Table 1. Energy (NADPH or reduced ferredoxin, ATP) costs and affinity for CO_2 [reciprocal of the $K_{1/2}(CO_2)$] of the 5 known autotrophic pathways of reductive CO_2 assimilation. RTCAC: reductive tricarboxylic acid cycle; PCRC: photosynthetic carbon reduction cycle; PCOC: photorespiratory carbon oxidation cycle

Pathway	NADPH/CO_2	ATP/CO_2	$K_{1/2}(CO_2)$ mol m^{-3}	Source
Total synthesis of acetate	2	1[a]	–40[b]	Rusching et al. (1976), Müller (2003)
RTCAC	2	1.67	~1.3[c], 2[d]	Furdui & Ragsdale (2000), Kanao et al. (2002), Lebedeva et al. (2002), Raven et al. (2008a)
3-hydroxy-propionate	2	2	0.01[e]	Hügler et al. (2003), Raven et al. (2008a)
3-hydroxy-propionate/ 4-hydroxy-butyrate	2	3	0.01[e] 2[d]	Furdui & Ragsdale (2000), Hügler et al. (2003), Berg et al. (2007), Raven et al. (2008a)
Dicarboxylate/ 4-hydroxy-butyrate	2	2.67	2[d]	Furdui & Ragsdale (2000), Huber et al. (2008)
PCRC	2	3	0.05 – 0.3[f]	Tcherkez et al. (2006), Raven et al. (2008a)

[a]Assuming no ATP synthesis in the conversion of CO_2 + H_2 to acetate (see Müller 2003); ATP required in gluconeogenetic pathway to produce free sugars

[b]Based on rate of reverse reaction of formate dehydrogenase in the CO_2 range 0 to 14 mol m^{-3}. Approximately 40 mol m^{-3} is the concentration in solution in equilibrium with 100 kPa CO_2 in the gas phase at the ionic strength of cytosol at 15°C

[c]For the enzyme with the lowest known affinity for CO_2 in the RTAC (Kanao et al. 2002, Lebedeva et al. 2002; the latter computed from the cited value for HCO_3^- assuming a pKa1' of 6.1 at the ionic strength of the assay medium and an assumed temperature of 25°C and the assay pH of 6.5)

[d]The pyruvate synthase needed to convert the acetyl CoA product of the cycles into 3C compounds for biosynthesis has a $K_{1/2}$ for CO_2 of 2 mol m^{-3} in *Clostridium*

[e]The carboxylases in these 2 pathways (acetyl CoA carboxylase and propionyl CoA carboxylase) have HCO_3^- as the inorganic carbon substrate; the equivalent CO_2 concentration was calculated from the pK_a and pH values at which the enzyme is thought to function in the cytosol, probably 0.7 units higher than the assay pH of 6.5. This calculation assumes that the $K_{1/2}$ for HCO_3^- is independent of pH

[f]NADPH and ATP requirements assume saturation of the carboxylase function of Rubisco with CO_2, completely suppressing the oxygenase activity. Additional ATP is used if this high intracellular CO_2 concentration is attained by a CCM rather than a very high external CO_2 with diffusive CO_2 entry. With lower intracellular CO_2 concentrations and in the presence of O_2, additional NADP and ATP are needed for the net fixation of CO_2 to allow for the cofactors required in the synthesis of 2-phosphoglycolate with subsequent excretion of glycolate and/or operation of the PCOC or its equivalent to convert glycolate into triose