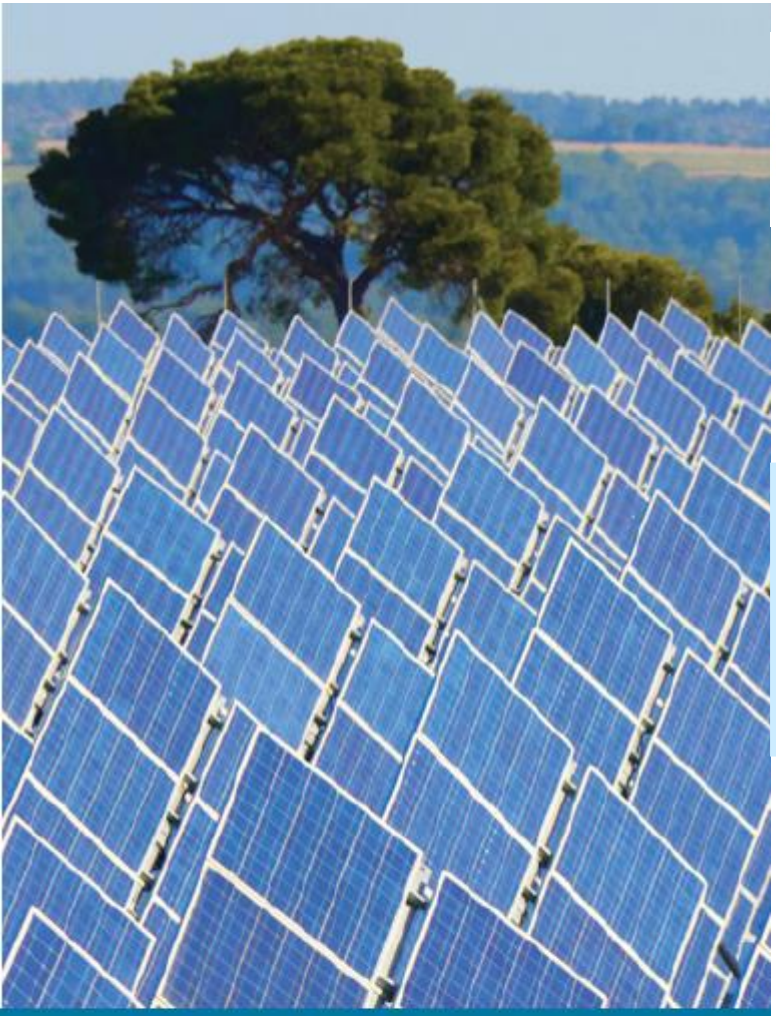


COLLOQUE – 21 avril 2022

Énergie solaire et société

COLLÈGE DE FRANCE 1530

Chaire Innovation technologique
Liliane Bettencourt 2021-2022

*Énergie solaire photovoltaïque et transition énergétique*

*Daniel Lincot*

Fondation Bettencourt Schueller
Reconnue d'utilité publique depuis 1987

# Le $CO_2$ pour stocker l'énergie solaire à très grande échelle
## *Promesses de la photosynthèse artificielle*


Marc ROBERT

Université Paris Cité – UMR CNRS 7591


Université Paris Cité

cnrs

institut universitaire de France

Use solar energy at a massive scale
for responding human increasing needs ?
So we need being able to store it !

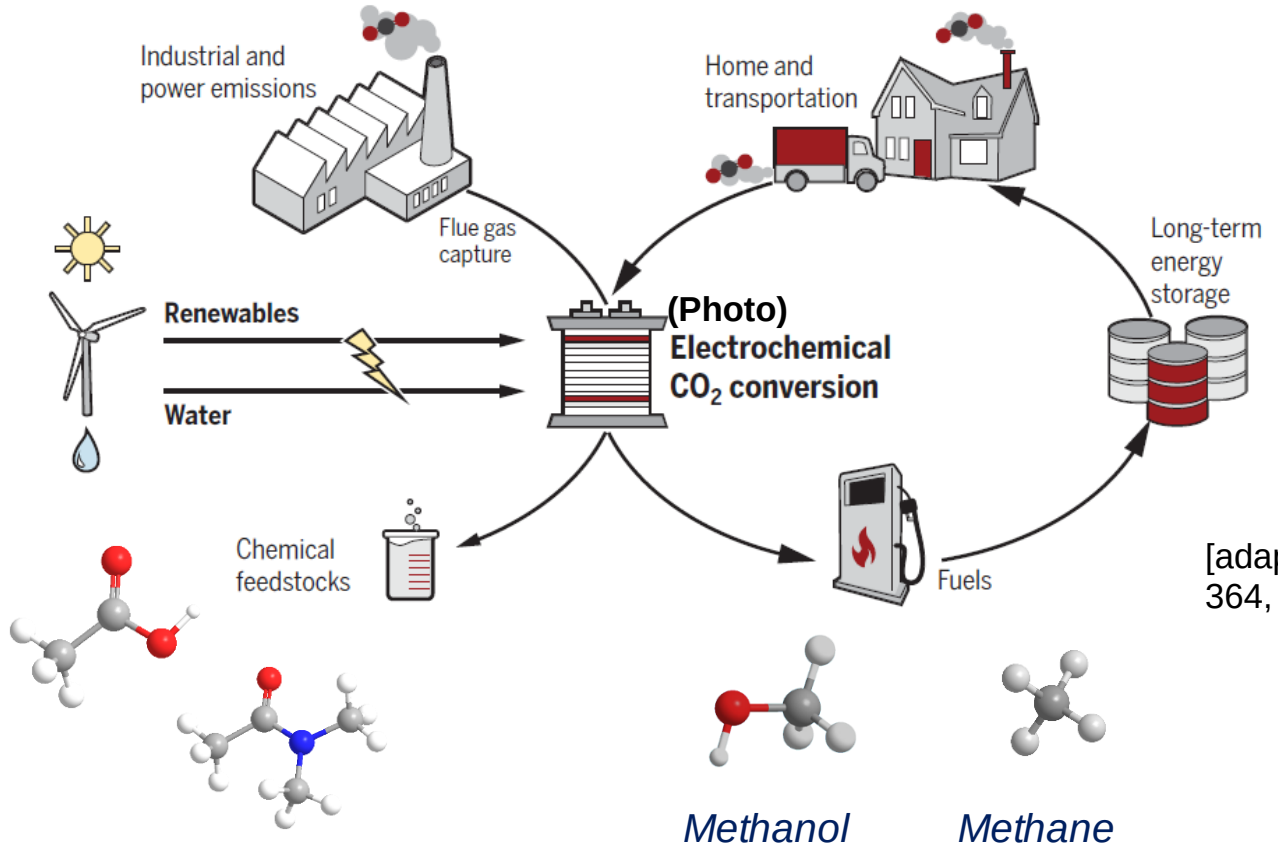
Molecules are ideal candidates to do so

**… in particular $CO_2$ !**

COLLÈGE DE FRANCE 1530

Fondation Bettencourt Schueller
Reconnue d'utilité publique depuis 1987

# Renewably powered (photo)electrosynthesis will displace petrochemical processes : a Revolution, not an Evolution

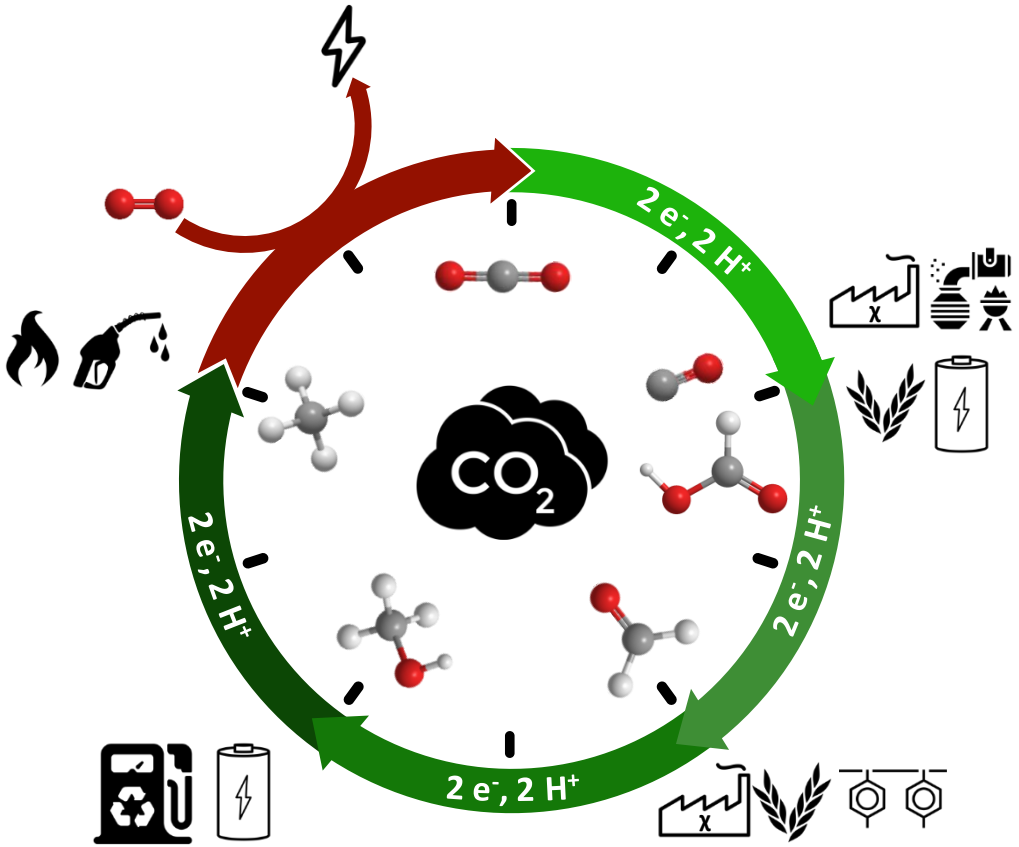



[adapted from *Science* **2019**, 364, 6438, eaav3506]

COLLÈGE DE FRANCE 1530

Fondation Bettencourt Schueller
Reconnue d'utilité publique depuis 1987

# The $CO_2$ clock




*Catalysis is mandatory.*

*What operating constraints ?*
- *earth abundant metals*
- *ambient T and P*
- *water as solvent*

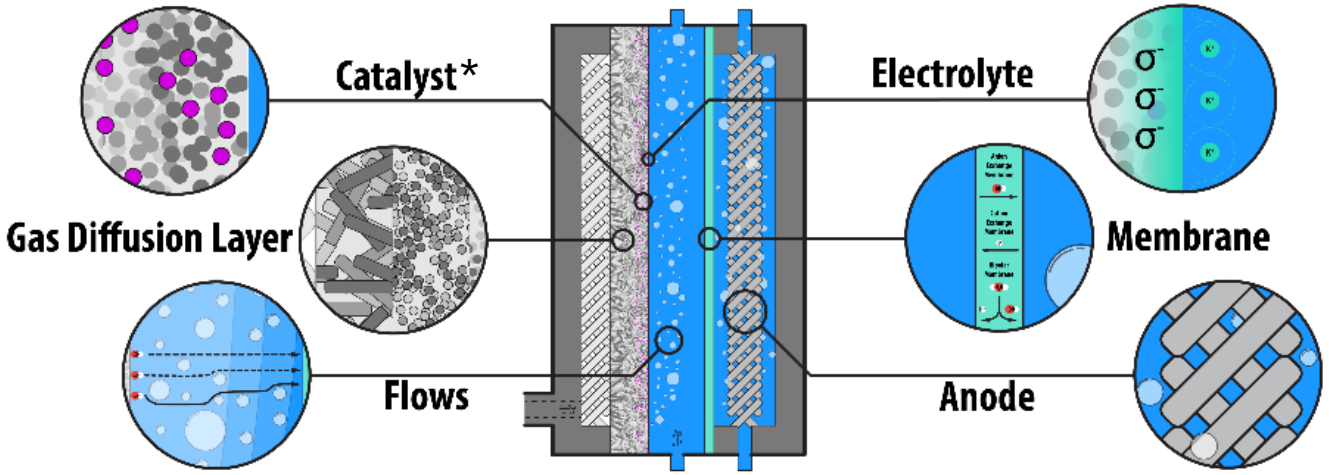
*ACS Energy Lett.* **2016**, 1, 281

COLLÈGE DE FRANCE 1530

Fondation Bettencourt Schueller
Reconnue d'utilité publique depuis 1987

# Example 1 (***indirect*** *use of solar energy*) : the $CO_2$ electrolyzer

Ultra-efficient $CO_2$ to CO conversion : **$j_{CO}$ > 450 mA cm$^{-2}$ in a flow cell @ pH 7**



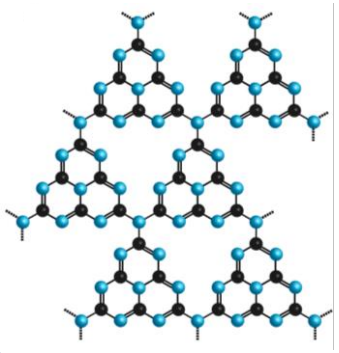

**metal (Fe, Co) complex deposited at carbon paper*

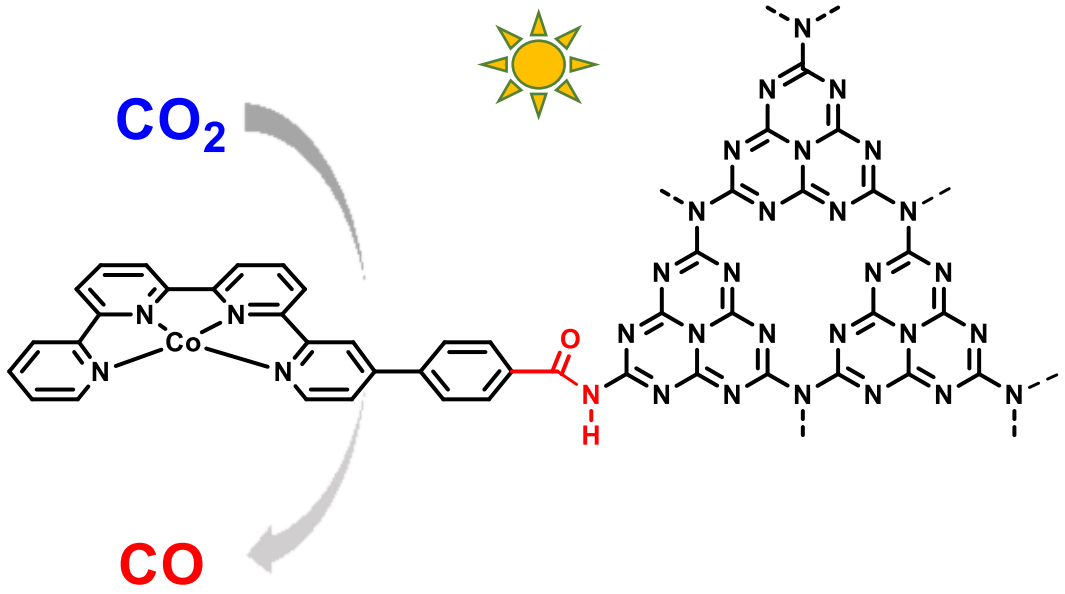
*Science* **2012**, *338*, 90
*Science* **2019**, 365, 367-369
*Nature Commun.* **2019**, 10:3602
6 patents – 1 start-up (*Carboneo*)

# Example 2 (***direct*** *use of solar energy*) : the photoreduction of $CO_2$

Hybrid molecule@(semi-conductive) material – a particulate system

***Carbon nitride***
*$C_3N_4$ polymer*
*(SC, band gap 2.8 eV)*





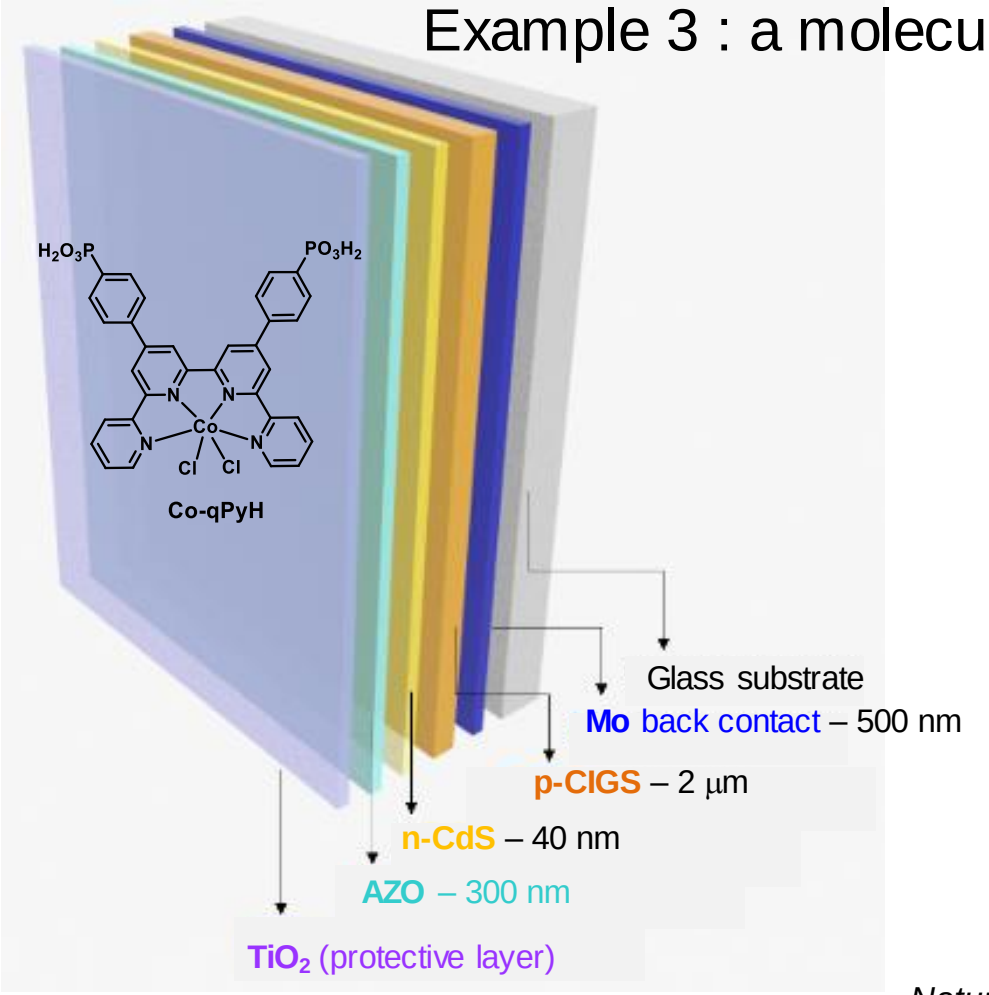

selectivity 97%
robustness (> 4 days)

*Nature*, **2017**, 548, 74
*Nature Catal.* **2019**, 2, 801
*Angew. Chem. Int. Ed.* **2022**, e2021116832
1 patent

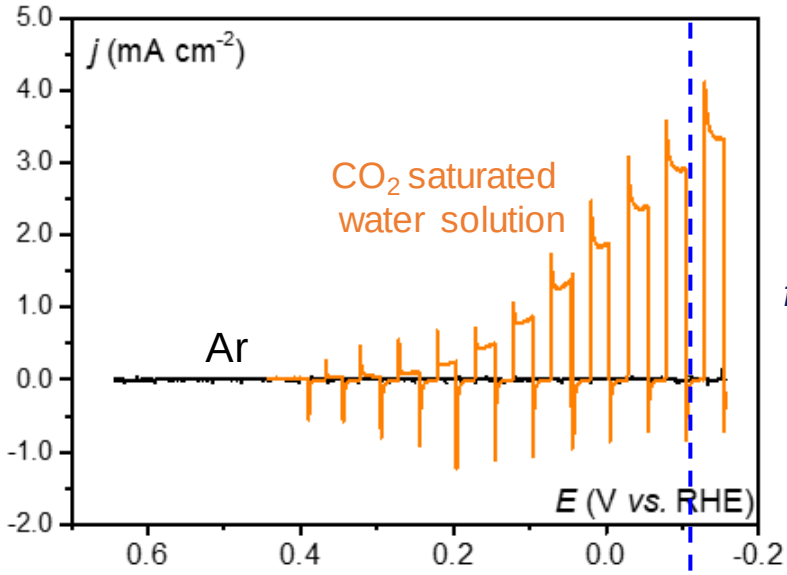
COLLÈGE DE FRANCE 1530

Fondation Bettencourt Schueller
Reconnue d'utilité publique depuis 1987

# Example 3 : a molecular photoelectrode for $CO_2$ reduction




*Photoelectrochemical response under chopped light illumination*




*> 95% efficiency for CO production; hours of stability*

$E^0(CO_2/CO)$

*Nature Commun.* **2020**, 11:3499
2 patents