In plants, photosynthetic energy conversion is confined to the thylakoid membrane system inside chloroplasts. The complex architecture of this membrane is characterized by strict stacking of part of the membranes to grana thylakoids fascinating researchers for over a half century. However, the functional meaning of grana stacking remains a mystery. Our work focusses on structural dynamics of this unique membrane system that ranges from the micrometer (entire membrane system) to the nanometer (molecular) level. This talk will present recent findings on architectural dynamics of thylakoid membranes triggered by environmental changes. The functional meaning of these structural dynamics for photosynthetic energy conversion will be discussed.