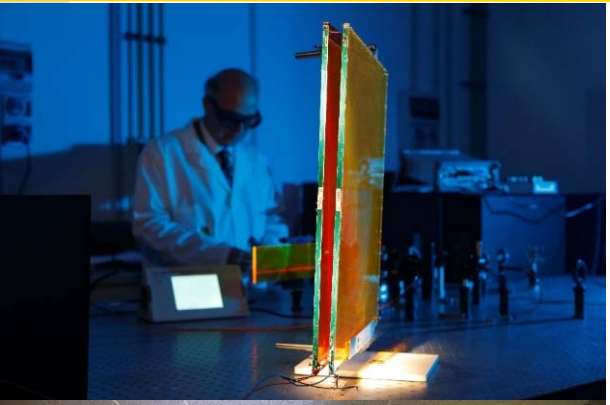
Eni R&D activities: an overview

October 2017

Research & Innovation in Eni

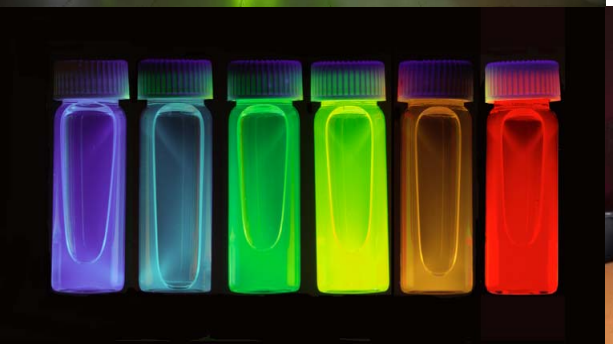


Since 2010 Eni has invested over 1.5 B€ in R&D, developing new technologies for Upstream, Downstream and Renewable Energy businesses.

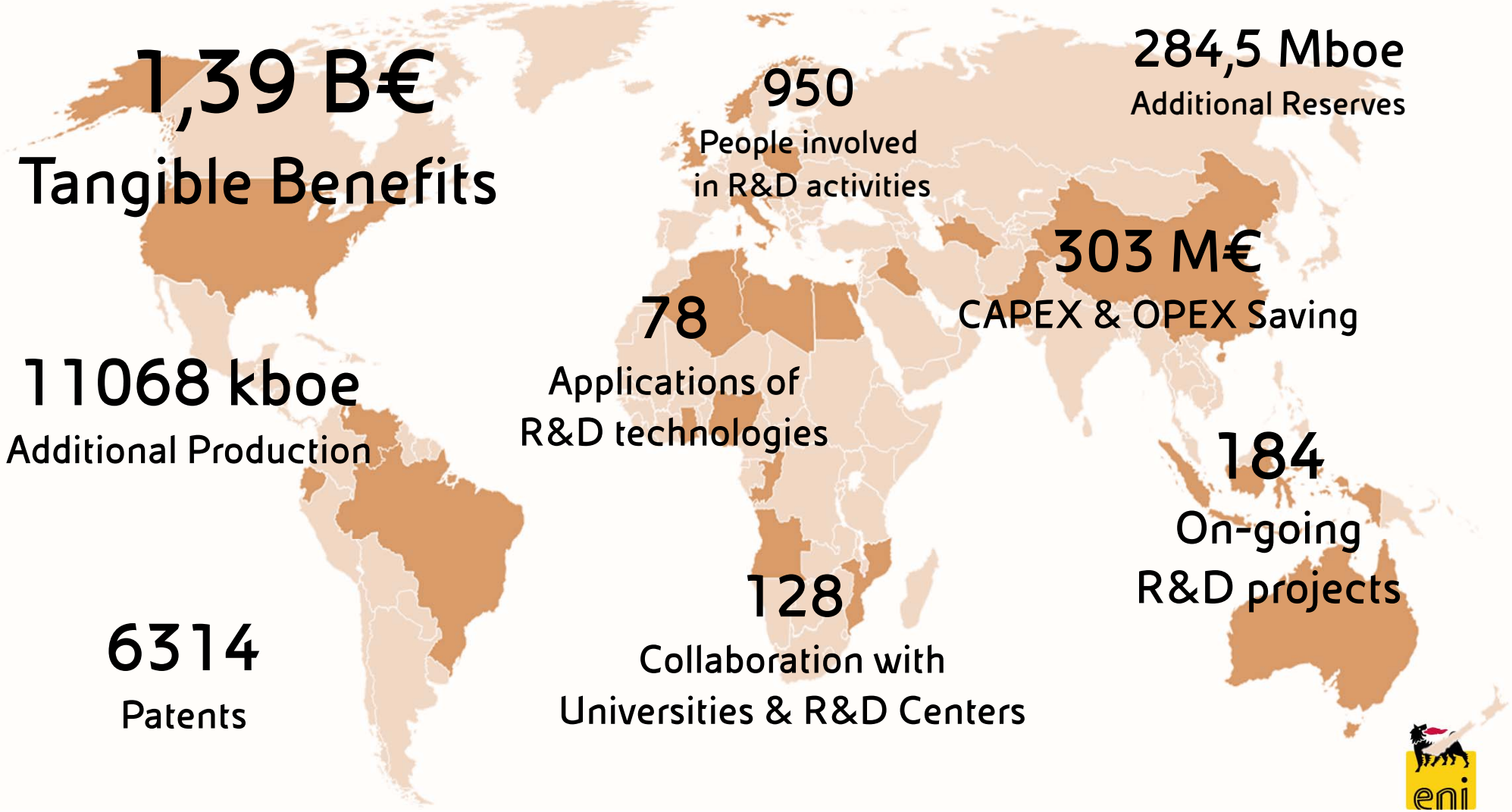
40% of investments focus on Renewable Energy, HSE, Energy Transition and Clean Energy, in particular:

- *Solar energy conversion;*
- *Second and third generation fuel from organic waste;*
- *Environmental technologies*

*The R&D centers are located in **Novara - Istituto Donegani** (Renewable Energy Labs) and in **San Donato Milanese** (Upstream & Downstream Labs)*



R&D numbers for 2016



1,39 B€
Tangible Benefits

950
People involved in R&D activities

284,5 Mboe
Additional Reserves

303 M€
CAPEX & OPEX Saving

78
Applications of R&D technologies

11068 kboe
Additional Production

184
On-going R&D projects

128
Collaboration with Universities & R&D Centers

6314
Patents

Technology Development

Technology challenges

In the energy sector, new technologies are being developed in the following areas:

- ***Exploration:*** *reduction of the mining risk and time-to-market of discoveries; increasing efficiency*
- ***Operational excellence****: technologies to operate in extreme conditions (ultra-deep waters), while improving drilling capacity and reducing operating costs*
- ***Downstream & chemistry****: process flexibility and optimization of feedstock from sustainable renewable sources; innovative materials development*
- ***Energy transition & renewable energies****: support structural and competitive changes of oil and gas companies towards an integrated energy business*
- ***Safety & environment****: enhance process safety by preventing risks and minimizing environmental impacts*

Exploration

- *Advanced seismic*
- *Integration of multiple physical measurements, including non-seismic data*
- *Reservoir characterization*

Operational Excellence

- *Subsea systems and infrastructures*
- *Drilling and well completion*
- *IOR/EOR (injection of steam – also from renewables – low salinity, chemicals e CO2)*
- *Abandonment & Decommissioning*
- *LNG production and storage*
- *Digital Oilfield*

Downstream& chemistry

- *Production of advanced biofuel and chemical products from renewables*
- *development of advanced polymeric materials*
- *Plasma technology for decommissioning*
- *Thermal gasification of biomass to liquids*

Energy Transition and Renewable energies

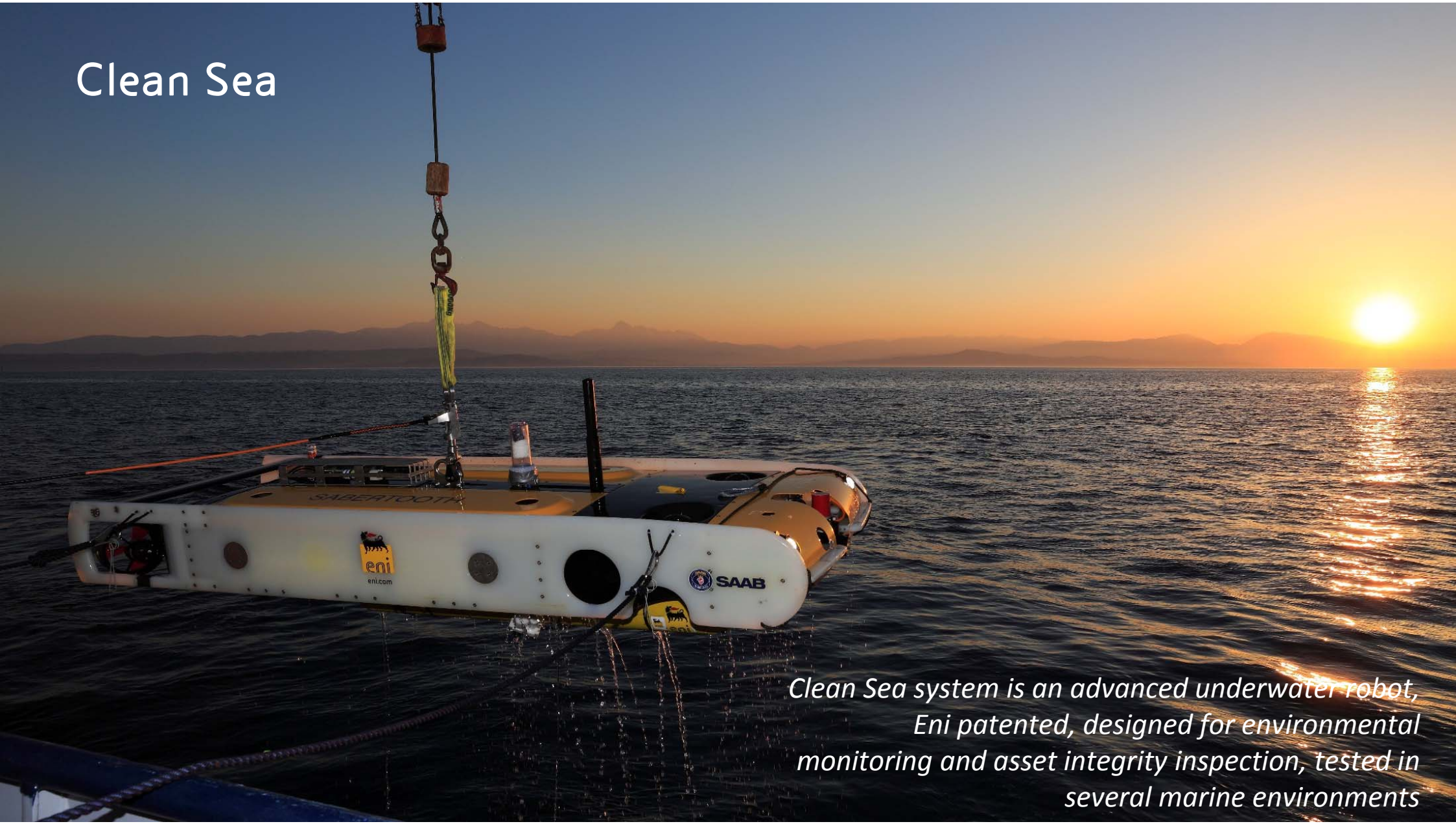
- *Development of innovative solution for CCUS, conversion into fuels and chemicals*
- *energy storage (flow batteries)*
- *Advanced solar cells and wind power*
- *fuel cell*
- *direct conversion of methane to methanol*

Safety and environmental protection

- *Drones to improve efficiency of environmental monitoring*
- *Oil-spill prevention and clean-up*
- *Advanced wastewater treatment*

Connected to climate change

Clean Sea



Clean Sea system is an advanced underwater robot, Eni patented, designed for environmental monitoring and asset integrity inspection, tested in several marine environments

Green Refinery

This biorefinery uses Ecofining™ process, an Eni – UOP technology. It is a process for the conversion of organic feedstocks into Green Diesel, a high-quality product for diesel fuel production.

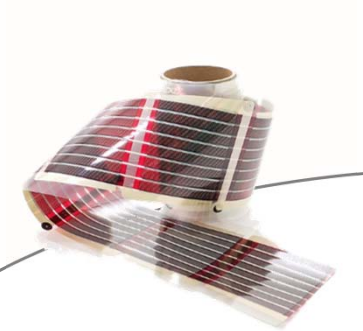
EST (Eni Slurry Technology)

- *Highly innovative proprietary technology, capable of completely converting refinery residues, heavy oils and bitumen into high quality lighter products, eliminating the production of both liquid and solid refinery residues*
- *The technology is based on a hydro-conversion process that employs a novel process scheme with dispersed Molybdenum catalysts and hydrogen*

Energy Transition

- *Direct conversion of natural gas to methanol*
- *New adsorbent materials for gas transportation (ANG)*
- *New materials for the separation of H_2S and CO_2*
- *Conversion of CO_2 , H_2S to polymers, fibers, building materials*

Renewable energy, our technological portfolio



Solar Energy - Polymeric and "paper like" cells

Low cost organic PV on flexible substrate for portable devices

Waste to Fuel

Second and third generation biofuels from organic fraction of urban solid waste

Renewable Energy

Energy storage

Flow batteries applications

Solar Energy - PV windows

Luminescent Solar Concentrators (LSC), for residential building integration

Solar Energy – CSP

A new, proprietary, cost-effective technology for solar energy conversion

Utility-scale renewables and hybrid solutions

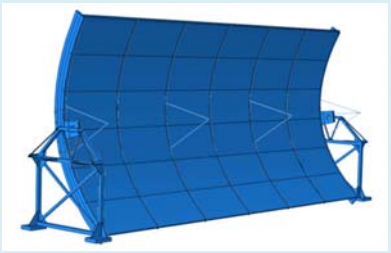
Hybrid systems among different renewables sources and gas plants

Concentrating Solar Power

- *A new, proprietary, cost-effective technology for solar energy conversion, also in co-production with fossil fuels*
- *CO2 emissions reduction*
- *Thermal energy storage for delayed use (night or no sun)*
- *Ongoing demonstration in an industrial site*

CASE STUDY: CSP development and deployment

Industrial objective from project start: a success story of academia and industry cooperation



Novel design

Simpler construction

Lower costs

Eni/MIT cooperation

R&D

Prototype Trough

PoliMi - Milano

Ready July 2016

R&D

Deployment 2017 - 2019

- *Assemini Renewable Park*
- *Algeria – demo site*
- *Tunisia – demo plant*
- *Masdar – Abu Dhabi test site*

10 -15 M€ investments

On-going projects

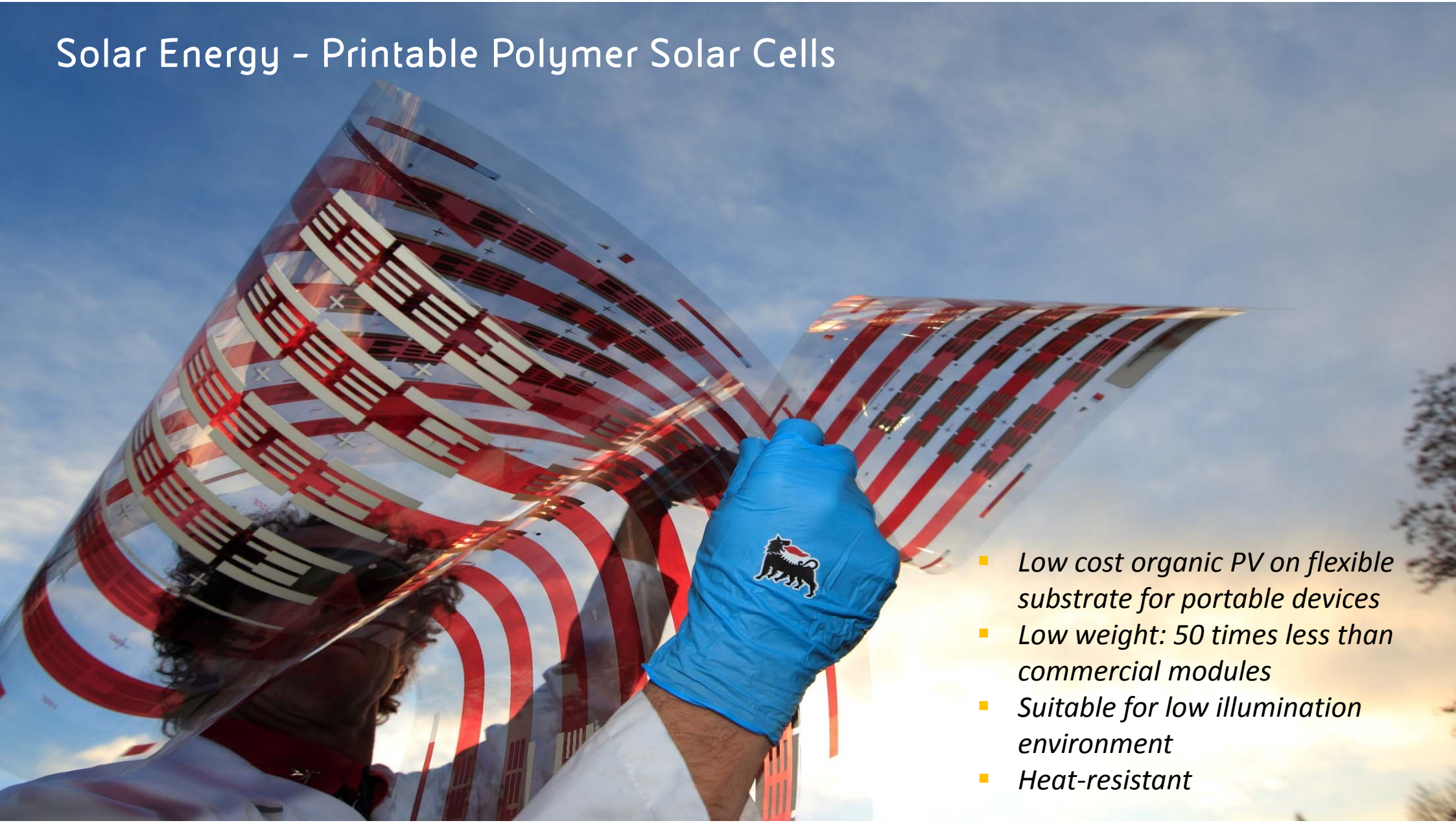
R&D/DES

Industrial phase

- *Low cost approach*
- *Brownfield/hybridization*
- *Local content*

DES

Solar Energy – Printable Polymer Solar Cells

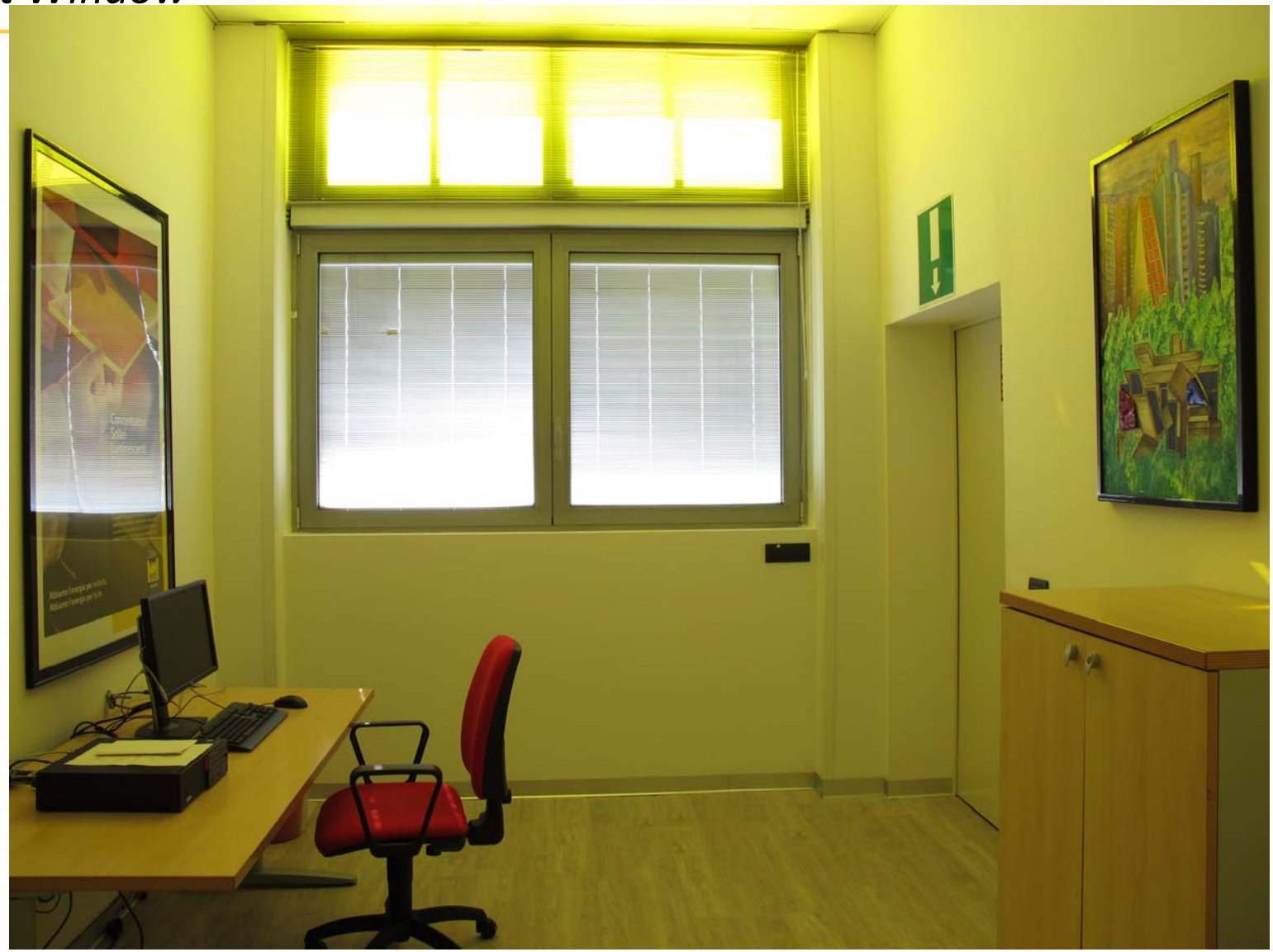


- *Low cost organic PV on flexible substrate for portable devices*
- *Low weight: 50 times less than commercial modules*
- *Suitable for low illumination environment*
- *Heat-resistant*

Luminescent Solar Concentrators & Smart Windows

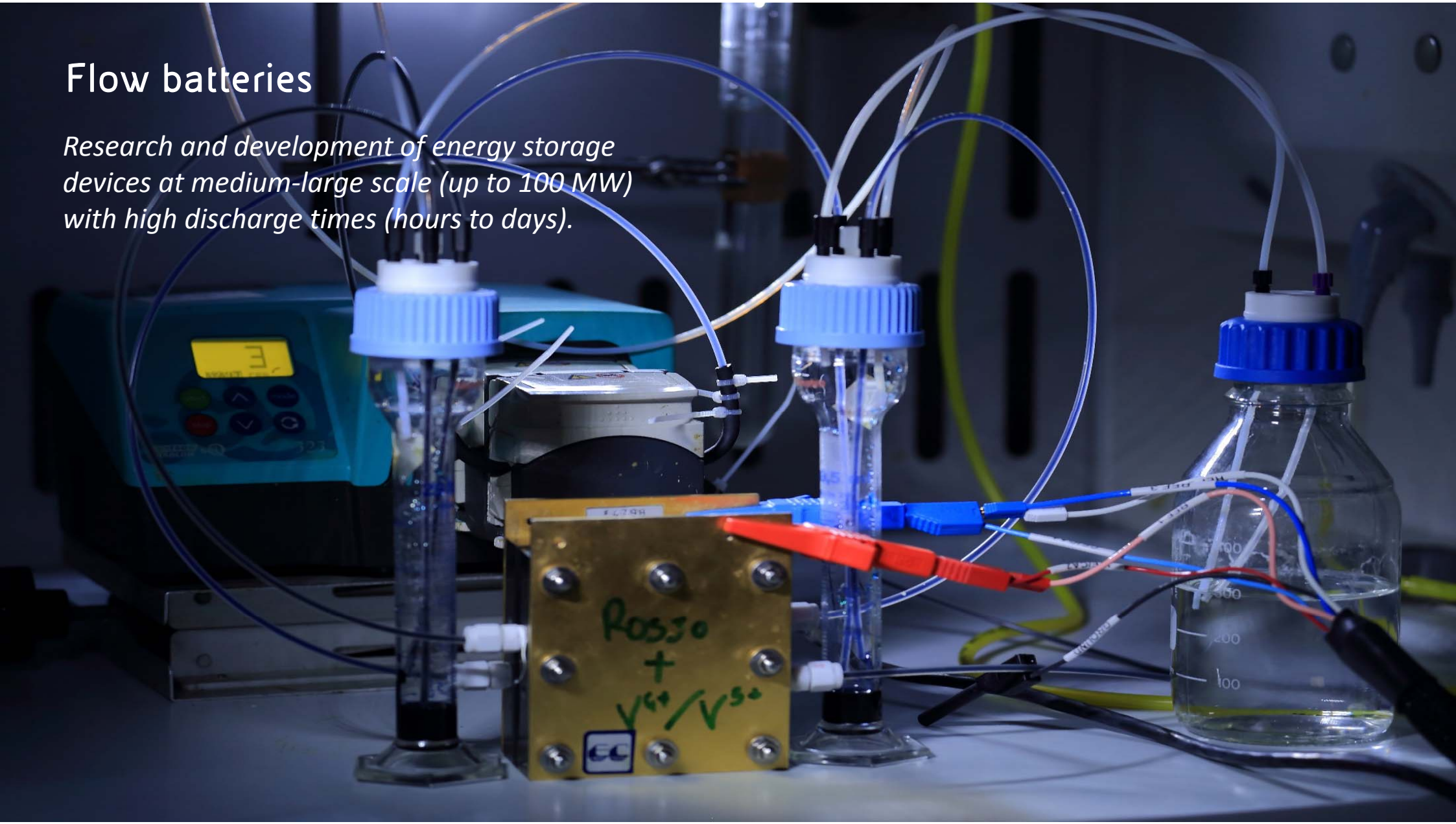
- *Semi-transparent PV devices using proprietary dyes and materials able to concentrate sunlight and shift spectrum*
- *Thanks to the complementarity to traditional PV, they can be applied on large areas such as building*
- *Smart windows enhance natural lighting and simultaneously produce electricity*

Smart Window



Flow batteries

Research and development of energy storage devices at medium-large scale (up to 100 MW) with high discharge times (hours to days).



Waste to fuel

This proprietary technology converts solid organic waste (not in competition with agricultural food production) into bio-oil that can be used for producing electricity or diesel fuel by using thermochemical conversion processes.

Fossil CO2 Biofixation

- *This fossil CO2 biofixation plant is using an exclusive patented process for Eni, which is based on "Intensified Photosynthesis reaction".*
- *The deployment of this technology will reduce CO2 emissions derived from several upstream assets.*
- *Furthermore, the bio-products can be commercialized, in particular the algal bio-oil can replace the palm oil as a feedstock of Eni Green Refinery for 3rd gen Green Diesel production.*

Environmental Technologies

- *Passive sampling methods*
- *Oil removal from water (absorbing materials incl natural fibers, hydrocarbon recovery)*
- *Mobility and bioavailability of contaminants in soil*
- *Bio-markers for environmental remediation (fingerprinting)*
- *DNA sequencing assisted remediation and monitoring protocols*
- *Phytoremediation of polluted soils*
- *Technical feasibility evaluations*

Collaborations

128

Collaborations with Universities and Research Centres World-wide

13/06/2017

Eni e l'Università di Bologna insieme per un nuovo paradigma energetico

Nell'ambito del G7 ambiente l'Amministratore Delegato di Eni, Claudio Descalzi e il Rettore dell'Alma Mater Studiorum Università di Bologna, Francesco Ubertini, hanno siglato a Bologna, alla presenza del Ministro dell'Ambiente Gian Luca Galletti, un accordo di collaborazione triennale su temi di ricerca e sviluppo attinenti al mondo dell'energia.