ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

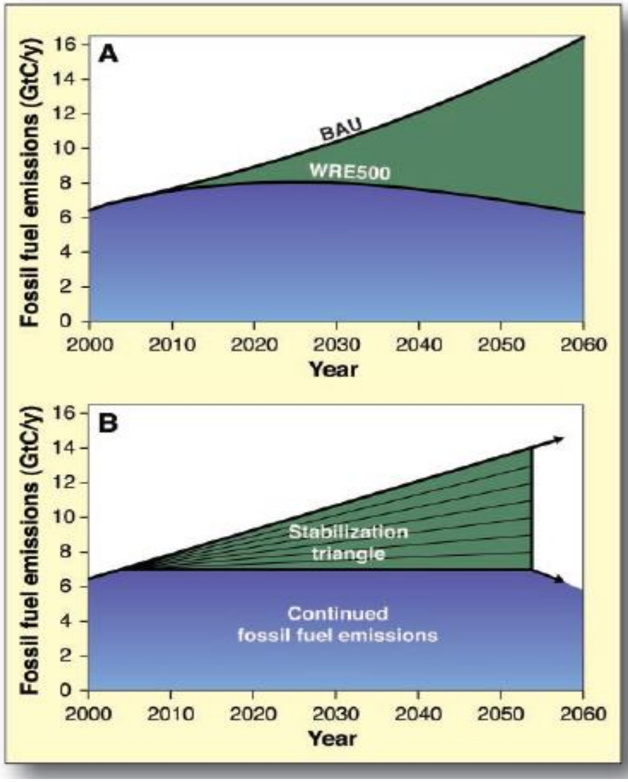
Principaux enseignements: Potentiel des technologies bas carbone pour les 40 prochaines années

P. Criqui, N. Alazard-Toux, J.-G. Deveaux, de Lavergne

ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Decarbonization Wedges
The second pilar (*)

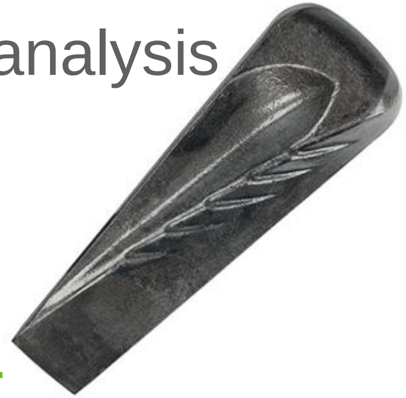


"Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies" S. Pacala and R. Socolow, Science (2004)

The « Wedge » concept

Aim of the « DW » Project:
Assess the potential of a large set of key technologies for meeting the 2°C objective

(*) The first pilar is our analysis of the DDPP study

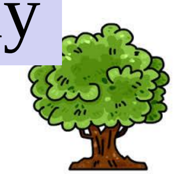


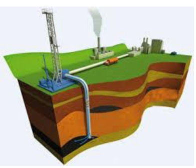
Alliance Nationale de Coordination de la Recherche pour l'Énergie

Technologies

Supply

Biomass





CCS

Geothermal Energy

Nuclear

Solar

Hydro

Wind

Networks/interactions

Storage

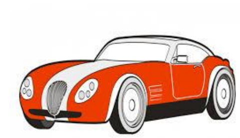
Network/Grids

Grids

Building

Industry

Transportation



But no agriculture

A specific methodology

- An inquiry (template = set of sheets) sent to all the Working Groups (GP),
- Based on experts opinions,
- An analysis carried out by researchers on 'their own' technologies,
- A compilation of results carried out by the Working Group 9

+ Iterations and Methodology complements

→ **Great thanks to all the Thematic groups!**

The « template »

Template

1. State of the art and **current development** in different regions
2. **Maturity level** and technological perspectives: costs, performances, markets
3. Long-term vision (2050): **perspectives and potentials** (National, European, International)
4. **Technical performances**: Energy returns, material contents, environmental impacts
5. Long-term economic **competitiveness** and socio-technical feasibility
6. Technological, economic and social **bottlenecks**
7. Potential radical and incremental **innovations**
8. **Potential vs. maturity**
9. **Ways and means to speed-up diffusion worldwide** (energy policies) (for 2°C scenario)
   i. Public policies and strategies of industrial stakeholders in the main regions
   ii. International cooperation (including public policies) for an accelerating path of the technology's deployment

Note: Section 9 = the less filled section

ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Maturity and mitigation potential Case of REs

Mitigation potential of Renewable energy technologies

	2020	2030	2040	2050
Solar photovoltaics	major technology vs. climate change	major technology vs. climate change	major technology vs. climate change	major technology vs. climate change
Concentrating solar power and solar thermal electricity	significant in some countries	significant in some countries	significant on the global scale	major technology vs. climate change
Hydro energy	very significant on the global scale	very significant on the global scale	major technology vs. climate change	major technology vs. climate change
Onshore wind power	significant on the global scale	very significant on the global scale	very significant on the global scale	major technology vs. climate change
Offshore wind power	significant in some countries	significant in some countries	significant on the global scale	significant on the global scale
Marine energy	0	significant in some countries	significant on the global scale	significant on the global scale
Geothermal energy	significant in some countries	significant in some countries	significant on the global scale	major technology vs. climate change
Combined heat and power production from biomass	significant in some countries	significant on the global scale	significant on the global scale	significant on the global scale
2G Biofuels	significant in some countries	significant in some countries	significant in some countries	significant in some countries
3G Biofuels (microalgae)	0	0	0	not significant

Source: ANCRE

Table 1 - Mitigation potential scaling

- *0*
- *not significant*
- *significant (i.e. more than 1% of global emissions reduction) in some countries*
- *significant on the global scale*
- *very significant on the global scale (i.e. up to 3% of global emissions reduction)*
- *major technology vs. climate change (i.e. more than 3% of global emissions reduction)*

Example: Maturity in the Cement industry

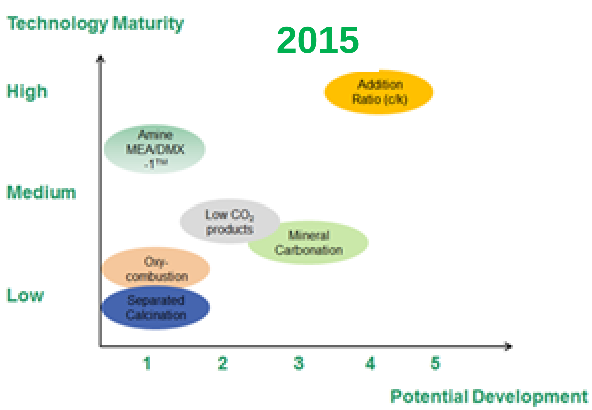
ANCRE
Alliance Nationale de Coordination de la Recherche pour l'Énergie

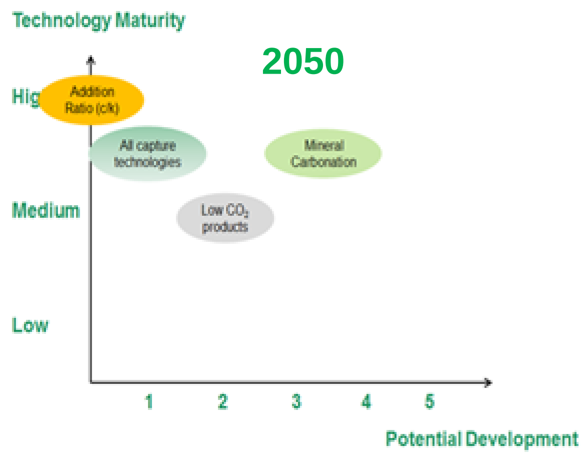
Levels of maturity and diffusion

Ex. low carbon cement making

8 basic technologies

Performance levers
1 Performance lever (1)New low-CO_2 product development (1): addition ratio to Portland clinker
2 Performance lever (1): kiln specific heat consumption
3 Performance lever (2): alternative fuels (specifically biomass)
Product development
4 New low-CO_2 (1) product development (2): alternate clinker to Portland cement (e.g. AETHER)
5 New low-CO_2 (2) product development (3): new non-Portland cement and concrete based on carbonation (e.g. SOLIDIA)
CO_2 Capture
6 Post-combustion Amine scrubbing base case (MEA) & DMX-1™
7 Oxy-combustion (full oxy or partial oxy at cement plant calciner)
8 Separated calcination



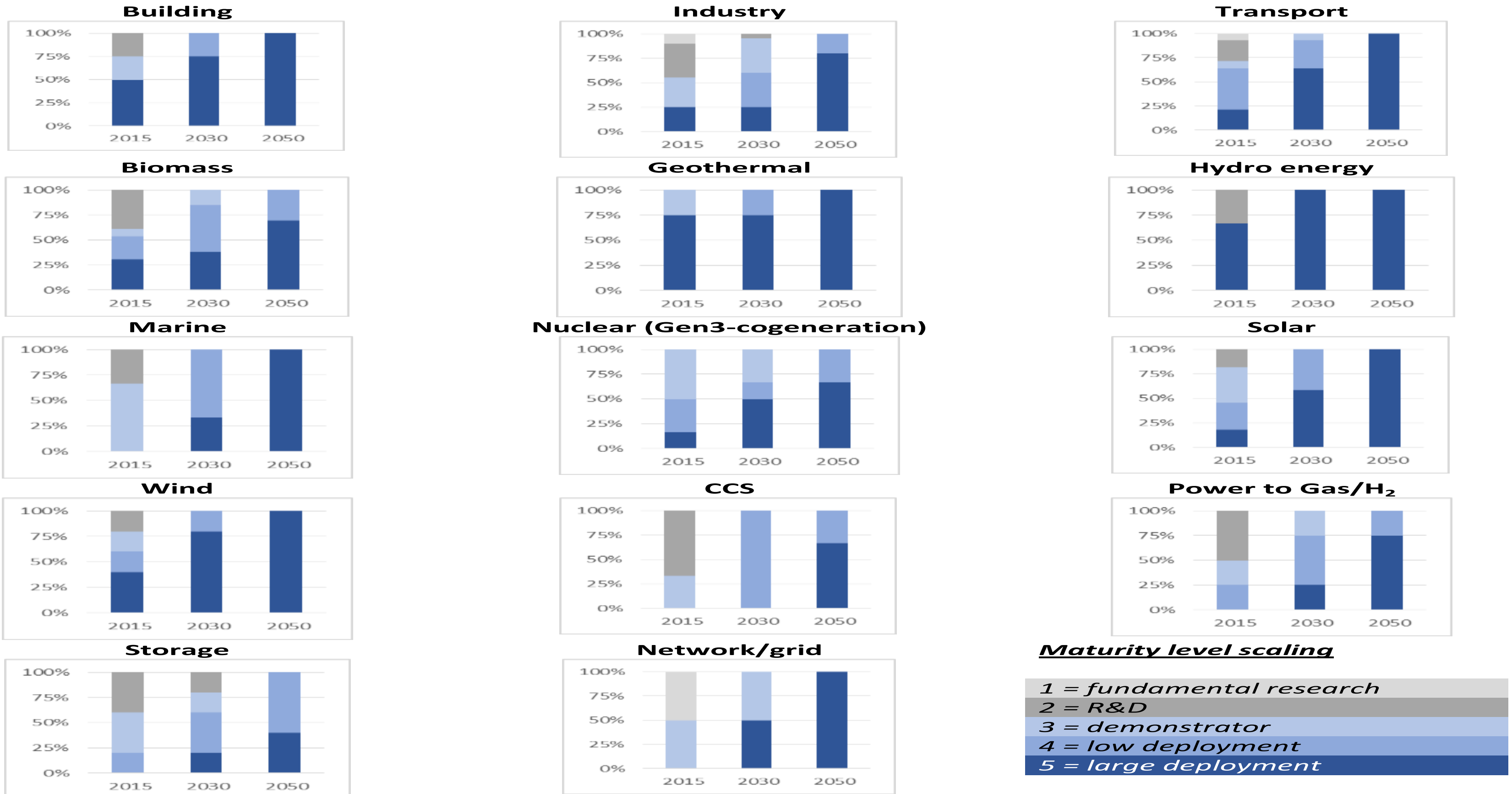


ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Technology Maturity and Mitigation Potential

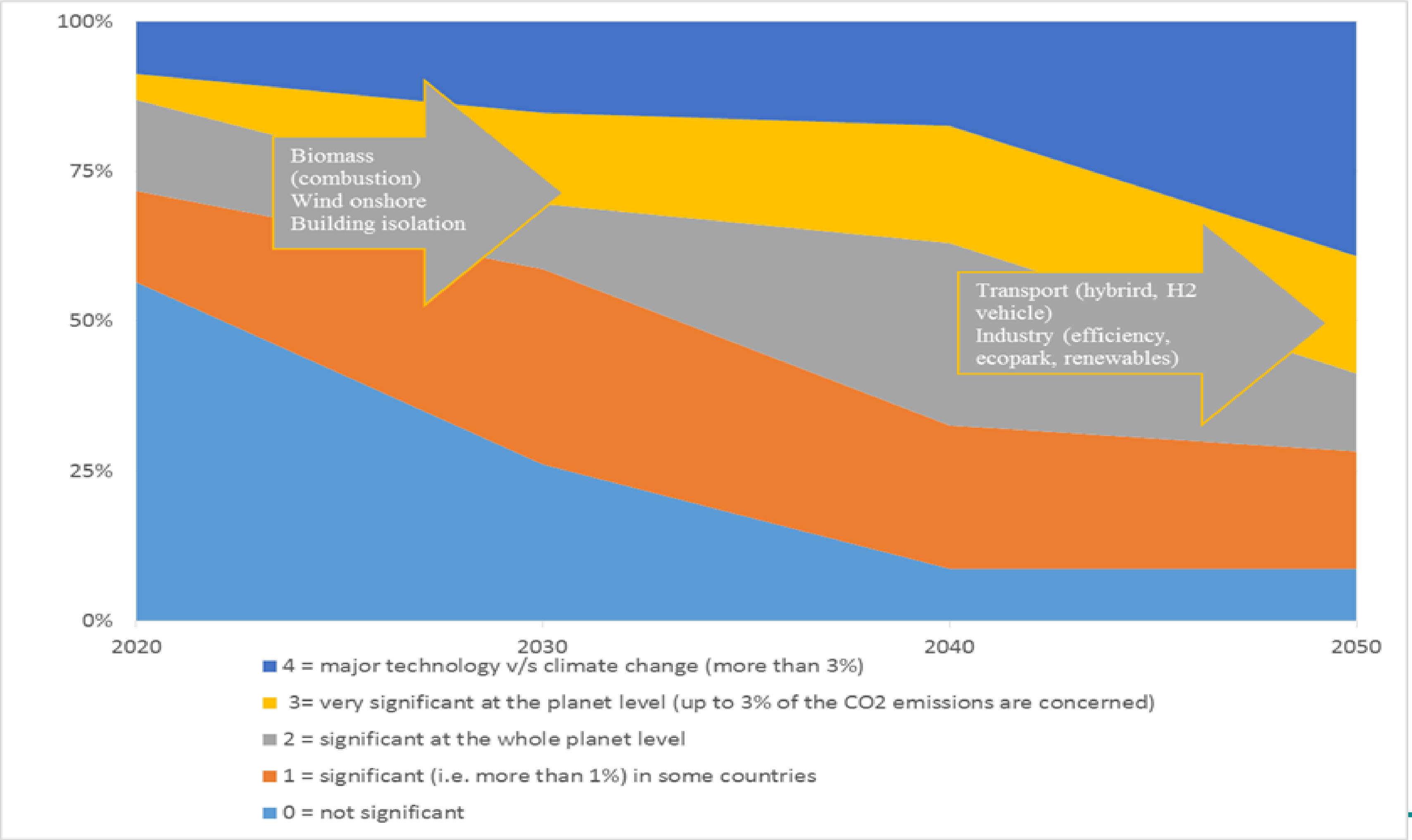
Technology maturity



Source: ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Wedges Dynamics



ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Bottlenecks

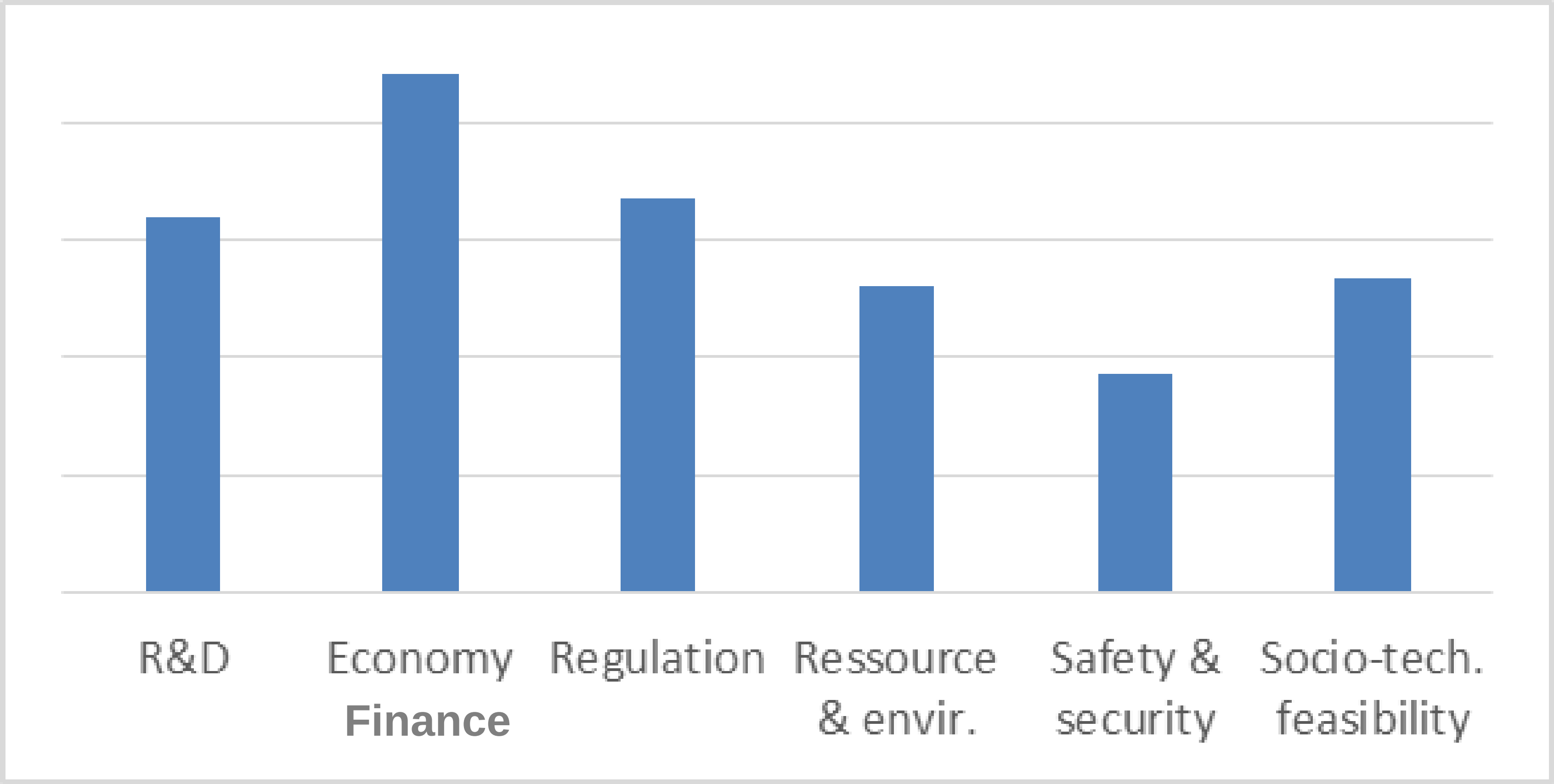
The main bottlenecks to technological development pertain:

1. to **economy & finance** (capital-intensive technologies often raise the issue of competitiveness and funding capacity)
2. to the **regulation & environment** (which does not always foster technological development and can vary significantly)
3. to **risk management** linked to possible insufficiency in terms of innovation performance (i.e. a lack of R&D funding or poor performance of innovations);
4. There are only few bottlenecks pertaining to **socio-technical feasibility,** and these are mostly associated with CCS and nuclear power in some countries

ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Main Bottlenecks



Innovation

Assessing technologies suggests that **radical innovations** are expected in several technology families and technologies.

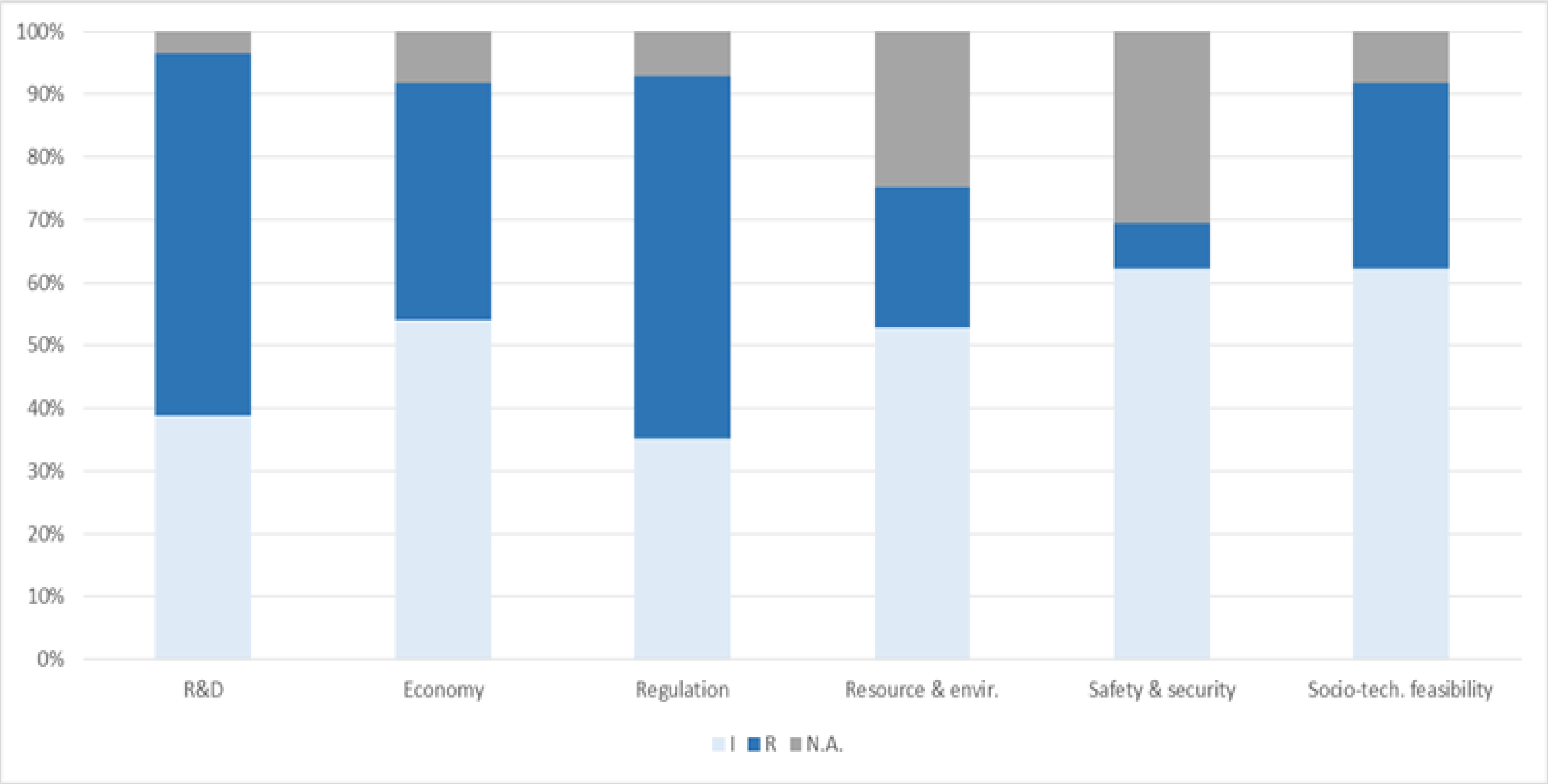
Radical innovations do not only pertain to the technologies themselves, but also to the regulation environment (standards, intellectual property, etc.) and to markets (electricity markets, access to finance, subsidies, taxes, etc.).

.

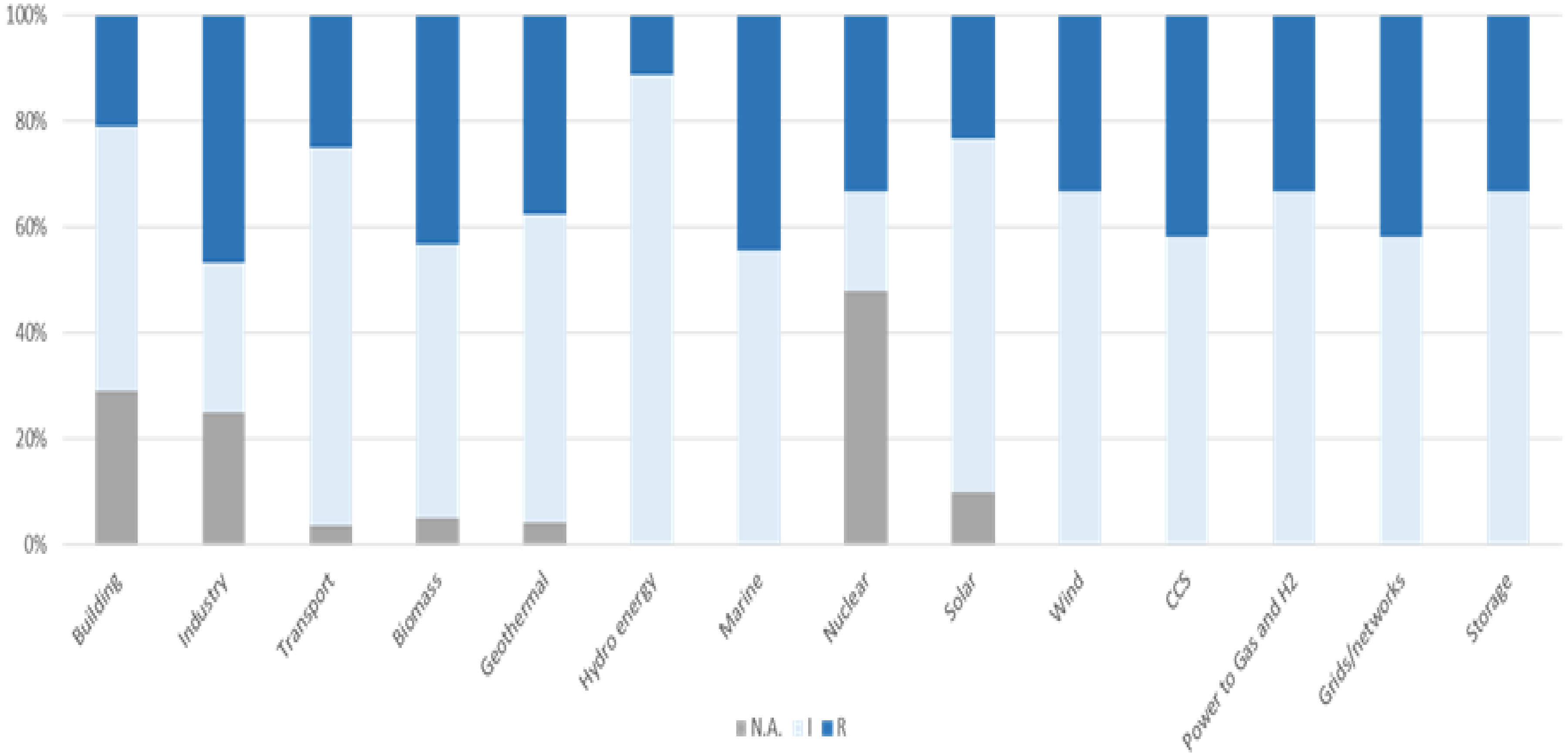
ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

The role of radical innovation



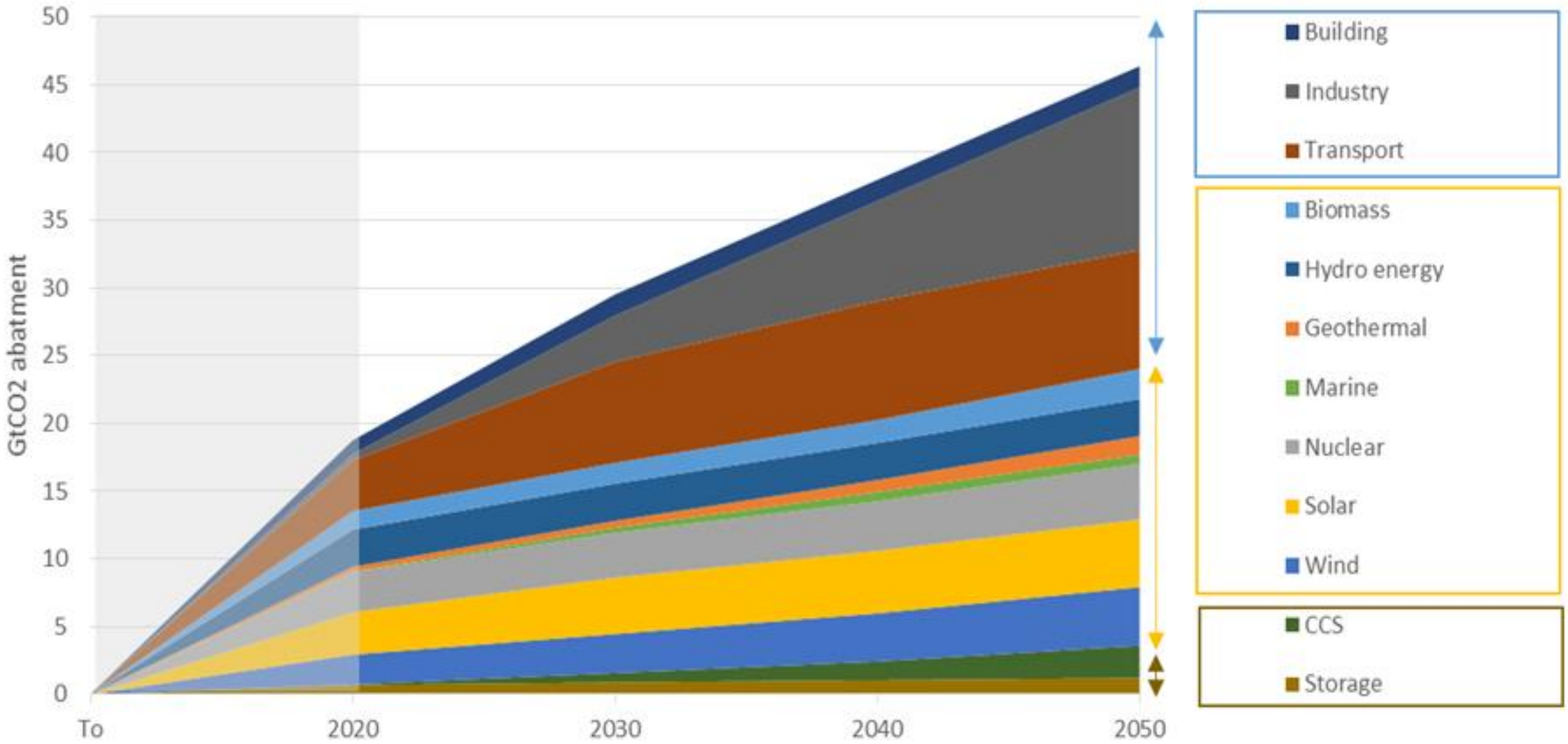
Incremental and radical Innovation



MAIN RESULTS

ANCRE
Alliance Nationale de Coordination de la Recherche pour l'Énergie

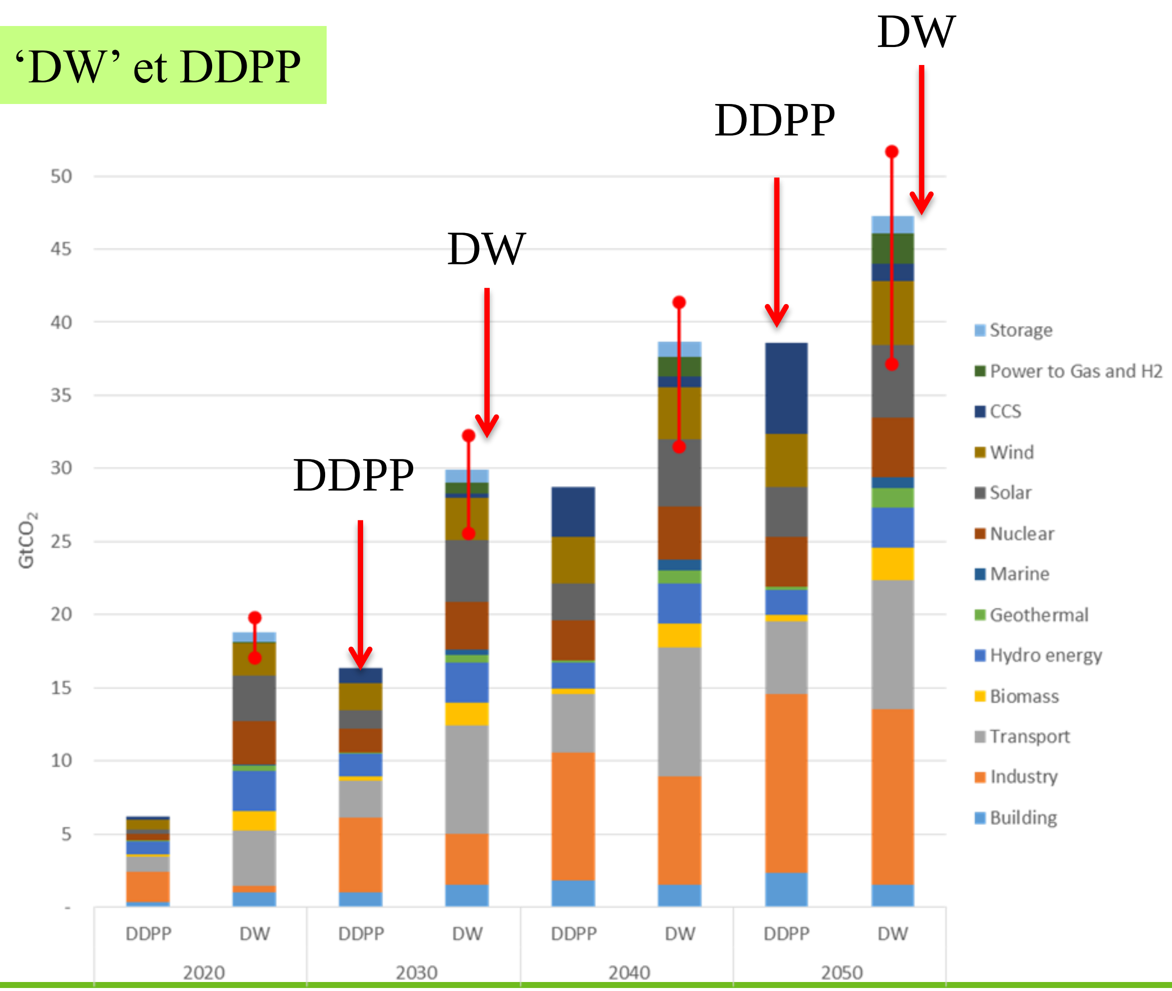
« Wedges »



Résultats quantitatifs: Quels abattements possibles vus de l'ANCRE?

ANCRE
Alliance Nationale de Coordination de la Recherche pour l'Énergie

Comparaison 'DW' et DDPP



ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Main Potentials Supply side

The main supply energy technologies capable of speeding up the 2°C pathway are:

1. **Solar energy** (this energy accounts for around 9% of global potential reduction),
2. Gen-3 **nuclear** reactors (8%),
3. **Wind power** and **hydro energy** (mostly in “southern” countries),
4. And **other new energies** (e.g. geothermal and marine energy).

Storage technologies will also play an important role in reducing global emissions. However ANCRE determined that **CCS** potential for mitigation will be of low importance

Main Potentials
Demand side

Concerning end-users, new decarbonization technologies implemented by the middle of the century should include:

- **industry** (25% of global reduction)
- **transports** (19%).

On the global scale the ANCRE study suggested that the **building sector** should play a rather small role in emissions reduction (3% of global reduction only).

CONCLUSION

Conclusions: An innovative set of methods

- **The innovative methodology** used in this study involves assessing and defining technological potential in a dynamic way, as well as comparing this potential to a recent exercise carried out within the context of the COP21

- This methodology aimed at **highlighting the technological wedges** which are implicit in the DDPP trajectories

- The ANCRE Working Groups carried out a structured assessment in order to **highlight the main factors driving low-carbon technologies development**.

Conclusions Findings

- There are **several technologies that could potentially contribute to reducing CO_2 emissions** by around 40 billion tons by 2050, compared to the baseline scenario ➔ ANCRE identified 108 such technologies in this report;
- **In 10 to 15 years' time,** those technologies (most of them currently exist) will reach a potential that **will make the GHG emissions reduction required by the 2°C scenario feasible**.
- **By 2050 there will be almost no room for uncertainty** (hopeful expectations give an order of magnitude of 20% for uncertainty margins) and uncertainties are such that it is only possible, as of yet, to assert that even if the 2°C scenario seems technically feasible, it will required a significant R&D effort;

Towards 2°C Scenario ➔ Increasing Innovation

In fine, these results show the importance of a strong and quick involvement for **increasing innovation** through R&D efficiency:

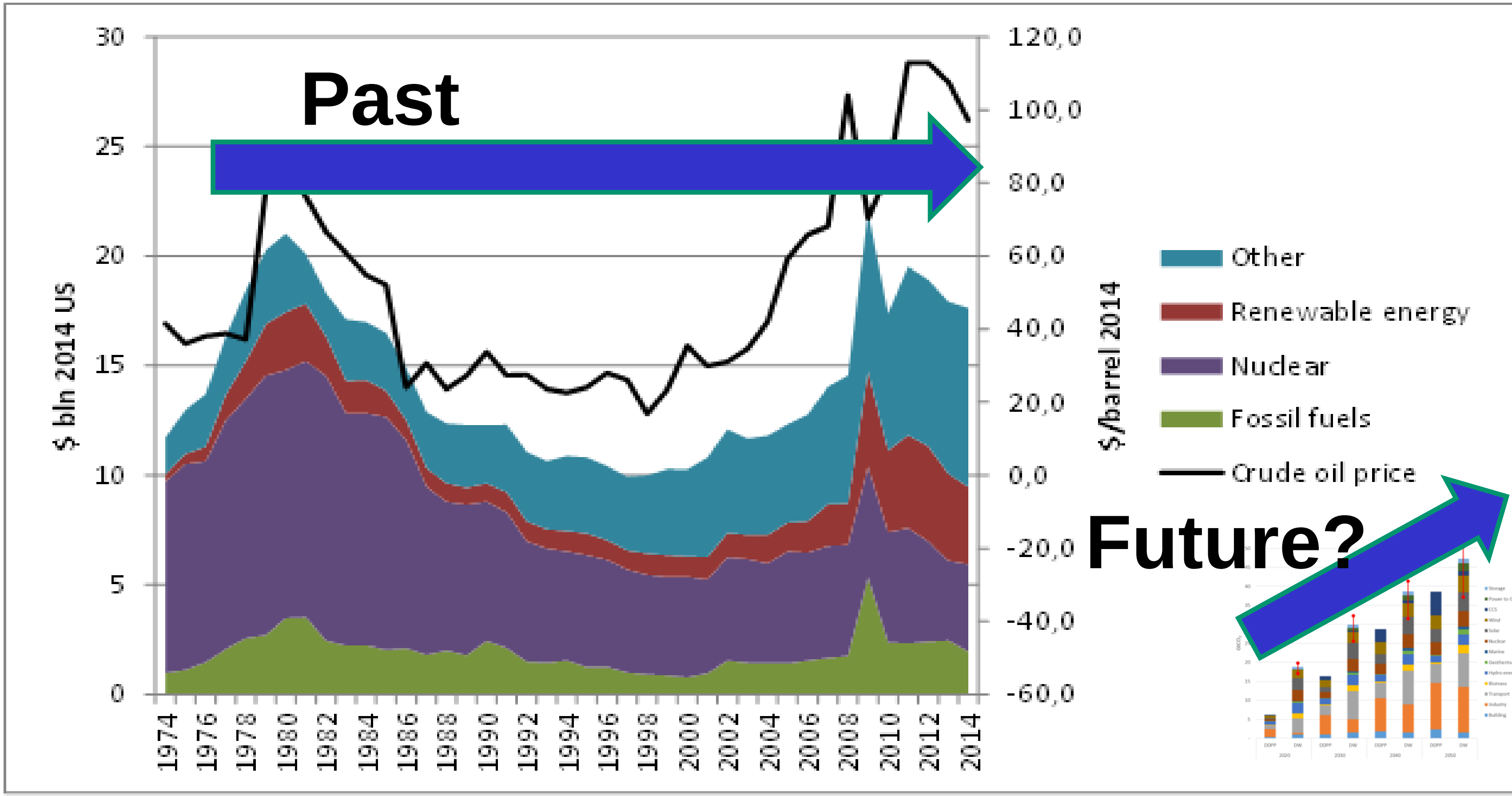
- Volume (➔ financing)
- Organization (multiscale/ Multidisciplinarity)
- International coordination (cooperation, coopetition, IP)

➔ **Boost innovation** and lead to **behavioral changes** that will enable the implementation of low-carbon technologies, starting with existing low-carbon technologies to **new technologies on a very large scale**.

ANCRE

Alliance Nationale de Coordination de la Recherche pour l'Énergie

Conclusions Findings: Boosting future R&D



Source: OECD/IEA

ANNEXES

Conclusions Actions for the future (1/4)

Assessing technologies suggests that **radical innovations** are expected in several technology families and technologies. What is more, these breakthrough innovations do **not only pertain to the technologies themselves,** but also to the regulation environment (standards, intellectual property, etc.) and to markets (electricity markets, access to finance, subsidies, taxes, etc.).

➔ **Actions: Increasing effort in R&D**

➔ **promoting Basic research**

Conclusions Actions for the future (2/4)

Carrying out R&D programs in an **interdisciplinary way** in order to start identifying the importance of technologies with a potential maturity by 2030 and onward. On the one hand research must therefore focus on implementing generic technologies, which will lead to radical innovations, when combined and implemented in various fields of applications. On the other hand technological development for low-maturity technologies is crucial (i.e. fundamental research).

➔ **Action: promoting interdisciplinary research, including socio-technical feasibility**,

Conclusions
Actions for the future (3/4)

Implementing a ‘market approach’ as a complement to the technological approach (i.e. the technology-push policies).

Implementing enough coordination (this level of coordination will still have to be defined on a case-by-case basis).

➔ Action: Define, optimize and use a diversified set of tools: Subsidies/Taxes, premium prices, feed-in-tariffs and strike prices….

Conclusions
Actions for the future (4/4)

Promoting technological availability for the least developed industrial world regions. **Radical innovations** would be favorable as regards intellectual property issues.

Redistribution of mechanisms such as carbon tax could benefit to technologies, either for direct finance of innovations that are shared according to pre-set rules (this rules have yet to be defined), or for patent buybacks (these patents will be made available for companies from "technologically underprivileged" regions).

➔ Action: include access of "Southern" countries to high level technologies into the decarbonization policies