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Photoelectrocatalysis in parallel, paired electrolysis - zero-waste approach for modern organic synthesis

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"*Climate emergency*" was chosen by the Oxford Dictionary as a *2019 Oxford Word of the Year* and it is defined as *"a situation in which urgent action is required to reduce or halt climate change and avoid potentially irreversible environmental damage resulting from it".*

Current social movements along with the international school strike for climate (Youth for Climate), reveals a rising awareness of 21st century challenges. Worldwide spread news of dramatic natural disasters has led to discussion about climate change and the need for urgent actions: for people to change their lifestyle and for scientific community to reconsider traditional methods for chemical synthesis and establish alternative, more sustainable techniques.

Planet Earth is on the edge of an ecological catastrophe not only due to climate change but also because of destructive forces of environmental pollution, wastes and consumption of limited fossil fuel resources. Over past few years, social movement called zero-waste strategy is gaining more and more popularity and it is focused on waste prevention. It is about time for urgent application of such strategy towards fine chemicals production. To this end electrochemistry and photochemistry are highly promising approaches – it has only been recently that organic chemists have started to realize the potential of light and electricity as energy sources and it will broadly impact synthetic chemistry and increasingly gain interest due to sustainability of reactions driven by electricity mainly from renewable resources, including wind-, solar- or hydropower. While the importance of photochemistry and electrochemistry is already growing, the focus is mostly on optimizing the efficacy of atom usage without consideration the energy efficiency. Although each redox process can be constructed as a combination of two half-reactions (cathodic reduction and anodic oxidation), during the majority of electrochemical processes only one half-reaction involves the transformation of interest while the other entails the redox process of sacrificial species which means that *during this transformation electrical power is irretrievably lost.* This problem can be solved by using paired, parallel electrolysis where two half-reactions are performed simultaneously – a thoughtful combination of the half-reactions can enhance the amount of useful products generated from electrolysis on both electrodes with maximizing time and energy efficiency.

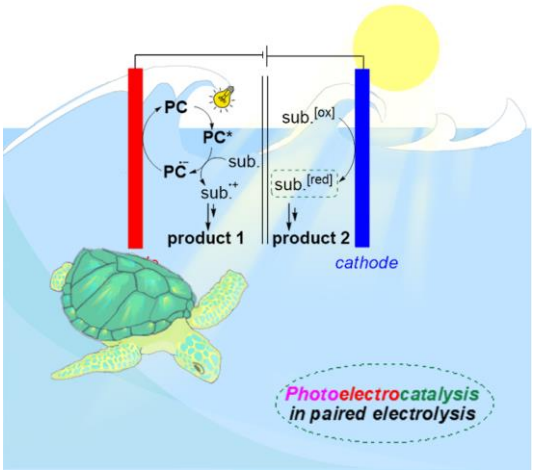

Figure 1. General idea for the proposal.

Therefore, the main goal of this project is to set a general paradigm for **designing and construction of the paired, parallel photoelectrocatalytic systems, where reactions on both electrodes (cathode, anode) will simultaneously produce highly desirable products with zero electrical energy loss.** Developing such methodology will set paradigms for future applications in genuinely green chemistry – by saving energy, increasing atom economy, and reduction of harmful wastes. **In the future, some of the developed systems may be applied in chemical industry, increasing the atom economy and energy efficiency.**