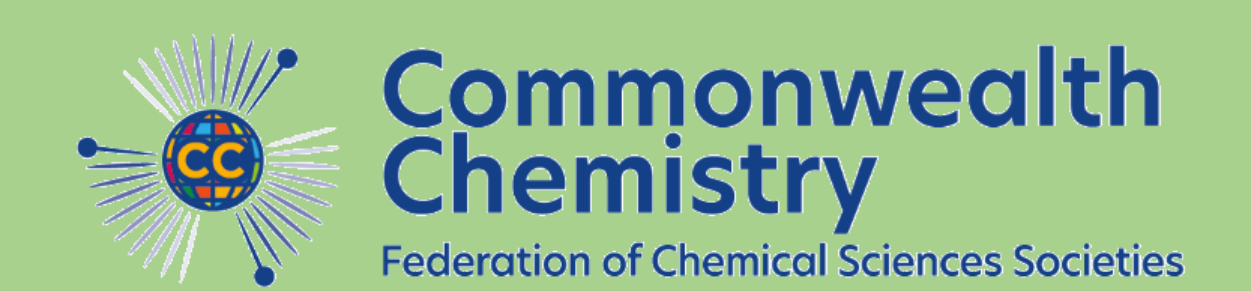


Carbon-Based Catalyst for Green Hydrogen Production and Simultaneous Organic Transformation: Towards Sustainable Energy Access



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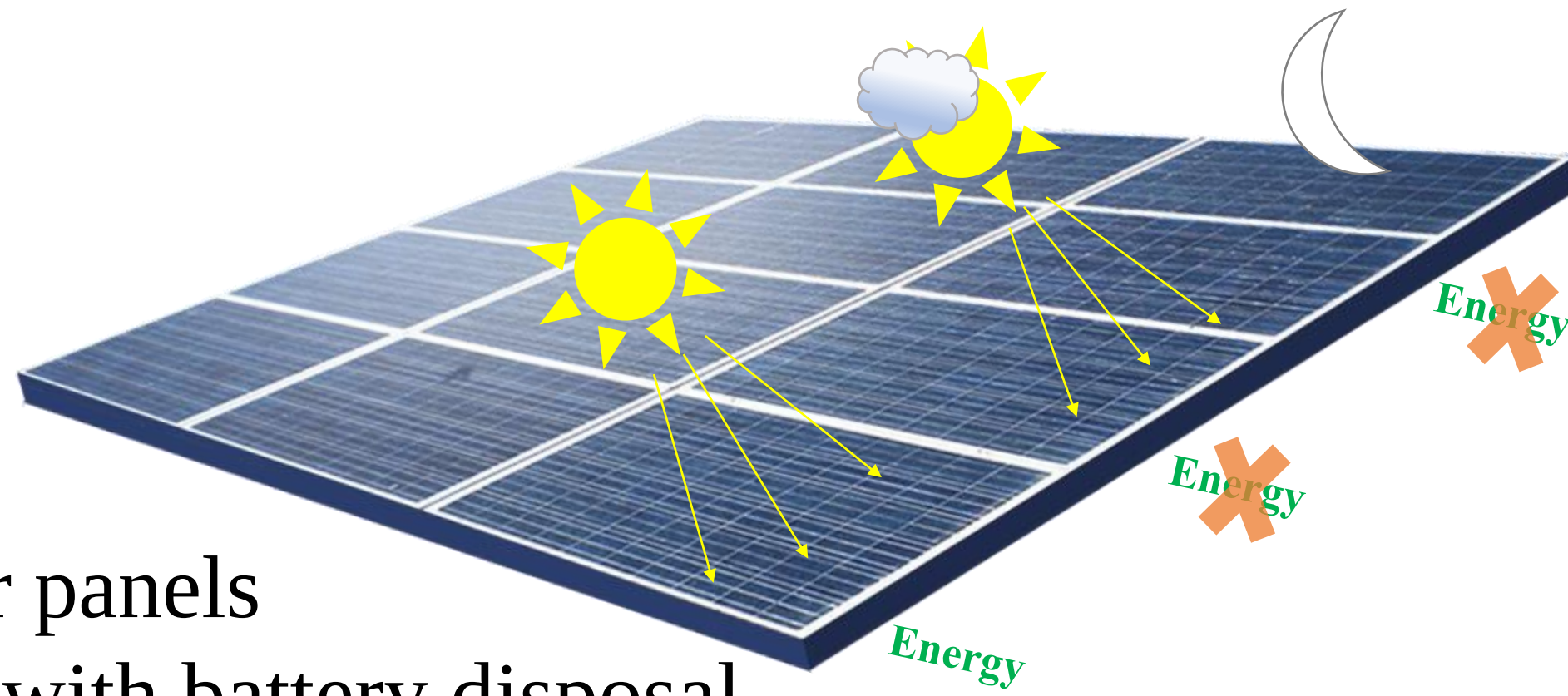
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1 Our quest to find a more efficient way to utilize solar energy

Solar energy plays a crucial role in the transition from fossil fuels to renewable energy sources; however, it remains underutilized due to several inherent limitations:

1. High Initial Costs
2. Weather Dependency
3. Costly Energy Storage
4. Large land requirements
5. Rare metal usage in solar panels
6. Environmental concerns with battery disposal

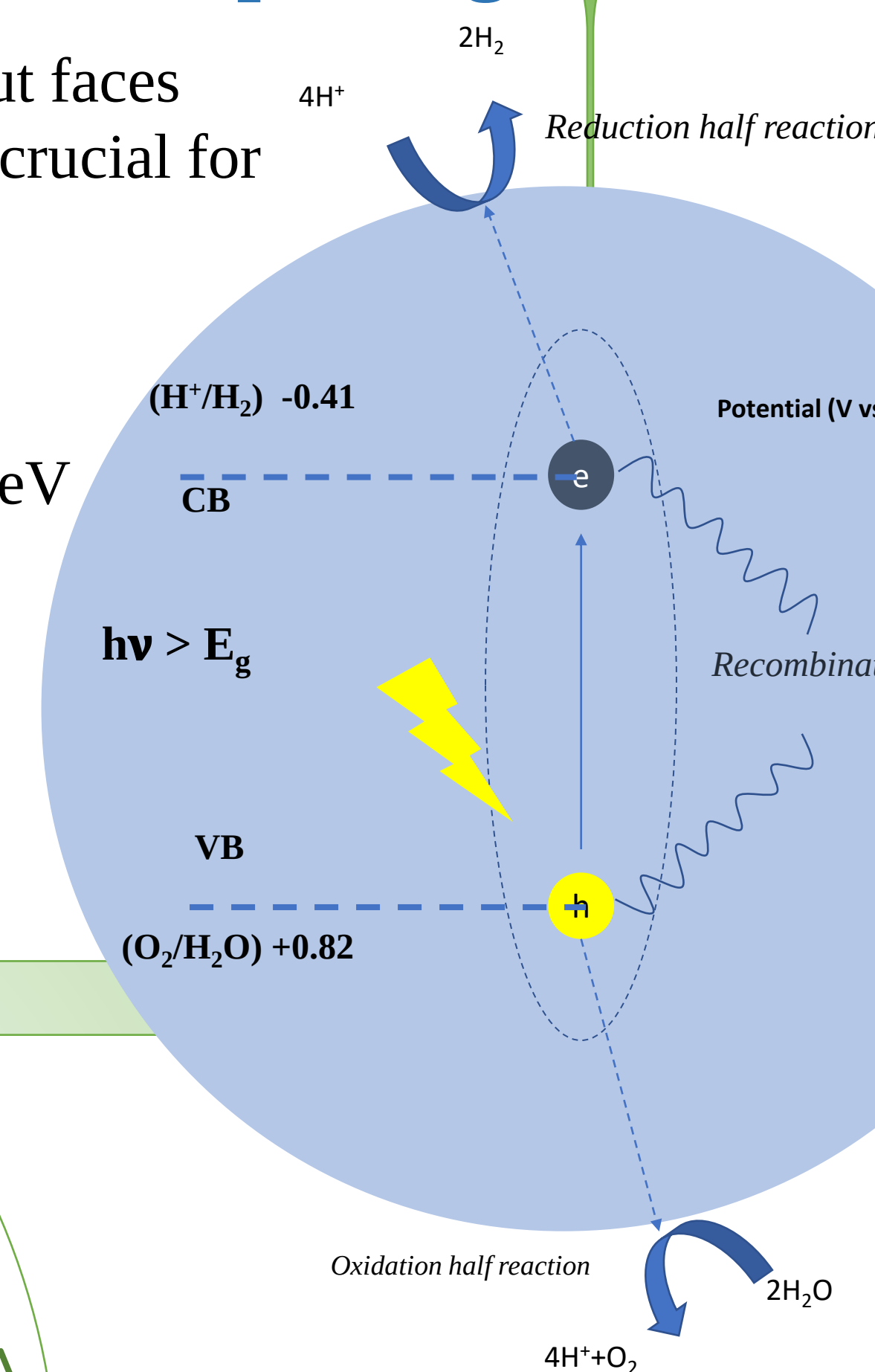


2 Photocatalytic hydrogen production by water splitting

Solar hydrogen generation from water splitting is eco-friendly but faces challenges. Therefore, the design of an efficient photocatalyst is crucial for unleashing clean energy potential.

Key photocatalyst design considerations:

1. Photocatalytic water splitting is energetically demanding.
2. Bandgap should be ≥ 1.23 eV with conduction band < -0.41 eV and valence band $> +0.82$ eV.
3. Photoexcited electron holes can recombine/reach the surface.
4. Surface electrons and holes drive redox half-reactions.

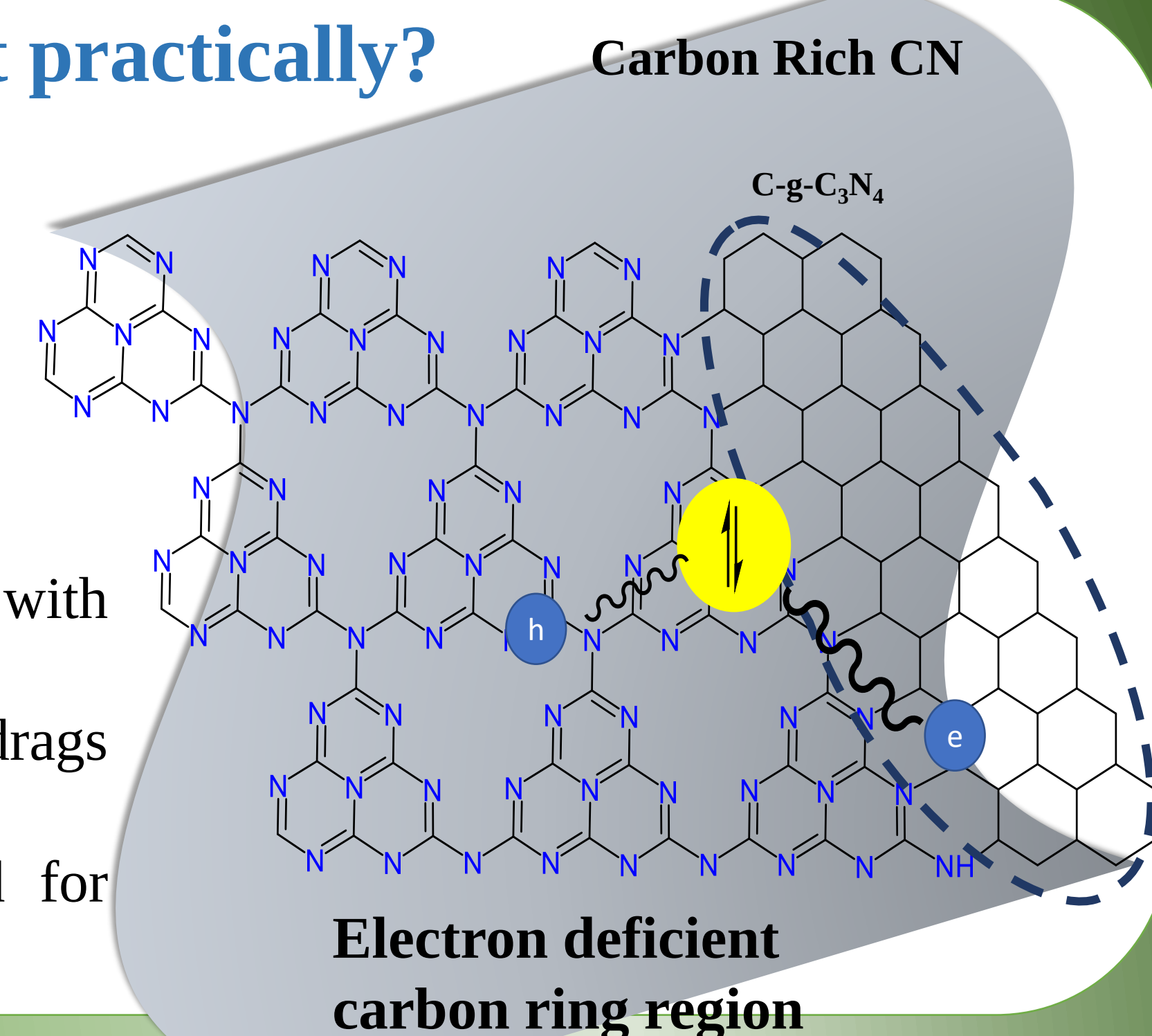


3 Challenge: How do we design it practically?

Melamine + Glucose

**Pyrolysis
2 hr., 500°C**

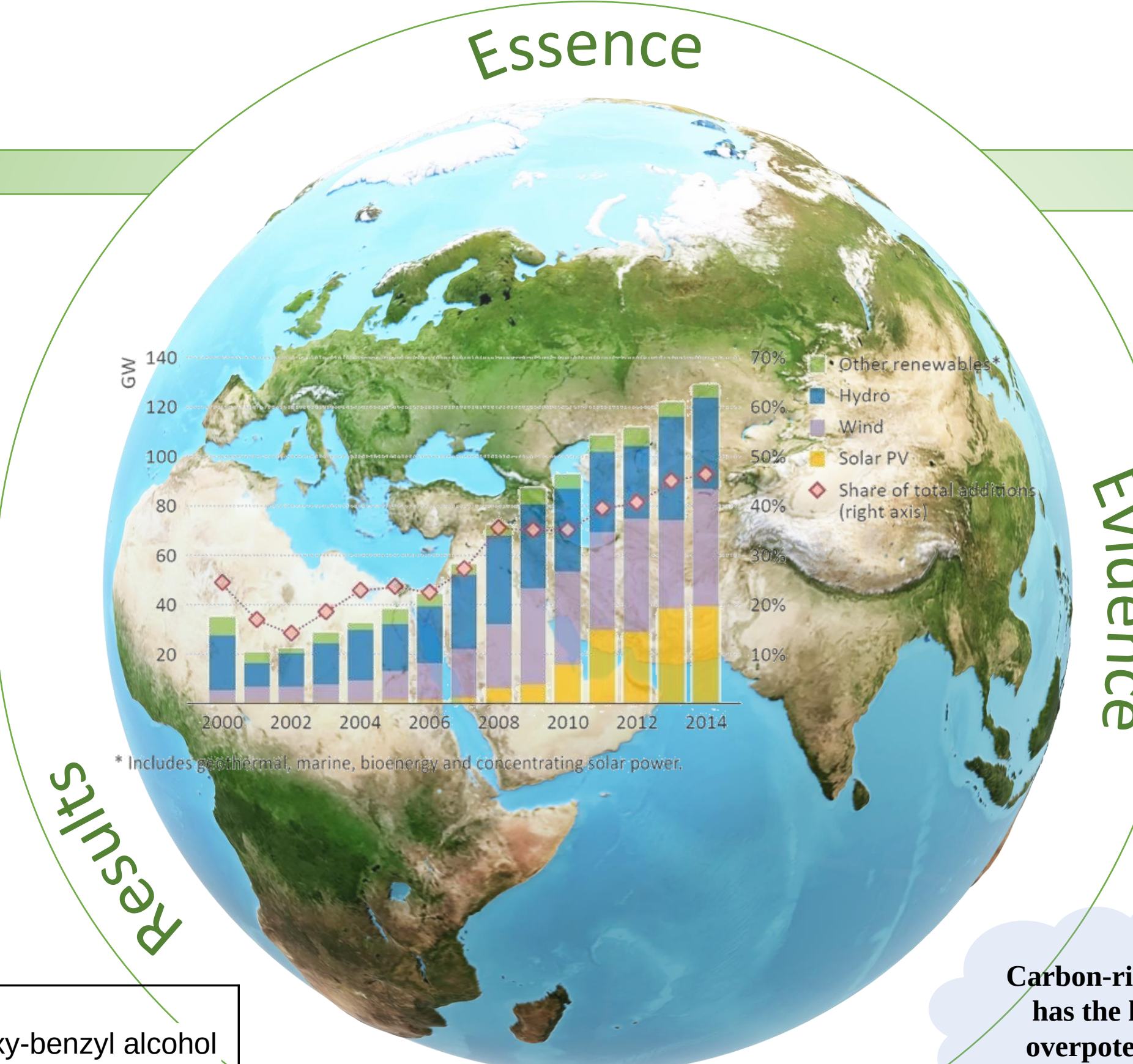
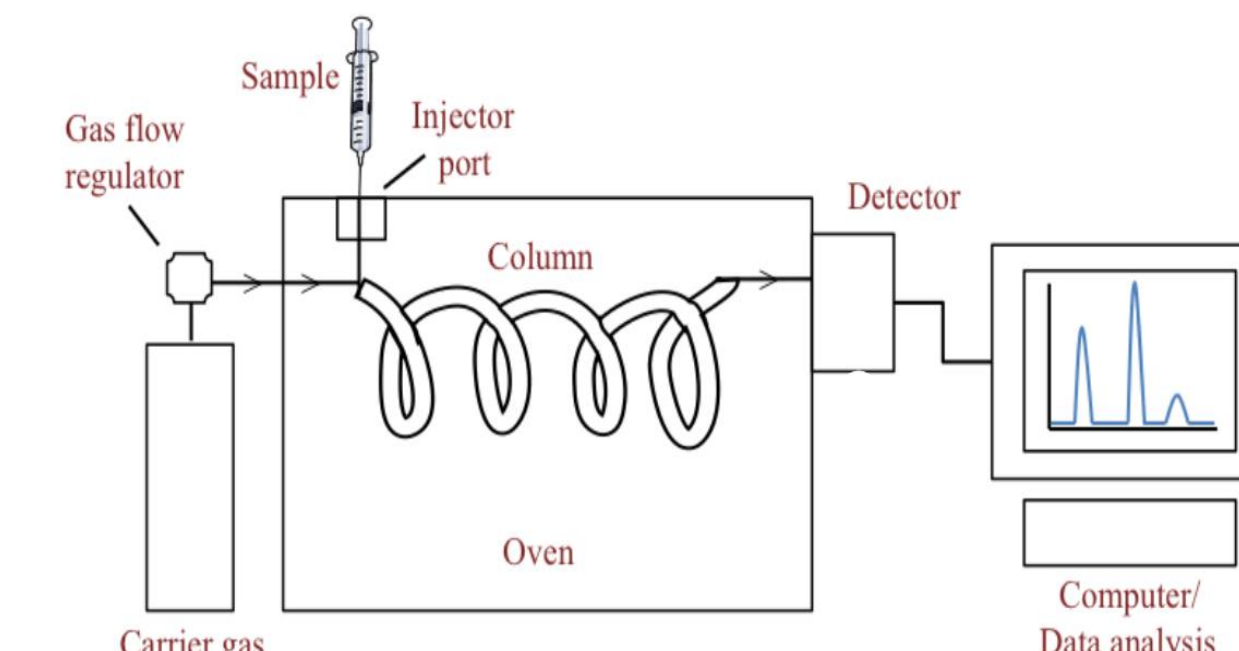
1. A heterogenous carbon nanomaterial with in-plane hetero-electronegativity
2. Electron-deficient carbon ring region drags and traps electron¹
3. Electron holes effectively separated for participating in respective red-ox halves



5 Results: How effective is the catalyst for real-life applications?



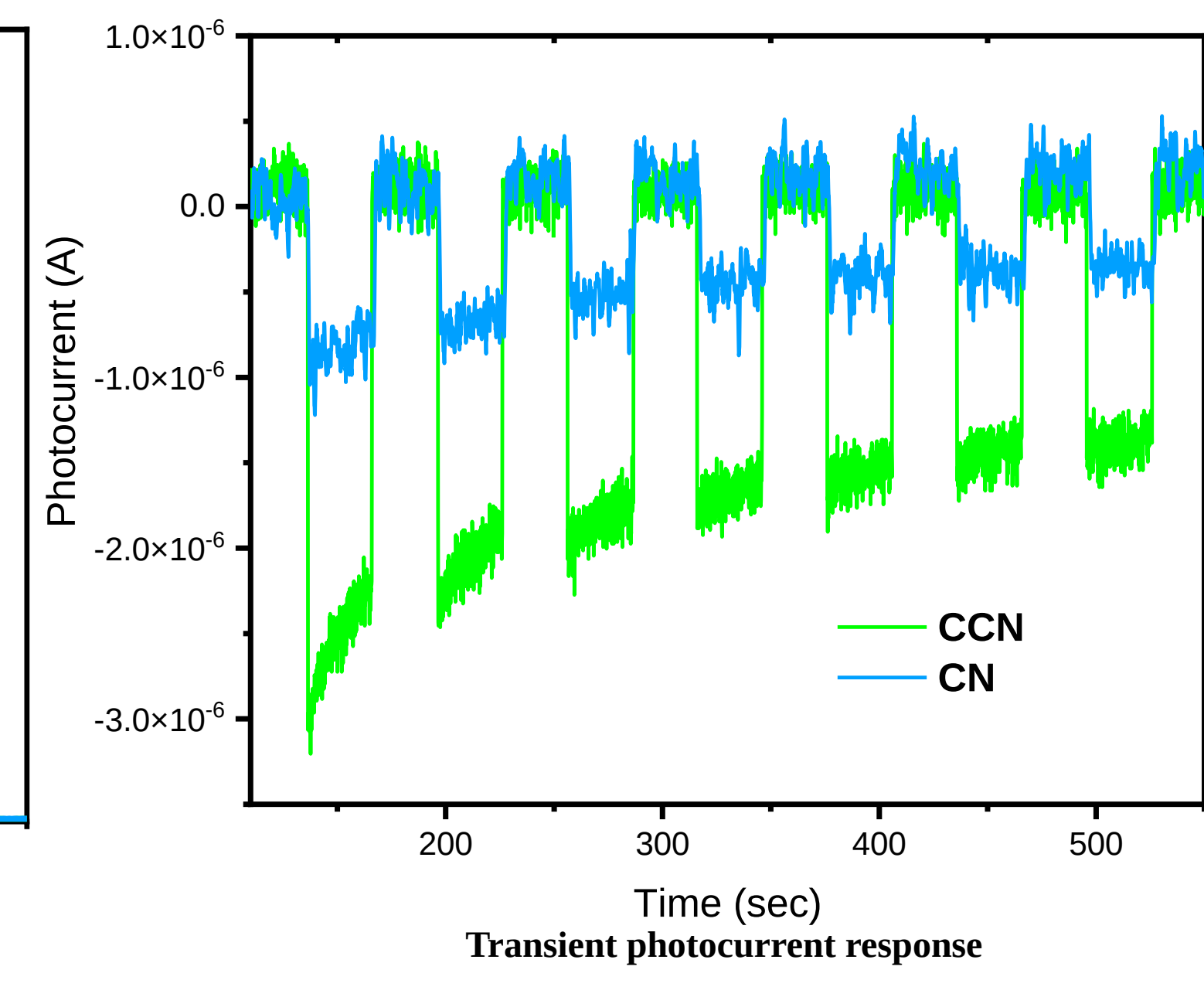
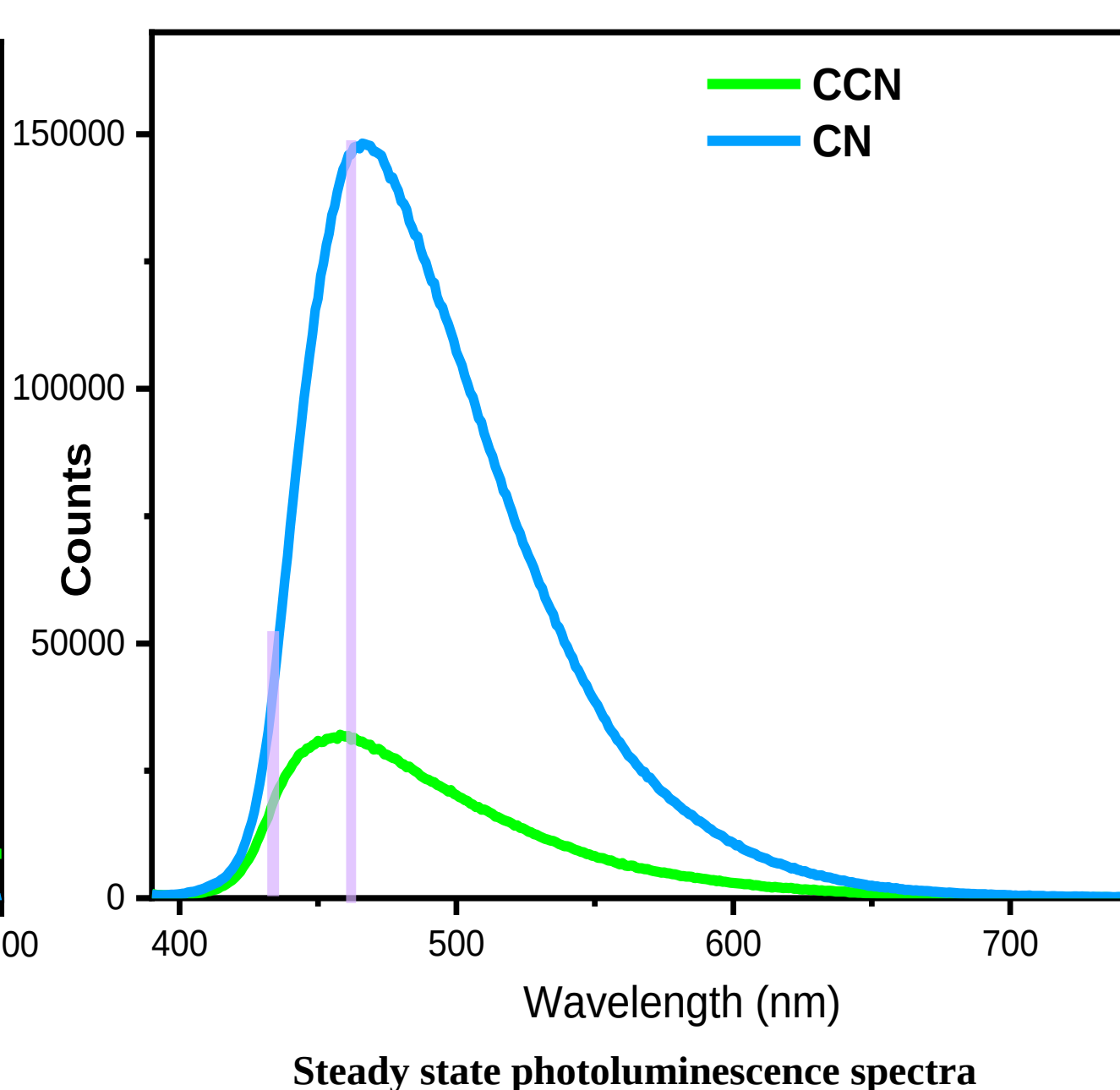
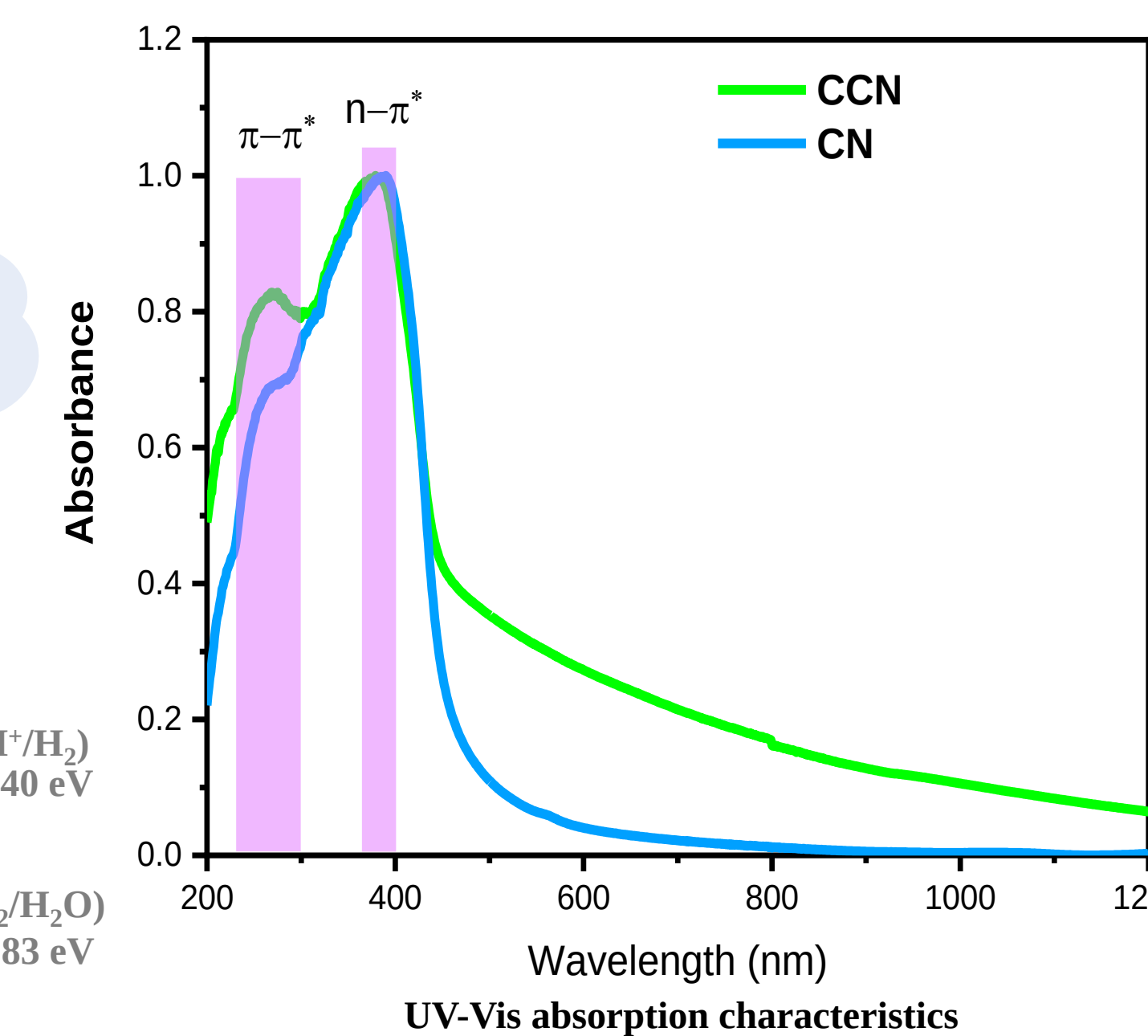
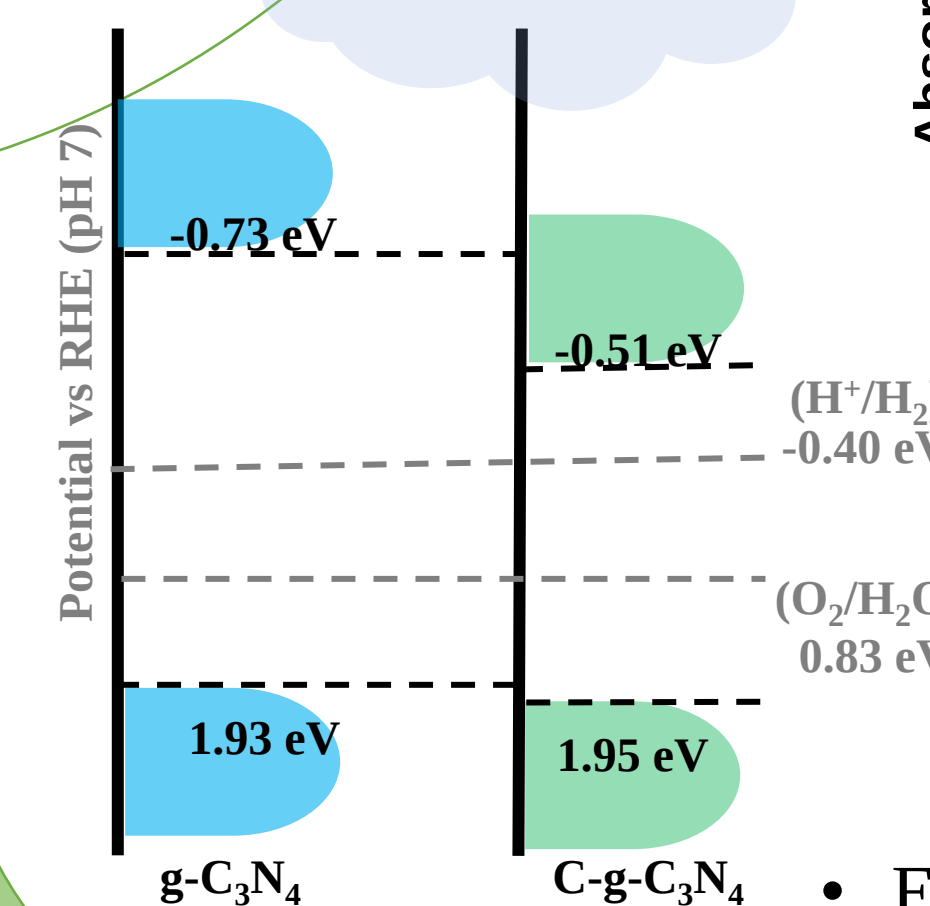
Xenon light source



Evidence

Results

Carbon-rich CN has the least overpotential



- ✓ Our catalyst efficiently absorbs visible light and has efficiently separated charge carriers, as seen in photoluminescence spectra.
- ✓ Band positions suggest lower overpotential needs, enhancing electron and hole availability for water splitting.

- Extended absorption leads to a broader spectrum of light harvesting
- Reduced photoluminescence indicates less radiative recombination with effective charge separation
- Increased photoinduced current indicates efficiently separated and available charge carriers for photocatalysis.

6 Acknowledgment

The author expresses gratitude to IISER Berhampur for their invaluable support in providing necessary facilities and to Dr. Bhattacharyya for their guidance and insightful suggestions. Special thanks are extended to INSPIRE for their generous fellowships during the thesis work.

7 References

1. *J. Am. Chem. Soc.* 2017, 139, 8, 3021–3026