THE FUTURE OF ENERGY

A feasible roadmap for a sustainable future

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Turin, September 28th, 2017





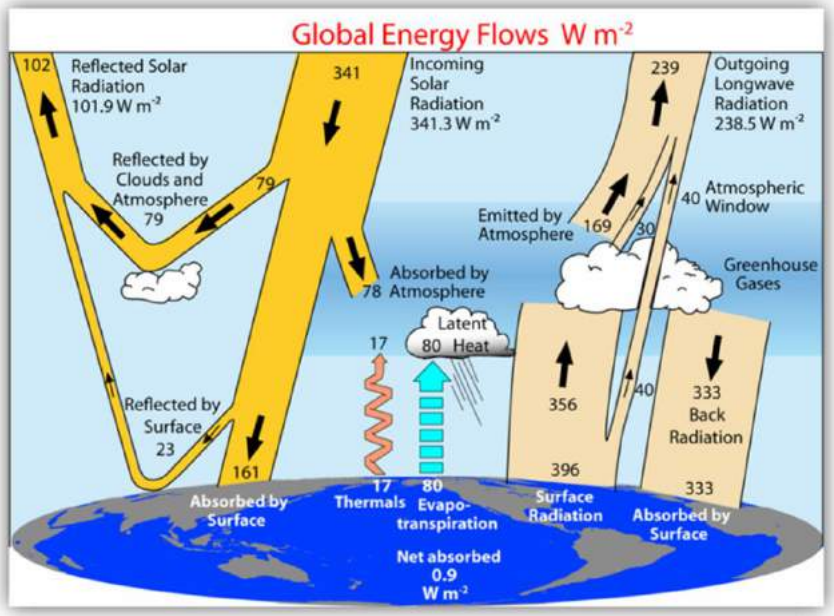




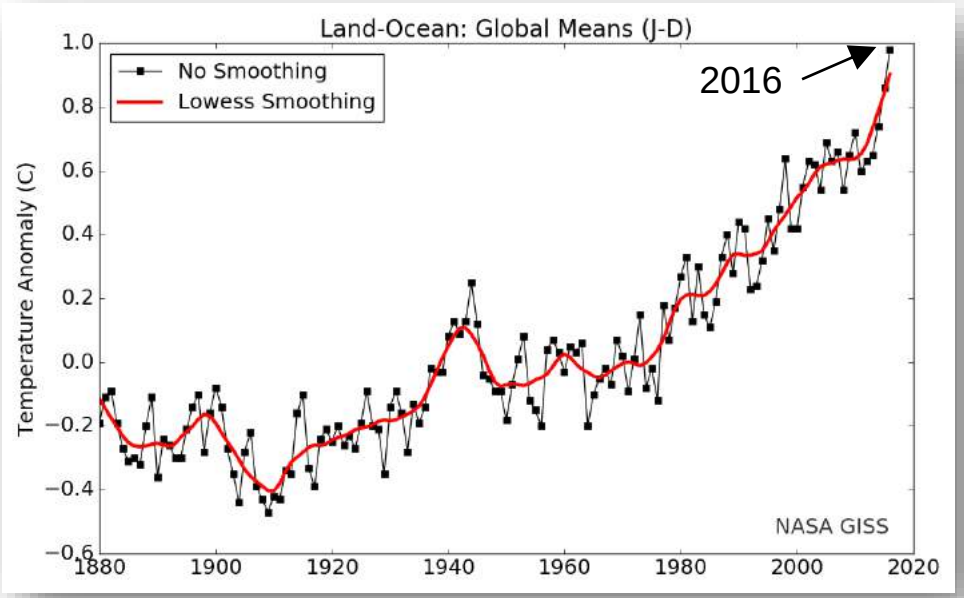
2016 data from GISS

NASA's *Goddard Institute for Space Studies*

In-out radiation has always been in "miraculous" perfect balance



A small imbalance in energy flows is responsible for the rise in Earth's average temperature

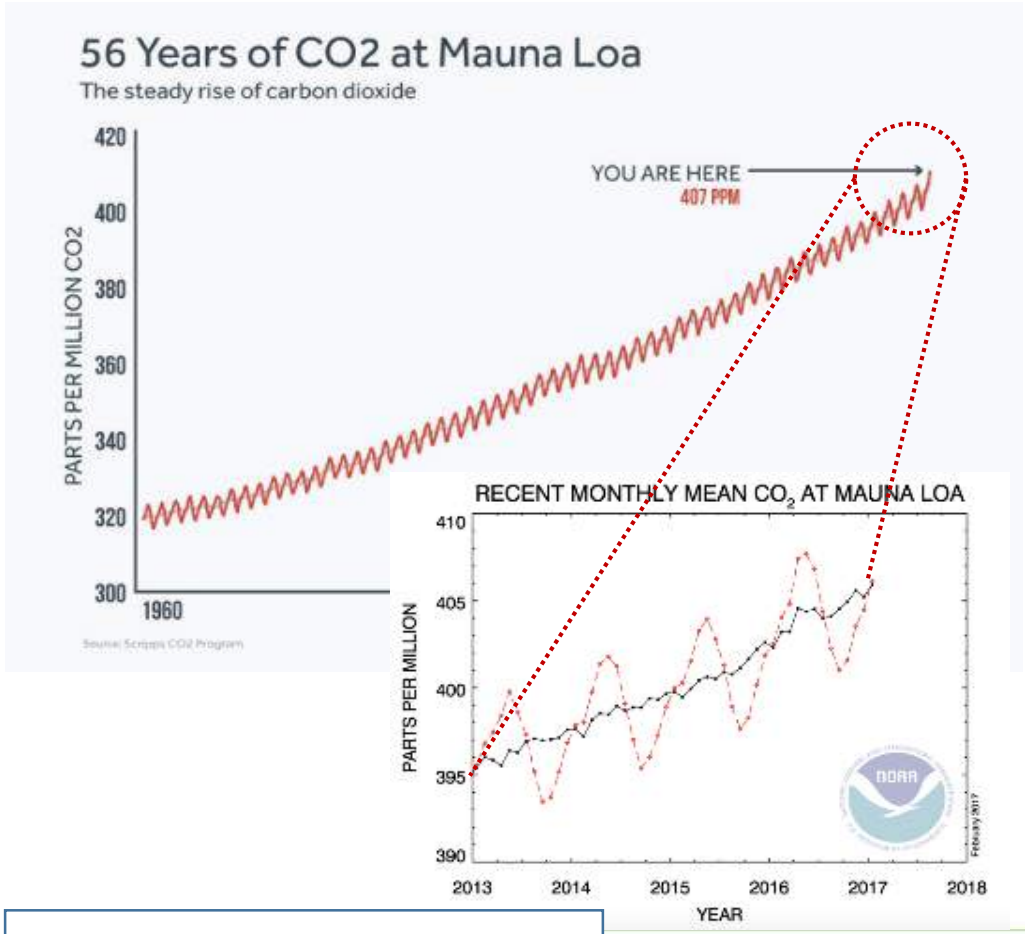


Global Warming Potential
of greenhouse gases (GHGs)

- Different GHGs have different effects on global warming.
- GHGs gases differ mainly in terms of their ”**radiative efficiency**" – effectiveness to restrict long-wave radiations from escaping back into space – and "**lifetime**" – persistence in the atmosphere.
- The notion of “**Global Warming Potential**” (GWP) was introduced to compare the effect of different GHGs on global warming. In particular, it is a measure of how much energy/heat a ton of the gas in question can absorb over a given period of time, in comparison to a ton of CO_2.
- The time unit for GWP is usually 100 years.
- **CO_2, by definition, has a GWP of 1** regardless of the time unit, since it is used as the benchmark gas.
- CO_2 remains in the climate system for a long time: emissions cause increased CO_2 atmospheric concentrations that last **thousands of years**.
- The GWP of methane was updated by IPCC (“*Intergovernmental Panel on Climate Change*”) in 2014, from 22 to 34. CH_4, on average, remains in the atmosphere only ten years, but it absorbs a lot more energy/heat than CO_2.

CO_2 increase

the main driver of global warming



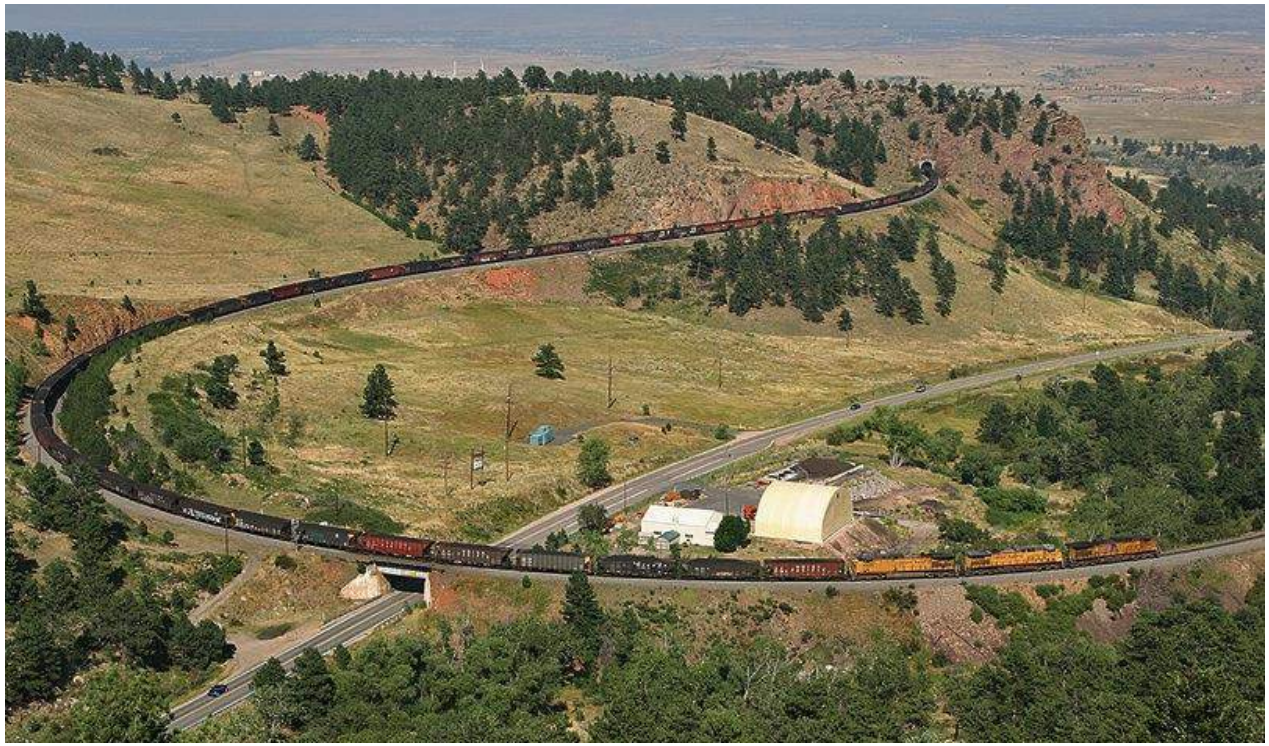
- Average atmospheric CO_2 concentration passed **400 parts per million** (ppm) two years ago.
- Pre-industrial level was **280 ppm**.
- A ppm of atmospheric CO_2 is equivalent to **2,1 billion tons of equivalent carbon content**.
- Therefore, man is responsible for the emissions of **262 billion tons of equivalent carbon content**.
- A pile of coal with the same equivalent carbon content would be as high as **mount Everest**.

National Oceanic and Atmospheric Administration
Earth System Research Laboratory - Hawai

CO_2 emissions from Italian cars

year 2015

CO_2 emitted by Italian cars in 2015 is equivalent to the amount produced by the combustion of **22 billion tons of coal**.



Such amount of coal would fill up a 14,000 km-long train (distance from Lisbona to Vladivostok).

Renewable Energy Sources

should be sustainable, too

Renewable energy sources are natural sources that **renew themselves over short periods of time** and can be exploited **almost indefinitely**.

A renewable source is defined **sustainable** if its regeneration rate is equal to or higher than its utilization rate.

This is particularly important for those resources – such as fossil fuels – whose regeneration rate is inconsistent with the utilization rate.

2015 - COP21

A historic agreement in Paris

Negotiations in Paris led to the **Paris Agreement,** encompassing post-2020 measures on climate change containment. With the adoption of this agreement, the work of Durban Platform came to an end. The agreement entered into force on November 4th, 2016.

For the first time in history, about 200 countries agreed on defining the goal of limiting warming to **well below 2 °C** above pre-industrial levels, while urging efforts to limit the increase to **1.5 °C**.

EU commitment to renewable energy sources

began in 1997

With the **1997 "White Paper"** on renewable energy sources, the UE set the following **targets for 2010:**

- a 12% share of RES in the Union's energy consumption mix;
- a 22,1% share of RES in the Union's power consumption mix.

In 2001, Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market, set for the first time binding targets for each Member State.

In the last 10 years

EU has gradually adopted a more comprehensive legislative framework

The lack of progress in meeting the 2010 targets led the European Union to adopt a more comprehensive and stringent legislative framework.

January 10th , 2007
The Commission outlined a long-term strategy for renewable energies up to 2020: «**Renewable Energies Roadmap.** Renewable energies in the 21st century: building a more sustainable future» (COM(2006) 0848).

April 23rd, 2009
Renewable Energy Directive (2009/28/EC). By 2020
(in comparison to 1990 levels):

- reduce GHG emissions by **20%**;
- reduce energy consumption by **20%**;
- reach a **20% share** (17% for Italy) of RES in the energy consumption mix.

October 4th, 2016
The European Parliament validated the ratification of the Paris Agreement. As a consequence, the agreement entered into force for all signing parties on November 4th 2016.

In order to implement the Paris Agreement

the EU (and Italy too) has to revise its 2030 goals

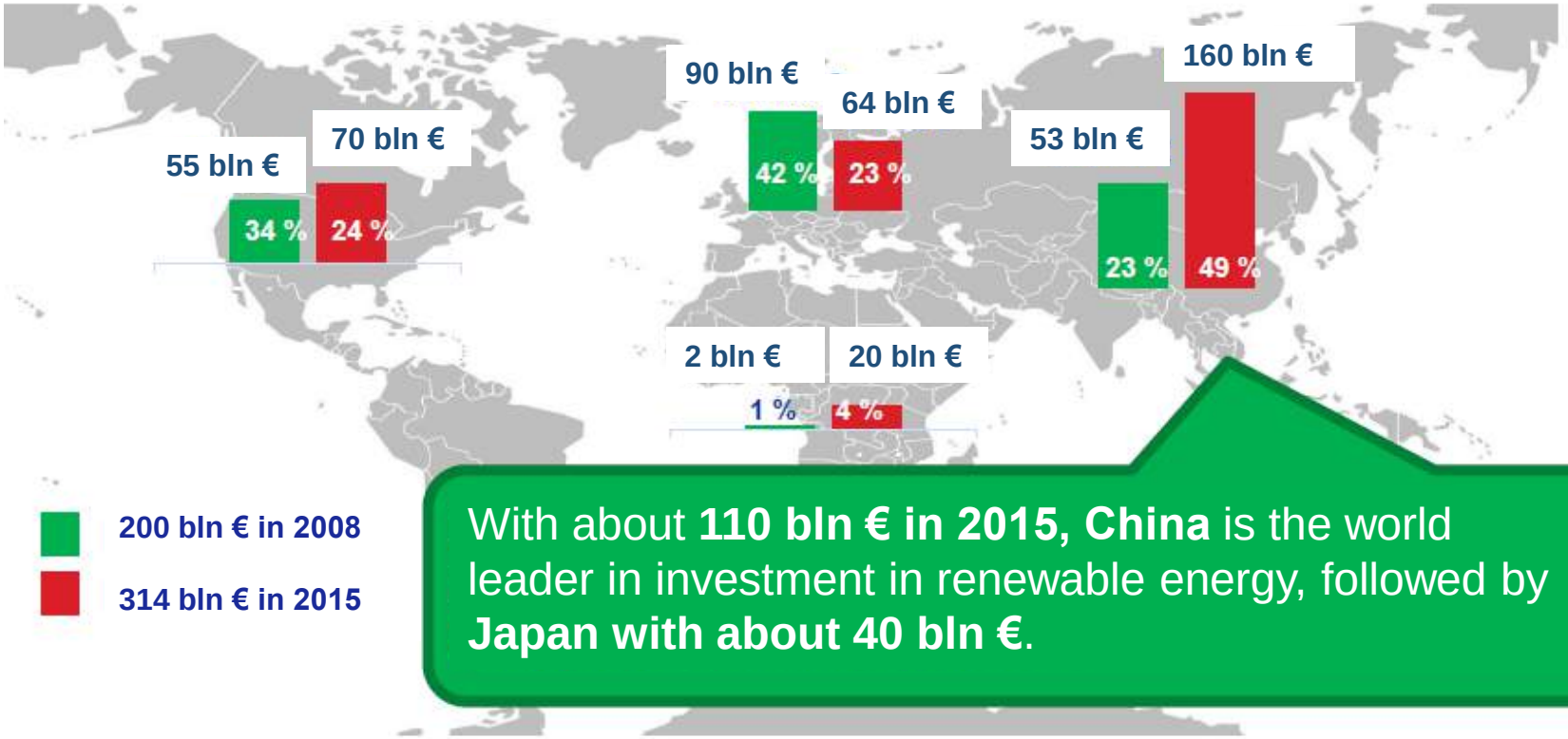
target	EU 2030 Pre COP21	**EU 2030 Post COP21**	ITALY 2030 Pre COP21	**ITALY 2030 Post COP21**
CO_2 emissions reduction (*vs 1990)*	-40%	**-55%[2]**	-38%[1]	**-60%[1]**
energy efficiency increase[3]	+ 27%	**+40%[2]**	+27%	**+40%**
renewable energy on final consumption	27%	**40%[2]**	24-27%[2]	**35%[1]**
renewable energy on power consumption	50%	**65%[2]**	50%[2]	**66%[1]**

Target for 2017 National Energy Strategy

(1) Source: Foundation for Sustainable Development
(2) Source: elaboration on data from assoRinnovabili
(3) Primes Scenario 2008

Renewables worldwide

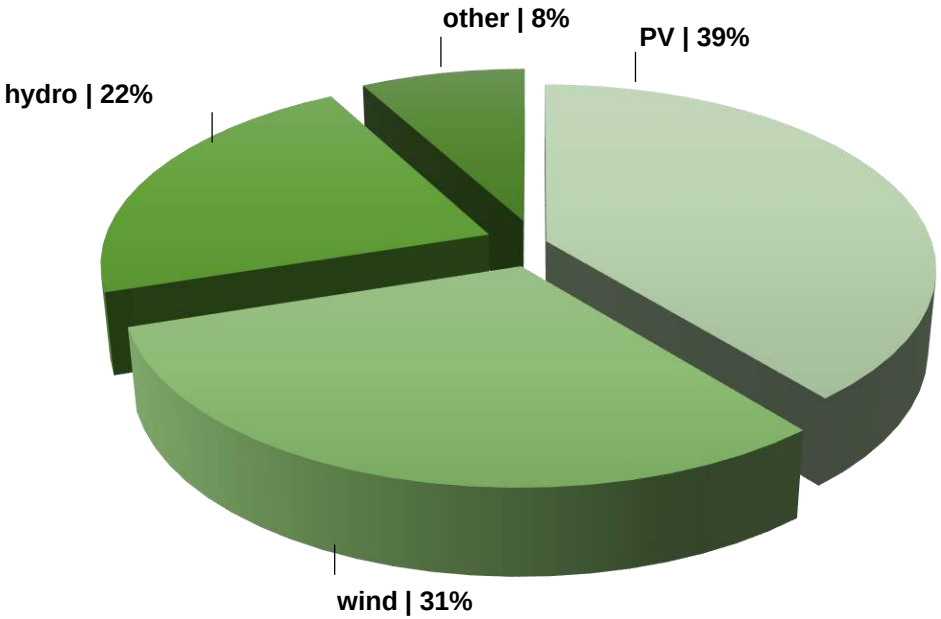
the geographical distribution of investments



With about **110 bln € in 2015, China** is the world leader in investment in renewable energy, followed by **Japan with about 40 bln €**.

Renewables worldwide

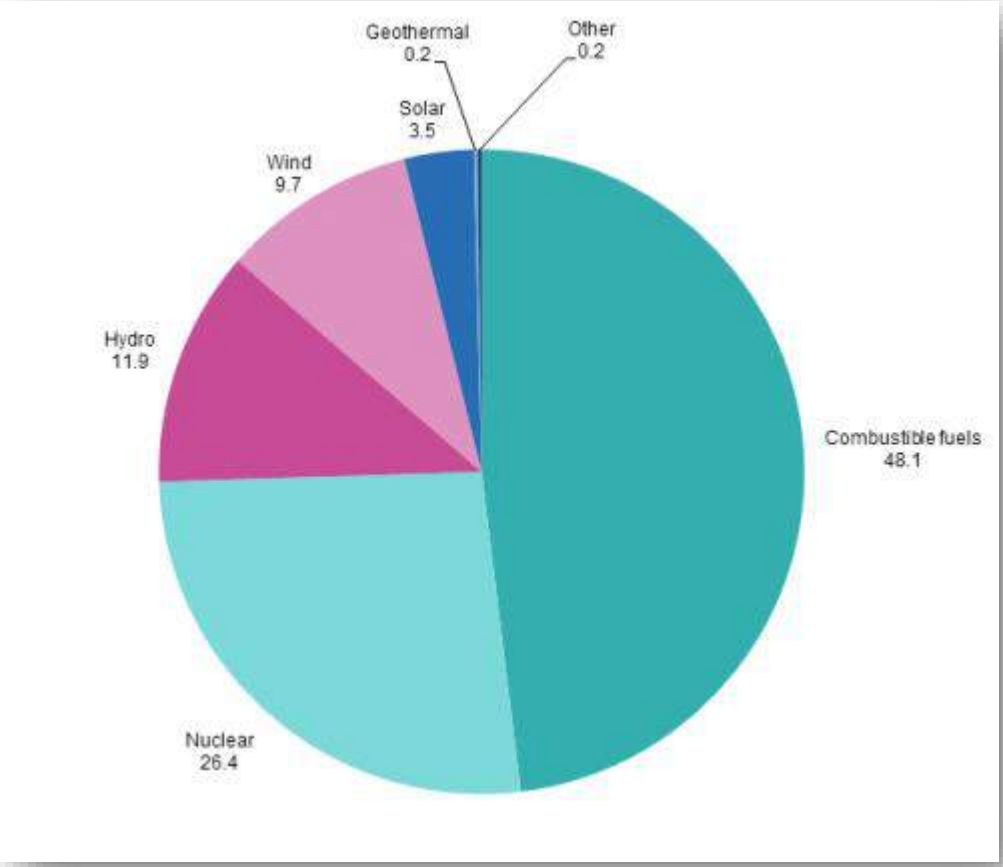
partitioning of investments per technology, 2015



Photovoltaic (PV), with more than **120 bln €,** is the first renewable energy source in terms of investments, counting for 39% of total investments, followed by wind with **92 bln €** (31% of total).

Renewable electricity generation in EU28

partitioning of total electricity generation, 2015



3.07 million GWh (+1.3 % vs 2014)

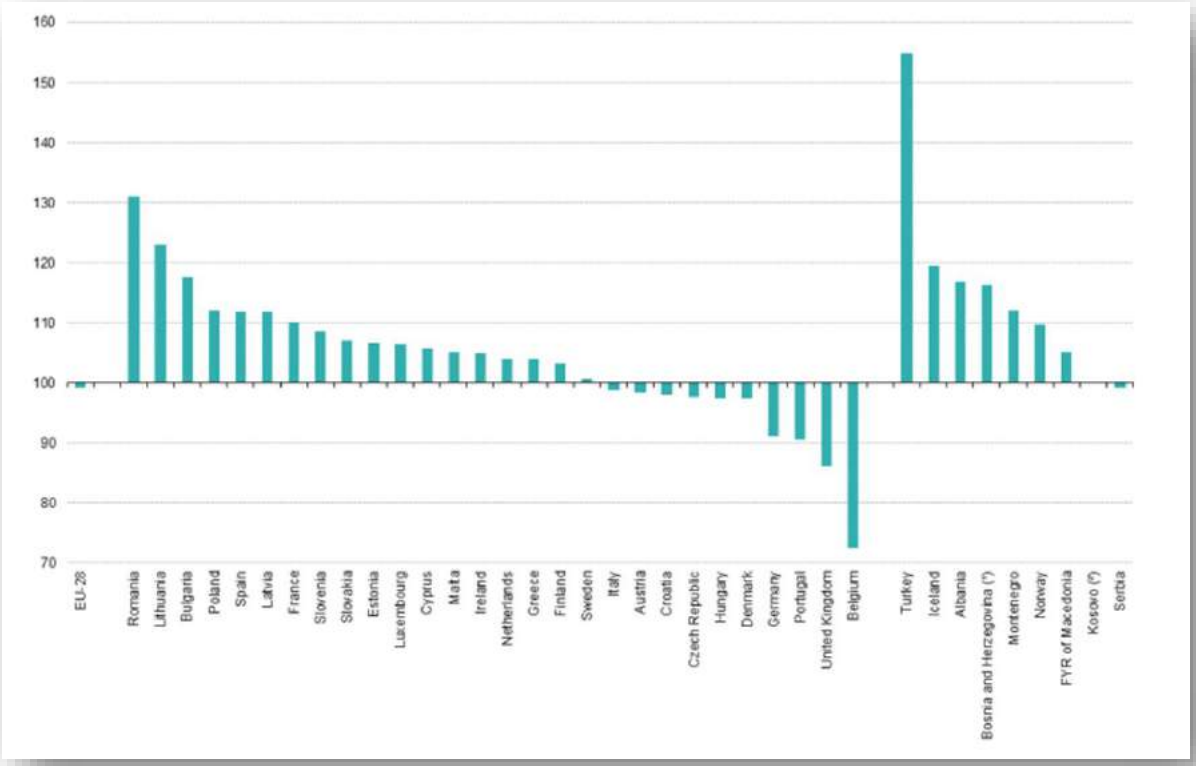
The level of net electricity generation in the EU-28 in 2015 was 4.5 % lower than its relative peak of 2008, when total output stood at 3.22 million GWh.

Energy consumption - Efficiency

Electricity consumption by households, 2015

Electricity consumption are likely to be influenced:

- by the average number of persons living in each household
- by the total number of households, both of which are linked to demographic events
- by extent of ownership and use of electrical household appliances and consumer goods
- by use of energy saving devices.



Source: Eurostat
Reference: 100 = 2005

Renewable electricity generation in Italy

	2010	2011	2012	2013	2014	2015
Gross Efficient Power (MW)						
Hydro	17.876	18.092	18.232	18.366	18.418	18.543
Wind	5.814	6.936	8.119	8.561	8.703	9.162
Solar	3.470	12.773	16.690	18.185	18.609	18.892
Geothermal	772	772	772	773	821	821
Bioenergy	2.352	2.825	3.802	4.033	4.044	4.057
Total	**30.284**	**41.398**	**47.615**	**49.918**	**50.595**	**51.475**
Gross power generation (GWh)						
Hydro	51.117	45.823	41.875	52.773	58.545	45.537
Wind	9.126	9.856	13.407	14.897	15.178	14.844
Solar	1.906	10.796	18.862	21.589	22.306	22.942
Geothermal	5.376	5.654	5.592	5.659	5.916	6.185
Bioenergy	9.440	10.832	12.487	17.090	18.732	19.396
Total	**76.965**	**82.961**	**92.223**	**112.008**	**120.677**	**108.904**
Gross Inland Consumption (GIC)	**342.933**	**346.368**	**340.400**	**330.043**	**321.834**	**327.940**
RES/GIC (%)	**22,4%**	**24,0%**	**27,1%**	**33,9%**	**37,5%**	**33,2%**

Source: elaboration on data from Terna

Asja is a first-mover

it started producing renewable energy in 1995, before the Kyoto Protocol was adopted

Asja generates **renewable energy** in Italy and abroad and designs, manufactures and sells **TOTEM micro-cogenerators**.

- Biogas
- Biomass
- Wind
- PV
- Micro-cogeneration

Asja: a growth path

1995-2017: 22 years of activity

«I have always believed in technology and innovation»
Agostino Re Rebaudengo

1995

Asja was born on **January 9th 1995** from the idea of transforming waste into the resource.

Since then there have been made many strides.

We went abroad in Argentina, China, Colombia (and not only), addressing, among the first, the difficult challenge of the Kyoto Protocol.

We started by just 10 asjaPeople from the early years, to more than **180 asjaPeople** today.

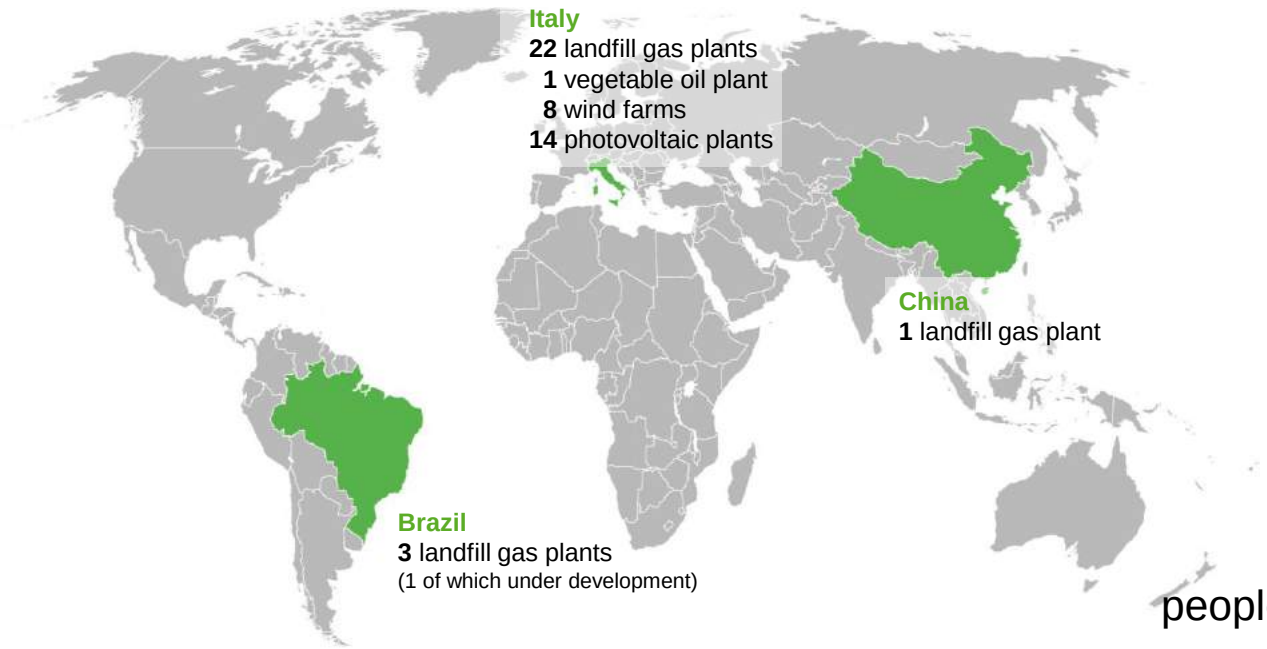
We have diversified our business in the **wind** energy sector (in **2001**), **photovoltaic** (in **2004**), in the production of **biomethane** from bio-waste (**2013**) and **energy efficiency** (the challenge of TOTEM, year **2013**).

1995-2017

Throughout this time we have produced clean energy enough to meet the energy needs of **7.5 million people for 1 year** (the inhabitants of Piedmont, Liguria and Sardinia).

ASJA WORLDWIDE

200 MW installed power



581,000 MWh
green energy produced

1,560,000 tons
CO_2 avoided

940,000
oil barrels saved

860,000
people enjoying clean lighting from our green energy

Data refer to 2016 production

The Gold Standard
Premium quality carbon credits
Applicant 3122 - 3434

The CO_2 emission reduction projects of Belo Horizonte and Uberlândia in South America have been registered under the **Gold Standard**.

ASJA RENEWABLE ENERGY PLANTS

8 wind farms

105 MW installed power

14 photovoltaic plants

11,6 MW installed power

ASJA RENEWABLE ENERGY PLANTS

Landfill gas plants

We generate energy from landfill gas

Asja is a major player in the international scenario of power generation from landfill gas generated at municipal solid waste (MSW) landfill sites.

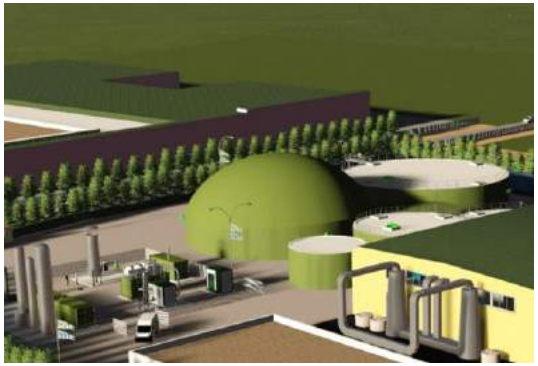
Biomass power plants

We generate energy from biomass

Asja designs, builds and manages plants that generate energy from vegetable oils or from animal fat.

Biomethane plants

We produce biomethane from wastes



A new frontier in waste-to-energy systems.

Production of biomethane from the organic fraction of municipal solid waste and from by-products from the agro-industrial sector.

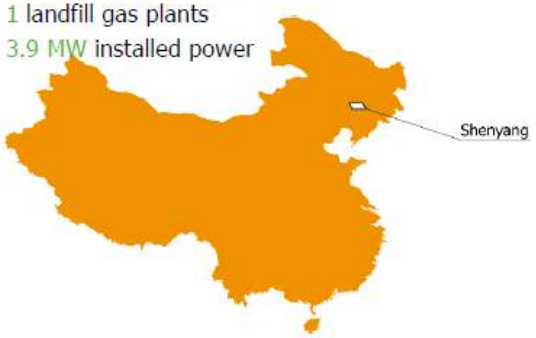
26 LANDFILL GAS PLANTS
71.6 MW installed power

Italy

21 landfill gas plants
1 biogas plant from OFMSW (under construction)
55 MW installed power

China (CDM projects)

1 landfill gas plants
3.9 MW installed power



Brazil (CDM projects)

2 landfill gas plants
12.7 MW installed power

MICRO COGENERATION

22 to 50 kW heat / 10 to 25kW power

We invest in energy efficiency

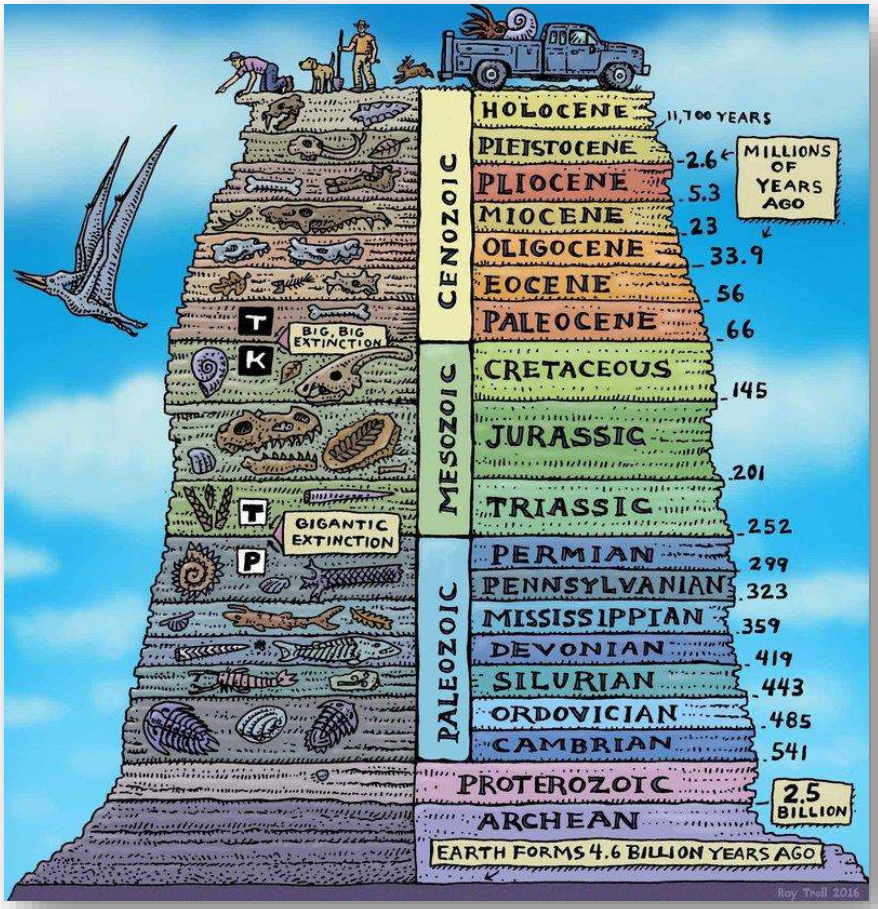
Asja manufactures and sells high-efficiency TOTEM micro-cogeneration units designed to generate both heat and electricity at the same time by using one type of fuel.

Currently marketed in many European countries, the **TOTEM micro-cogenerators** are the ideal solution to cut energy bills while protecting the environment.

WHAT ABOUT THE NEXT ENERGY TRANSITION?

New Era

Welcome to Anthropocene!



The Holocene has been a good time for human civilization to emerge and thrive. The seasons have been pretty regular, moving between relatively mild boundaries of hot-ish and cold-ish. That transition was the key change and allowed humans to get stable and productive agriculture started.

But, thanks to civilization, the Holocene is now at an end.

Scientists now recognize that **our impact on Earth has become so significant we've pushed** it out of the Holocene **into the Anthropocene**, an entirely new **geological epoch dominated by our own activity**

New Era

Transition to a new planet

The need for a new energy transition will be faster than the previous ones

- **The current transition will largely be based on the renewable energy revolution that has been in place for years.**

The energy transition will be different from the others - Towards an integrated man-Earth system

- **The problem is not just how to “save the planet," but how change so it works, respecting the rights of the people living there and the value they attribute to it**
- **Human activities is now part of the many streams and cycles of the Earth system, and that the latter is increasingly dependent on the political and economic systems of its human component.**

Targets for 2050 - A year-by-year commitment we had never seen

- **Many countries are still committed to reduce of about 80% their emissions according to COP in Paris by 2050.**
- **Emissions will have to be reduced by 4% annually for about 35 years.**

Targets for 2050

Transition to a new planet

Power generation & distribution

It can almost totally eliminate CO2 emissions by 2050.

- Electricity could partially replace fossil fuels in transport and heating.
- Electricity will come from renewable sources like wind, solar, water and biomass or other low-emission sources like nuclear power plants or fossil fuel power stations equipped with carbon capture & storage technology. This will also require strong investments in smart grids.

Transport

Emissions from transport could be reduced to more than 60% by 2050.

- In the short term: more fuel-efficient petrol and diesel engines.
- In the mid- to long-term: plug-in hybrid and electric cars
- Biofuels will be increasingly used in aviation and road haulage

Buildings

Emissions from houses and office buildings can be almost completely cut – by around 90% in 2050. Energy performance will improve

Industry

Energy intensive industries could cut emissions by more than 80% by 2050.

- Up to 2030 and just beyond decreases in energy intensity.
- After 2035, carbon capture & storage technology applied from industries unable to make cuts in any other way

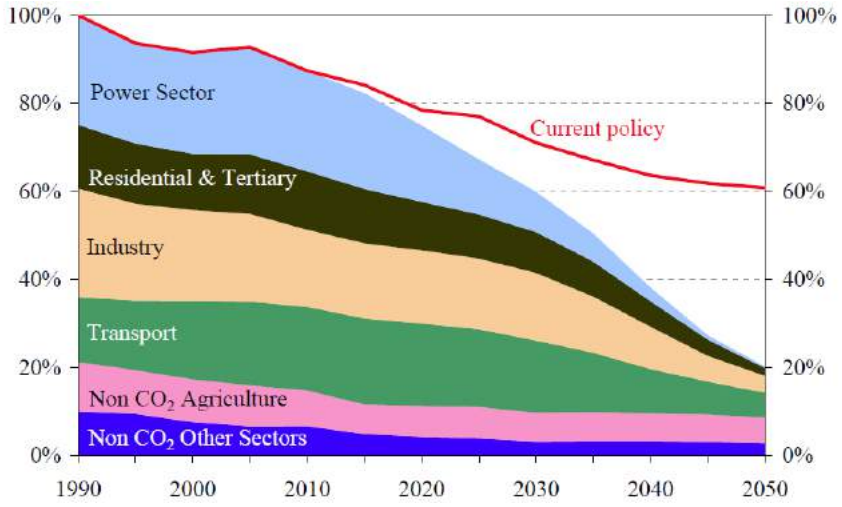
Agriculture

As global food demand grows, the share of agriculture in the EU's total emissions will rise.

- cut emissions from fertilizers, manure and livestock
- storage of CO2 in soils and forests.
- healthy diet with more vegetables and less meat can also reduce emissions.

By 2050, **the EU should cut greenhouse gas emissions to 80% below 1990 levels**

- Milestones to achieve this are 40% emissions cuts by 2030 and 60% by 2040
- All sectors need to contribute
- The low-carbon transition is feasible & affordable.



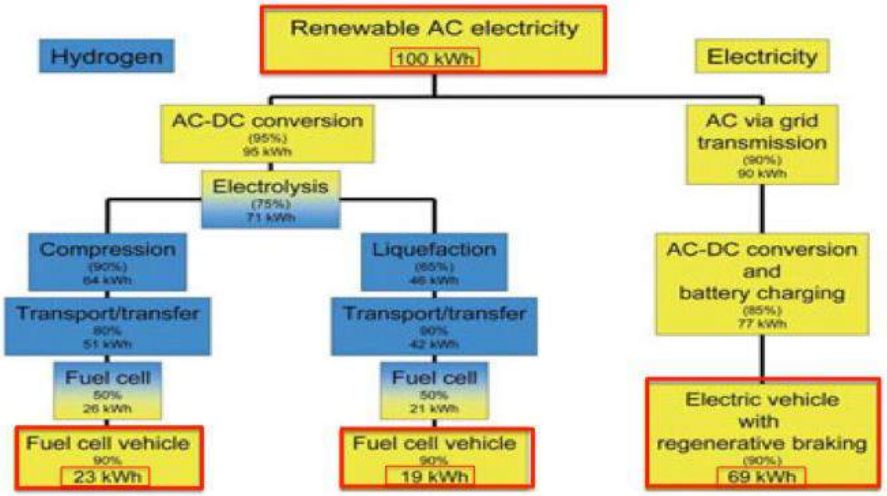
From: EU commission - Climate action

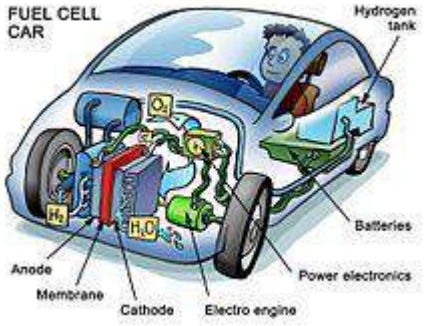
Hydrogen Challenge

For sustainable transports

Hydrogen seems to be the best candidate for a sustainable and clean energy for Transports

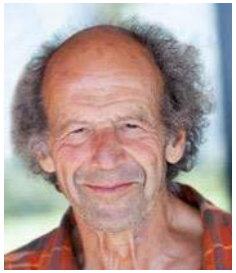
- **Hydrogen is not an energy source:** it's an energy carrier, it's a form of storage.
- **Hydrogen is not always 'Renewable'**: it is if it comes from primary energy sources like the sun, but it's not if it's from coal, natural gas, or uranium to generate the power needed to extract Hydrogen from a source material like natural gas or water.
- **Hydrogen needs dedicated infrastructure**: they are extremely delicate in terms of seals and transport efficiency. Hydrogen can't be stored and moved at gaseous phase.





Climate geoengineering

A chance to manage the atmosphere



In 2008 l' *American Physical Society* has gathered in Calgary three great scientists to discuss themes of **climate geoengineering technologies** for the management of the atmosphere.

1. **Klaus Lackner** from Columbia University presented his idea of "artificial trees", based on CO_2 capture by sodium hydroxide
2. **Peter Eisenberger**, of Columbia, proposes to use heat (eg concentrated solar energy) for the selective adsorption of CO_2 on amine beds
3. **David Keith,** at the time of the University of Calgary and today at Harvard, presented his proposal to cool the planet by introducing **sulfur particles** in the stratosphere that would capture part of solar radiation.

No one left Calgary thinking that direct capture of CO_2 was an instrument available to carry out large-scale geoengineering.

Unfortunately, at present, direct air capture can not be developed on a significant scale because there is no reliable technology to absorb CO_2 from the air that is both practical and economical.

CO_2 –trapping artificial trees

by Klaus Lackner

Prototypes are currently under development by the **Georgia Institute of Technology**, the **Tucson Global Research Technologies,** the **Columbia University**, the **University of Calgary** and the **Zurich Institute of Technology**.

A fan pushes air through reel-type resin filters with straw-sized holes. As air passes through, CO_2 reacts with the hydroxide contained in the resin filters, according to the following reaction:

$2\ NaOH + CO_2 = Na_2CO_3 + H_2O$

This reaction takes place in two stages:

$NaOH + CO_2 = NaHCO_3$

$NaHCO_3 + NaOH = Na_2CO_3 + H_2O$

As filters get saturated, the CO_2-releasing reaction is activated.

While it takes a year for a chestnut tree to absorb a ton of GHGs, an artificial three can do it in just one day.

Global Thermostat's "GT Solution"

by Peter Eisenberger

Peter Eisenberg's technology uses only process heat (and heat from concentrated solar thermal plants, in the future) to capture CO_2.

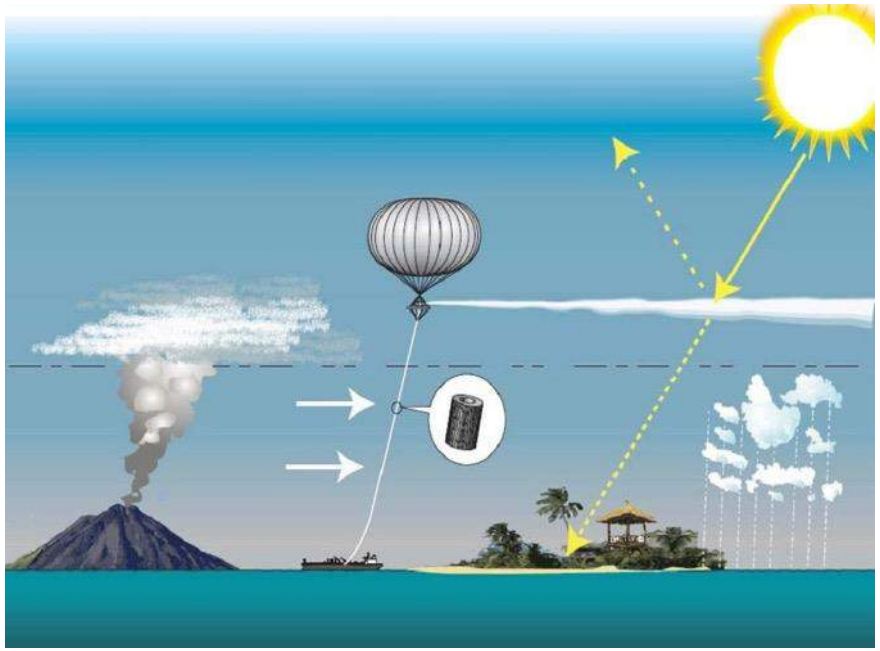
Global Thermostat's patents are based on the concept of **adsorption from appropriate substrata (amines or zeolites).** As air passes through the filter, it comes in contact with the sorbent material that bonds CO_2, while nitrogen, oxygen and the remaining substances are released back into the atmosphere.

As filters get saturated with CO_2, a process of regeneration is activated. Trapped gas is then released by the sorbent and pressed until it reaches a liquid state.

An experimental plant has been operating since 2010 at SRI International in Menlo Park, CA.

The sun shield

by David Keith



The ability of stratospheric sulfate aerosols to create a global dimming effect has made them a possible candidate for use in solar radiation management climate engineering projects to limit the effect and impact of climate change due to rising levels of greenhouse gases.

David Keith suggested to inject sulfide gases such as **dimethyl sulfide, sulfur dioxide (SO2), carbonyl sulfide, or hydrogen sulfide (H2S)** into the stratosphere by means of artillery, aircraft or balloons.

This method could rapidly counter climate change in a cost-effective and reversible way.

However, addressing global warming do not solve the problem of rising CO_2 emissions.

For an integrated and sustainable energy system

where man becomes part of the ecosystem

we have to act along four lines:

1. **Energy consumption and production optimization**
2. **Further improvements in renewable energy technologies (Wind – Water – Sunlight)**
3. **Biomass sustainable management**
4. **Biotechnologies**

A comparison between microalgae and other crops

an example drawn from biodiesel production

In terms of biofuel production potential, no biomass can compete with algae, both from a quantitative and quality perspective.

Raw material	Lipid content (%)	Kg biodiesel / ha
CORN	4	152
SOY	18	562
JATROPHA	28	656
RAPESEED	41	946
SUNFLOWER	40	1 156
PALM OIL	36	4 747
MICROALGAE	30	51 927
MICROALGAE	50	86 515
MICROALGAE	70	121 104

Source: ENEA

Biodiesel production process from microalgae includes many stages: biomass feedstock production; separation of cells from farming substrata; lipid extraction.

The remaining stages are akin to those needed for biodiesel production from other raw materials.

Jobs in renewable energy

Some figures for economy impact

- **Green jobs are professionals with green expertise**, whose work is aimed at producing eco-sustainable goods and services or at reducing the environmental impact of industrial processes.
- Green jobs usually require **higher levels of education**: 40% of new employees in the green sector hold a degree vs about 12% in other sectors.
- Demand for green jobs is the highest in the building sector, counting for about 30% of new hires, for less than 20% of new employees in the manufacturing sector and less than 10% in the tertiary.
- As for the **company size**, demand for green jobs is rather homogeneous: from 11,9% in small firms (10-49 employees) to 13,6% in large enterprises (250-499 employees).
- There is a link between green economy, **innovation and competitivity**, not only in terms of a company's economic performance but also from an employment perspective: 66,2% of new hires in planning/design and R&D areas are professionals with green expertise.

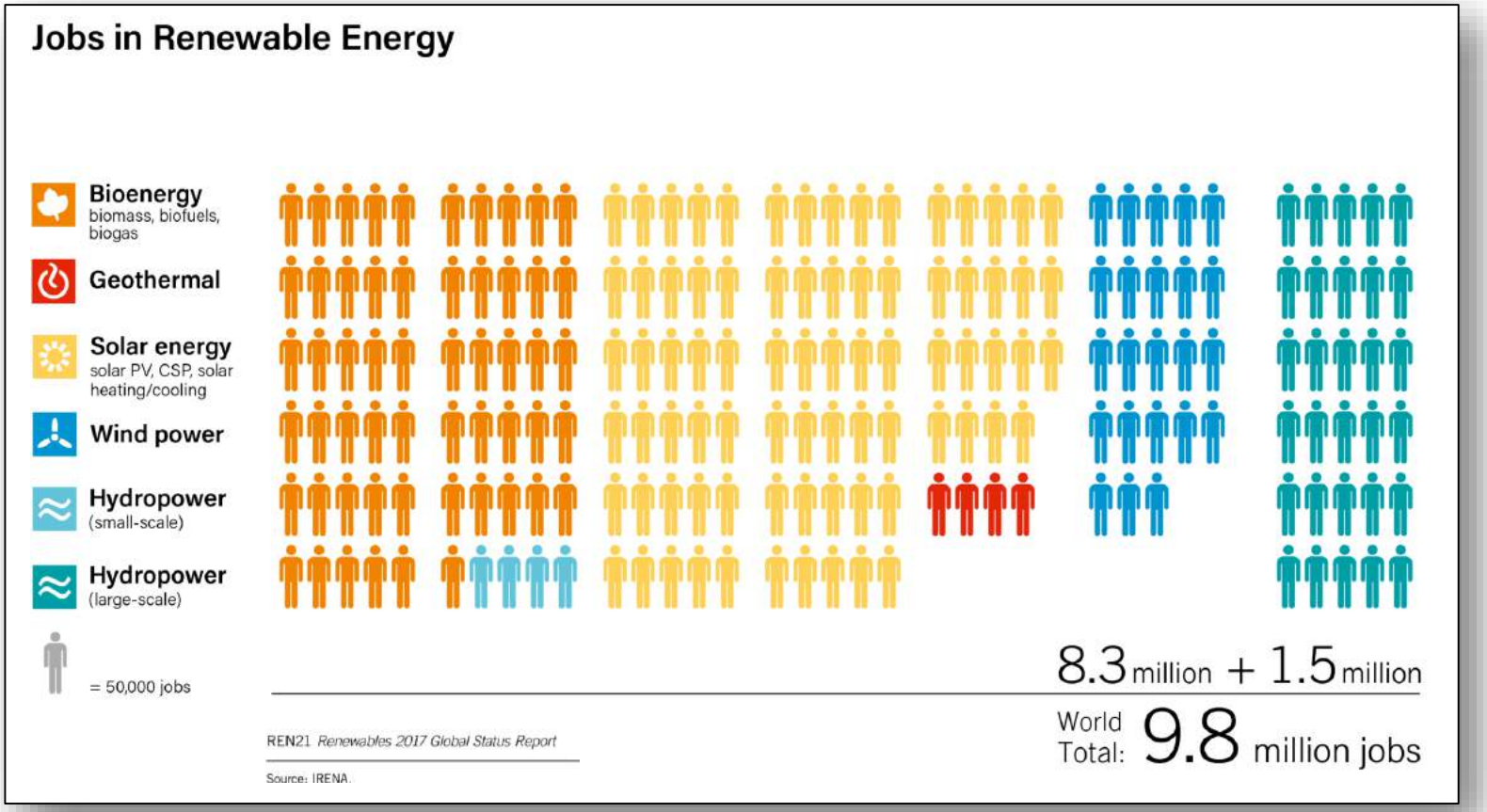
Renewable energy sources and energy efficiency — 8 FTE

Fossil fuel industry — 2 FTE

(2016 study from the University of Massachusetts)

Jobs in renewable energy

Some figures for economy impact



ASJA Research & Development

We invest in the future

Asja believes that research is fundamental for its work, hence its main activities in the field:

- AsjaLab: lab-based research into anaerobic digestion of waste and by-products;
- Biomethane: biogas upgrading technology studies, development and application;
- Micro-cogeneration: development of energy-efficiency projects.

Corporate Social Responsibility

MAcA - A come Ambiente Museum of Turin

We are active partners in Museo A Come Ambiente, an interactive museum aiming at environmental awareness education and dissemination.

We support modern art through Sandretto Re Rebaudengo Foundation.

Every year we award the best documentary among the ones competing in the Cinemambiente Film Festival in Turin (Italy).

We take part to the World Environment Day with initiatives aiming to improve environmental awareness.

We support the Poligrow Foundation in the implementation of social and environmental projects in disadvantaged areas of Colombia.

We do not live in the best of all possible worlds, but we live in the BEST WORLD SO FAR.

WE MUST ENSURE that this will be true for future generations as well.

green energy by asja

Thanks!

