The great adventure of Photovoltaics

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Nui Island, Tuvalu, sighted in 1568 by Álvaro de Mendaña

Photo from http://www.cbspowersolutions.com

23th Becquerel Prize, Hamburg, September 2015
The adventure began long ago in a sunny land.

photo from Africa Clean Energy Corridor, IRENA 2015
Ancient and modern civilization

photo from Africa Clean Energy Corridor, IRENA 2015
The scientific adventure: a staircase to the sun

Best Research-Cell Efficiencies
Alexandre Edmond would be pleased

incroyable!
magnifique!
formidable!

Edmond Becquerel
scientifique

mais, c’est quoi une cellule solaire?

Edmond Becquerel

Edmond Becquerel
Solar cell basics

Rules
1. Promote photogeneration
2. Suppress recombination, **everywhere**!
3. Facilitate the flow of electrons towards one terminal
4. Create a conductive path for holes towards the second terminal
“Ancient” silicon solar cells (ca. 1978)

p⁺nn⁺ cell (Sandia Labs)
16.8%, \( V_{oc} = 622 \text{ mV} \)
(J. Fossum and E. Burgess, APL1978)
and what is hot now

\textbf{p}^+\textbf{n}n^+ \textbf{cell (Sandia Labs)}
16.8\%, \(V_{oc}=622\) mV
(J. Fossum and E. Burgess, APL 1978)

\textbf{p}^+n/\textbf{SiO}_x/\textbf{n}^+ \textbf{polySi cell (ANU)}
20.8\%, \(V_{oc}=675\) mV
What is cool: self-passivating contacts

MoO$_x$– Si heterojunction (EPFL)
22.5%, $V_{oc}$=725 mV
(J. Geissbühler et al., APL 2015)

“new” materials deposited at very low temperature

from apl.aip.org
“Learning curve” of PV science

Preliminary analysis by Black and Cuevas
The inexorable law of the pyramid

\[
\frac{\text{papers}}{\text{MW}} = (\text{MW}_{\text{cum}})^{-\frac{1}{1.7}}
\]

\[
\frac{\text{flat surface}}{\text{pyramid surface}} = \frac{1}{1.7}
\]
PV technology is unstoppable!

PV electricity will soon be the cheapest

Yes, PV can

~100 times higher installed capacity by 2050 to provide 44% of the world’s electricity

The adventure continues

The Cuevas-Macdonald group

Thank you all for sharing the dream of solar energy!