Facing Energy future :

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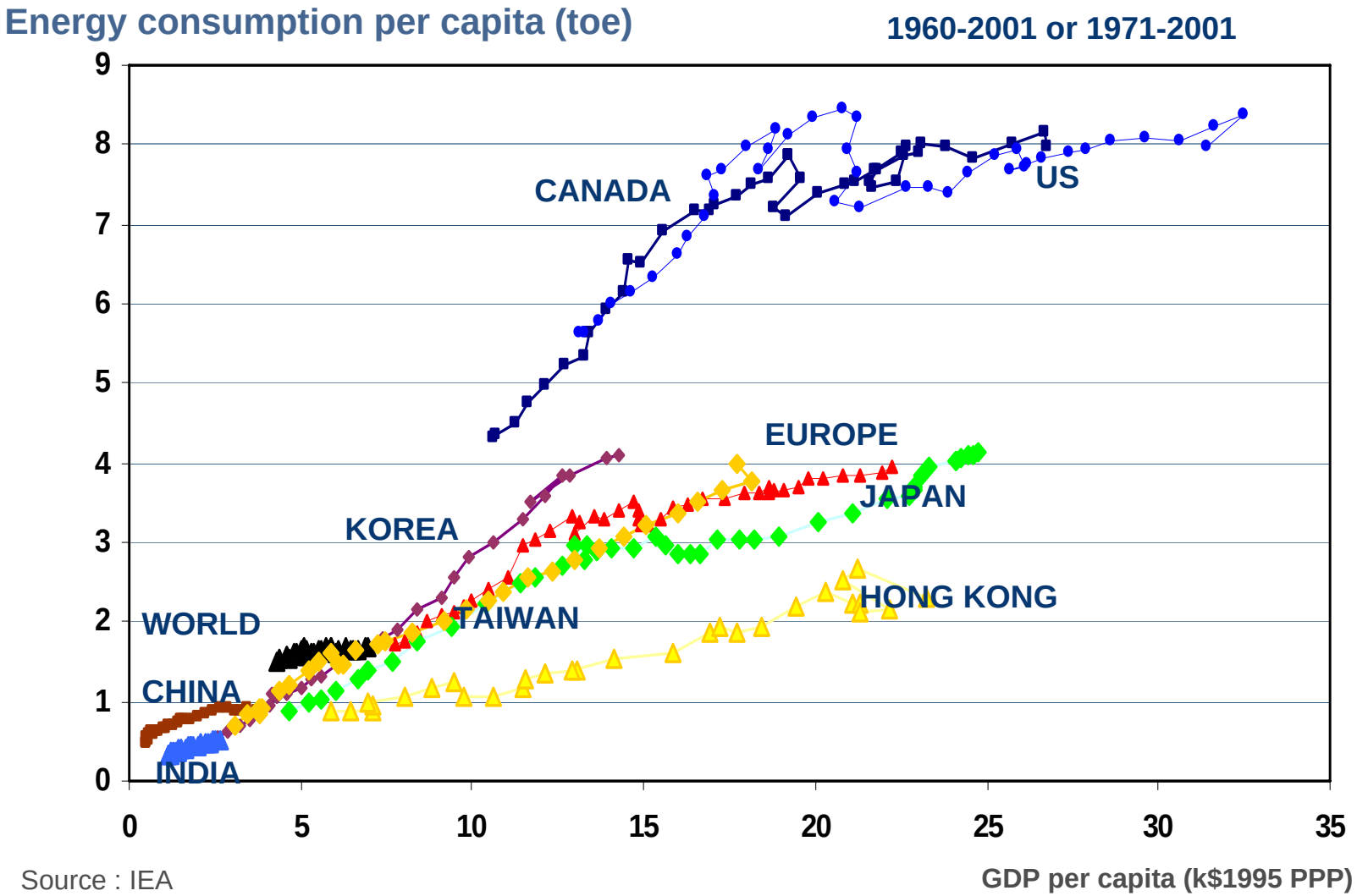
TOTAL

Energetic needs associated to development

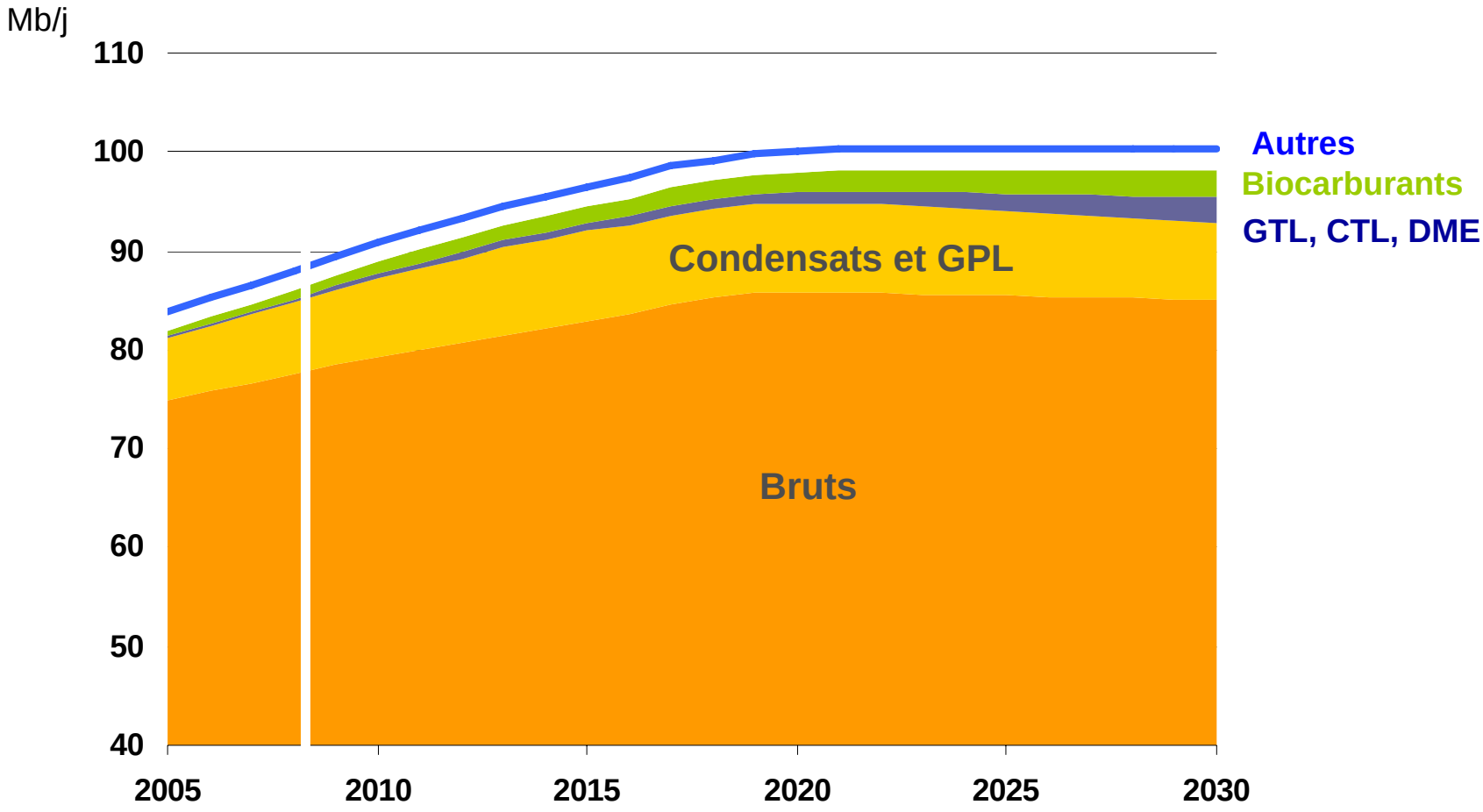


Source : IEA

At least 1 G extra people in their way to modern development

Total production assessment.

Demand will have to adapt to a production limited to about 100 Mb/d after 2020



- Until 2020, an average demand growth of 1.2%/y (1Mb/d)
- Productions limited to 100 Mb/d, including XtL and biofuels
- After 2020, important energy efficiency requirements

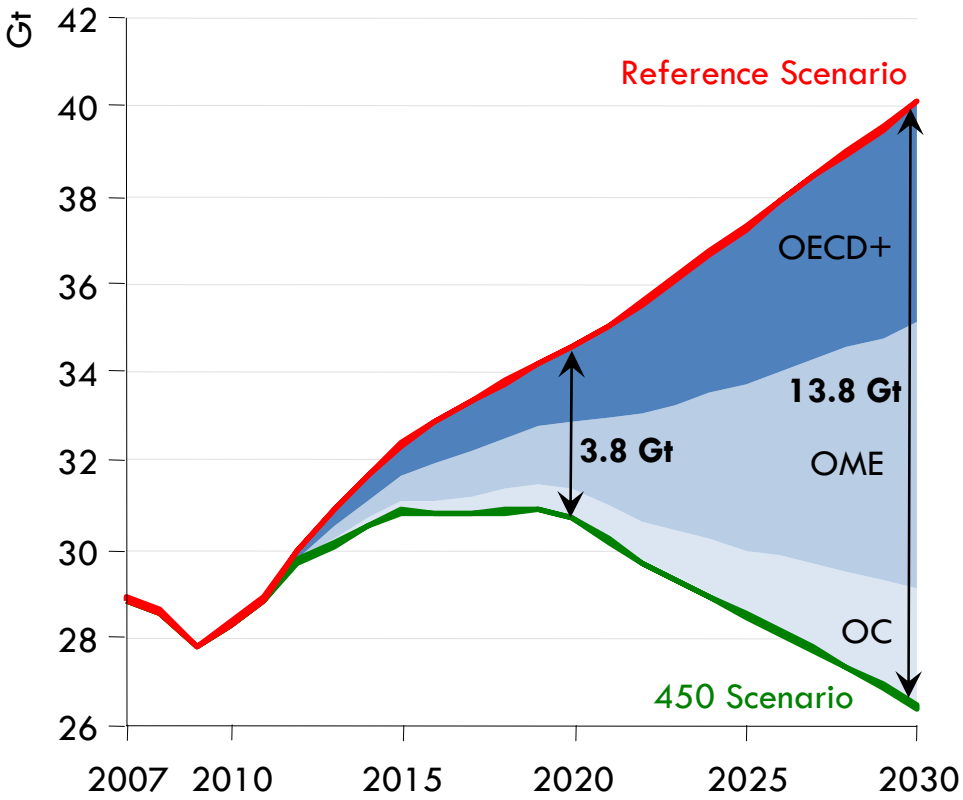
Challenges of climate change and its impacts

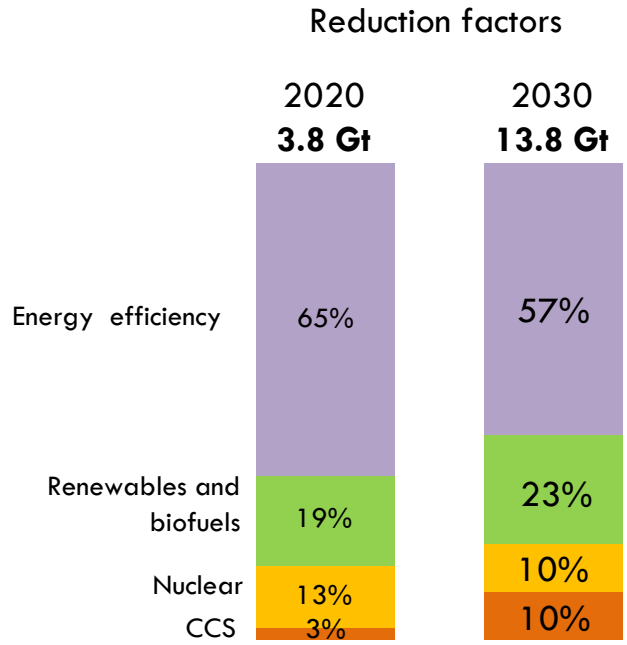
- **Observed and expected regional changes**
  - Rainfall
  - Extreme events
  - Sea level
  - Sea ice – polar caps
  - Species migrations
  - Seasonal changes in ecosystems
  - Agriculture and forests
  - Socio-economic effects

  ...

- **Recommendations and policies (GIEC, economist, Grenelle, UE…)**
  - Develop energy efficiency, energy mix, and CCS
  - Act at the soonest
    - ➢To avoid temperature rise above 2°C
    - ➢ Because investing now is cheaper than adaptation
  - Prepare impact management

World reduction of CO_2 emissions in the energy sectors in the 450 ppm scenario

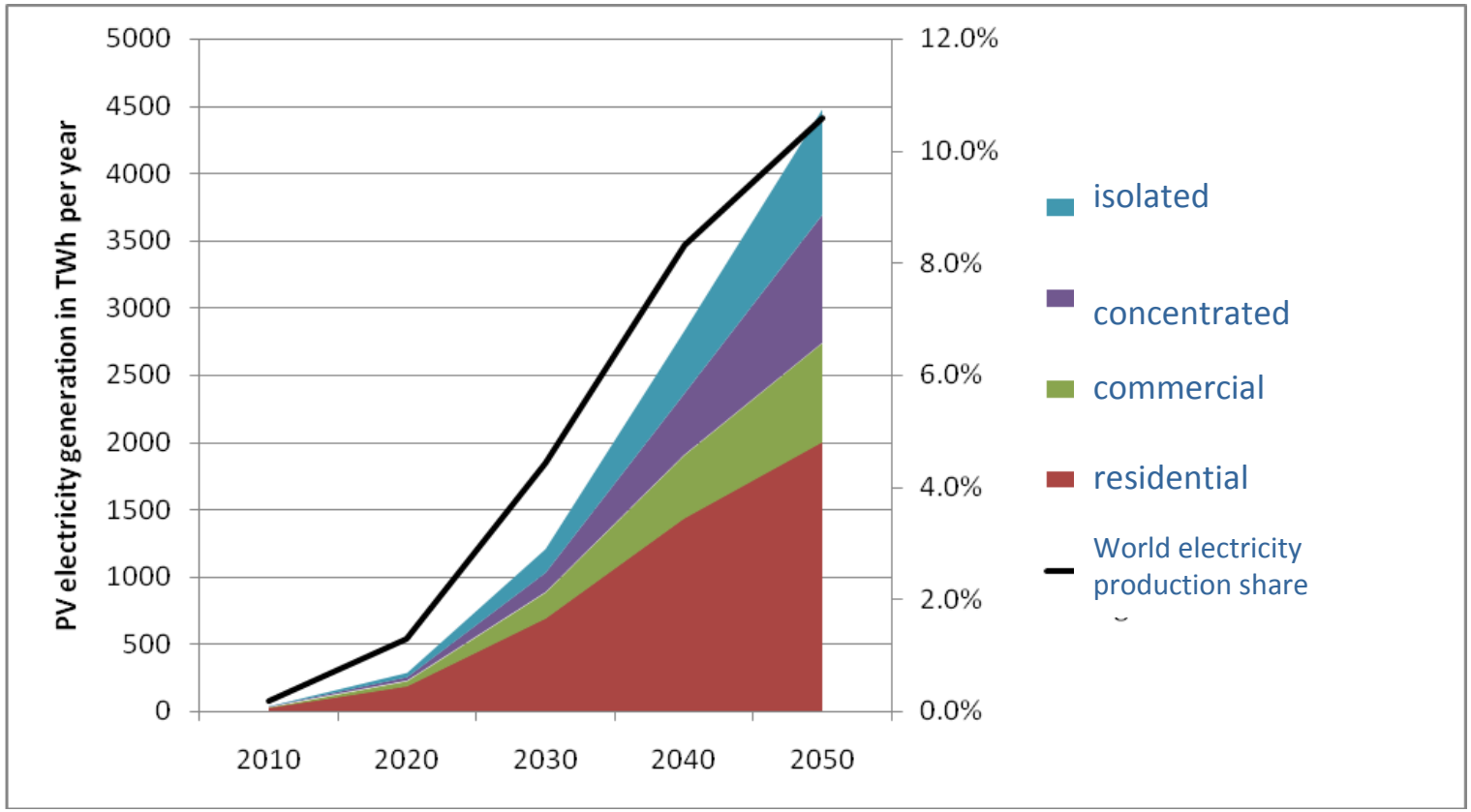




- ***Additional investment in the 450 ppm scenario is 10.5 trillions dollars by 2030. More than half of the reduction should come from energy efficiency.***
- ***Renewable energies being the second source of reduction***

Scenario for solar PV

PV electricity production (TWh/yr)



Source: IEA, Solar PV Roadmap (2009).

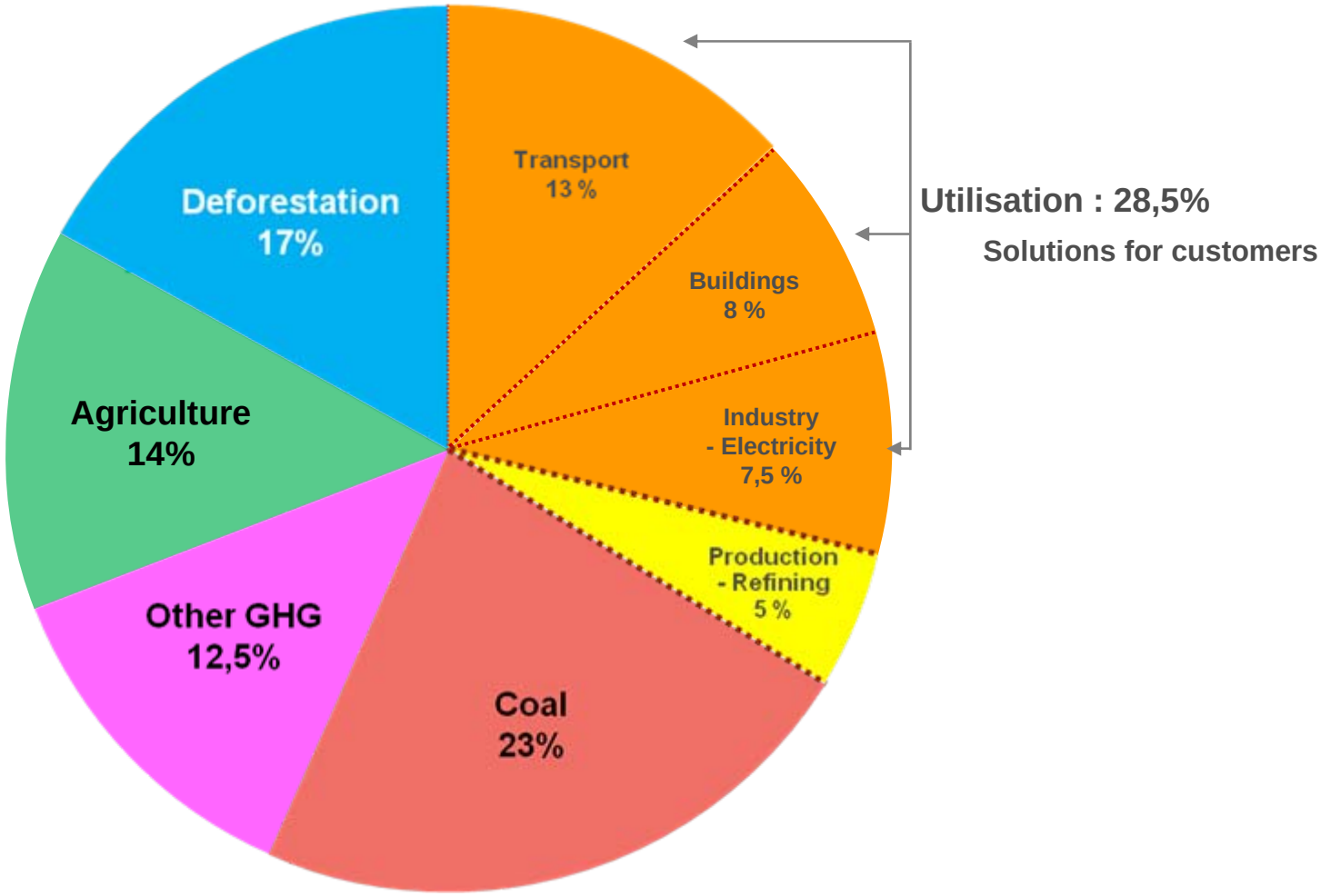
PV can provide 11% of world electricity production in 2050

The environmental constraints

- Green house gases
- Water, oil, soil, biodiversity
- Toxicity and ecotoxicity
- Natural resource limitations (eg trace metals)
- Space (eg agriculture, conservation of biodiversity)
- Life cycle assessments

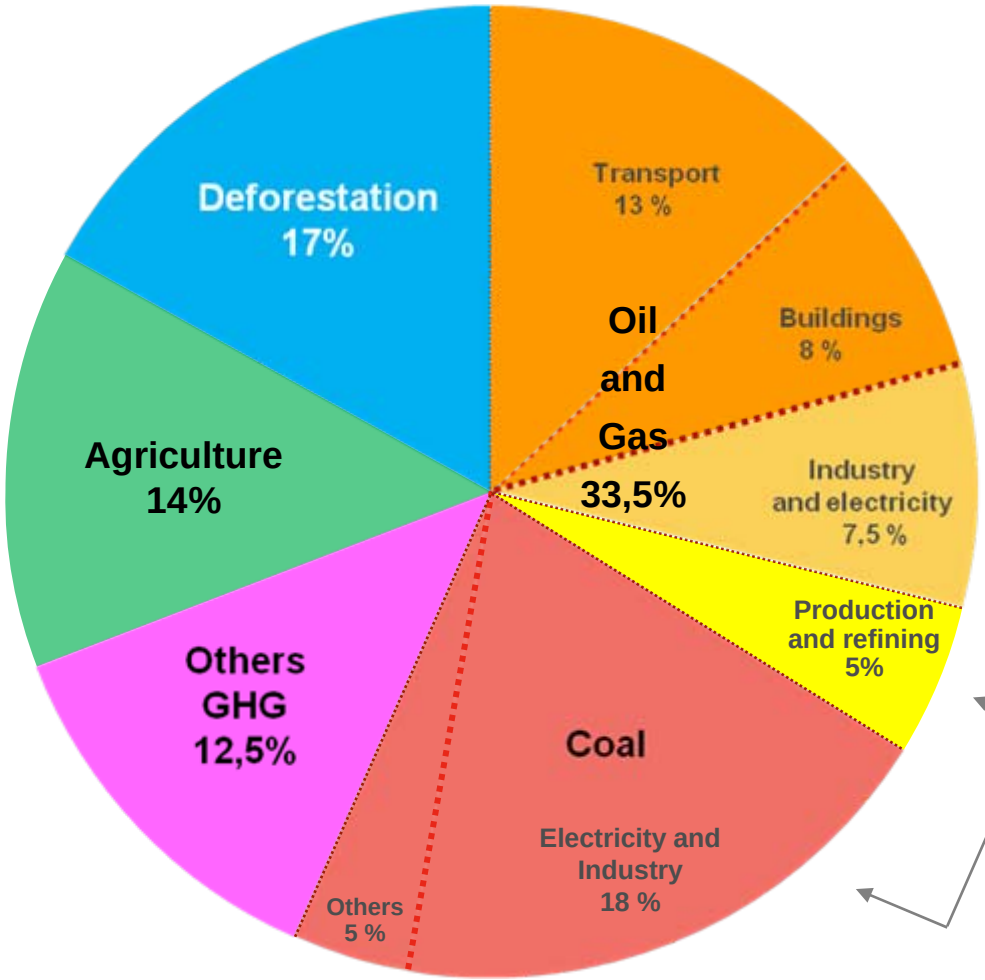
This should be considered from the beginning of the technology development.

Green house gas emissions. What is of concern for oil and gas?



sources GIEC et AIE

Green house gas emission : CCS for concentrated sources



Capture and storage CO_2

Solutions for strong emissions

sources GIEC et AIE

Producing Energy : what for?

- **Needs are for:**
  - Heat and cooking
  - Mobility
  - Work

Energy technology will be developed in close connection with usage : reliability, flexibility and energy efficiency should be key elements

Strong B to B relationships and understanding of customer needs.

The Energy industry will likely evolve toward

- A more diversified and less centralized energy mix
- A faster evolution of technologies

Implies evolutions of the industrial and R&D ecosystems as well as new competences.

The infrastructures for energy distribution and storage capacities will be critical elements and will likely determine the energy mix

R&D challenges at Total (1)

- **Knowledge, tools and competences for discovery and optimal exploitation of technologic oil and gas resources *to satisfy world energy demand.***

- **Development and industrialization of solar and biomass renewable energies, and carbon capture and sequestration *to transform the world energy mix.***

- **Development of innovative and market competitive products that take into account improved energy efficiency for our customers, a reduction of their environmental impact and toxicity, and an easier life cycle management, *aiming to the replacement of present products by improved ones, and to the satisfaction of new markets.***

R&D challenges at Total (2)

- Development and industrialization of **processes for oil, gas, biomass and coal transformation**, in order to cope with the ***evolution of resources and the market, to improve reliability, security and energy efficiency, to reduce environmental impacts, and to enhance economic margins.***

- Understanding and measurement of the impact of the Group activity on **water, air, soil, biodiversity and the ecosystems**, aiming to ***satisfy regulations, improve environmental security, and to evolve toward sustainability.***

- Development of competences on advanced technologies (**biotechnologies, nanotechnologies, high performance computing, information and communication technologies, analytical techniques**), aiming to their ***rapid and early introduction in the Group activities***.

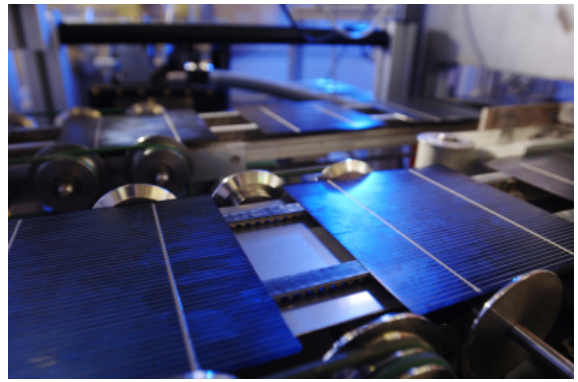
Challenges being addressed in synergy

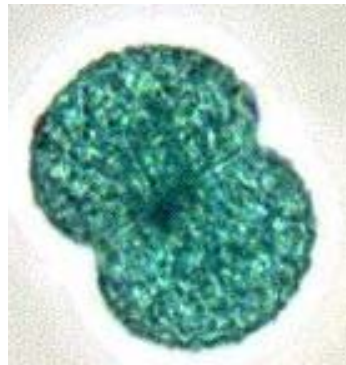
R&D challenges in E&P

- **Sustain our growth strategy**
  - extra-heavy oil, gas solutions, tight gas
    deep reservoirs, deep offshore, EOR
- **Improve our technological know-how and tools**
  - geological concepts, carbonate production, field monitoring,
    reservoir modeling, HP computing, reservoir modeling
- **Improve safety and reduce environmental impact**
  - residual gases, water management, safety
    Lacq CO_2 project

R&D challenges in Gas & Power
Securing the future of energy at Total

- **Technologies for coal exploitation and transformation with limited greenhouse gas emissions**
  - DME synthesis (Di-Methyl-Ether)
  - Fischer-Tropsch synthesis
  - New CO_2 capture technologies
  - CO_2 storage in coal veins and saline water reservoirs
- **Technologies for solar energy, with reduced coasts**
  - Crystalline silicon cells
  - Thin layer cells
  - Concentrated thermal systems
- **Biotechnology for 2nd generation biomass processing**
  - Enzymatic transformation of lignocellulosis
  - Direct production by specialized microorganisms





R&D challenges in Petrochemicals
Catalyst, process and product innovation

- **Technologies to produce monomers from new resources**
  - Olefins from methanol (MTO) ex Coal & Gas
  - Ethylene from bio-ethanol
  - Bio-Naphta.
- **Develop differentiated polymers at low cost**
  - Anticipate market needs through product innovation
  - Tailor polymers through catalysts and process expertise
  - Develop added value applications
- **Develop polymers from renewable resources**
  - Proprietary PLA technology (Futerro)
- **Continuously improve reliability, yields and energy efficiency of manufacturing operations**

Conclusion

- R&D is a major asset for Total. It benefits from continuously increasing resources.
- R&D is to be thought of in relation with strategy.
- R&D is facing renewed drivers to be faced in synergy.
- R&D competences is a key factor.
- R&D management is adaptating to new practices to face burgeoning technologies.