The modernized world is over-consuming low-cost energy sources that strongly contributes to pollution and environmental stress. As a consequence, the interest for environmentally friendly alternatives has increased immensely. One such alternative is the use of solar energy and water as a raw material to produce biohydrogen through the process of photosynthetic water splitting. In this work, the relation between H₂-production and photosynthesis in the green algae Chlamydomonas reinhardtii was studied with respect to three main aspects: the establishment of prolonged H₂-production, the involvement of PSII in H₂-production and the electron pathways associated with PSII during H₂-production. For the first time, this work reveals that PSII plays a crucial role throughout the H₂-producing phase in sulfur deprived C. reinhardtii. It further reveals that a wave-like fluorescence decay kinetic, before only seen in cyanobacteria, is observable during the H₂-producing phase in sulfur deprived C. reinhardtii, reflecting the presence of cyclic electron flows also in green algae.