
YAMAHA
Touching Your Heart


GREENFUEL


THÖMEN
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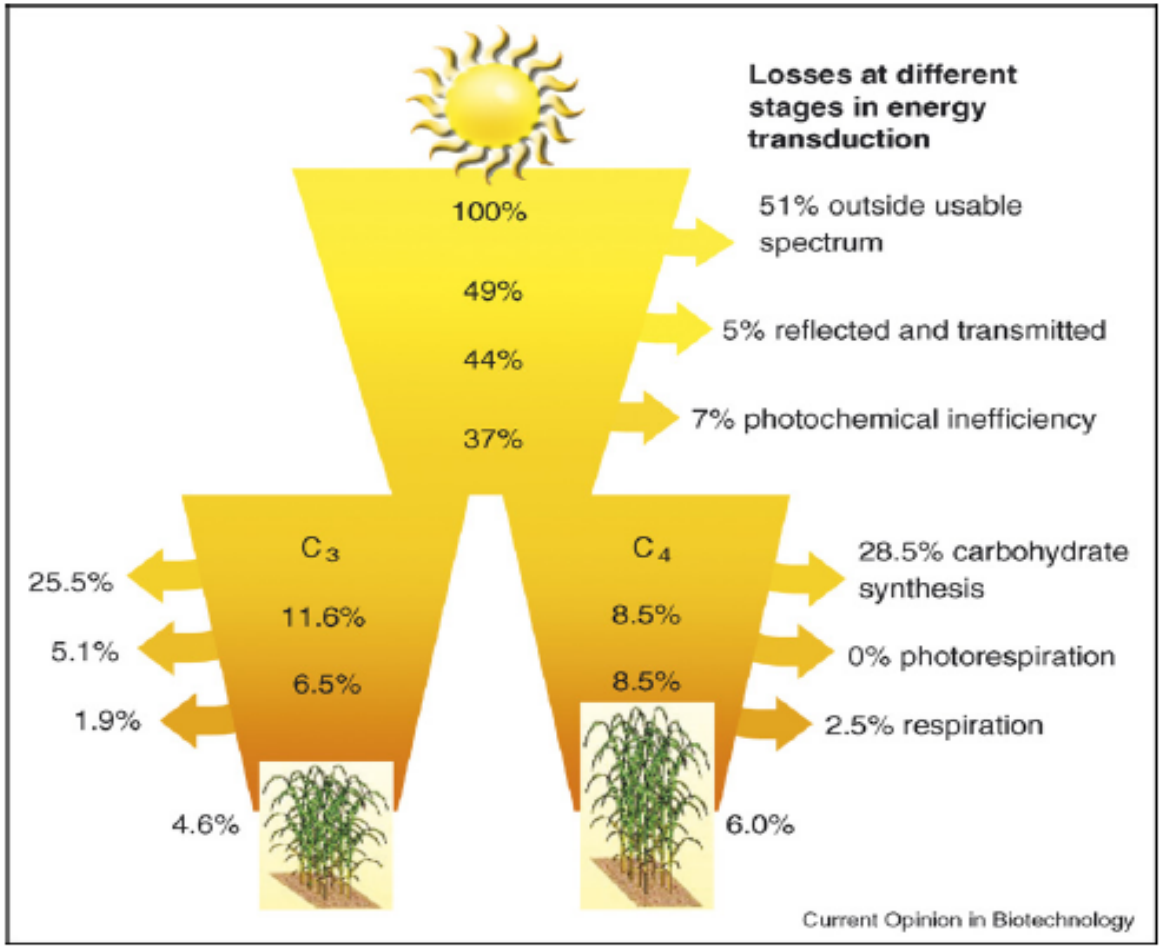

Because single-celled algae do not require nonphotosynthetic roots and stems, their respiratory costs may be lower, but even if these are halved they could not achieve efficiencies greater than between 5.5 and 7.3% on a full solar spectrum basis.

t/ha·a	g/m².day	PE	Organism	Type/Location	References
475 - 1263	130 - 346		algae	Prediction model	Raven (1988)
	110		photoautotrophic cell mass		Richmond (1996)
		< 47	Chlorella	PBR, labscale	Pirt (1986), Richmond (2000)
< 756	< 207			PBR biofilm	Bayless (2006)
	800	15	algae	PBR, LED pulsed	Gordon/Polle (2007)
140	30 - 40	4	Spirulina	Raceway pond	Richmond (1992)
10-30	3 - 8		Chlorella, Arthrospira	Raceway ponds	Jimenez et al. (2003)
30 - 50	3 - 40	< 10	algae	Raceway pond	Benemann &Oswald (1996)
50 - 100	17 - 33		Dunaliella, Spirulina	Raceway ponds	Benemann (2003)
58 - 68	19 - 22	5,5-6,9	Chlorella	PBR open , CZ	Doucha (2005)
50	7 - 9		Chlorella	PBR open , CZ	Doucha/Livansky (2009)
90 - 180	30 - 60		Tetraselmis sueica	PBR	Pedroni et al. (2006)
130	43	7,1	Chlorella	PBR	Tamiya (1957)
130 - 150	43 - 50		Chlorella vulgaris	Tubular PBR	Moore (2001); Pulz (2001)
180 - 210	60 - 70	13 - 18	Tetraselmis		Laws et al. (1986)
	34	8,7	Chlorella sorokiniana	PBR	Morita et al. (2000)
180 - 220	61 - 73	15 - 20	Phaeodactylum	PBR	Fernandez et al. (1998)
	38	9,3	Tetraselmis	PBR	Zitelli et al. 2006
195	53			PBR	Chisti (2007)
	62		Synechocystis	PBR	Zhang et al. (2001)
	80 - 100	7,7	Chlorella vulgaris	PBR 3DMS	Bullock/Pulz (2007)
263	87		harvestable dry matter	USA southwest	Hall (1993)
186	62		Sorghum	USA	Hall (1993)

Summary of possible increases in solar radiation conversion efficiency (ε_c)

Change	% Increase in ε_c relative to current realized value (range)
Rubisco with decreased oxigenase activity but without decreased catalytic rate	30% (5-60)
Efficient C_4 photosynthesis engineered into C_3 crops	18% (2-35)
Improved canopy architecture	10% (0-40)
Increased rate of recovery from photoprotection	15% (6-40)
Introduction of higher catalytic rate of Rubisco	22% (17-30)
Increased capacity for regeneration of RuBP	10% (0-20)
	105% (30-225)

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The value under the heading „% Increase…“ is the suggested mean, followed by the range of possible change, calculated by substituting the changed properties into the simulation model of Humphries & Long (1995).

Long et al., Plant, Cell and Environment (2008)29:315-330