



# Why have a Hydrogen Webinar? Research activities at HVL

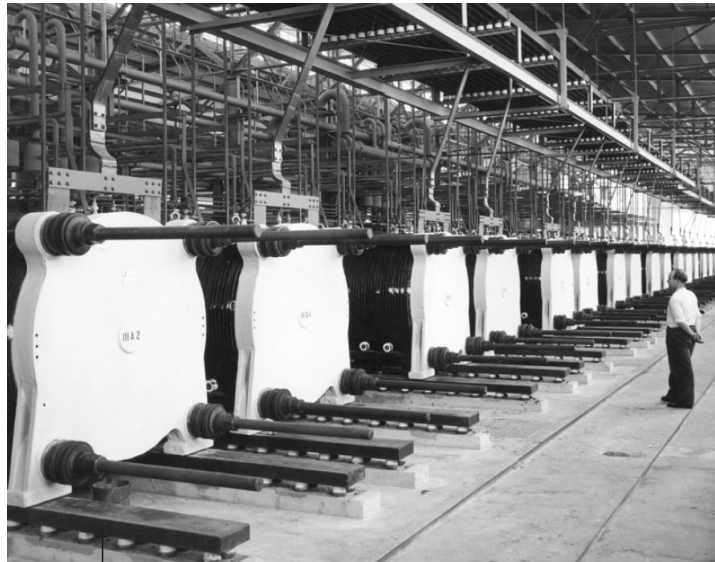
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# Why HVL Hydrogen Webinar?

- **The Norwegian hydrogen strategy – June 2020**

An important goal for the government is to increase the amount of pilot- and demonstration projects in Norway by contributing to and supporting technology development and commercialisation.



Norwegian Ministry of Petroleum and Energy  
Norwegian Ministry of Climate and Environment

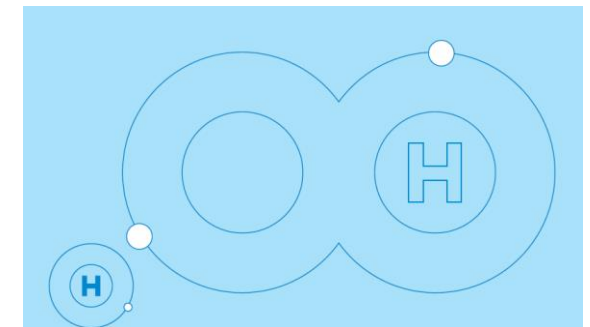
Strategy

The Norwegian Government's  
hydrogen strategy  
towards a low emission society



**A Hydrogen Strategy**  
for a climate neutral Europe

#EUGreenDeal

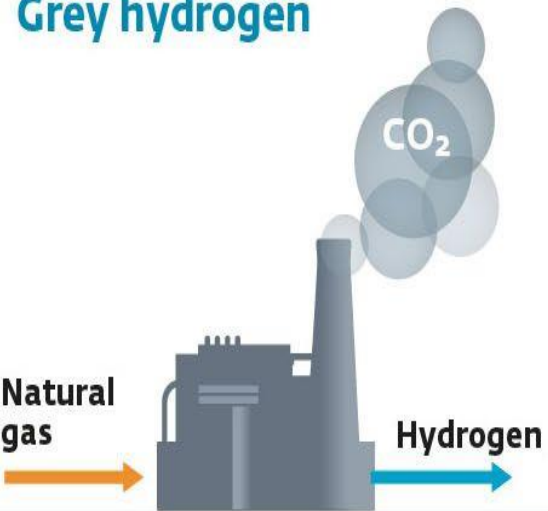


# Different Classifications

2020

2030

## Grey hydrogen



Split natural gas into hydrogen and  $\text{CO}_2$ , where  $\text{CO}_2$  is emitted into atmosphere

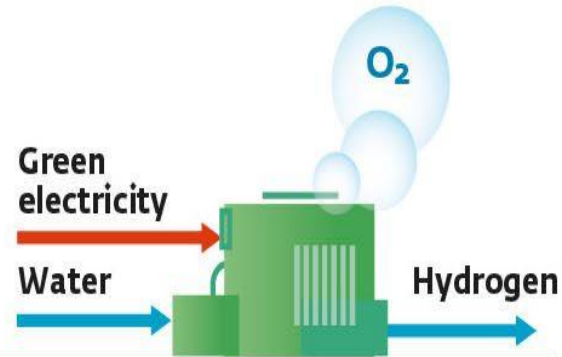
## Blue hydrogen

Split natural gas into hydrogen and  $\text{CO}_2$ , where  $\text{CO}_2$  is stored or reused.



Underground storage

## Green hydrogen

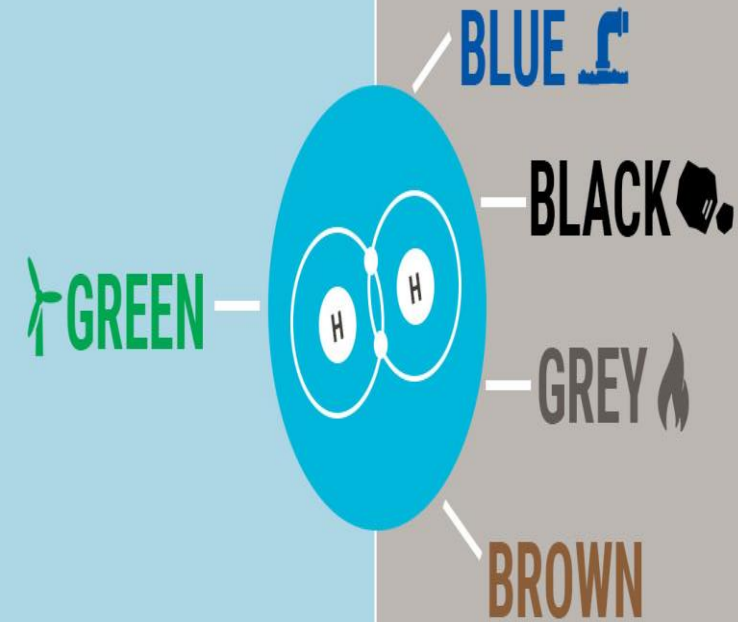


Split water into hydrogen and  $\text{O}_2$  without the emission of biproduct called  $\text{CO}_2$ .

## THE HYDROGEN RAINBOW

Renewable  
Hydrogen

Fossil Fuel  
Hydrogen



Wind, solar and hydro

Gas

Any fossil fuel with partial carbon capture

Brown coal

Black coal

# Clean, widespread use of Hydrogen globally

- International Energy Agency

## Challenges :

- Producing Hydrogen from low-carbon energy is costly today
- Development of Hydrogen infrastructure is slow and holding back widespread adoption
- Hydrogen is atmost entirely supplied from natural gas and coal today
- Regulations currently limit the development of clean energy Hydrogen

## What should be done? What is the role of HEIs?

- Research and Development to bring down costs
- Skill development

# Hydrogen Research & Development

## **HVL Campus Sogndal, Mohn Senteret (Bergen):**

Societal, environmental, economical, political aspects of Hydrogen Energy Transition

## **HVL Campus Haugesund:**

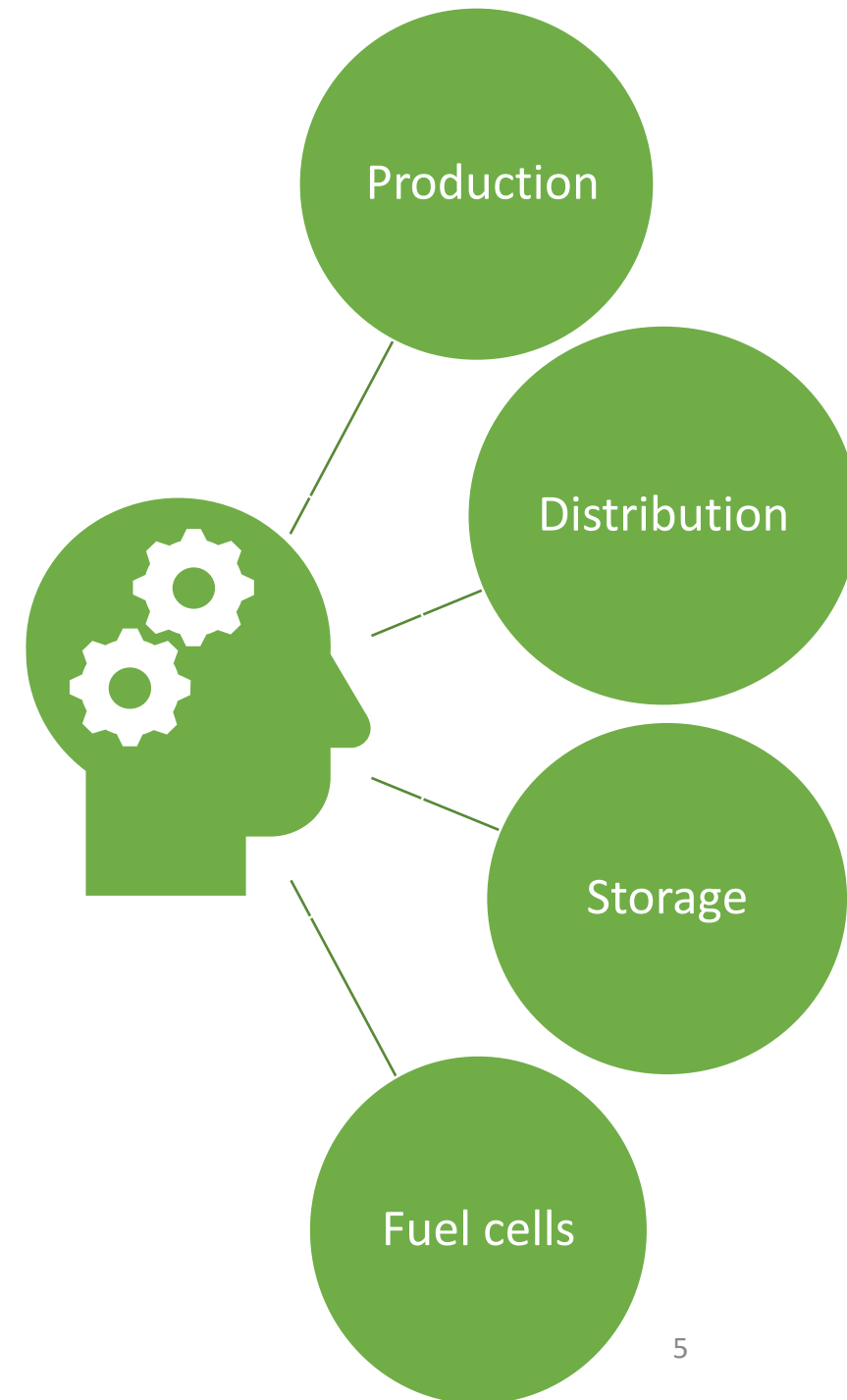
Safety and environmental issues related to Hydrogen

## **HVL Campus Bergen:**

Hydrogen production – Solar, Wind (Off-shore, In-shore)

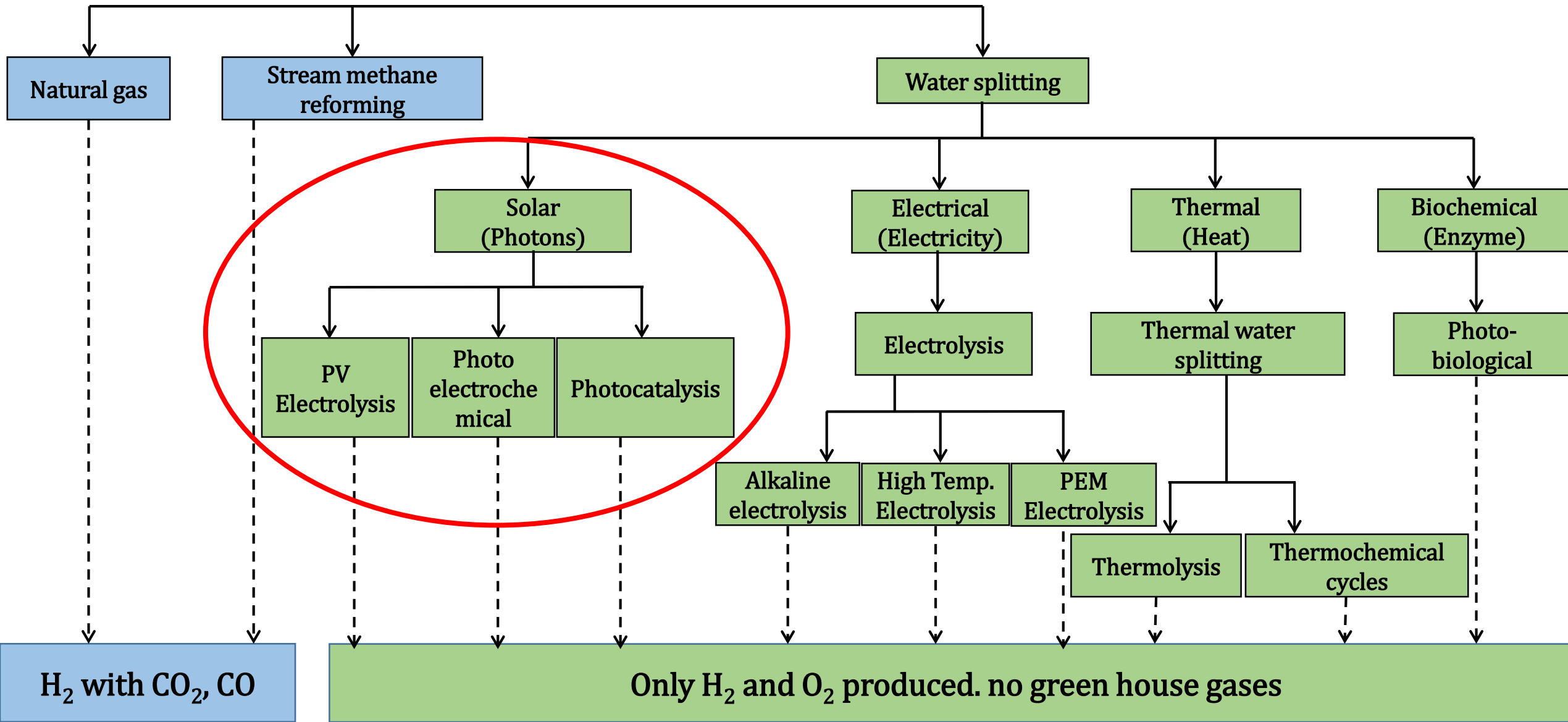
Storage - metal hydrides, NH<sub>3</sub> in combustion engines, Liquid H<sub>2</sub>, LOHC

- Bachelor, Master, PhD projects
- Infrastructure facilities – Clean Energy Lab
- National and international partnerships

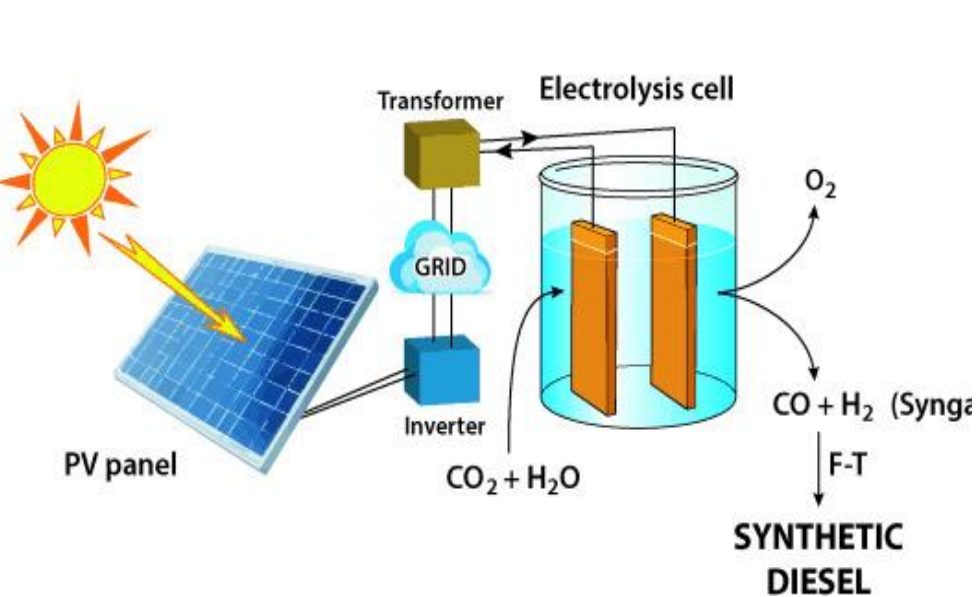




# Hydrogen production methods

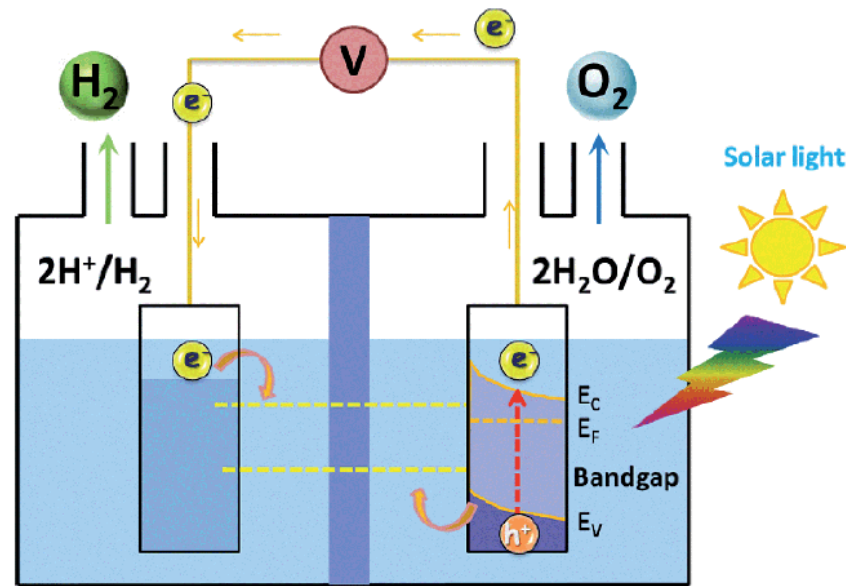


# Solar energy to Hydrogen production



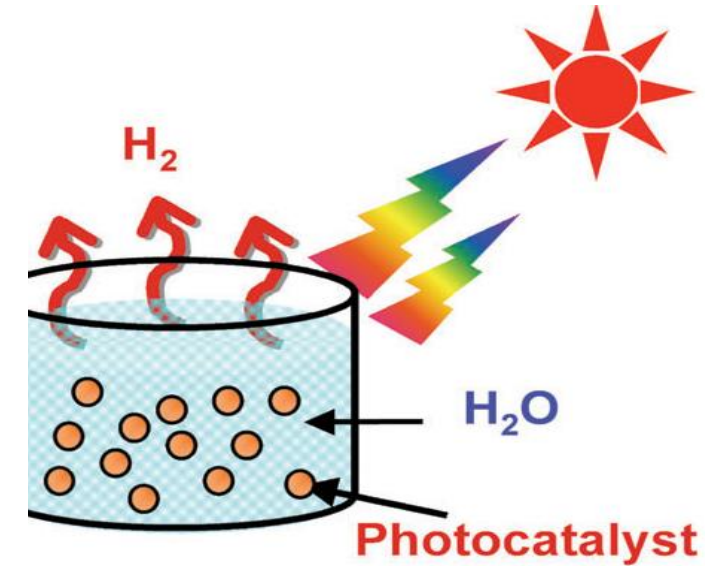
## PV electrolysis

*Armaroli et. al, 2015*



## Photoelectrochemical

*Datt Bhat et.al, 2015*



## Photocatalysis

*A.Kudo et al, 2009*

# Advanced Nanomaterials for Hydrogen production

- Modelling and Simulation

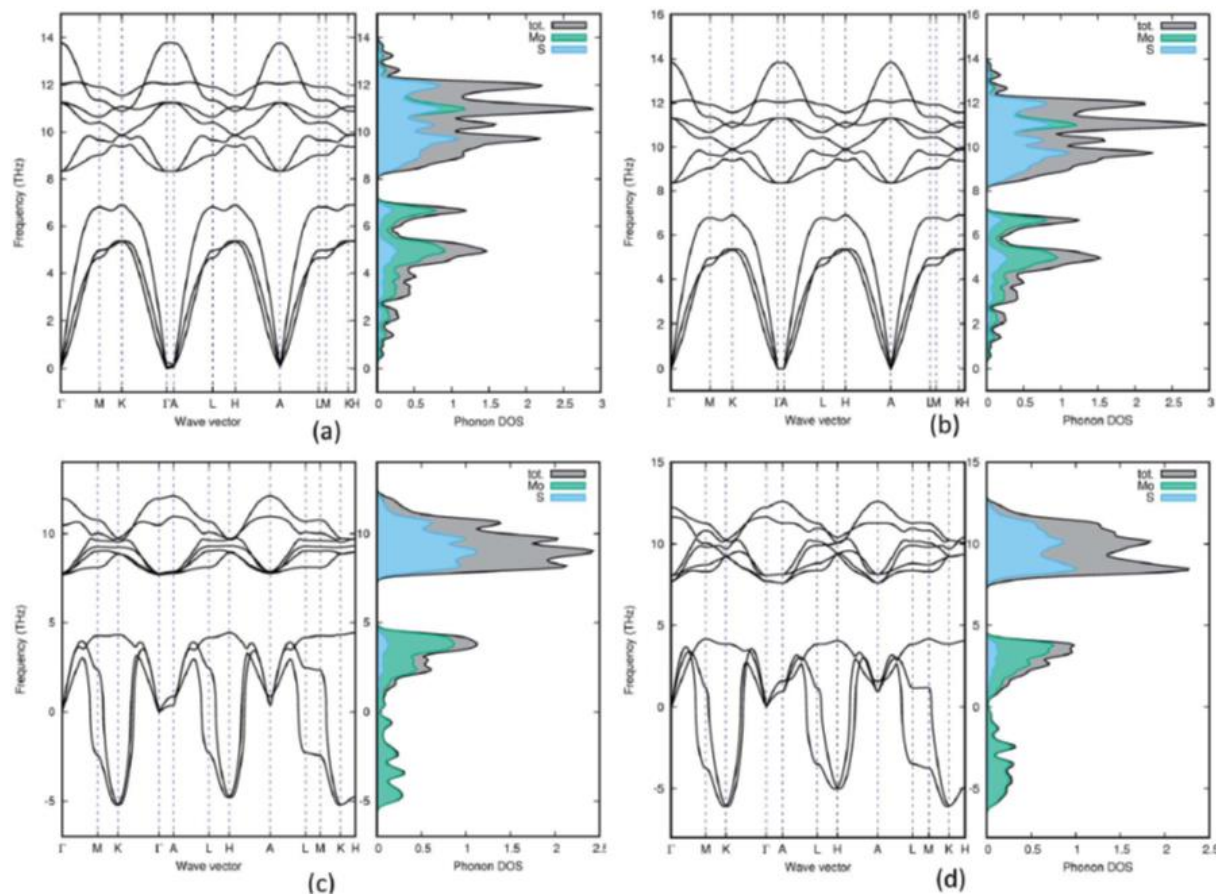


Fig. 5 Phonon density of states for 3H<sub>b</sub> (a), 1H (b), 2R<sub>2</sub> (c) and 1T<sub>1</sub> (d). Both group B polymorphs (2R<sub>2</sub> and 1T<sub>1</sub>) contains negative frequencies, which means that they are dynamically unstable.

- Synthesis and H<sub>2</sub> production

