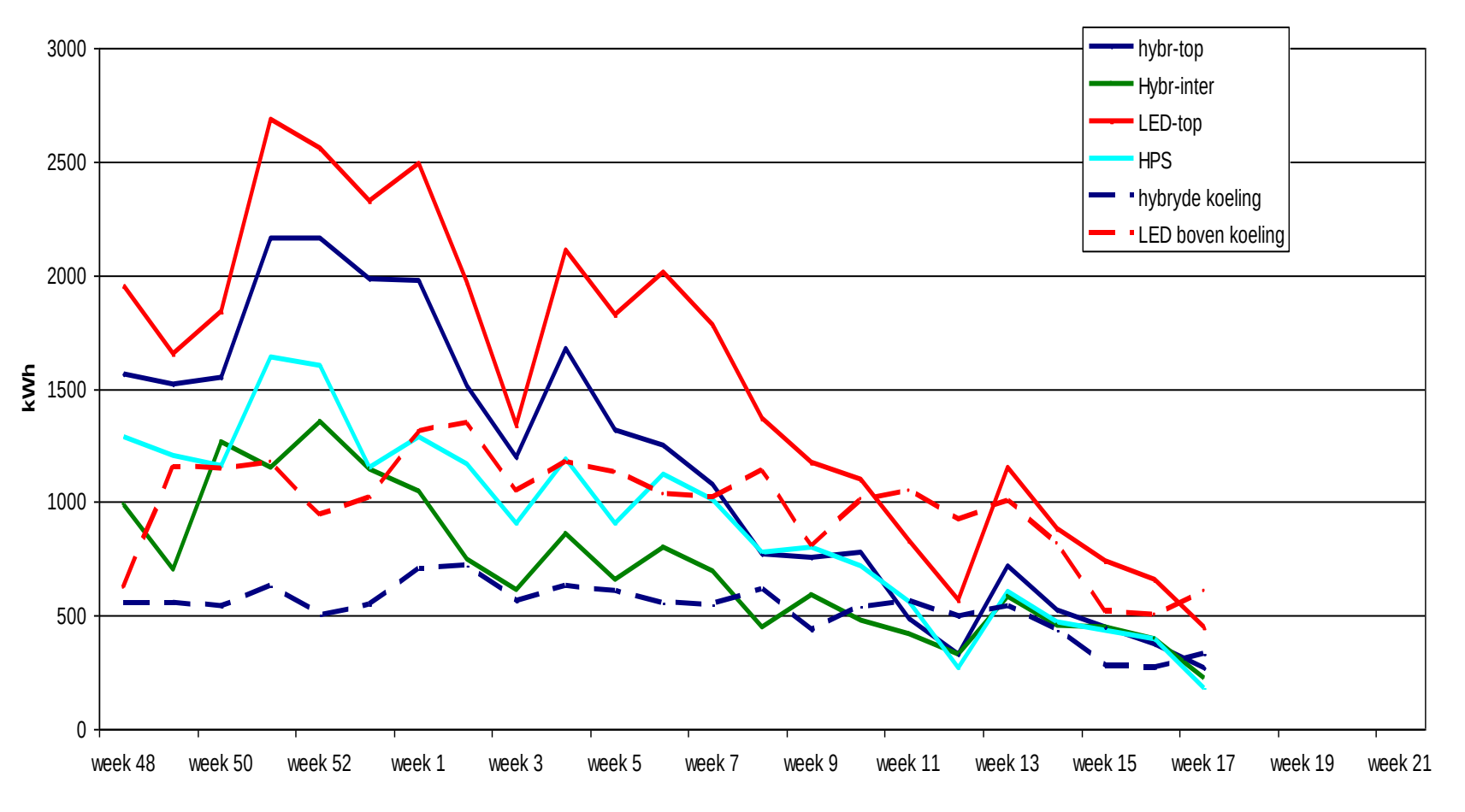
Energy input for lighting



Energy input for heating



Energy input for heating + cooling LEDs



Some adaptations in the experiment

- LED-top higher greenhouse temperature necessary (more heating) and more screening - compensation for the lower head temperature
- Interlighting is hung quite high:
  - At low (sun)light levels, the head requires enought light
  - Otherwise too many burnt leaves
- Interlighting = ‘continuous’ mimimum pipe
- Later on - less heat (+ cooling) from LEDs might be positive?!

What have we learned?

- LEDs can take a heavier (fruit) load than HPS
  - Higher plant density, extra fruit, extra stem
- Each lighting system requires a different heating regime
  - Less heat with interlighting
  - More heat, more screens with LEDs-top
- Top of crop requires sufficient light for development (interlighting system needs to be hung higher
  - Light loss above
- HPS crop was pushed in its production (higher production, thin leaves, aged faster)

- We have learned to grow with various LED lighting systems
- Development of LEDs still continues……

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Innovations in Horticulture

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