

Phototrophic microalgal EPA/DHA production

A Techno-economic analysis

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OPEN PONDS / RACEWAYS



Seamiotic, Israel

10/02/2

Tubular PBR (flat horizontal)

Biotopic, Huelva



AZU flat panel PBR



Flat panel PBR



ProviApt, Belgium

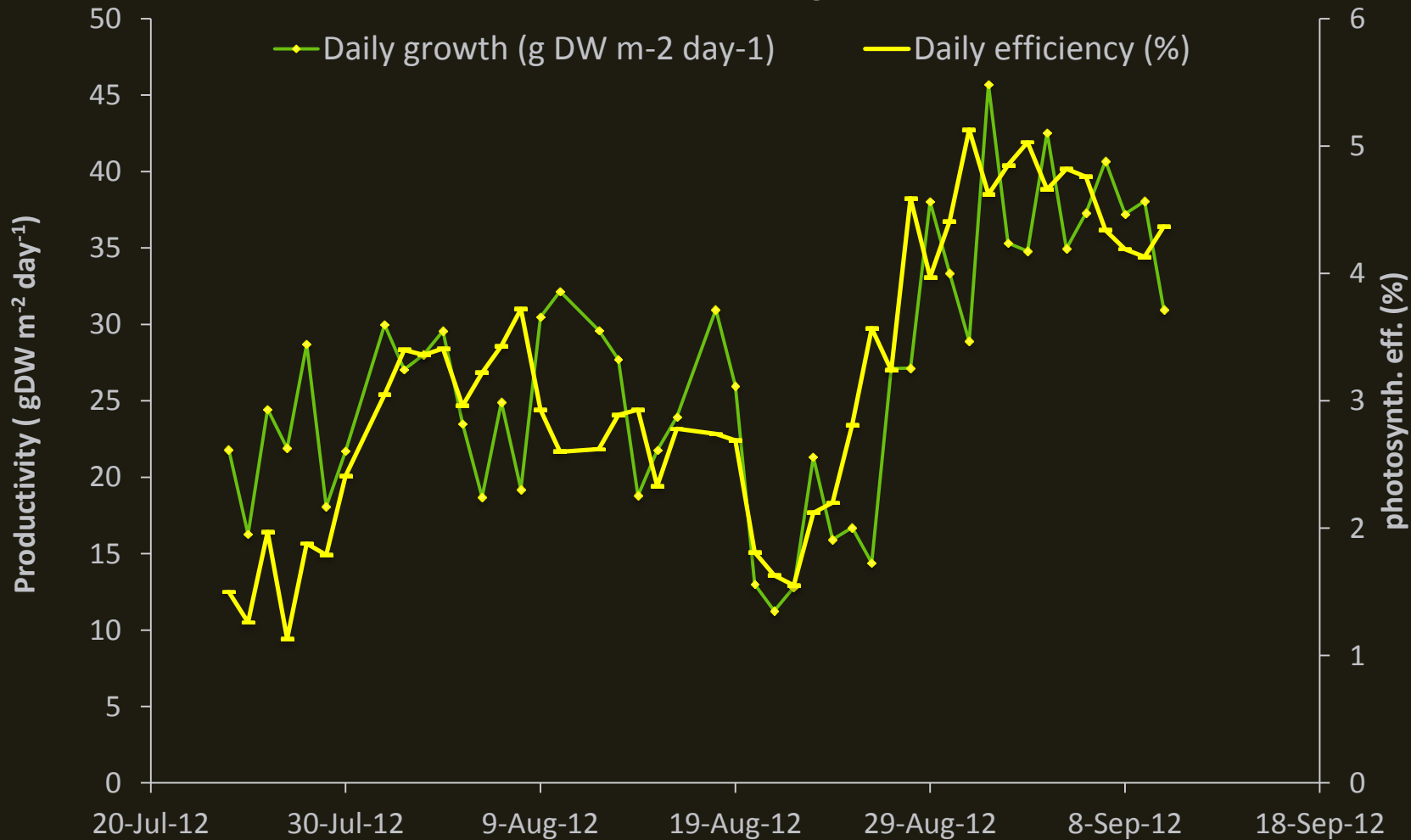
Proviron flat panel PBR



Proviron flat panel PBR

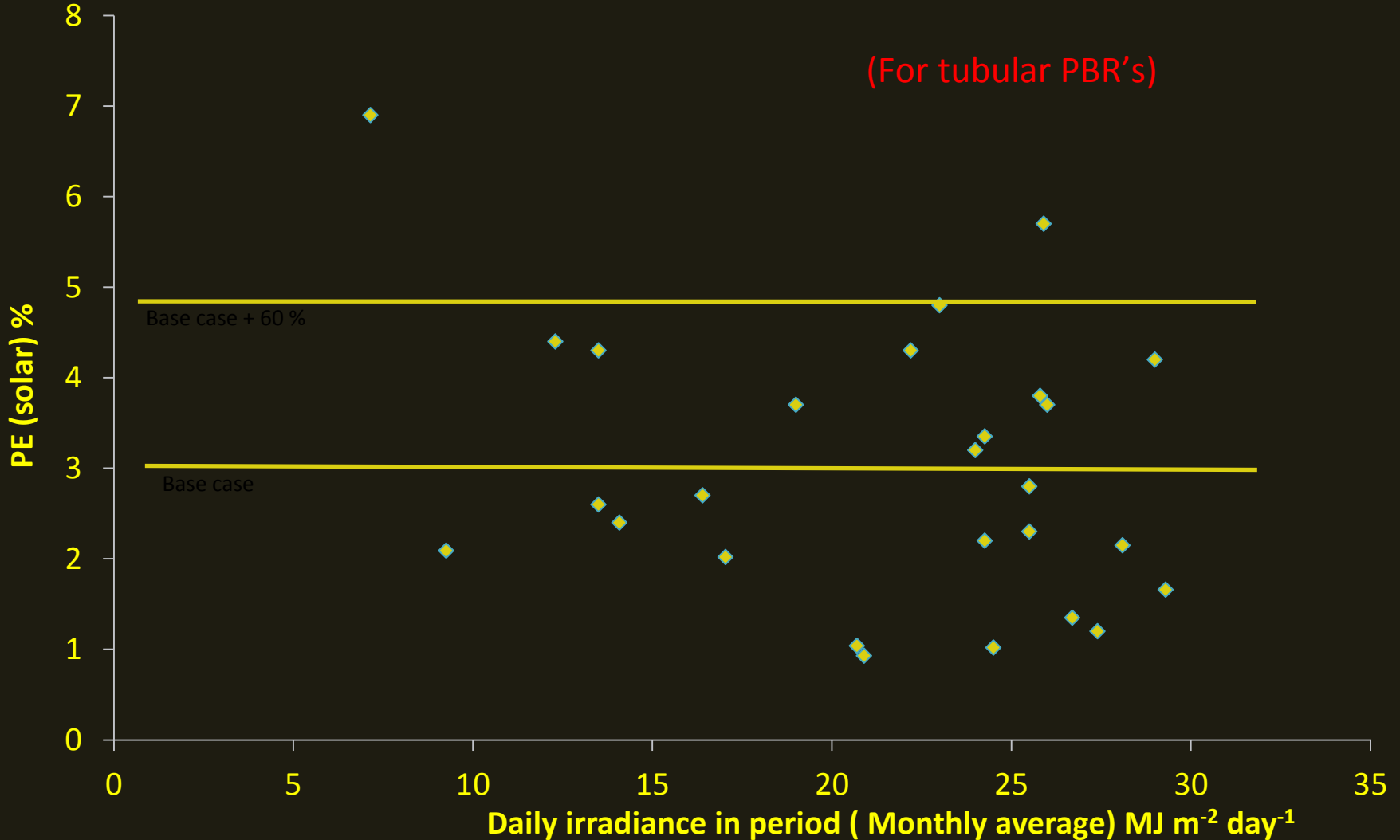


CO₂-absorption based PE and productivity in a flat panel PBR (Proviapt)

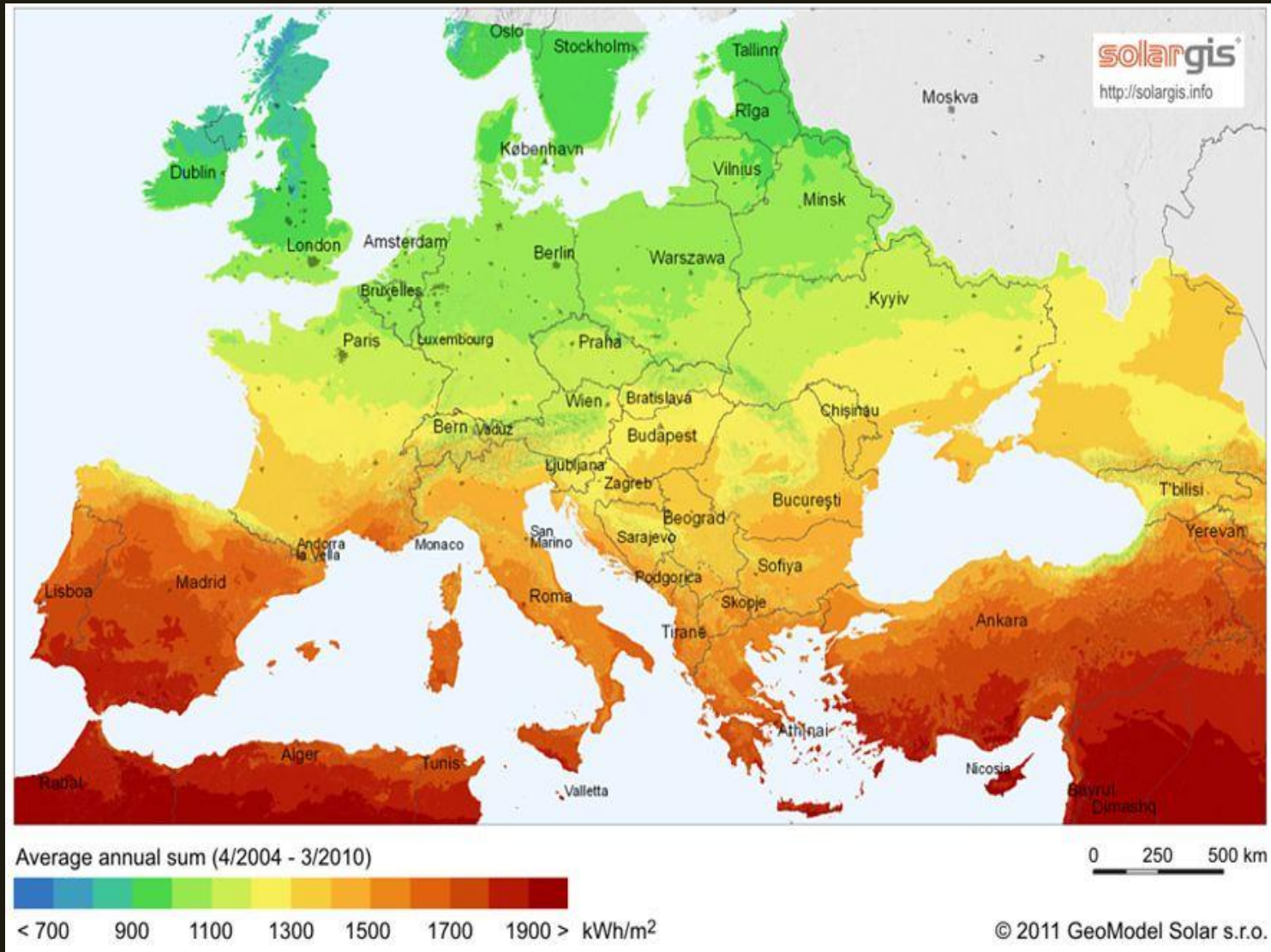


The photosynthetic efficiency?

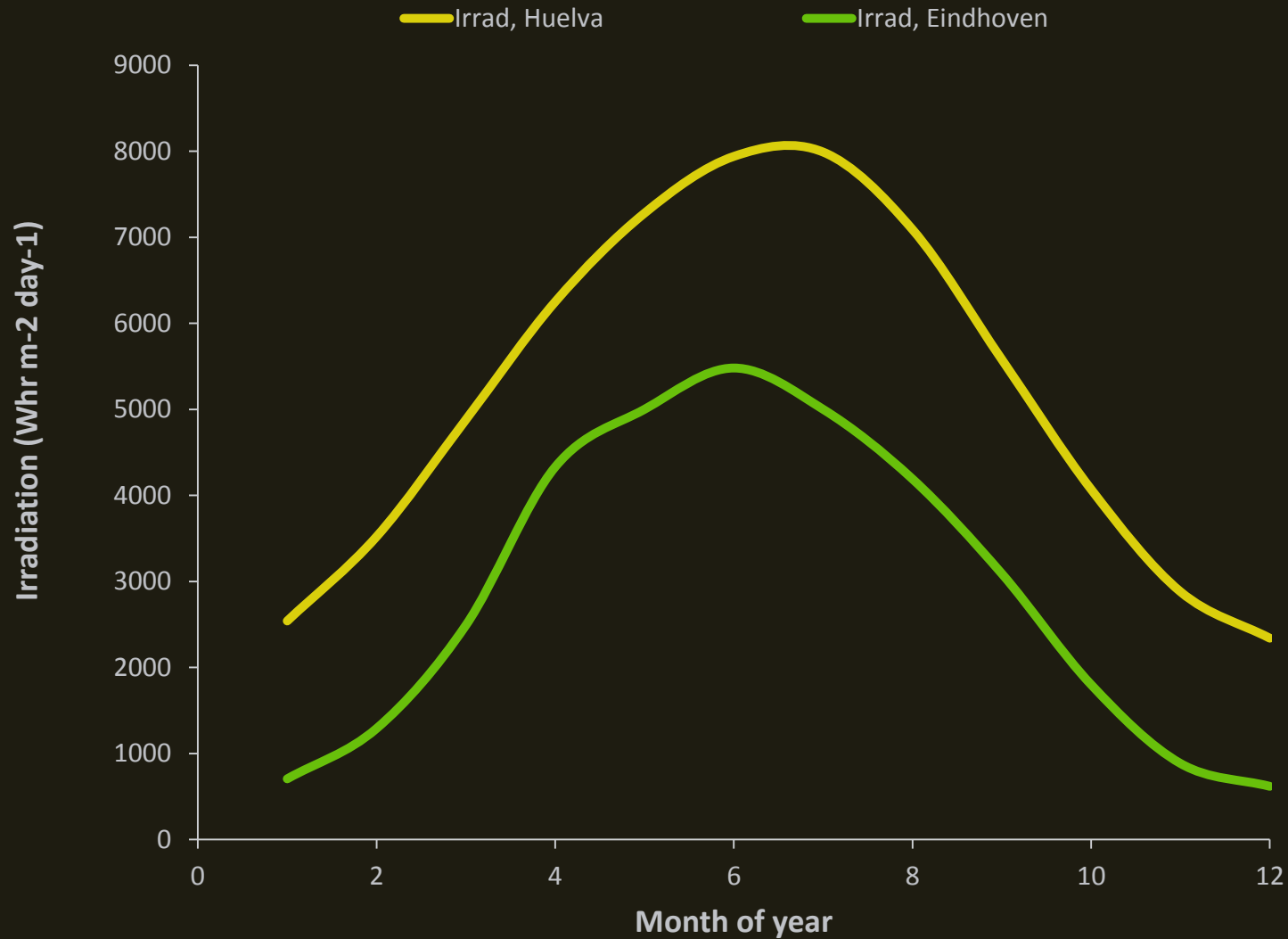
(For tubular PBR's)



Irradiation, europe



Irradiation – north/south Europe



Land, interests and power

COUNTRY	AREA REQUIRED	PURCHASE PRICE	TOTAL ANNUAL COST
	Ha	€ / m ²	€
NETHERLANDS	130	38	2,500,000
SPAIN	130	23	1,500,000

Interests: 5 %

Powercost: .05 € Wh⁻¹

EPA/DHA content in Isochrysis (autotrophic microalga)

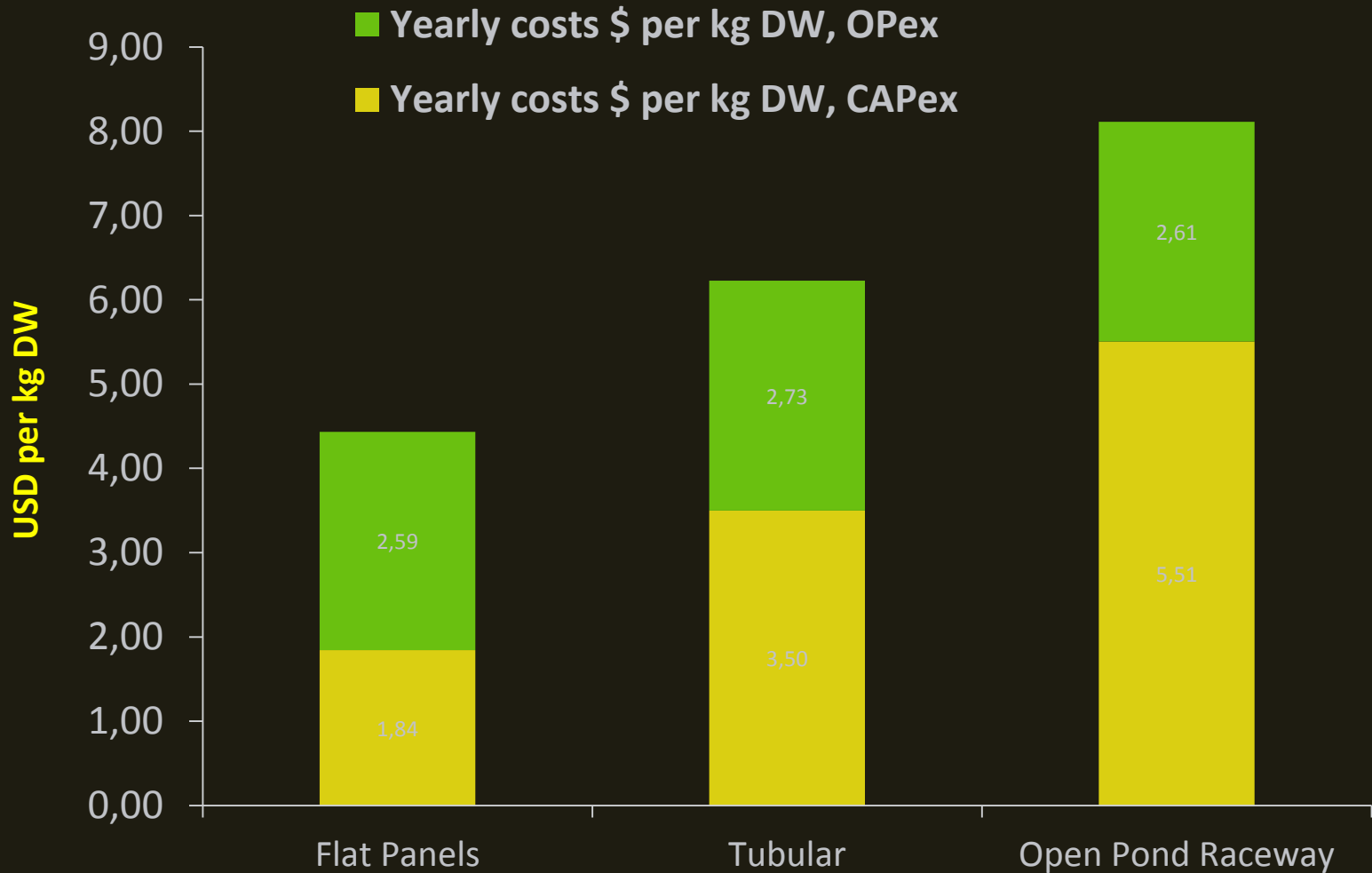
Light-path length, (cm)	30
Areal volume (L m ⁻²)	150
% EPA	4.78 ± 0.32
% DHA	2.21 ± 0.14

Zhang, C. W. and A. Richmond (2003). Sustainable, High-Yielding Outdoor Mass Cultures of Chaetoceros muelleri var. subsalsum and Isochrysis galbana in Vertical Plate Reactors. Marine Biotechnology 5(3): 302-310.

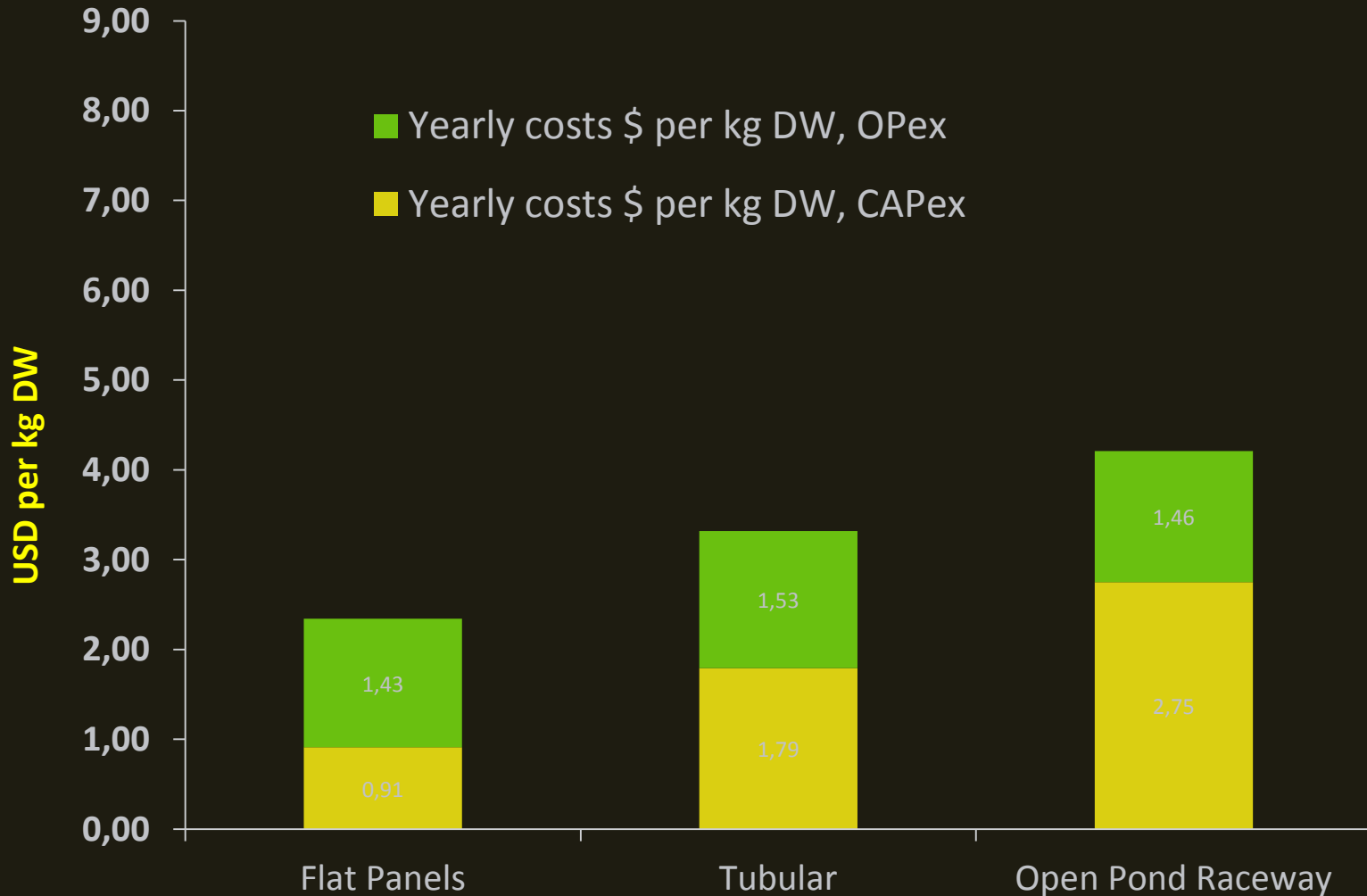
Assumptions, tubular PBR, NL

Photosynthetic efficiency	3	%
Annual production per ha per year	14.61	
Annual production per ha per year	43.83	ton/ha ground/yr
Total production per year	4383	ton/yr
CO2 fixation (ton CO2 / ton Biomass)	1.8	
Share of EPA/DHA	0.06	
EPA/DHA production total per year	350.64	ton/yr
Interest rate	5	%
Depreciation	10	%
Production area	100	ha
Total land area	1.3	ha
Land price (rent per m2 per year)	2	EUR/m2
Power cost	0.05	€ / kWh
	47,869,32	
Power consumption	6	kWh
Labor, technicians	6	person
Labor, engineers	1	person
Wage, technicians	35000	EUR/year
Wage, engineers	50000	EUR/year
Payroll charges	25	% of wage
		Cost per EUR of capital
Maintenance	0.04	equipment

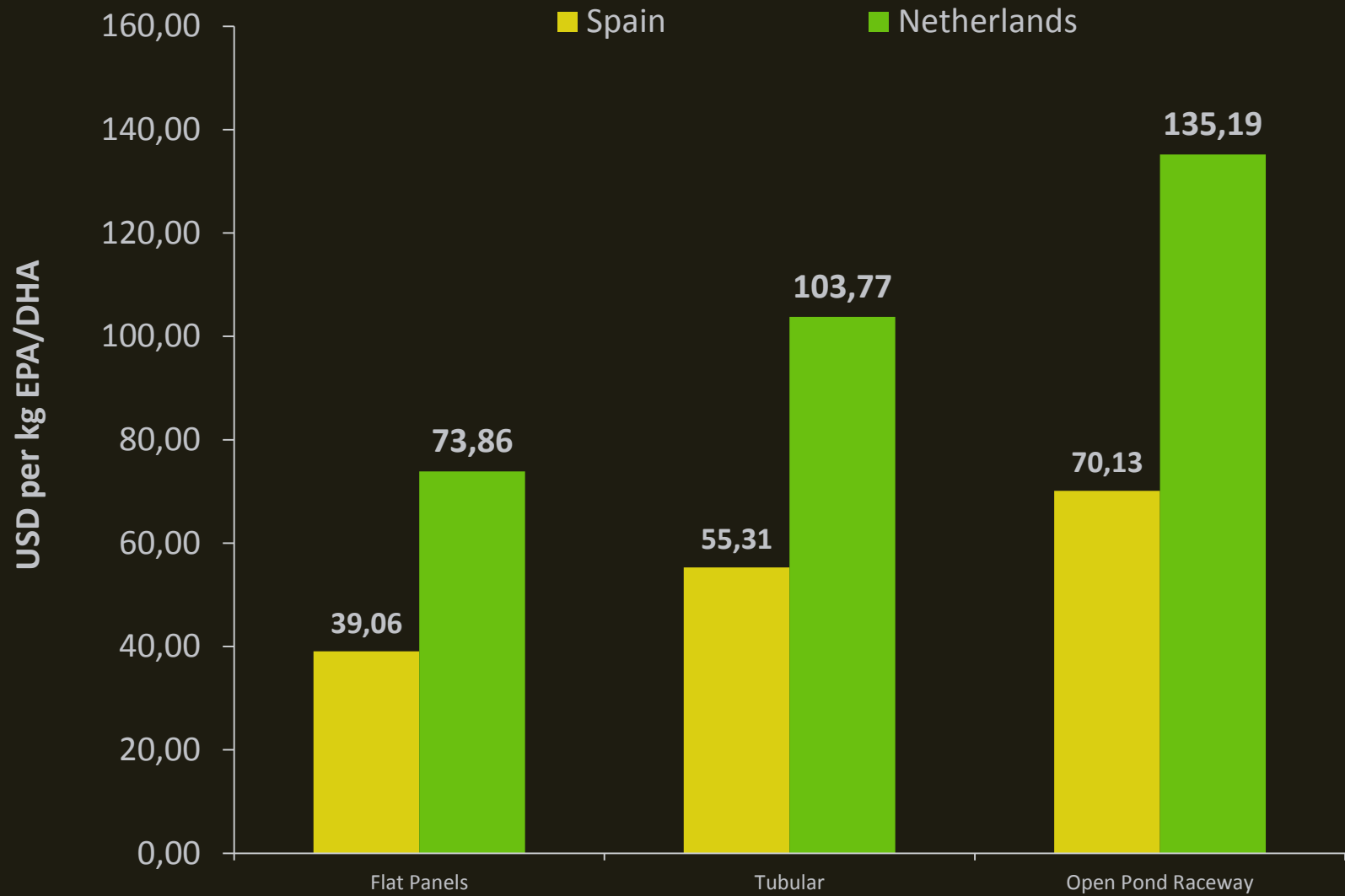
Base case , break down of costs (per kg DW) Netherlands)



Base case , break down of costs (per kg DW) (Spain)



Base case



Effect of individual factors (Spain)

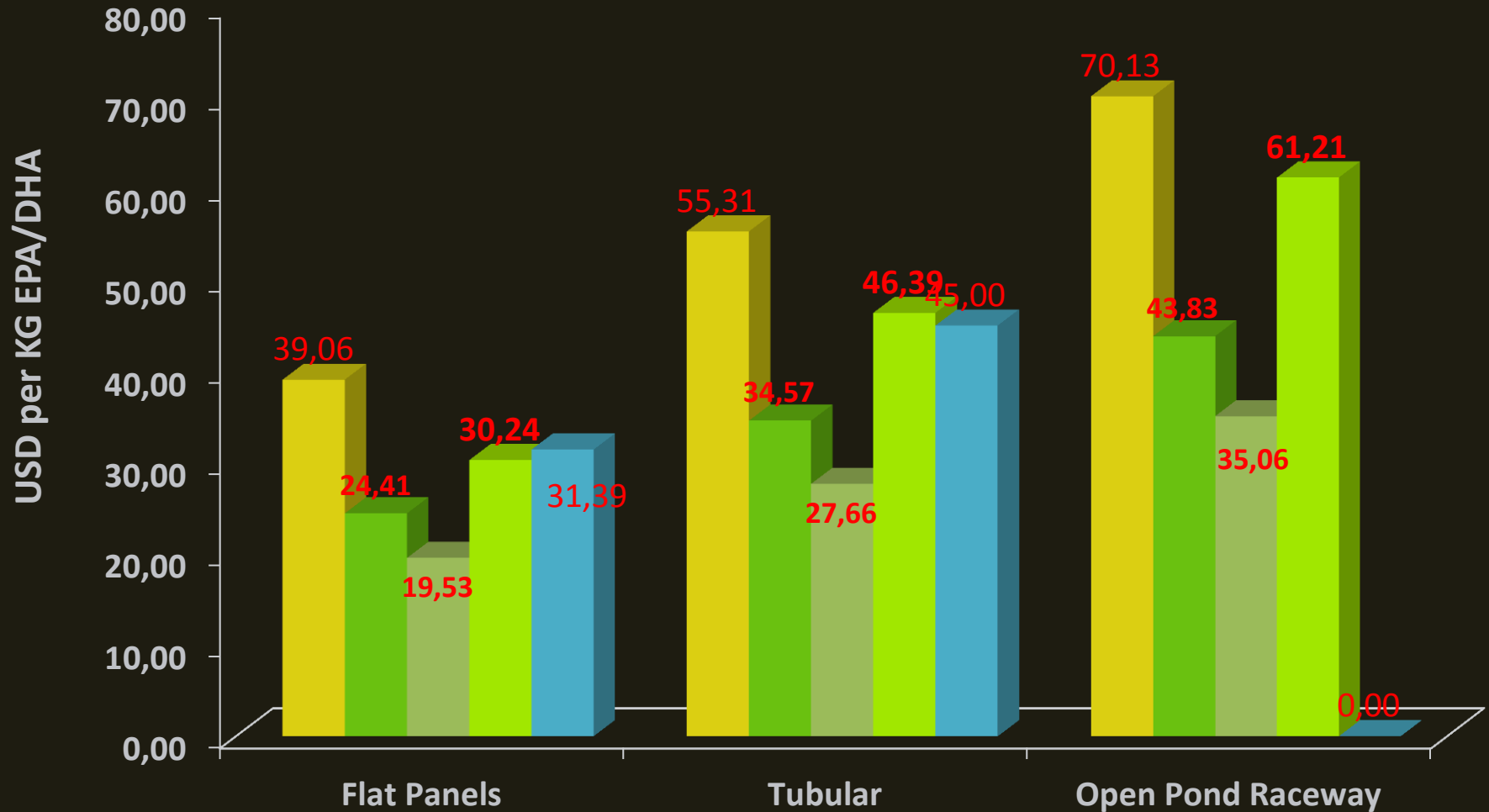
■ Base case

■ increased PE 60%

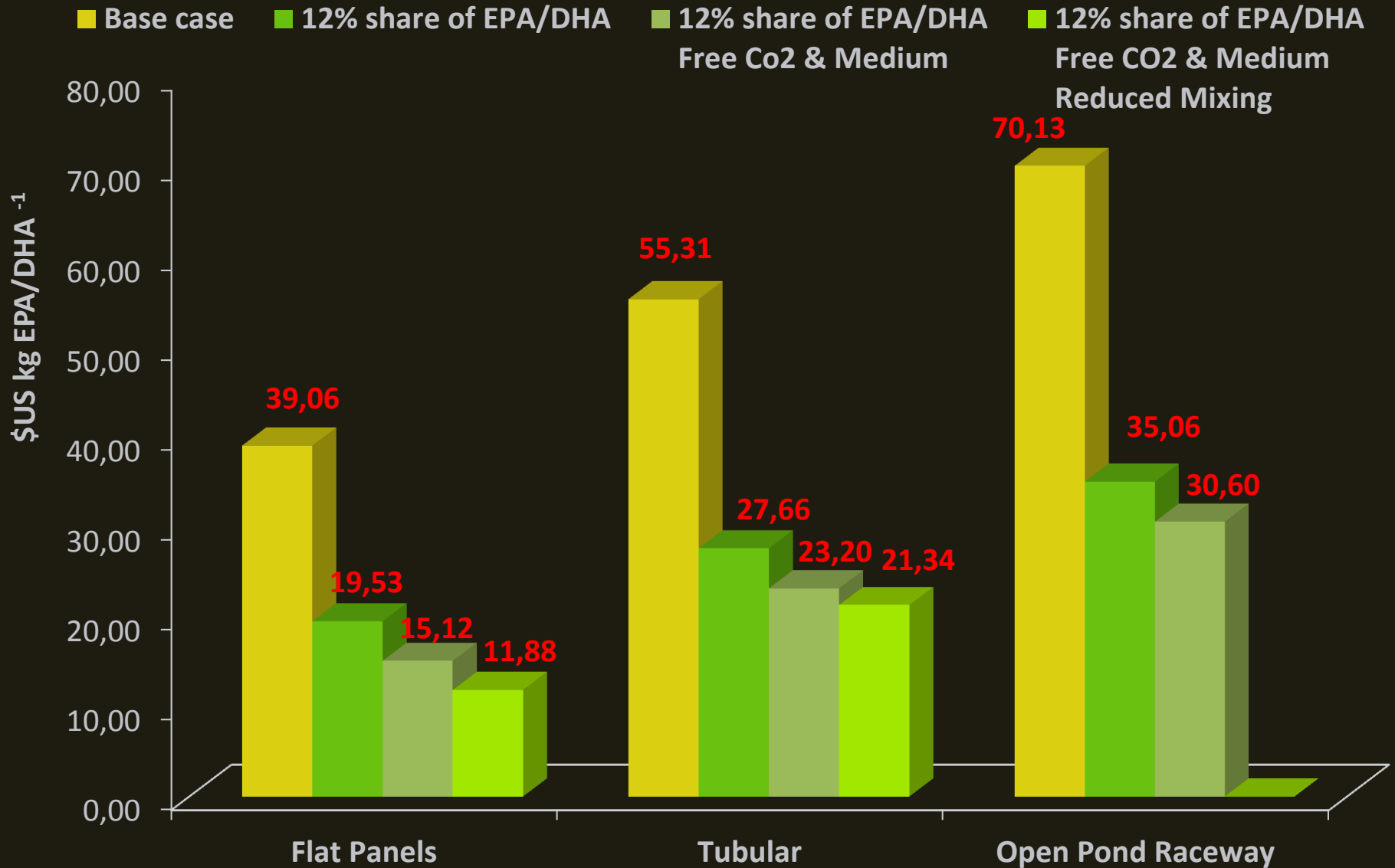
■ 12% share of EPA/DHA

■ Free Co2 & Medium

■ Reduced mixing

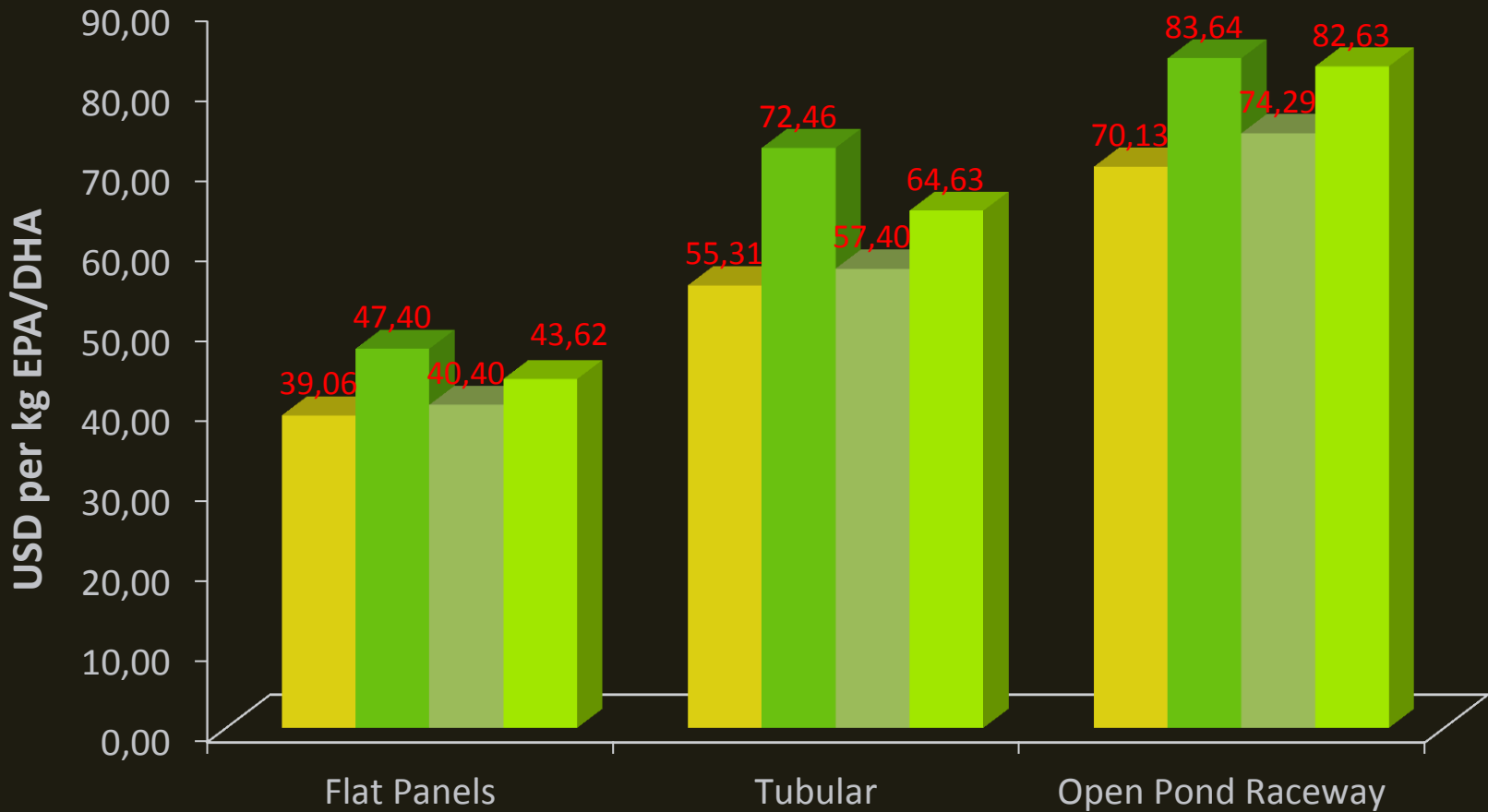


Best case – combined factors (Spain)



Worst cases –individual factors, Spain

■ Base case ■ Interest rate 15% ■ Land cost +50% ■ Fixed capital +30%



Conclusions

- Flat panels show lowest production costs of the 3 technologies with USD 22.5 / kg EPA-DHA in south Spain and 42.5 in the Netherlands (base case)
- Production costs in south Spain are less than 50% of the costs in Netherlands with all technologies
- *Reasonable optimizations* suggest potential production cost of EPA/DHA of USD 11.88 kg⁻¹