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FROM DISTRACTION TO ACTION
FOR A BOLD EUROPEAN ENERGY UNION INNOVATION STRATEGY

Thomas Pellerin-Carlin | *research fellow at the Jacques Delors Institute.*
Pierre Serkine | *End-user Architect, KIC InnoEnergy.*

EXECUTIVE SUMMARY

Europe is at a crossroads. It faces a multifaceted crisis with rising distrust in representative democracy, doubts about the purpose of the European project, an urgency to tackle climate change, and a poisonous definition of competitiveness. In this context, the Energy Union Research Innovation and Competitiveness Strategy (EURICS) can kill three birds with one innovative stone: to boost its competitiveness, Europe should become the global provider of low-carbon solutions, an objective best achieved democratically - with citizens at the centre and in the driving seat of Innovation.

This policy paper is therefore about Research and Innovation (R&I) in Europe. More precisely, it intends to bring new perspectives to the debate on EURICS, a strategy that should not be a distraction from policy choices but an action towards a faster, fairer and more democratic energy transition in Europe and the world. This paper argues that:

- Europe needs **a renewed approach to competitiveness and put innovation -rather than cost minimisation- at its core**, to become the global provider of low-carbon solutions. Support to R&I must be legitimate in the eyes of citizens and thus requires a convincing narrative. Fighting climate change is consensual among Europeans, especially after the Paris Agreement, and can therefore ground a narrative guiding the EU R&I policy.
- Innovation is much more than technology. EURICS thus needs to embrace all human and social aspects of how people produce, consume, use and maintain energy products and services. As energy is omnipresent in our daily life it should foster the **appropriation of energy** to transform NIMBYs into PIMBYs (please in my backyard), integrate **social sciences** as the cornerstone of innovation projects, valorise **maintainers** and promote **frugal innovation**.
- To paraphrase Mariana Mazzucato, companies sometimes behave like pussycats fearful of change, rather than being innovative tigers bringing novelty into the market and people's life. As the solutions for a carbon-neutral economy and energy system stem from public-private cooperation, EURICS should also seek to transform business pussycats into energy transition tigers. This notably involves to **complete a cultural paradigm shift: demystify failure and unleash the entrepreneurship potential lying in researchers and employees**.
- In a post-Paris world, the EU must do more to support energy-climate research. It can for instance **create the European Climate Energy Labs**: an interdisciplinary basic and applied research centre based on a single location to foster the development of disruptive technologies and ideas enabling the **global transition towards a carbon-neutral society in this century**.

Innovation is better when it is open, it is more legitimate when it is democratic. The EU should therefore create a citizen-based instrument to steer European energy innovation: **a digital platform where innovators and citizens can co-create** innovations that are democratically selected, and then financed by citizens, business angels, local communities and the European Union. **On this platform, EU budget allocation would be very simple: where an EU citizen invests one euro, the EU invests one euro.** Supported projects can then become a start-up or, as start-up is no panacea, an intrapreneurship project to transform conservative companies into energy transition tigers.

All in all, the EU ship has a capable crew of entrepreneurs and researchers, and enough public and private investment capacity that can blow in its sail to safely navigate towards a carbon-neutral future. The Energy Union provides the right compass, but EURICS should allow Europe to set its own course, placing the citizen at the helm to keep the heading, ignoring the US Sirens' songs and avoiding the reefs of immobilism. Only then can Europe lead the global energy transition race.

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The views expressed are those of the authors and do not necessarily reflect those of the KIC InnoEnergy or the publisher.

INTRODUCTION

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This policy paper is therefore about Research and Innovation (R&I) in Europe. More precisely, it intends to bring new perspectives to the debate on EURICS, a strategy that should not be a distraction from policy choices but an action towards a faster, fairer and more democratic energy transition in Europe and the world.

While the EU seeks to transform its Energy Union strategy into a reality, EURICS should not be a distraction from current key policy issues (e.g. new electricity market design, energy governance, Nordstream, ETS reform). Instead, EURICS should be the first action leading to many others to kick-start the global energy transition necessary to achieve the objectives laid out in the Paris Agreement.

In this context, this policy paper first discusses what EURICS should be about, it sets the scene of how innovation is understood and what political role it can play.

The paper then analyses the situation of energy innovation in Europe. After having clarified what an 'energy transition'[1] entails, we suggest strategic objectives (implementing the Paris Agreement, democracy, a renewed vision of competitiveness) to be used as the compass for EU research and innovation policy.

This paves the way for three sets of proposals for incremental and disruptive changes to the EU energy innovation policy, presented in the Part 3 of this paper.

1. For a discussion on the meaning of the term 'energy transition' see Part 2.4 of this policy paper.

1. What innovation strategy stands for

1.1. Characterizing an Energy Union Research, Innovation and Competitiveness Strategy

The **Energy Union** is an ambitious political project set-out in the European Commission's Energy Union Framework Strategy. One of its salient elements is about putting citizens and consumers at the centre of a change to decarbonise Europe's economy. Achieving such an ambitious objective requires to adopt a good **strategy** i.e. analyse challenges, clearly define an overarching goal, match means and ends, prioritize and establish a feasible timeframe.

The EU energy policy debate often tackles the issue of **competitiveness,** an often ill-defined[2] buzzword often used to mean cost-competitiveness[3] (i.e. cost-minimisation: doing what everyone does, but cheaper), a definition that Paul Krugman assesses to be "not only wrong but dangerous"[4]. In this policy paper, we thus define competitiveness as being the capacity for businesses to develop their activities by "doing what no one else can do[5]", something that is first and foremost characterized by their capacity to innovate[6].

There is a rich debate on the several ways to define **innovation**[7]. Building on definitions by academics[8] and the OECD[9] we hereby define innovation as the action of introducing something *new to a given organisation*. For innovation to be beneficial, this 'something' must be useful and valuable, and is sometimes –but not always- something *new to the world* that is the outcome of a research activity. **Research** is indeed the process of *creating new ideas*, processes, technologies, services or techniques. It usually distinguishes between basic research (e.g. discovery or invention[10] of a new material/idea) and applied research (e.g. trying to apply this new material/idea to a specific sector)[11].

1.2. Understanding Innovation

The modelling and understanding of innovation process[12] and its management has changed over time. Its more recent evolution goes hand in hand with the new knowledge economy, frequently characterised by the ubiquity of ICTs. This salient position of ICTs in our society brings new concepts at the forefront of innovation, such as dynamics, flexibility, change and responsibility[13].This led to the "open innovation" paradigm, presented by Chesbrough in 2003 (see Box 1) that puts a stronger emphasis on flexibility, interactivity and, interconnection.

2. The concept of 'competitiveness' is criticised by academics. For instance, Robert Reich considers competitiveness as one of those 'few terms in public discourse [to] have gone so directly from obscurity to meaninglessness without any intervening period of coherence'. Robert Reich, *American Competitiveness and the President's new relationship with American Business*, 21 January 2011. For a deeper critical discussion on the definitions of competitiveness, cf. Karl Aiginger, Susanne Bärenthaler-Sieber, Johanna Vogel, "Competitiveness of EU versus USA", *WWWforEurope Policy Paper*, n°29, November 2015.
3. European Commission, *Energy Union Framework Strategy*, 25 February 2015, p. 10.
4. Paul Krugman, "Competitiveness: A dangerous Obsession", *Foreign Affairs*, March/April 1994.
5. Andrea Ovans, "What is Strategy Again?", *Harvard Business Review*, May 2015.
6. Other definitions exist, among which the World Economic Forum defines "competitiveness as the set of institutions, policies and factors that determine the level of productivity of an economy", hence using competitiveness as a synonym for 'elements improving productivity'. Cf. Klaus Schwab, *The global competitiveness report 2015-2016*, World Economic Forum, 2015.
7. For a deeper discussion on the definitions of innovation, cf. Baregheh, Rowley and Sambrook, "Towards a multidisciplinary definition of innovation", *Management Decision*, 2009.
8. 'Innovation is the process of making changes, large and small, radical and incremental, to products, processes, and services that results in the introduction of something new for the organization that adds value to customers and contributes to the knowledge store of the organization' *in* O'Sullivan and Dooley, *Applying Innovation*, 2009, p. 5.
"innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace." Baregheh, Rowley and Sambrook, "Towards a multidisciplinary definition of innovation", *Management Decision*, 2009.
9. "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." OECD & Eurostat, *Oslo Manual*, Third Edition. 2005.
10. We should indeed make a clear distinction "between invention and innovation. The former is the generation of newness or novelty, while innovation is the derivation of value from that novelty." Cf. du Preez Niek, Louis Louw, and Heinz Essmann, "An Innovation Process Model for Improving Innovation Capability", *Journal of High Technology Management Research*, 2009.
11. According to a 1953 National Science Foundation publication, basic research is the "pacemaker of technological progress' and a researcher in basic research as someone "motivated by a driving curiosity about the unknown ... Discovery of truth and understanding of nature are his objectives. ... The essential difference between basic and applied research lies in the freedom permitted the scientist. In applied work his problem is defined and he looks for the best possible solution meeting these conditions. In basic research he is released of such restrictions; he is confined only by his own imagination and creative ability."
12. In the European debate, the innovation process is often characterised as a 5-steps cycle: research, development, demonstration, deployment and maturity. For a recent example, cf. i24c and Capgemini Consulting, *Scaling up innovation in the energy union to meet new climate, competitiveness and societal goals*, 2016.
13. Ondrej Žižlavský, "Past, Present and Future of the Innovation Process", *International Journal of Engineering Business Management*, 2013.

Meissner and Kotsemir[14] moreover introduce a human resources dimension as it becomes increasingly difficult for companies to attract and retain talent. This leads to what they call an "active innovation" model that is referred to in Part 3.3.

Beyond this theoretical approach, one can differentiate innovations according to their incremental or disruptive[15] consequences. Disruptive innovation and unicorns are currently popular buzzwords in the EU policy debate[16]. However, even though some unicorns can appear to be spectacular successes, the EU should take a critical look at this phenomenon (see Box 2) and subsequently set its own innovation path.

BOX 1 ► Innovation process modelling: past and present

Roy Rothwell identifies five generations of model[17], which could be complemented by the open innovation paradigm introduced by Chesbrough[18]. While those models appeared successively in the academic literature (see Figure 1), they have co-existed until today in both academic writing, policy and business decisions. For instance, the EU seeks to impact energy innovation through elements inspired from different models (see Part 2.2, e.g. the SET Plan is inspired by the technology-push model while the KIC InnoEnergy is inspired by the Networking model).

The first model is a simple linear **technology-push model,** created in the 1950s when society buys any available product on the market. The Research & Development (R&D) department is seen as the beginning of the innovation process (the idea generation and the conception of the innovative service or product), followed by the production and marketing.

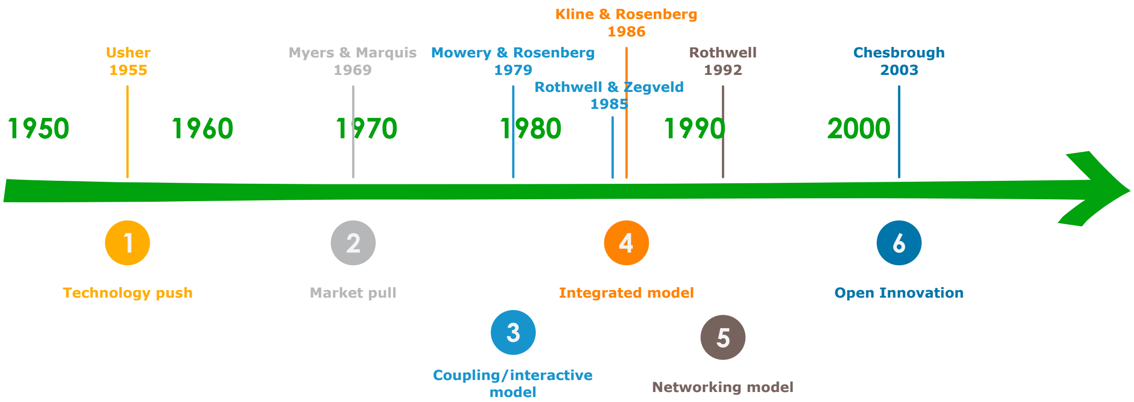
As market competition grew, it became more important to consider consumer needs. This led to the **market-pull model**, that is linear but reverses the direction of the previous model: it is now the market that informs R&D.

Then came the **coupling model**, that basically couples technology-push and market-pull. This model starts to consider the linkages between the various functions of a company, as well as linkages outside the company, and feedback loops in the innovation process.

To overcome the linear approach of the first three models, **the Integrated Model** considers innovation to be the result of interactions (in-house, and between the company and its environment), with markets becoming both the beginning and the end of the process.

This paved the way for the fifth generation, a **Networking model**, driven by a need to increase the efficiency and shorten the lifecycle of the innovation process. This has been eased by the development of internet and IT methods, which facilitate collaboration and linkage between people inside and outside the company, be that through the involvement of upstream and/or downstream to co-develop innovation, or through the establishment of consortia, alliances and other forms of partnership. Putting a more important emphasis on flexibility, interactivity and interconnection, Chesbrough coined the **open innovation model**. While there is no consensus among academics whether to consider open innovation as a new generation of model or as a feature of the networking model, the term 'open innovation' has become an important work in the EU policy debate[19].

FIGURE 1 ► Timeline of the apparition of the main innovation models, with founding authors



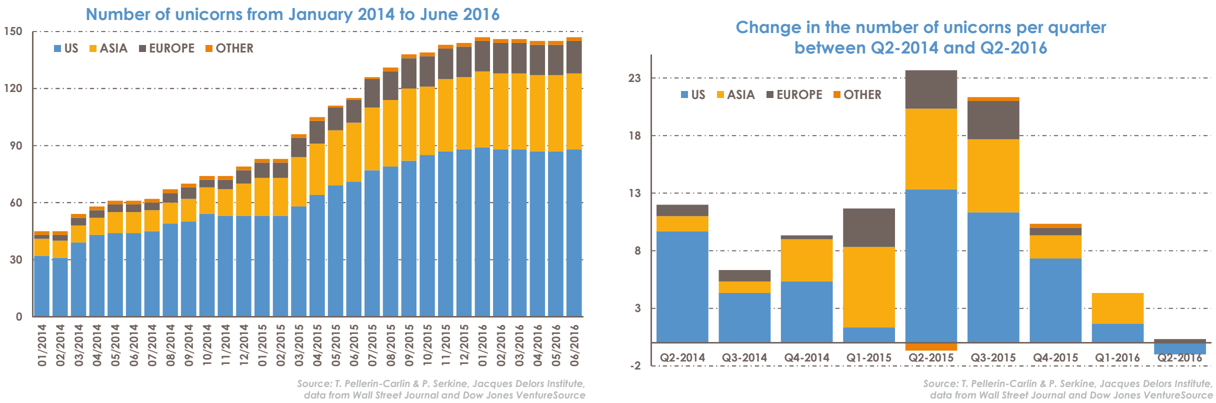
Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, adapted from Meissner and Kotsemir

14. Dirk Meissner and Maxim Kotsemir, "Conceptualizing the innovation process towards the 'active innovation paradigm'—trends and outlook", *Journal of Innovation and Entrepreneurship*, 5(1), 2016, p.12.
15. Disruptive innovation is often used to make the difference between what is incremental (i.e. improving a product/process that already exists) and what is disruptive, meaning an innovation that 'makes it impossible for existing players to compete on their own terms. Cf. Alex Ryan and Michael Dila, "Disruptive Innovation reframed: Insurgent design for systemic transformation", *Relating Systems thinking and Design 2014 working paper*, 2014.
16. "Europe has excellent science, but we lack disruptive market-creating innovation. This is what is needed to turn our best ideas into new jobs, businesses and opportunities." Carlos Moedas, European Commissioner for Research, Science and Innovation, in the context of the Call for Ideas for the project of European Innovation Council (EIC).
17. Roy Rothwell, "Towards the fifth-generation innovation process", *International marketing review*, 11(1), 1994, pp.7-31.
18. Henry Chesbrough, *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press, 2003.
19. For a discussion on the open innovation model from an EU perspective see Garry Gabison and Annarosa Pesole, "An overview of models of distributed innovation", *JRC Science and Policy Reports*, 2014.

BOX 2 ► The EU should not listen to the US Sirens' song

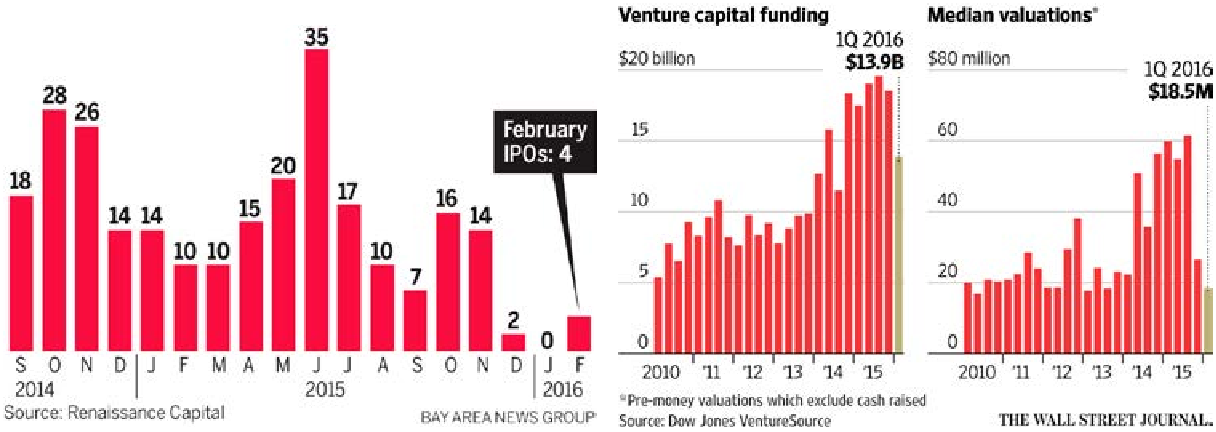
The EU seems to look with a certain envy at what is happening in the Silicon Valley and at the rise of the so-called "unicorns"[20]. 60% of them are indeed from the US, 28% from Asia, 11% from Europe[21] (see Figure 2, left-hand side). These companies are considered as champions and engines of the new economy, they are thus seen as the visible tip of the innovation iceberg and a good argument to market the competitiveness and/or the investments opportunities in one's country.

FIGURE 2 ► Evolution of the number of unicorns around the world between January 2014 and June 2016 (left-hand side) and new unicorns per quarter (right-hand side)



However, this point should be tempered. As Figure 2 suggests (right-hand side), the rate of birth of unicorns decreased over the past 12 months, and the number of unicorns has virtually stagnated between January and June 2016. One hypothetical reason for this decline could be that "unicorns" enter classic financial markets by making an Initial Public Offering (IPO), thus going out of the definition of what a unicorn is. This is however not the case: the last IPOs have been disappointing[22], their number is in sharp decline (see Figure 3). Another reason which could explain this slowdown is that, as shown in Figure 3, venture capital firms have reduced the amount of money invested in start-ups for two successive quarters, leading to a plummeting of the value of the US start-ups, since these start-ups are highly VC-dependent[23].

FIGURE 3 ► IPO activity (in number of IPOs) in the US between September 2014 and February 2016 (left-hand side) and quarterly venture capital funding and median valuations from 2010 to Q1-2016 in the US (right-hand side)



All in all, we still have to be very cautious, but there are signs of a sort of 'unicorn bubble' close to burst, especially in the US[24]. It therefore may not be wise for the EU to copy the "US unicorn way" that may appear to be a bubble in the upcoming months or years: EURICS should avoid listening to the US Sirens' songs on unicorns and sets its own energy innovation path (see Part 3.3.4).

20. A unicorn is a young company owned by venture capital firms and valued over 1 billion dollars. When a unicorn makes an Initial Public Offering (IPO), it stops being owned by venture capital firms only, thus exiting the category.
21. Source: Wall Street Journal.
22. See for instance a research by Capital Renaissance.
23. Unicorns can thus be seen as a bet venture capital firms make on the future, even on companies that are not profitable but are expected to grow and become profitable later on, when they would monetize their activity.
24. They are obviously many other parameters at play and this issue deserves further research and analysis.

1.3. Salvation, failure and public support: what to expect from the politics of R&I?

A wisely thought and implemented research and innovation (R&I) policy can help the global energy transition[25], but it will never be the silver-bullet. To develop a relevant R&I strategy, the EU needs to understand three key elements of the politics of R&I: do not hope for technological salvation, demystify failure and acknowledge the importance of public support.

Political discourse on innovation too often implies that 'technology will save us all'. **Technology alone is not the solution** as technology does not exist in a vacuum but is enshrined in a specific system composed by values, habits, other technologies, human capital, political beliefs etc.[26] A holistic and integrated approach is therefore needed.[27]

The politics of innovation moreover often assumes that innovation is intrinsically good while, in itself, **innovation is neither good nor bad, it is amoral and its use can have good and bad consequences**[28]. Innovation usually creates losers and winners which raises the question of how a society decides which and how innovations can be deployed.

In politics, **innovation is often used as a pretext for policy inaction, a means to avoid taking bold decisions.** Talks about innovation can thus allow politicians to create the feeling of change while keeping the situation unchanged. This tactic is a new avatar of an old phenomenon famously expressed in *Il gattopardo*: "if we want everything to remain as it is, everything needs to change"[29].

Achieving a disruptive research finding or innovation is a risky endeavour. and there is a need to debunk the real path to disruptive innovations that is usually made of ups and downs. In a way, **the road to success is paved with teaching failures** that are accepted and understood as a useful element in any R&I process. Accepting failure can be difficult as risk-adversity is an element present in many European cultures, with strong national differences[30]. Civil society is at the forefront of the dynamics of such cultural changes, but policy-makers can help[31] for instance by sending signals such as the creation of a European prize for the best failed business idea.

Acknowledge the importance of public support

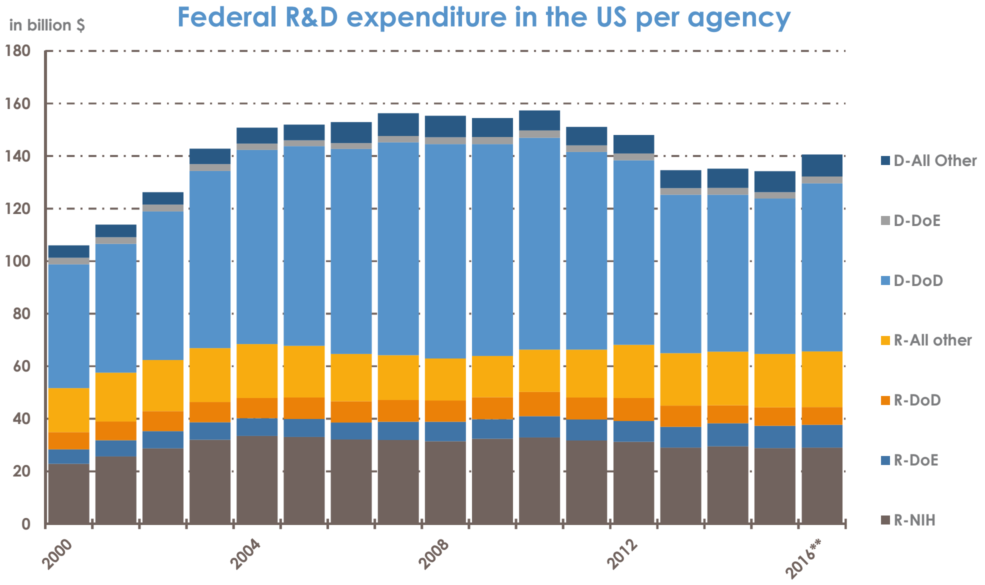
A widely diffused prejudice among European decision makers is that innovation stems from a business community made of roaring tigers, like Apple, while the public sector is a sort of clumsy elephant unable to 'pick the winners'[32] and that should be limited to 'technology-neutral'[33] and market-based approaches that are only legitimate when addressing 'market failures'[34] for instance by creating a CO2 emissions market, the EU-ETS[35]. This myth is efficiently debunked by scholars such as Mariana Mazzucato[36] who argue that most of the business

25. For a discussion on the meaning of 'energy transition', see Part 2.4.1.
26. To illustrate, in order to reduce the energy consumption in transport, many tools can be used, for instance increasing the number of passengers in a single car/bus/plane, increasing the engine's fuel efficiency, reducing the weight of the vehicle, opting for a more energy-efficient means of transportation (e.g. walking/cycling over car/buses, reducing the speed limit to the most energy-efficient speed (e.g. usually situated between 80 to 100km/h for a passenger car), or reducing distances between home and workplace, or place of production and place of consumption of a good.
27. Paul Burger et al., "Advances and understanding energy consumption behaviors and the governance of its change: outline of an integrated framework", *Frontiers in energy research*, Vol 3, Article 29, June 2015.
28. For instance, in energy, already existing nuclear power plants can produce a lot of cheap low-carbon baseload electricity, which is generally considered to be a positive consequence, while having negative consequences in terms of the production of radioactive wastes as well as a risk of nuclear accident. The debate on nuclear energy highlights that the choice of an energy source over another option (e.g. coal, renewables, electricity savings etc.), has both positive and negative consequences.
29. The original quotation is "Se vogliamo che tutto rimanga come è, bisogna che tutto cambi". Cf. Giuseppe Tomasi di Lampedusa, Il Gattopardo, 1958.
30. For instance, between cultures that are more at ease with uncertainties (e.g. the UK or Denmark) and uncertainty-adverse cultures (e.g. Germany or Poland). For an in-depth analysis on this risk-taking dimension, cf. the works of Geert Hofastede.
31. For instance, if an entrepreneur starts a business with a bank loan, the business fails, to what extent can the bank seize the entrepreneur private assets (e.g. personal car, private house etc.) to pay back portions of the loan?. Cf. Robin Wauters, Fail Better, Tech.eu, 11 May 2015.
For an example of a concrete EU action to demystify failure, see the EU supported LIFE (learning incrementally from failed entrepreneurship) initiative.
32. For instance, according to then European Commissioner for Competition Policy Neelie Kroes: "Let's be under no illusion: it is markets and not politicians that pick the winners". Neelie Kroes, Speech to the Villa d'Este Forum, September 2nd 2006.
33. European Commission, *Energy Union Framework Strategy*, 25 February 2015, p. 14.
34. David Edgerton, *The shock of the old – technology and global history since 1900*, Profile Books, 2008, p. 107.
35. For an example of a paper where the EU-ETS is thought as a means to boost innovation, cf. Georg Zachmann, "Making low-carbon technology support smarter", *Bruegel Policy Brief*, 2015.
36. Mariana Mazzucato, *The entrepreneurial state: Debunking public vs. private sector myths*, Anthem Press, 2015.

community is not made of roaring tigers kept in regulatory cages, but rather resemble "a bunch of domesticated animals – gerbils, hamsters and pussycats"[37]. The role of public support to foster R&I must therefore be acknowledged and understood as a role of turning a business community made of pussycats into a grown-up community of wannabe innovative tigers.

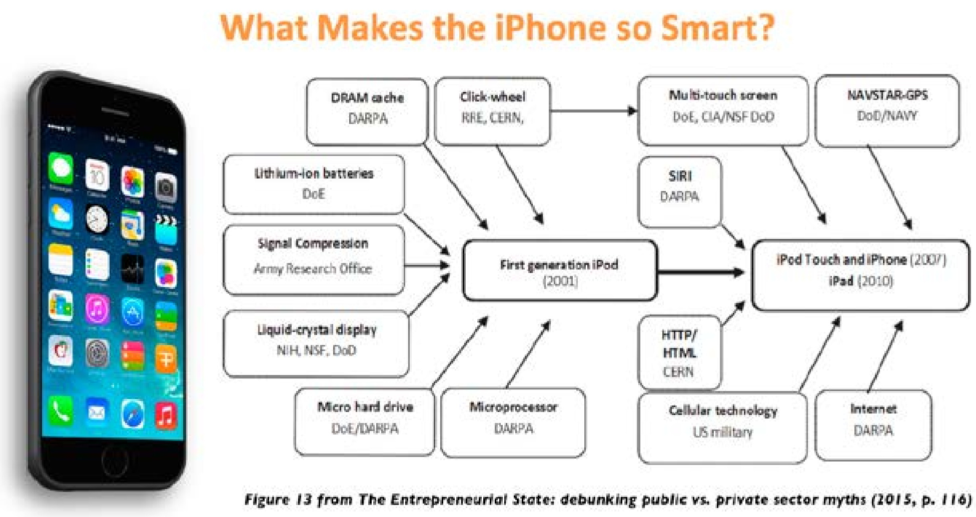
Public support to R&I is strong in the US thanks to high defence and military research spending for both basic and applied research (see the importance of the Department of Defence (DoD) in Figure 4). US defence research programmes thus create new elements that can later be used by private companies to make innovations in consumer products, such as Apple's iPhone (see Figure 5).

FIGURE 4 ► **Federal spending in research and development in the US between 2000 and 2016 (expected), per agency**[38]



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from AAAS

FIGURE 5 ► **Debunking public vs. private sector myths: the example of the iPhone**



Source: Mariana Mazzucato[39]

37. This metaphor is used by Marianna Mazzucato. See. Marianna Mazzucato, Speech at the OECD, 28 May 2014. It originates form a private letter written by John Maynard Keynes to Franklin D. Roosevelt in 1936.
38. Source: American Association for the Advancement of Science.
39. Mariana Mazzucato, *The entrepreneurial state: Debunking public vs. private sector myths*, Anthem Press, 2015. p.116.

In the EU, by contrast, national military research effort is low, fragmented and declining[40] while the EU budget does not have a military expenditure line[41]. A boost in R&I spending –military and/or civil- would be beneficial to Europe's innovation capacity and competitiveness but advocating for more European military research spending is unlikely to provoke major changes as the military is not a factor of consensus in Europe. There is however a factor of consensus that exists in Europe –but not in the US: the necessity to fight and adapt to climate change. The EU could thus use Energy and Climate issues to build a consensus in Europe vis-à-vis citizens[42] and businesses, to legitimate a more ambitious R&I budget at national and EU level (see Part 3.2). In other words, **fighting climate change is our best defence.**

1.4. Innovation at the heart of a renewed EU competitiveness policy

"The world is in the midst of a new wave of economic development, with entrepreneurship and innovation as the catalysts". Donald Kuratko[43]

In this policy paper, **competitiveness** is understood as the capacity for businesses to develop their activities by "doing what no one else can do[44]", something that is first and foremost characterized by their capacity to innovate. As argued by the EU-supported Research, Innovation and Science Policy Experts High Level Group (RISE) group an "open and transformative R&I policy, [can make] Europe world leader in the new networked innovation economy, but geared towards the benefit of the citizens. This change will be an important part of a new EU R&I policy in the revised Europe 2020 strategy to ensure that the European recovery is sustainable, based on sustainable growth, knowledge-intensive society, not just the old growth model where productivity is achieved through cost reduction"[45].

This entails a paradigm shift. With innovation at its core, competitiveness is no longer a defensive policy meant to allow national companies to do what everybody else does, but cheaper –through smaller wages, lesser taxes, smaller energy prices or protectionist measures. **With innovation at its core, competitiveness becomes an offensive policy meant to help European workers and European businesses to do what no-one else does, to really innovate be able to sell European products and services on European and other markets** (e.g. frugal innovation for emerging markets, see Part 3.1.4).

EURICS thus needs to consider ways to foster entrepreneurship in Europe, not only to create start-ups but also to harness the innovation potential currently existing within employees of companies, notably the energy incumbents. In other words, the human capital dimension is one of the key building blocks of an innovation strategy, to truly embed "active innovation"[46] within it.

40. For instance, European Defence Agency Member States (i.e. EU Member States minus Denmark) cut their defence research & technology expenditure by 25%, from 2.7 billion euros in 2006 to 2 billion euros in 2014, the lowest level ever recorded by the European Defence Agency. Source: European Defence Agency, *Defence Data 2014*, 2016.
41. Even if a budget line for military or dual-use research is currently debated for the EU Multiannual Financial Framework 2021-2028. See Group of Personalities, *European defence research – the case for an EU-funded defence R&T programme*, EUISS, February 2016.
42. Climate change is however a stronger source of legitimacy to foster public spending on basic research in Europe, especially after the EU's success with the Paris Agreement. According to Eurobarometer study, 90% of Europeans consider climate change to be a 'very serious problem' (69%) or a 'serious problem' (21%); while 80% agree that fighting climate change can boost the economy and jobs in the EU. Such figures are likely to be higher still today, after the Paris Climate Agreement. Cf. Eurobarometer, *Climate Change Report*, March 2014.
43. Donald Kuratko, *The entrepreneurial imperative of the 21st century*, Business Horizons, 2009, p. 421.
44. Andrea Ovans, *"What is Strategy Again?"*, *Harvard Business Review*, May 2015.
45. Matthias Weber, Dan Andrée and Patrick Llerena, *A new role for EU research and innovation in the benefit of citizens: towards an open and transformative R&I policy*, European Commission, 2015.
46. Dirk Meissner and Maxim Kotsemir, "Conceptualizing the innovation process towards the 'active innovation paradigm'—trends and outlook", *Journal of Innovation and Entrepreneurship*, 5(1), 2016.

2. The EU innovation policy needs new ways to serve the Energy Union

2.1. From a project-driven to a policy-driven European R&I policy for energy

The EU R&I policy has changed over past decades[47], moving from a project-driven approach (1983-2002) which helped developing transnational cooperation, to a more programmatic approach (2003-2013), and then closer to a policy approach with Horizon 2020 (running from 2014 to 2020) and its partial focus on societal challenges[48-49] (see Figure 8).

The current EU R&I policy for energy however still over-focuses on technologies[50], as exemplified by the Strategic Energy Technology Plan (SET Plan). The implementation framework of the SET Plan is made of 3 pillars, namely a Steering Group composed of EU Member States[51] in charge of the governance; the European Industrial Initiatives (EIIs) composed by EU countries; researchers and industry to better align national, European and industry goals; and the European Energy Research Alliance (EERA) that brings together EU research organisations to implement joint programmes[52]. The EIIs are based on the European Technology Platforms (ETPs)[53] which produce technology roadmaps as well as a transversal roadmap on materials. These roadmaps are an excellent state-of-art of technologies and provide very good insights in terms of cost and performance of the corresponding technologies[54], but as argued in Part 1.3, technology alone is never the solution.

Beyond its technology-focus, the current EU approach further raises two key problems. The first is the **lack of prioritisation** as "hardly any de-prioritisation has been done"[55], the thematic content has been extended thanks to a growing budget, which opens up the way to "interest and lobby groups to pressure for continuity in terms of thematic content"[56] (e.g. CCS, see Box 3). The second is the absence of a **consumer-centric approach** to innovation focusing on demand rather than supply, on energy services (e.g. heating or mobility) rather than on technologies –such an approach is suggested in particular in Part 3.1.

BOX 3 ► CCS should be de-prioritised but CCU may be useful

Carbon Capture and Storage (CCS) is a technology aiming at capturing CO_2 emissions and store them to avoid this CO_2 to be emitted in the atmosphere. This technology has been repeatedly pushed by the EU and is one of the technologies put forward in the 2007[57] and 2015[58] Strategic Energy Technology – Plan (SET-Plan). It has been largely seen as a way to continue to use coal, oil and gas to produce electricity in a supposedly 'clean' way. The cost of CCS is very high[59] and yet often largely under-estimated[60]. Fossil-fuel power plants with CCS will likely be more expensive than renewable electricity production, energy efficiency or demand-side management, apart in yet hypothetical and exceptional cases.

To reach the net-zero emissions world contained in Article 4 of the Paris Agreement, some currently unavoidable CO_2 emissions would need to be capture, such as emissions coming from the production of aluminium. While this captured CO_2 may be stored underground, with the possibility that it would leak, it can also be used to build carbon-based elements such as carbon fibre. This Carbon Capture and Usage (CCU) approach treats CO_2 not as a pollutant, but rather as a waste that can be recycled. While most CCU techniques are still at a very early stage[61], they might prove useful to allow some limited but crucial sectors to reach the net-zero emissions objective. Moreover, as CCU produces something useful out of carbon, it can theoretically be profitable even without a carbon price.

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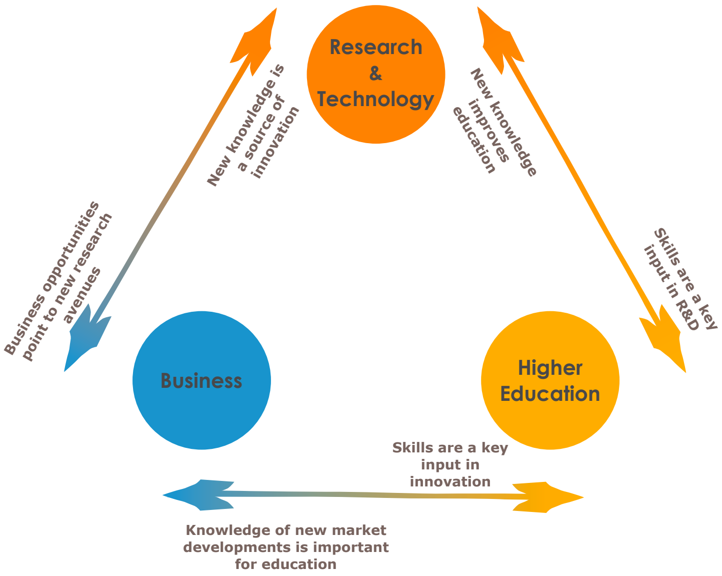
47. Research, Innovation and Science Policy Experts High Level Group, set up by the European Commission in June 2014.
48. Among those seven societal challenges three are directly related to energy, (Energy, Climate Change and Transport) while two have strong links with energy (food-agriculture, inclusive societies).
49. Vincent Reillon, *Horizon 2020 budget and implementation – a guide to the structure of the programme*, European Parliamentary Research Service, November 2015.
50. European Commission, *Energy Technologies and Innovation communication*, 02 May 2013.
51. The list of members can be retrieved from the European commission website.
52. The SET Plan is also supported by the SET Information System (SETIS) which is coordinated by the Joint Research Centre (JRC), a European Commission in-house research service with more than 2000 researchers from various fields, working in 7 research institutes.
53. More information about the ETPs can be found here.
54. Cf. European Commission, *Working Document on Technology Assessment*, 02 May 2013.
55. Matthias Weber, Dan Andrée and Patrick Llerena, *A new role for EU research and innovation in the benefit of citizens: towards an open and transformative R&I policy*, European Commission, 2015.
56. Matthias Weber, Dan Andrée and Patrick Llerena, *A new role for EU research and innovation in the benefit of citizens: towards an open and transformative R&I policy*, European Commission, 2015, p. 6.
57. European Commission, *A European Strategic Energy Technology Plan*, 22 November 2011, p. 10.
58. European Commission, *Towards an Integrated Strategy Energy Technology Plan*, 15 September 2015, Section 4.9.
59. For instance, the International Energy Agency (IEA) estimated in 2011 that the projected levelised cost of electricity produced by a coal-fired power plant with CCS is around 105USD/MWh, higher than the 2014 German Feed-in Tariff for on-shore wind (58€/MWh). Cf. IEA, Cost and Performance of Carbon Dioxide Capture from Power Generation, 2011. Cf. Craig Morris, "Why is UK wind power so expensive?", Energy Transition – The German Energiewende, 29 April 2015.
60. Sarang Supekar & Steven Skerlos, "Reassessing the efficiency penalty from carbon capture in coal-fired power plants", Environment Science & Technology, 2015.
61. CCU is currently being used mostly for enhanced oil recovery. For a closer look at CCU, cf. Henriette Naims et al., "CO2 recycling – an option for policymaking and society?", Institute for advanced Sustainability Studies *Working Paper*, Potsdam, December 2015.

FIGURE 6 ► **The Knowledge Triangle**[65]



source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, adapted from EIT (2012)

The creation of the European Institute of Innovation and Technology (EIT)[62] in 2008 goes into the direction of a mission-based approach of the R&I policy, as the Knowledge and Innovation Communities (KICs[63]), integrate the knowledge triangle at their core (see Figure 6), are structured towards markets, and dedicated to societal challenges, such as energy or climate change. KICs are furthermore operating according to an impact-oriented approach using Key Performance Indicators (KPIs) to assess their action and **embracing the entrepreneurship culture**. The official mission of the EIT is indeed to boost the innovation process from idea to product, from lab to market, and from student to entrepreneur[64]. As KICs main interlocutors are staff members of the innovation department, rather than lobbyists or Member States representatives –who are the traditional interlocutors of the European Commission- the KICs are less prone, though yet susceptible, to see their decision-making being captured by powerful Member States and lobbies.

2.2. The existing R&I EU instruments for energy are not sufficient

The EU currently has a set of programmes to support R&I, with the biggest one being H2020, which is the focus of this section. The EU has put a stronger emphasis on R&I and has increased over time its dedicated budget[66] (see Figure 7). The EU H2020 however still represents a minor element of public and private R&D spending in Europe (see Figure 9), which implies **that the raison d'être of EU R&I policy is probably not primarily to fund R&I, but to steer it**.

H2020 is structured in three pillars (see Figure 8): excellent science, industrial leadership and societal challenges.

H2020's first pillar is dedicated to research and knowledge building activities. One of its key tool is the European Research Council (ERC) that funds research led by teams fully created and organized by a single individual researcher. Its budget quickly rose to significant levels (currently 1,6 bn €). The money granted is attached to the researcher, regardless the structure where he/she works. ERC schemes are not on specific calls, the researchers themselves propose the topic on a bottom-up basis to finance basic research, applied research, and some limited funding for elements that are at the frontier between applied research and innovation: the Proof of concept grants[67]. Even though the ERC support for energy-related projects has brought successes, for instance for new ways to produce solar cells[68], **energy seems to be a poor brother of ERC-supported projects**: between 2007 and 2013, the ERC financed, every year and on average, 10 projects

62. For a critical assessment of the EIT, see: European Court of Auditors, "The European Institute of Innovation and Technology must modify its delivery mechanisms and elements of its design to achieve the expected impact", *Special Report n°4/2016*, April 2016.
63. The authors would like to remind the reader that one of the authors, Pierre Serkine, is currently working for KIC-InnoEnergy that is one of the KICs mentioned in this paragraph. The views expressed here are endorsed by both authors and do not reflect those of any organization.
64. EIT, *The EIT at a Glance*, November 2012.
65. Adapted from European Institute of Innovation and Technology, *Catalysing innovation in the knowledge triangle. Practices from the EIT knowledge and innovation communities*, 2012.
66. However, the gap between the commitments and the payments has to be highlighted. In 2014, the commitments represented an amount of 9.3 billion euros, while actual payments represented an amount of 6.5 billion euros.
67. For a longer description of the organisation of the ERC, cf. Vincent Reillon, *Horizon 2020 budget and implementation – a guide to the structure of the programme*, European Parliamentary Research Service, November 2015, p.20-21.
68. Aswani Yella et al., "Porphyrin-sensitized solar cells with cobalt (II/III)-based redox electrolyte exceed 12 percent efficiency", *Science*, November 2011.

related to energy[69]; compared to around 130-140 projects related to health[70]. This important difference can be due to many different reasons, but indicates that energy-related basic and applied research can be better supported by the EU.

H2020's second pillar aims to speed up the development of technologies and innovations for European businesses. This pillar targets three specific objectives: developing Key Enabling Technologies (KETs)[71], providing financing tools for R&D activities in the private sector (loan guarantees, venture capital, direct corporate lending), and supporting specifically innovative SMEs.

H2020 brought a much welcomed evolution with **a third pillar** meant to address societal challenges (see Figure 8) aligned with the Europe 2020 strategy, thus starting to bring policy orientations into the EU's innovation policy.

Despite attempts to simplify the system through pooling all R&I activities under the same programme, **complexity remains**. Indeed, H2020 involves no less than 8 Commission Directorates General and the JRC when it comes to budget responsibility, and the budget is implemented by 22 different bodies[72] under different types of partnerships[73]. An illustrative example is on R&I for SMEs where the original attempt to simplify the situation through a SME instrument was not sufficient to overcome path-dependency: the instrument is fragmented into 17 distinct budget lines managed by 7 DGs.

Complexity is further increased by the national fragmentation of national public support to R&I. Despite political difficulties, it would make more sense to make research an EU exclusive competence, thus pooling national and EU R&I support schemes into a common integrated Research & Innovation policy for the European Union. In this regard, EURICS can attempt to be the guiding strategy to ensure an integrated approach to energy R&I, with the aim of enhancing the performance of R&I policy in Europe.

69. European Research Council, *Science behind the projects*, 2014. p. 40. Those projects mostly dealt with fuel cells and hydrogen, Li batteries supercapacitors and photovoltaics.
70. European Research Council, *Science behind the projects*, 2014. p. 43.
71. For a study on the KETs, cf. European Parliament DG for internal policies, *Horizon 2020: key enabling technologies, booster for European leadership in the manufacturing sector*, European Parliament 2014.
72. Namely: 5 Commission DGs directly, 4 public-public partnerships, 7 public-private partnerships, 4 executive agencies, the EIT and the European Investment Bank.
73. European Parliamentary Research Service, "Overview of EU Funds for research and innovation", *Briefing*, September 2015.

FIGURE 7 ► Evolution of the Framework Programmes' budget between 1984 and 2020[74]

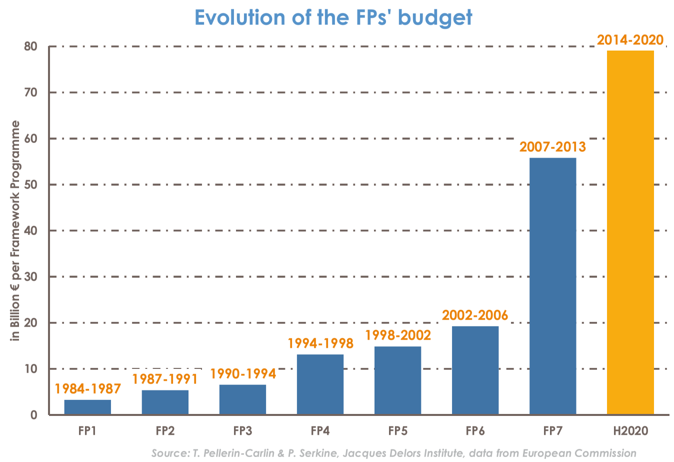
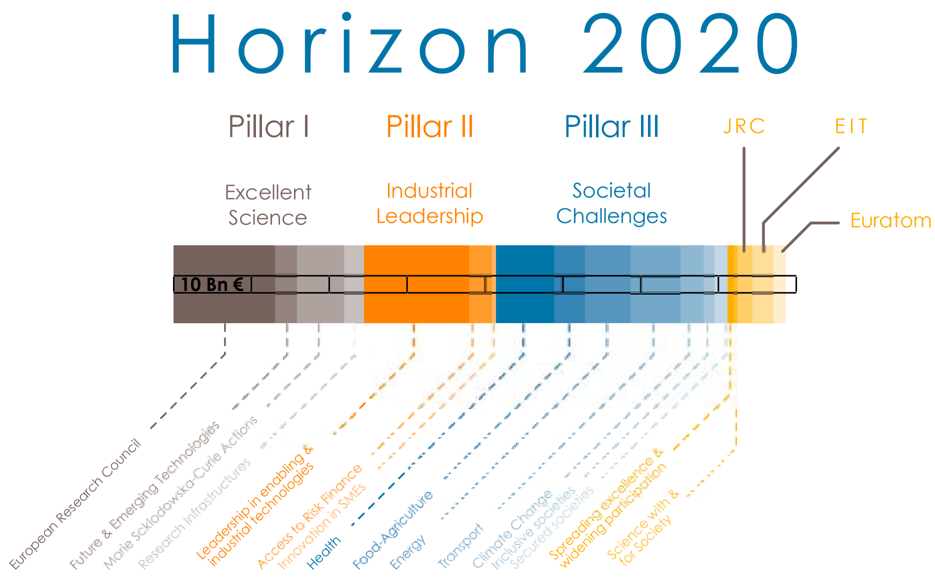
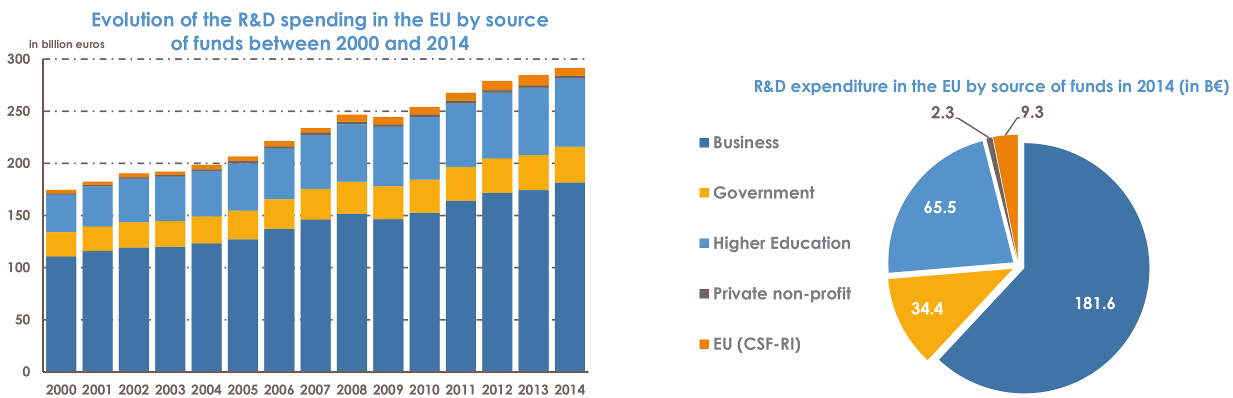


FIGURE 8 ► Breakdown by pillar of the Horizon 2020 budget for 2014-2020



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from European Commission

FIGURE 9 ► R&D spending in the EU by source of funds: evolution between 2000 and 2014 (left-hand side) and in 2014 (right-hand side)[75]



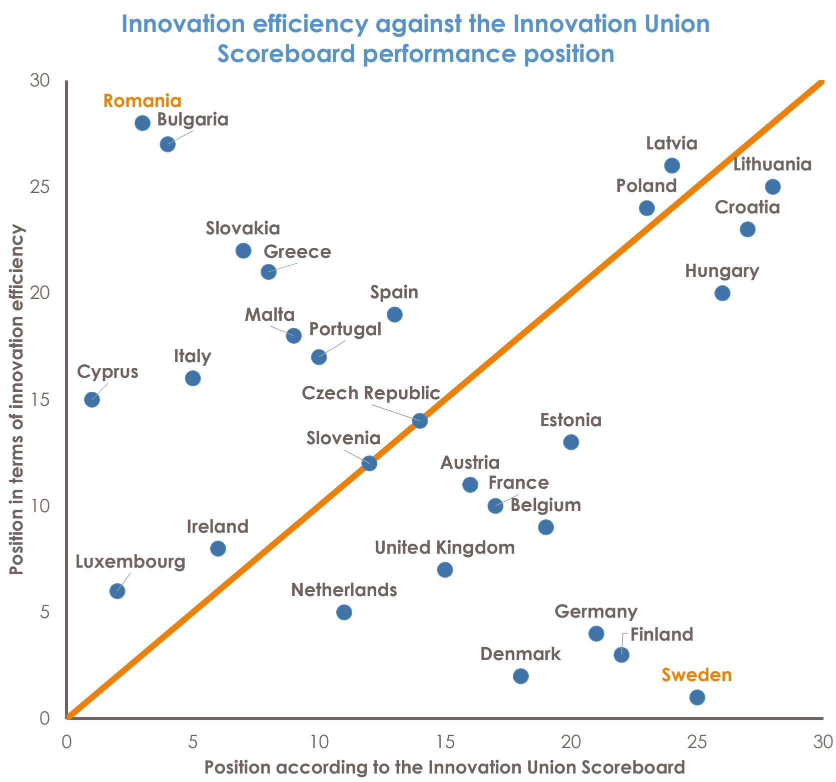
74. Accessible for the first seven FPs, and for the H2020 programme.
75. The definitions for the first four sources of funds come from Manual Frascati, *Proposed standard practice for surveys on research and experimental development*, OECD, 2002. "EU (CSF-RI)" corresponds to the sum of H2020 and Euratom.

2.3. European R&I policy for energy is performant but can be improved to allow Europe to lead the energy transition race

Assessing innovation performance is a tricky exercise. Large aggregates are obviously relevant to have an insight, such as the patents[76] filed, the scientific articles issued, or the number of researchers. The EU has created a methodology to compare Member States, track progress, and set objectives: The Innovation Union Scoreboard (IUS)[77-78]. Its methodology is based on the combination of 25 indicators spread into 3 categories: enablers, firm activities and outputs.

The use of the IUS to assess national innovation performance is however questionable. Edquist and Zabala-Iturriagagoitia[79] indeed raise concerns about it as innovation outputs and inputs are considered on an equal foot[80], whereas innovation performance may rather be seen as a measure of the efficiency of the innovation system: delivering high outputs with low inputs[81]. Adopting a different approach, based on the distinction between inputs and outputs they draw drastically different conclusions (see Figure 10[82]). Sweden goes from n°1 to n°25 in terms of "performance" (meaning innovation efficiency), while Romania goes from n°28 to n°3.

FIGURE 10 ► **Comparison between the ranking in the Innovation Union Scoreboard and the efficiency measure according to Edquist and Zabala-Iturriagagoitia**



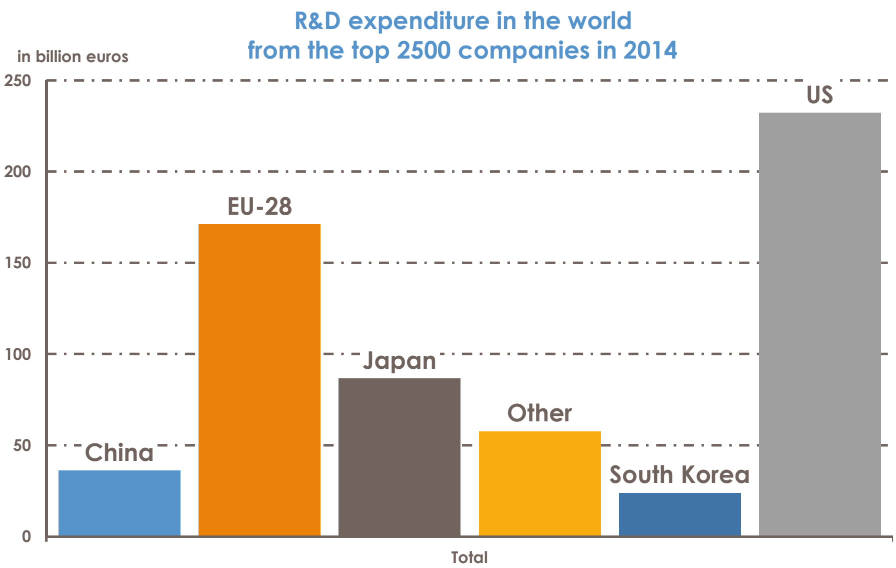
Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from IUS and Edquist & Zabala-Iturriagagoitia

76. See Box 4.
77. The Innovation Union Scoreboard performance index is the average of the 25 distinct indicators, mixing up the enablers, the firm activities and the outputs of innovation.
78. European Commission, *Innovation Union Scoreboard 2015*, 2015.
79. Charles Edquist, Jon Mikel Zabala-Iturriagagoitia, "The Innovation Union Scoreboard is flawed: The Case of Sweden – not the innovation leader of the EU – updated version", Papers in Innovation Studies of CIRCLE Lund University, *Paper n. 2015/27*, 2015.
80. This approach is also the one chosen to compute the Global Innovation Index (GII) present in the Global Innovation Index report published annually since 2007 by INSEAD and the World Intellectual Property Organization. The GII is more complex as it involves 79 distinct indicators, both quantitative and qualitative. However, the Global Innovation Index report also implies the computation of the Innovation Efficiency Ratio, which is the ratio between Innovation Input and Innovation Output.
81. This idea of performance is also present in the Global Innovation Index (see footnote 80) that assesses it through their innovation efficiency ratio.
82. This figure shows the discrepancies between the position in the IUS and the measure of efficiency according to Edquist & Zabala-Iturriagagoitia. The distance to the orange line materialises the gap between the two approaches. A country located exactly on the orange line occupies the same position in both rankings.

Our point here is not to discuss the relevance of the IUS nor to question a given country's ranking. We however seek to point out that the **notion of performance**, in particular in the context of innovation, may be reconsidered to foster better policy choices.

Looking at one of the innovation inputs, R&D expenditure in Europe has risen over the past decade (see Figure 9) even though its share in the GDP remains around 2%[83] instead of the 3% EU objective that exists since the 2000 Lisbon Strategy. More than two thirds of EU expenditures are done by businesses. Business R&D expenditure are however significantly lower in the EU than they are in the USA (see Figure 11). The role of EURICS is therefore threefold, find ways to boost public R&D to compensate for the lack of private investment in this area, ensure that all R&D expenditure is managed as efficiently as it possibly can, and seek to emulate R&D investment from European companies to, at least, be on an equal footing with their US counterparts in terms of innovation capacity.

FIGURE 11 ► R&D expenditure in the world from the top 2500 companies in 2014



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from European Commission

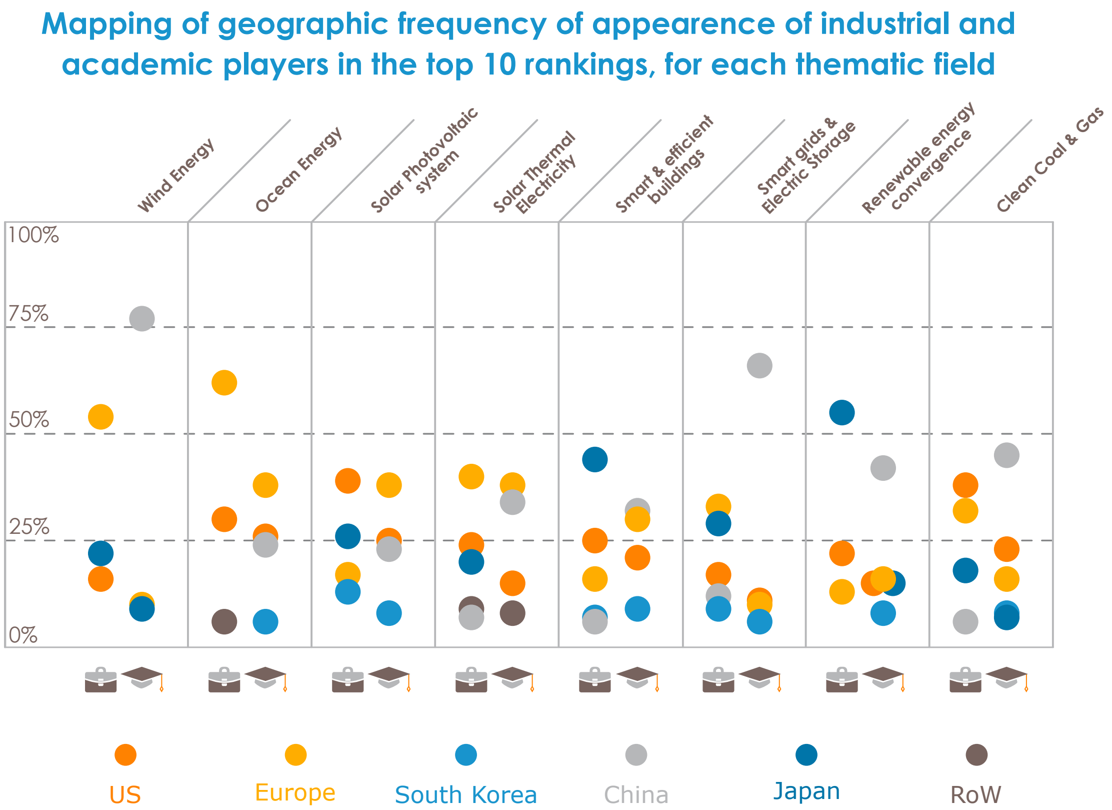
It is however difficult to know in which sector private R&D expenditure (that represents 2/3 of Europe's R&D expenditure) is invested as available statistics are insufficiently detailed (see Box 4), an element that advocates in favour of the creation of a public European Energy Information Service that would be tasked to produce good statistics to allow policy makers, business leaders and citizens to avoid bad decisions[84].

Finally, when it comes to energy technologies specifically, the Top 10 report[85] issued in January 2015 provides a picture of the positioning of Europe, the USA, Japan, China, South Korea and the rest of the world, both in terms of academic and industrial players.

Figure 12 displays the share of each region in the total appearance of industrial and academic players in the 8 energy thematic fields identified. From the yellow dots which correspond to Europe, we can clearly identify fields in which **Europe leads in terms of innovation**, such as the **Ocean Energy, Solar Thermal Electricity,** and **wind energy**. Interestingly, **China** (light grey dot in the graph) is among the top players when looking at research institutions, but is clearly **lagging behind in terms of industrial players**.

83. Source: Eurostat.
84. Jacques de Jong, Thomas Pellerin-Carlin, Jean-Arnold Vinois, "Governing the differences in the European energy union: EU, regional and national energy policies", *Policy paper n°144*, Jacques Delors Institute, October 2015.
85. KIC InnoEnergy & Questel Consulting, *Top 10 Energy Innovators in 100 Energy Priorities: A unique report mapping industrial and academic players in global competition*, January 2015. The report is based on a methodology involving several key dimensions of R&I, such as patents, scientific publications, R&D collaborations and R&D commercialisation (spin-offs, start-ups, acquisitions, licenced technologies for instance), using quantitative and qualitative measures. The report analyses 100 energy technologies, spread among 8 thematic fields. For each of the 100 energy technologies, the report provides the top 10 reference companies and the top 10 reference research institutions, with a scoring based on a methodology developed specifically for this occasion. It is available upon request, contacting Pierre Serkine by mail (pierre.serkine@kic-innoenergy.com).

FIGURE 12 ► Overview of the results of the Top 10 Energy Innovators in the 8 distinct thematic fields, for industrial and academic players[86]



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from KIC InnoEnergy

To summarise, even with smaller public and private investments in R&I than in the US, Europe has strong assets and capabilities to enable the energy transition: technologies, top industrial players, and an ambitious political framework coined 'Energy Union'. If all stakeholders honestly believe, trust and take part in the innovation strategy to come, the EU could lead the energy transition race. To carry such active support from energy stakeholders, **the EU should clearly identify the political objectives EURICS is meant to achieve**.

86. N.B. figures below 5% are not shown in the graph.

BOX 4 ► Good statistics cost money, but so do bad decisions[87]

The lack of recent and detailed energy statistics is a challenge for EU policy makers. Most energy statistics can be old[88], irrelevant and/or not disclosing key elements of their methodology.

Most statistics used by EU policymakers[89] are coming from the International Energy Agency (IEA) that studies 'OECD Europe', i.e. an aggregate that includes non-EU Member States (such as Turkey, Norway and Switzerland) but excludes 8 EU Member States (including Romania and Bulgaria). It is doubtful to believe that relying on statistics for only 20 EU Member States is the best way to build smart Energy Union policies for the 28 Member States. IEA data moreover do not always have an open methodology, which means that political choices can alter statistics without the reader being aware of their existence[90]. Key IEA documents such as its 'World Energy Outlook' are moreover not freely available to citizens.

Having an open methodology is important to avoid misunderstanding of statistics. For instance, R&D business expenditures figures used in this paper are also available on a sector-by-sector basis. The methodology used by the statistical dataset is however irrelevant as they allocate all the R&D expenditures of a single company to a single sector, even if this company may do R&D into several sectors. Moreover, the choice of the sector is sometimes strange as, for instance, in the EU industrial R&D investment scoreboard[91], Chinese telecom giant Huawei is considered to invest all its R&D expenditure into the financial services sector. Similarly, when assessing the geographical origin of R&D expenditure, the report considers the headquarter of the company rather than the countries where R&D expenditure actually occur.

The European Commission sometimes[92] relies on the number of low-carbon patents to assess Europe's innovation capacity. This is a questionable choice as "there is no empirical evidence that [patents] serve to increase innovation and productivity"[93] as the number of patents indeed indicates rather the level of maturity of a technology than the importance of innovation[94]. Data can moreover be artificially boosted by the phenomenon of 'patent holdup'[95] through which companies try to obtain an important number of patents, not because they have made significant improvements, but rather to deter newcomers from entering a market.

As for Eurostat, their data is available but however sometimes quite old (e.g. with most recent data being available for the year 2013) and usually not user-friendly. Promising open-data and user-friendly approaches have however been chosen by key players, such as the US Energy Information Administration, the French transmission system operator RTE or think tanks like The Shift Project or Carbon Atlas. Such approaches should guide the creation of a European Energy Information Service[96] that would be able to provide open and user-friendly energy data concerning all 28 EU Member States, to decisions makers, business leaders and citizens.

2.4. An innovation strategy that truly serves the Energy Union political objectives

"A policy vision and strategy driving the [R&I] instruments is important [...] to avoid policy instruments to become just the result of 'arbitrary lobbying for partial interests'."[97]

2.4.1. From an energy transformation to a genuine energy transition

The mainstream expression to talk about the transformation of the energy system is "Energy transition". It first appeared in the USA in 1974 as the US administration was seeking a less anxiety-driven word than 'energy crisis' to talk about the first oil shock[98]. This choice of word is political and other expressions were available (e.g. change, transformation, shift, evolution, revolution, mutation)[99].

Energy historians[100] have shown that over past centuries, energy systems saw phenomena that may resemble **energy *additions* rather than *transitions***: with a growing energy demand, coal was added to bioenergy

87. This title paraphrases the title of an event organised by CEPS in December 2015 for the launch of the 7th Annual Report of the European statistical governance advisory board.
88. For Instance, in its November 2015 documents provided with the first State of the Energy Union, the European Commission seeks to assess the EU's capacity in low-carbon innovations by showing a graph of EU Member States' number of low-carbon technology patent applications with data dating from 2011. Cf. European Commission, *Monitoring progress towards the Energy Union objectives*, 18 November 2015, p. 68.
89. European Commission, *State of the Energy Union Communication*, 18 November 2015.
90. Informal conversations between the authors of this paper and IEA staff members tend to indicate that the issue of political choices over statistics is a regular feature of the IEA's work.
91. Joint Research Centre, *EU industrial R&D investment scoreboard*, 16 January 2015.
92. European Commission, *Monitoring progress towards the Energy Union objectives*, 18 November 2015, p. 68.
93. Michele Boldrin and David Levine, "The case against patents", *Journal of Economic Perspectives*, Vol 27, n°1, 2013. p. 3.
94. Michele Boldrin and David Levine, "The case against patents", *Journal of Economic Perspectives*, Vol 27, n°1, 2013. p. 18.
95. Mark Lemley and Carl Shapiro, "Patent Holdup and Royalty stacking", *Texas Law Review*, Vol 85, 2007.
96. Sami Andoura and Jean-Arnold Vinois, "From the European energy community to the energy union – a new policy proposal", *Studies & reports n° 107*, Jacques Delors Institute, January 2015.
97. Matthias Weber, Dan Andrée and Patrick Llerena, *A new role for EU research and innovation in the benefit of citizens: towards an open and transformative R&I policy*, European Commission, 2015, p. 7.
98. Jean-Baptiste Fressoz, "Pour une histoire désorientée de l'énergie", *Entropia n°15*, 2013.
99. Sylvain Di Manno, *La transition énergétique, entre histoire politique et politique de l'histoire*, Ecole thématique de l'institut francilien recherche innovation société, 2014.
100. Vaclav Smil, *Energy Transitions: History, Requirements, Prospects*, Praeger, 2010; E. A. Wrigley, *Energy and the English Industrial Revolution*, Cambridge: New York, Cambridge University Press, 2010. Astrid Kander, Paolo Malanima, Paul Warde, *Power to the people*, Princeton University Press, 2013; Timothy Mitchell, *Carbon Democracy*, Verso, 2013; Jean-Baptiste Fressoz, "Pour une histoire désorientée de l'énergie", *Entropia n°15*, 2013.

then followed oil, nuclear and gas. So far, the world is seeing another energy addition, with new renewables (e.g. solar and wind) adding to the mix while demand for coal, oil and gas still increase globally[101].

While a mainstream view is that "in each case, the new fuel was in some way better, faster, cheaper or more suited to its purpose than what came before"[102], a closer historical look suggests that political objectives played a key role in shaping energy systems. For instance, after 1945 the rise of oil in the European power sector was not due to oil being more suited than coal to generate electricity, but was an energy transformation wanted by US and Western-European governments for political reasons: limiting the power of left-wing coal miners trade unions in a Cold War context[103].

This historical background is crucial to understand three critical elements. First, if "energy transition" means the substitution of an energy source by another one (e.g. a situation where fossil-fuels would be substituted by renewables), then **there has never been a global energy transition in human history**. Second, the current energy system is **the result of past political decisions** and should not be fantasised as a natural outcome of technological progress. Lastly, the choice of an energy system is a political choice that shapes our society and political regimes.

Today, the EU has its own definition of its energy transition. Its **Energy Union** is an ambitious political project clearly set-out in the European Commission's Energy Union Framework Strategy of February 2015. It is about putting citizens and consumers at the centre of a change aiming at decarbonizing our economy[104]. EURICS' objective is therefore clear, to use the tool of R&I policy to **help the Energy Union live up to its ambition:** decarbonise the economy in a democratic and competitive way.

2.4.2. Living in a post-Paris world: reaching net-zero emissions

Climate Change is one of the biggest threats to what is called "civilisation"[105]. According to the Global Challenge Foundation, climate change is indeed a global catastrophic risk[106], together with threats such as nuclear war, pandemic and a catastrophic disruption from Artificial Intelligence[107].

In the past, human societies have collapsed or even disappeared because their social structures did not adapt to a changing environment[108]. Greenland Viking[109] disappeared in a few decades largely because their ruling class ensured the preservation of their power by supporting the *status quo* rather than adopting changes necessary for their society's survival[110]. As Jared Diamond ironically points out, "by insulating themselves in the short run from the problems of society, the elite merely bought themselves the privilege of being among the last to starve"[111].

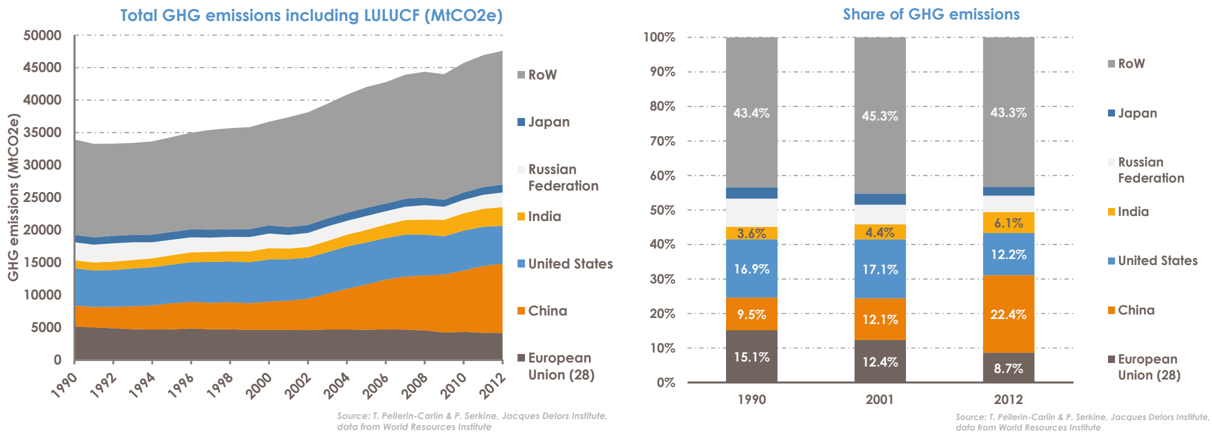
101. For instance, data from the BP Statistical Review 2015 suggests that global coal consumption increased by 1.500 millions of tonnes of oil equivalent (mtoe) from 2000 to 2014, gas consumption grew by 884mote and oil by 630 mt; while renewable energy consumption increased by only 543 mtoe (of which 278mtoe of hydropower and 265 mtoe of other renewables).
102. World Economic Forum, *Energy Vision 2013*, 2013, p.5
103. Timothy Mitchell, *Carbon Democracy – political power in the age of oil*, Verso, 2013.
104. In more details, the Energy Union official goal "is to give EU consumers –households and businesses- secure, sustainable, competitive and affordable energy". In practice, "With citizens at its core", the Energy Union aims to "move away from an economy driven by fossil fuels ... where energy is based on a centralized, supply-side approach and which relies on old technologies and outdated business models" it furthers wishes to "empower consumers" and "move away from a fragmented system characterized by uncoordinated national policies". Quotes are from the European Commission's Energy Union Framework Strategy of 25 February 2015.
105. Paul Ehrlich, Anne Ehrlich, "Can a collapse of global civilization be avoided?", Proceedings of the Royal Society B, 9 January 2013.
106. According to the Global Challenges Foundation, a global catastrophic risk is a threat that could kill at least 10% of the global population. As a comparison, the second World War killed around 3% of the global population of that time, and the Spanish influenza pandemic killed between 2.5% and 5%.
107. Global Challenges Foundation, *Global Catastrophic Risks 2016*, 2016.
108. Alexandre Magnan et al., "Addressing the risk of maladaptation to climate change", *Wiley interdisciplinary reviews: Climate Change*, 2016.
109. Other examples can be the Mayas, the Anasazi, the Easter islanders, the Pitcairn and Henderson islanders, the Angkor Wat Khmers of the Peruvian Moche society.
110. Cf. Jared Diamond, *Collapse: how societies choose to fail or succeed*, 2005. See in particular the book's conclusion for the application of Jared Diamond's study to climate change in the 21st century. For an analysis of successful adaptation to a changing environment, cf. the book's sections on 17th century Japan and Renaissance's Netherlands.
111. This quotation is meant for the Maya elite but can be equally applied to the Greenland Vikings. Cf. Jared Diamond, "The ends of the worlds as we know them", *New York Times*, 01 January 2005. For an alternative view on the impact of a changing environment on societies risk to collapse, see Joseph Tainter, *The collapse of complex societies – new studies in archaeology*, 1990.

As climate change is already occurring, climate change adaptation is crucial[112] and so is resilience, i.e. the ability of our system to get back to an equilibrium (potentially different from the previous one) after a shock, and to maintain its vital functions. Adaptation is moreover closely related to local action and benefits, and is a very interesting case for a multi-level governance approach to innovation, as well as a multi-disciplinary approach as resilience is about human beings and systemic approach. One example of implementation of resilience is the recent urban planning of Hamburg in Germany, in the HafenCity district, or the Rebuild by Design[113] project launched in the US to reshape New York City, to make it resilient.

Reducing risks arising from climate change (i.e. mitigation) is both a global public good, and an intergenerational one. As for any public good, market economy tends to lead to a sub-optimal allocation of funds, making public intervention economically rational in order to address this "market failure" (a private cost for a global benefit).

Climate change mitigation is obviously everyone's duty, but as the EU represents only 8.7% of global greenhouse gas (GHG) emissions[114] (see Figure 13) while gathering 23.7% of global GDP[115], **Europe can be most climate-effective by becoming the global provider of low-carbon innovations**. The aim is here to allow developing countries to leapfrog: i.e. to go from poverty to low-carbon prosperity, without going through a phase of high-carbon economic development.

FIGURE 13 ► Total GHG emissions including LULUCF between 1990 and 2012 (left-hand side), and corresponding share of global GHG emissions in 1990, 2001 and 2012 for some major areas (right-hand side)



In this context, the Paris Agreement signed in December 2015 may constitute a game-changer as it sets, for Europe and the world, the arguably most ambitious objective ever: net-zero emissions in the 2nd half of the 21st century[116]. Reaching such an ambitious objective is necessary –but not necessarily sufficient- to stop global warming[117] and reaching it entails to boost energy-climate R&I on an unprecedented scale (see Part 3.2).

112. Despite some economists who, like Richard S. Tol, argue that "mitigation and adaptation should be kept largely separate", usually to promote a reduction of the mitigation effort and a stronger adaptation effort, it is clear that emphasising adaptation should definitely not be a leeway to reduce the mitigation effort, but rather a way to increase the credibility of the commitment and to establish its determination to fight climate change, whatever it takes. Combining credible adaptation policy and mitigation roadmap would reduce the incentive of free-riding in the international climate change negotiations. From an economic perspective, mitigation policy is a local cost for a global benefit, whereas adaptation policy is a local cost for a local benefit, which makes the latter easier to implement. However, this approach embeds assumptions, such as the fact that society will be able to adapt to future climate (no catastrophic risk), or the use of discount rate up to 5.5%, which leads to undermine the welfare of future generations compared to present and nearer generations.
For a more in-depth discussion, see: Richard S. Tol, "Adaptation and mitigation: trade-offs in substance and methods", *Environmental Science & Policy*, n° 18, 2005, pp. 572-578. And also, William D. Nordhaus, "A review of the 'Stern review on the economics of climate change'", *Journal of economic literature*, 2007, pp.686-702.
113. This project is very relevant, as it enhances the relative value of New York compared to cities that did not implement resilience programme. Consequently, the Rebuild by Design project is a spectacular incentive to innovate in a multi-level, multi-disciplinary and multi-stakeholder way, with the (urban) citizens at the centre of the process, as well as one of the stakeholder around the table. For more information: www.rebuildbydesign.org/
114. CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute. Available online.
115. Data from the World Bank.
116. This objective is presented in an unnecessarily complex wording, at Article 4.1 of the Paris Agreement: *"so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century"*.
117. The climate system is an utterly complex one involving various components such as the atmosphere, the oceans or the lands. The climate change issue cannot be reduced to a simple linear causal relationship between the GHG emissions and the global temperature rise, so that there is no scientific certainty that the temperature rise would cease even if the anthropogenic emissions decrease down to zero. However, there is no uncertainty on the fact that any mitigation of GHG emission is already positive for our climate system and thus, help to limit the risk of irreversible climate change and of exceeding the tipping points, beyond which the phenomenon is self-reinforcing. Consequently, human emissions must reach a net zero level as quickly as possible, cf. IPCC, *5th Assessment Report*.

2.4.3. Democracy: the citizen at the centre of Energy and Innovation

"[Our] administration favours the many instead of the few; this is why it is called a democracy. … we [citizens] are all sound judges of a policy" Pericles[118]

This quotation by Pericles was famously retaken by Abraham Lincoln[119] who defined democracy as a system where decisions are taken for the people (i.e. 'favours the many') by the people (i.e. 'we [citizens] are all sound judges of a policy'). This notion is also at the core of the Energy Union rhetoric: "Most importantly, our vision is of an Energy Union with citizens at its core, where citizens take ownership of the energy transition"[120]. Applied to the issue of energy innovation, democracy can mean that EU Energy Innovation should be done for *citizens*, and ideally by *citizens*.

Innovation for citizens. So far, the EU energy innovation policy has mostly focus on pushing technologies, thus largely ignoring what matters for people: having an energy need (e.g. heating or mobility) fulfilled. An innovation strategy for citizens would therefore start by focusing on what they actually need, and how they use energy. It would moreover ensure that its resulting actions seek to reach the notion of 'justice as fairness' and, more specifically, the idea that all actions should try to 'be to the greatest benefit of the least-advantaged members of society'[121]. Section 3, and in particular section 3.1 makes concrete proposals to ensure that energy innovation better serves citizens.

Innovation by citizens. European representative democracies are in crisis. Citizens are increasingly defiant as exemplified by rising abstention to both national and European elections[122] and severe distrust in mainstream political parties[123]. Citizens may therefore appeal to a clear, transparent and more direct control over policy choices. In the context of EURICS, the EU can **make a simple and disruptive strategic choice in its energy innovation policy: answer defiance with democracy, really put citizens in control of energy union innovation choices.** Section 3.3. makes concrete proposals to put the citizen in the driving seat of a segment of the EU energy innovation policy.

With democracy and citizens at the core of the EU innovation policy, EURICS will not only be more democratic and legitimate, but also more effective and efficient. There is indeed wide evidence supporting the idea that a more active involvement of citizens leads to better innovations[124], and it would increase the chances that citizens not only accept the energy transition, but become more active players and enablers of this transition[125], thus **fostering a change from NIMBY to PIMBY**[126].

2.4.4. Innovation as the new EU competitiveness policy

"The ability to continually innovate—to engage in an ongoing process of entrepreneurial action —has become the source of competitive advantage." Donald Kuratko[127]

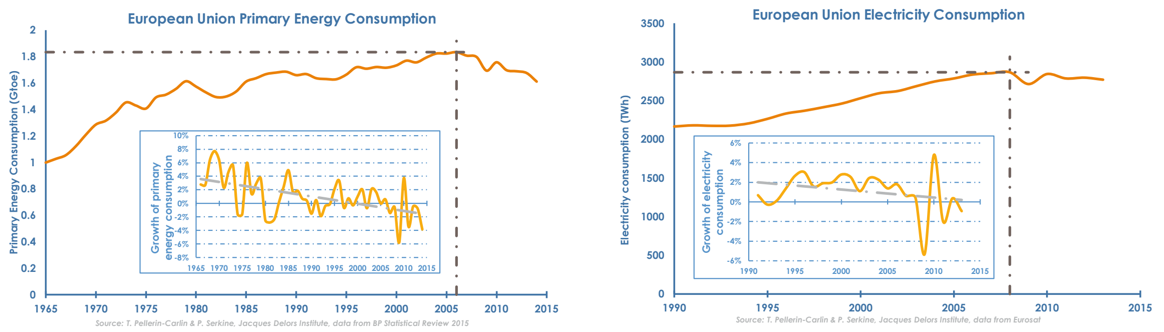
With innovation the core of EU competitiveness, European workers and businesses will be supported to do what no-one else does, to really innovate and be able to sell European products and services on European and

118. This quotation is attributed to Pericles by Ancient Athens historian Thucydides. Cf. Thucydides, *The Peloponnesian War*, Book II, written around 410BC.
119. Abraham Lincoln, Gettysburg Address, 19 November 1863. Both Lincoln and Pericles speeches were given as funeral orisons to soldiers who recently died in war.
120. European Commission, *Energy Union Framework Strategy*, 25 February 2015, p. 2.
121. The authors here embrace the notion of justice as fairness as expressed in the late-life lectures and writings of John Rawls. Cf. John Rawls, *Justice as fairness: A Restatement*, Harvard University Press, 2001.
122. Yves Bertoncini, "European elections: the abstention trap", *Policy Paper No. 110*, Jacques Delors Institute, 13 May 2014, Table 4.
123. Examples of such parties are UKIP in the UK, Podemos and Ciudadanos in Spain, Movimento 5 Stelle in Italy, Alternative für Deutschland in Germany, Kukiz'15 in Poland, and other recently created political parties.
124. Cf. in particular the work of Prof. Arun Sundararajan on the sharing economy, blockchain markets and on crowd-based capitalism.
125. For instance, in Germany, around half of the renewable capacity installed between 2000 and 2010 has been installed by citizens. Cf. Noémie Poize and Andreas Rudinger, "Projets citoyens pour la production d'énergie renouvelable : une comparaison France-Allemagne", *IDDRI working Papers*, 2014.
126. The acronym 'NIMBY' means 'not in my backyard' and is used to name individuals –or organisations- who favour something (e.g. wind power development) as long as it does not directly impact their lives (e.g. people opposing a windfarm from being built in their area). By contrast, our acronym 'PIMBY' means 'please in my backyard' and can be used to name individuals –or organisations- who suit the word to the action by both advocating for something and actually do it (e.g. investing money in a windfarm through a crowdfunding campaign).
127. Donald Kuratko, "The entrepreneurial imperative of the 21st century", *Business Horizons*, 2009, p.421

global markets, especially the booming markets for the bot-economy (see Box 5), renewable energy[128], energy efficiency[129], and frugal innovation products (see Part 3.1.4).

European energy incumbents are currently struggling with **outdated business models**. As Figure 14 shows, EU primary energy consumption is decreasing, and so is electricity consumption albeit to a lesser extent. This change jeopardises the traditional business models and is one of the drivers pushing to reconsider and transform their activities via innovation.

FIGURE 14 ► **Evolution of EU Primary Energy Consumption and of its growth rate between 1965 and 2014 (left-hand side) and evolution of EU Electricity Consumption and of its growth rate between 1990 and 2013 (right-hand side)**



Some EU players have started to shift. As an illustration, E.ON decided to create two distinct entities to keep only activities related to networks, renewables and customer solutions in the entity E.ON, while the remaining activities (conventional power generation, energy trading, and exploration and production) are in a new entity named Uniper. Similarly, GDF Suez decided to change its organisational layout and to operate a brand mutation, which goes far beyond the change of its name to Engie[130].

To foster this transformation from conservative pussycats into energy transition tigers (see Part 1.3), incumbents could **unleash the dormant innovative potential** present in many of their current employees. This would make European companies more competitive while helping Europe to retain and attract talents[131]. In this perspective, European policy makers and civil society can promote and implement "active innovation" policy measures, incentivising companies to move into this direction (see Part 3.3.4). The entrepreneurship mind-set is not limited to private sector companies and can also flourish in research centres with researchers bridging with companies to harness the full potential of their work[132]. Put differently, **the EU should expand the pipes for the stock of knowledge to flow** towards applied research and further down to markets (see Part 3.2.2).

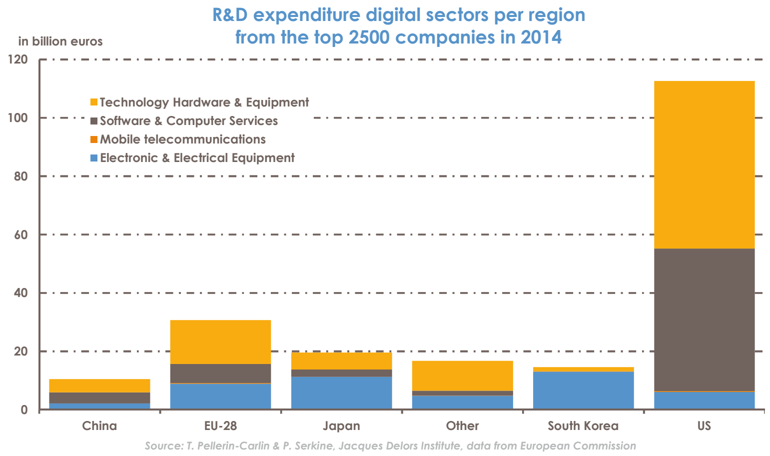
128. International Energy Agency, *World Energy Outlook 2015*, p. 60.
129. Cf. Thomas Pellerin-Carlin, "How can the Juncker Plan unlock energy efficiency investment in the short and long term?", *in* Eulalia Rubio, David Rinaldi & Thomas Pellerin-Carlin, "Investment in Europe: Making the best of the Juncker Plan", *Studies & Reports No. 109*, Jacques Delors Institute, March 2016.
130. "Faced with an evolving energy market, this transformation is intended to serve the development of our group and our position as the global leader of the energy transition. It will allow us to take on the many challenges of the energy market: decarbonisation of the energy mix, digitalisation of activities, decentralisation of energy production and development of energy efficiency." Gérard Mestrallet, then CEO of Engie, 4 January 2016.
131. Jack J. Phillips and Lisa Edwards, *Managing talent retention: An ROI approach*, John Wiley & Sons, 2008. p.1.
132. This already exists to a limited extend thanks to some EU policy tools, such as the ERC's proof of concept grants. See Part 2.2.

BOX 5 ► Towards a bot-revolution?

Carlota Perez identifies five successive technological revolutions over the past 200 years. The most recent one has been triggered with the announcement of the microprocessor by Intel in 1971, and led to the new economy, characterised by the ubiquity of ICTs[133].

Another technological revolution could be coined "Bot revolution", enabled by Artificial Intelligence and Deep Learning, fuelled by big data, and materialised in our daily life by Internet of Things and the distributed ledger technology (DLT), and many additional elements yet unimagined. DLT has indeed the potential to disintermediate and enable the decentralisation of many activities, as illustrated with its most famous application: Bitcoin. In energy, DLT is under scrutiny and could deeply transform the electricity value chain, forcing utilities to dramatically reimagine their activities[134-135].In this context, it is relevant to notice that Europe is lagging behind the US, and R&I is clearly linked to this situation (see Figure 15) since the funds invested in digital-related sectors are almost 4 times greater in the US than in the EU, with a key role being played by major US digital companies such as Microsoft, Facebook and Google (which represented more than 20 billion euros of R&D expenditure in 2014, i.e. more than twice the EU's H2020 budget for 2014).

FIGURE 15 ► R&D expenditure in digital-related sectors per region from the top 2500 companies in 2014



Europe has on its soil private research centres in Artificial Intelligence, owned by US companies, such as DeepMind from Google in London, or the new Facebook centre in Paris. Strategically speaking, it can be viewed as a way to drain the brilliant European brains, as they make challenging offers, both in terms of working conditions and content. Europe should address this issue and find the solution (e.g. such as the one proposed in Section 3.2) to retain these crucial talents to feed in its innovative engine and shape the future Economy[136].

133. Carlota Perez, "Technological revolutions and techno-economic paradigms", *Cambridge journal of economics*, 2009.
134. The JRC has started to investigate this technology for the European energy retail market, see UK Government Chief Scientific Adviser, *Distributed ledger technology: beyond block chain*, January 2016, pp. 76-77.
135. In Brooklyn (New-York), a project named TransActiveGrid is currently implementing this type of technology to create a genuine microgrid, in which citizens can exchange electricity from peer to peer without intermediary.
136. A key element here has to do with the ethical dimensions raised by the Bot Economy. If Europe shapes the bot economy, it has stronger chances to ensure that European values are embedded into the bot economy. Cf. Nick Bostrom and Eliezer Yudkowsky, *The Ethics of Artificial Intelligence*, The Cambridge Handbook of Artificial Intelligence, 2014, pp. 316-334.

3. Because innovation means action: three proposals for EURICS

3.1. Competitiveness starts from people

3.1.1. From NIMBY to PIMBY: a citizen appropriation of energy

"There's a lot of talk about drones, but people don't like them, and it's social acceptance that determines whether a robot will work". Ahti Heinla, CEO of Starship[137]

As citizens may oppose energy projects (e.g. coal mine extensions, nuclear power plants, windfarms etc.), a stronger focus has been put on the notion of acceptance where an end-user or citizen is seen as a passive recipient of a technology/project –or opposes it. So far, public consultations and processes involving the citizen through representatives of "the civil society" have been the favoured –and arguably very disappointing- means to this end. Beyond this focus on acceptance, one can look at ways to foster end-user and citizen appropriation.

Appropriation tries to imagine the process through which citizens can actively decide to introduce new goods and practices into their life, and thus to steer transformation. In energy, it corresponds to an energy transition desired and powered by citizens themselves. Unlike acceptance, appropriation is not about imposing to people what they do not want, **it is about co-creating with citizens** and end-users the energy solutions that they need and want.

In the long term, appropriation of energy could correspond to the process by which an individual learns to consider energy as an essential part of himself/herself, a part of his/her social identity, and to integrate energy matters in daily life, decisions and resulting behaviours. Appropriation of energy could for instance be acquired in childhood[138] through daily management of and recurring experiment with energy; via a process similar to the way notions like **time and money are taught throughout life**[139].

A focus on appropriation of energy entails focusing on what consumers actually need: not energy technologies (e.g. thermal solar panel) but energy services (e.g. heating). Such an approach favours a stronger focus on the role of people-as-citizens in the innovation process (see Part 3.3) as well as on the role of social sciences to help understand energy behaviours, thus paving the way for innovative and competitive solutions.

3.1.2. Social sciences first: the starting point of innovation

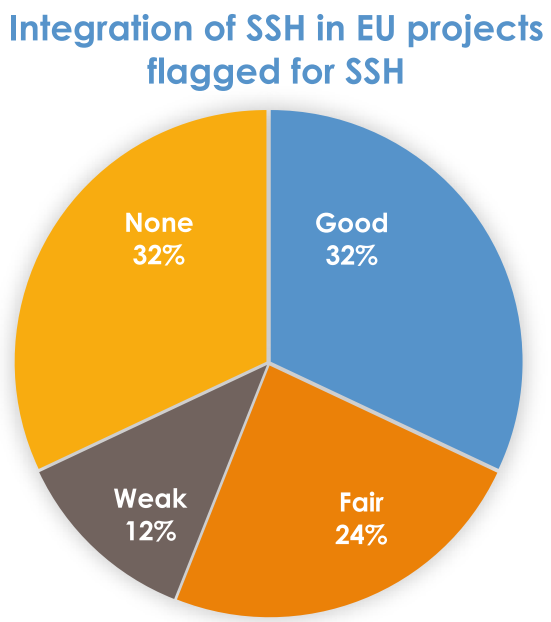
Once **Technology is acknowledged as only one optional component** of a wider innovation process, it becomes important to focus on non-technological elements, especially the role of social sciences & humanities[140] (SSH). Their approaches[141] indeed help to increase the chances that the given research/innovation project is able to tackle societal needs, as well as increase the chances of delivering a cost-efficient and applicable solution.

A key example of the usefulness of social sciences for the Energy Union has to do with **understanding individual and collective energy choices**[142]. To illustrate, transport needs can largely be understood through a geographical approach as choices of location of the home place, the workplace, or the distance between two

137. *in* Ryan Health, *Politico's EU Playbook*, 12 May 2016.
138. This could be achieved by the use of games or gamified techniques of teaching.
139. Energy is certainly a very complex and technical industry. However, monetary policy and money creation are also very complex processes, and it does not preclude citizens to routinely use money. Similarly, Time is a very abstract concept which is not more natural for human beings than Energy, which is not seen as an obstacle to use this notion every day.
140. SSH are defined as the following disciplines: anthropology, economics, business, marketing, demography, geography, education, communication, history, archaeology, ethics, interpretation, translation, languages, cultures, literature, linguistics, philosophy, religion, theology, political science, public administration, law, psychology, sociology. Cf. European Commission, *Integration of social sciences and humanities in horizon 2020*, 2015. p. 8.
141. For a literature review on social sciences insights for understanding energy consumption behaviours, cf. Paul Burger et al., "Advances and understanding energy consumption behaviors and the governance of its change: outline of an integrated framework", *Frontiers in energy research*, Vol 3, Article 29, June 2015.
142. The European Commission launched a much welcomed Horizon 2020 call (LCE-31) for projects aimed at understanding the social, cultural, economic, gender etc. drivers of energy choices.

partner businesses are defining the transport needs for people and goods. Better understanding the drivers behind those choices can help adapt policy and business decisions to diminish the need for transport, and ceteris paribus diminish the quantity of energy that will be consumed in the transport sector. This would help the EU achieve its objective of reducing GHG emissions, as well as boosting energy efficiency as the EU energy efficiency objective is defined as the reduction of the quantity of energy consumed in Europe[143]. An approach articulating anthropology, sociology and history would also be useful to analyse drivers of energy choices, particularly in the transport sector, where political considerations play a key role[144].

FIGURE 16 ► **Quality of integration of SSH in EU projects flagged for SSH**



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from European Commission

In matters of EU funding, **social sciences are a poor brother**. Only 6% of the EU H2020 funding goes to SSH with the best-integrated SSH disciplines being economics, business and marketing. Disciplines like geography or anthropology, that are critical to understand energy behaviours are nearly absent from H2020[145]. What is even more worrying is that, according to the European Commission, only a third of the "projects funded under topics flagged for SSH[146] show good integration of SSH"[147], while SSH integration is judged to be 'weak' in 12% of the projects and inexistent in a third of them (see Figure 16).

To foster a **genuine interdisciplinary approach to societal challenges** in general and energy in particular, the EU has several tools at its disposal, such as:

- Require students benefitting from an Erasmus grant to have a minor in another discipline than their major one, at least during their year of study abroad. For instance, an automotive engineer could opt for a minor in anthropology.
- Invite the KICs to propose interdisciplinary master programmes.
- Invite EU publically funded teaching and research institutions, such as the College of Europe[148], or the European University Institute to have interdisciplinary master or doctoral programmes on a given topic, such as energy-climate issues.
- Redirect the Marie Sklodowska Curie Actions[149] to support transdisciplinary mobility of researchers.
- For SSH flagged H2020 projects, a social science analysis of the topic could be required to assess the proposal sent by H2020 grant applicants.

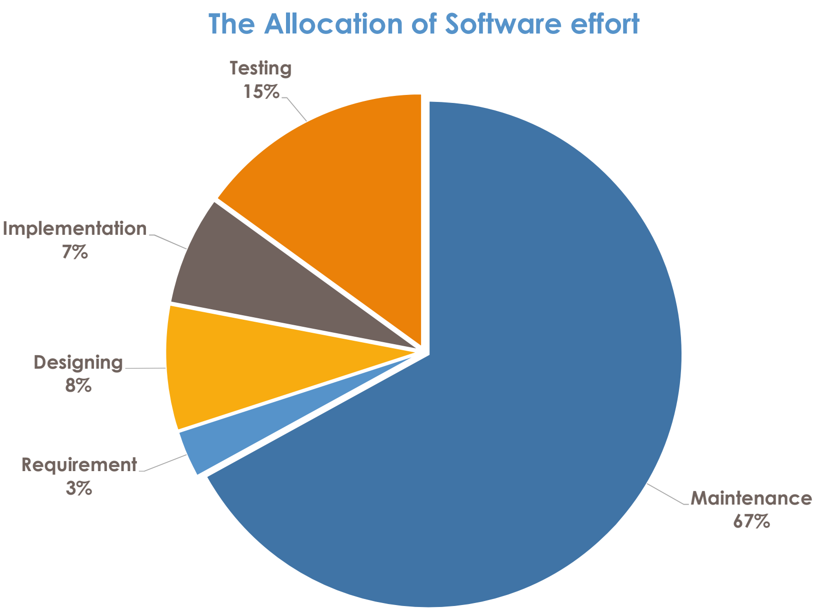
143. For a more in-depth analysis of the definition of the EU energy efficiency objective, cf. Thomas Pellerin-Carlin, "How can the Juncker Plan unlock energy efficiency investment in the short and long term?", *in* Eulalia Rubio, David Rinaldi & Thomas Pellerin-Carlin, "Investment in Europe: Making the best of the Juncker Plan", *Studies & Reports No. 109*, Jacques Delors Institute, March 2016, p. 133-134.
144. A classic example is the role by public authorities to develop highways. Without the political support for the construction of highways, cars and trucks would have a less important role in our society. This support continues until today as, for instance, one of the first project to be backed by the so-called Juncker Plan was the extension of the German A6 highway in Baden-Wurttemberg. Cf. Grégory Claeys and Alvaro Leandrio, *Assessing the Juncker Plan after one year*, Bruegel, 17 May 2016. For another historical example, cf. the deployment of individual passenger cars in Frankfurt: Glenn Yago, *The decline of transit : urban transportation in German and US cities 1900-1970*, Cambridge University Press, 1984.
145. European Commission, *Integration of social sciences and humanities in horizon 2020*, 2015, p. 9 & p. 14.
146. It is indeed worth pointing out that this poor performance concerns only the projects flagged for SSH, precisely the ones that should have a very good integration of SSH.
147. The quality of the integration of SSH is assessed "in terms of share of partners, budget allocated to them, inclusion of explicit and purposeful contributions, and variety of disciplines involved". European Commission, *Integration of social sciences and humanities in horizon 2020*, 2015., p. 16.
Data shown in the graph excludes the projects financed under the part SC6 of H2020 as this section is *de facto* devoted to SSH and inclusion is therefore 100% good. Including SC6 would however not significantly alter the assessment as the share of projects judged to have a good integration of SSH rise from 32% to 40%, while all others decline: Fair from 24 to 21%, weak from 12 to 11% and None from 32 to 28%.
148. The proposal for the creation of a "College of Europe for energy" originates from Michel Derdevet, *Energie – l'Europe en réseaux*, La documentation française, February 2015.
149. Those actions currently support the mobility and training of European researchers, but also interdisciplinary but only to a limited extent, such as within the European Joint Doctorates. Our redirection proposal would for instance mean that the support of a Marie Sklodowska Curie Action would be granted to a researcher's geographical mobility only if it includes a transdisciplinary mobility.

3.1.3. Hail the maintainers: a life-cycle approach to innovation

"In almost no instance can artificial-rational systems be built and left alone. They require continued attention, rebuilding, and repairs. Eternal vigilance is the price of artificial complexity"[150]

Adopting a holistic approach entails to look at the entire life-cycle of an innovation; notably looking at the innovation's maintenance. Maintenance[151] is a too-often overlooked crucial element of human societies[152]. To illustrate, many of the so-called "natural disasters"[153] damages are actually due to deferred maintenance of critical infrastructures[154] meaning, quite literally, that good maintenance saves lives.

FIGURE 17 ► **The Allocation of Software effort**[156]



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, adapted from Ensmenger

Maintenance is as necessary as it is costly, even in sectors where one may think that innovation expenditures are important, such as software, maintenance costs beat them by far: two thirds of the software development expenditures are maintenance costs[155].

Innovators can obviously be praised, and they are praised in our societies as Steve Jobs became a glorified hero with his own biopic. Maintenance should also be valorised as maintainers are the ones that allow innovations to remain able to be used by those who need it.

There is little point in opposing innovators and maintainers, not least because maintainers often prove to be front-line innovators, when noticing a problem, they often attempt to introduce something new (i.e. innovate) to improve the system. A good guiding principle for EURICS would therefore be to foster an innovation that helps maintenance, where innovation, to the greatest extend possible, is sustainable and/or can be repaired easily and entrenched in a circular economy approach[157].

This would likely lead to lower costs over the life-cycle of products[158], thus boosting cost-competitiveness of companies and the purchasing power of consumers. Designing easy-to-maintain products can moreover lead to a competitive advantage, as for the Ford Model T car[159]. Focusing on easily maintained or repaired products

150. Langdon Winner, *Autonomous technology – technics out of control as a theme in political thought*, MIT Press, 1978, p. 183.
151. "Hail the maintainers" refers to the recent work by Andrew Russell and Lee Vinsel, *Hail the maintainers*, Aeon Essays, 2016.
152. David Edgerton, *The shock of the old – technology and global history since 1900*, Profile Books, 2008, p. 77. This low status of maintenance was one of the driver behind a British government committee attempt to rename 'maintenance' into 'terotechnology' from the Greek prefix *teros* meaning 'to watch, guard, observe'.
153. Greg Bankoff, "No Such Thing as Natural Disasters", *Harvard International Review*, 23 August 2010.
154. For the US example, cf. Scott Gabriel Knowles, *Maintenance deferred: slow disaster and the politics of infrastructural decay*, 4 April 2016.
155. Nathan Ensmenger, *When good software goes bad – the surprising durability of an ephemeral technology*, Indiana University, 2016.
156. Nathan Ensmenger, *When good software goes bad – the surprising durability of an ephemeral technology*, Indiana University, 2016.
157. In this respect, the legislative details of the upcoming revision of the EU EcoDesign directive can be a significant step forward.
158. For instance, promoting open source technologies and interoperability is critical to rationalise maintenance costs.
159. Henry Ford, *My life and work*, 1922, p. 29.

would moreover reduce raw materials consumption[160] as well as boost local job creations as repairing or maintenance tends to be a labour-intensive sector less easily outsourced than manufacturing.

3.1.4. A fair energy transition for European and emerging countries

"In short, the way to wealth, if you desire it, is as plain as the way to market.
It depends chiefly on two words, industry and frugality; that is, waste neither time nor money,
but make the best use of both. Without industry and frugality nothing will do, and with them everything."
Benjamin Franklin[161]

A large share of the effort to mitigate climate change lies in emerging countries as most of the future emissions will be emitted on their territory. The **challenge for emerging countries is thus to leapfrog** from relative poverty to low carbon prosperity, without going through a stage of carbon intensive economy. To a much larger extent, it is about doing with energy systems what Africa did with telecommunications: going directly from no access to phones to the large diffusion of mobile phones, leapfrogging the landline stage. For Europe, the challenge is to help emerging countries to ensure sustainable energy for all, promote human development while tackling climate change **while creating jobs in Europe**.

In emerging countries, such as India, technological transfer is not as straightforward as it could be sketched on paper because local specificities hinder to directly apply similar processes and technologies. For instance, their growing middle class, even though becoming wealthier, still have a lower purchasing power than developed countries' middle class. It implies that services and products in these markets have to be cheaper to be marketable. To this aim, **frugal innovation**[162], which is the process of simplification of a product (removing nonessential features) in order to reduce its cost, can be highly relevant.

In addition to limited income, constraints such as different set of skills, infrastructures, natural resources, can be an opportunity to think outside the box, thus helping to design innovative products, practices and business models. As an illustration, the "pay-as-you-go" billing scheme for electricity (i.e. a prepaid purchase of a certain amount of electricity) is a sound way to bring light and charging points for mobile phones in remote areas. In the same vein, the lack of existing electricity network can be seen as an opportunity for decentralised electricity generation such as solar photovoltaics complemented with storage. Besides, as local communities are not accustomed to an easy access to electricity yet, adapting demand (consumption) to supply (availability based on sun path) might be easier, if suitably addressed from the beginning thus making emerging countries' population more advanced than Europeans in terms of energy consumption behaviours. Last and not least, frugal innovation is also associated to **reverse innovation**: when an innovation first conquers emerging markets before being transferred to developed countries[163].

Frugal innovation should therefore be further explored and promoted[164], not only to support emerging countries in developing a low carbon energy system for their economy and help European companies to enter new markets, but also to **get inspiration from these constrained regions to bring innovations back in Europe**. To promote frugal innovation, the EU might further develop energy innovation in its external relations, using in particular its outermost regions as creators, test beds and showcases for innovations that can then be implemented in third countries in collaboration with EEAS, Member States embassies and local partners who can assess the situation on the ground. Some outermost regions may present common features with some third countries (e.g. climate conditions, cultural traits and/or geography), and for some particular cases, the relative scarcity of infrastructure (esp. small islands).

160. Philippe Bihouix, *L'âge des low-tech: Vers une civilisation techniquement soutenable*, Broché, 2014
161. Benjamin Franklin, "Letter to his friend A. B.", 1748, *in* Benjamin Franklin, *Memoirs of Benjamin Franklin*, Volume 2, 1834, p. 480.
162. Stephan Winterhalter, *Resource-Constrained Innovation and Business Models in Emerging Markets*, PhD diss., University of St. Gallen, 2015. See also, Navi Radjou and Jaideep Prabhu, *Frugal Innovation – how to do more with less*, The Economist Books, 2015. Other terms than 'frugal innovation' exist and have in common to foster the exchanges between innovation in emerging and in developed countries: cost innovation, low-cost innovation, good-enough innovation, jugaad innovation, Gandhian innovation, and reverse innovation.
163. The authors here embrace the notion of justice as fairness as expressed in the late-life lectures and writings of John Rawls. Cf. John Rawls, *Justice as fairness: A Restatement*, 2001. See footnote n°121.
164. The EU has already launched a H2020 tender to assess the 'frugal innovation potential for Europe's competitiveness'. Cf. Tender: 2015/RT/D1/OP/PP-02381-2015, published on May 5th 2015.

3.2. The post-Paris world starts now: European Climate-Energy Labs for the global energy transition

Speaking of the Paris Agreement, European Commissioner for Climate Action Miguel Arias Cañete said "We have the deal. Now we need to make it real"[165], and EURICS is a very good tool to start making it real. As emphasised in Part 2.4.2, this Agreement stipulates that Europe and the world should reach a level of net-zero GHG emissions by 2050-2100 which implies a triple need: diminish to near-zero the emissions of the most important sectors (e.g. civilian transport, electricity, buildings), reducing as much as possible the sectors where getting close to zero seems unlikely for technical (e.g. aluminium production[166]) and/or political reasons (e.g. military activities[167]), and developing ways to compensate remaining emissions by manmade carbon sinks (e.g. developing passive carbon sequestration solutions such as reforestation). This entails a revolution of the ways we produce, use and dismantle. To do so, the world needs a lot of basic research, applied research and innovation, and needs it now, for real.

3.2.1. Basic research is fundamental, so is a revived narrative

Basic research findings can be thought as a pool of knowledge where applied researchers and innovators will tap into to find elements of already existing knowledge that can serve a specific purpose. This is why 'basic research' has a very straightforward synonym: 'fundamental research', fundamental in the sense that it lies at the foundation of any research & innovation process. Basic research obviously has to do with hard sciences and can lead to fully-fledged disruptions. It also has to do with social sciences as they create concepts to better understand human behaviour and think in different ways.

Asking for more support to basic research is very politically correct to say and write, but words too often fall short of actions, for at least two reasons. First, basic research is too often misunderstood. Basic research aims at finding/inventing new things, regardless of their usefulness, it is therefore not the technical improvement of something that is useful and already exists: contrary to what the European Commission writes repeatedly in some of its presentations[168] 'upscaling technologies currently at lab-scale' cannot be considered to constitute 'basic research'. Second, really boosting public support for basic research requires a revived narrative in favour of more money being earmarked for basic research.

Private funding for basic research is virtually inexistent[169] as an individual or a company has no direct economic interest in promoting basic research[170]. **Basic research is therefore a key sector where public intervention is needed** to help innovation spur in both the public and private sector[171]. Such public funding is however threatened by current cuts to public spending –what is euphemized in EU jargon as 'fiscal consolidation'. Research funding, especially basic research funding is politically easy to cut as the only ones directly affected by those cuts are researchers[172]. Hence, when it comes to arbitrating savings in national budgets, funding to basic research is more likely to be cut than funding in other areas, such as pensions, healthcare or education. Enhancing public support for basic research therefore requires a popular narrative[173]. In the US, the narrative is that public money poured into basic research (as well as applied research) is meant for the mili-

165. Miguel Arias Cañete, *Speech in Brussels*, 02 March 2016.
166. Aluminium production involves an electrolysis that transforms alumina into aluminium and CO2. It moreover produces other GHG, especially CF4(g) and C2F6(g) that are potent GHG (respectively 6500 and 9200 times more potent than CO2). For more information on aluminium production, cf. International Aluminium Institute.
167. The military sector is often neglected in energy-climate debates. It is a very particular sector for both political and technical reasons. Politically, it the realm of exceptions from classic legislations as the essence of the military is about exerting violence: killing and getting killed. For instance, for civilians, a vehicle's capacity to accelerate is an element of social status. For the military, the capacity of a vehicle (e.g. a battle tank) to accelerate is a matter of survival in combat.
168. European Commission, *The EU framework programme for research and innovation Horizon 2020*.
169. Exceptions can be found, especially in companies in a situation of monopoly, such as AT&T during most of the 20th century in the US, that funded the Bell Labs. Cf. Jon Gertner, *The idea factory – the Bell Labs and the great age of American innovation*, Penguin Books, 2012.
170. We should mention here the existence of philanthropy and the involvement of various foundations in R&I activities, see for instance the EUFORI study on this aspect.
171. Mariana Mazzucato, *The entrepreneurial state: debunking public vs private sector myths*, 2013.
172. For instance, EUu budget lines dedicated to research were cut to finance the so-called "Juncker Plan". For a recent example in a European member state, cf. Françoise Barré-Sinoussi et al., "Coupes budgétaires dans la recherche", *Le Monde*, 23 May 2016.
173. Basic research is about discovering/inventing things that are new, but not necessarily useful. However, without a strong usefulness-centred narrative, funding for public research is unlikely to rise significantly, and is therefore unlikely to provide the technologies and ideas necessary for a fully-fledged energy transition towards a net-zero emissions world by the end of this century.

tary (cf Part 1.3). This narrative is unlikely to be successful in Europe but the **fight against climate change can become a strong narrative** to support public funding for basic and applied research in many disciplines such as physics, mathematics, life sciences, social sciences, computer sciences, or chemistry.

3.2.2. A single location for energy-climate research

When it comes to improving basic and applied research, Europe luckily does not need to start from scratch. It already possesses among the best network of research centres in the world, such as the French CEA and the German *Fraunhofer* that are considered by Reuters to be respectively the first and second most innovative research institution in the world[174]. Europe has also outstanding individual researchers, for instance, 25 of the 56 Fields medals were awarded to Europeans, compared to 14 to US citizens[175]. In addition, the ERC makes a key contribution (see Part 2.2). What Europe however lacks is a heart for this network, a single location where researchers from different nationalities and disciplines would work for some years after and/or before pursuing their research at another place or transforming research findings into an economic activity. This would present three added values to the existing strings of the European Research & Innovation bow.

First, it can **allow serendipity to flourish**. With the current development of public funding based on specific projects financed for a limited time span, basic research may tend to become less efficient. The difficulty with detailed projects is that they limit the space for serendipity, as some promising ways of research may not be undertaken (or even may not be thought of) as they fall outside of the project's scope.

Second, it can **ease the demystification and early-acceptance of a failure**. Project-by-project financing may entail that researchers will, consciously or not, delay the acceptance of failure as they may risk to lose their job if a given project fails. Ensuring a constant flow of money pouring into a given institution however leaves this institution's management the decisions of where the money should be eventually channelled.

Third, it **can encourage interdisciplinarity, in particular in applied research**. Within the ERC, projects with transdisciplinary potential can apply to two of the twenty-five selecting panels. The success rate of projects applying two panels is however lower than the success rate of projects applying to a single panel, an issue that the ERC currently tries to address[176]. Moreover, Marie Sklodowska Curie Actions are not yet used to encourage transdisciplinary mobility.

There is therefore a bow string missing: a tool to boost interdisciplinary basic and applied research, in order to increase the chances that EU public money finances breakthroughs.

To achieve these objectives, the EU could finance the creation of a new research centre located **in one specific place.** Having a pool of researchers in a single location is indeed important as new ideas come from the human interconnection of minds, very often in non-scientific locations[177]. Like the US Bell Labs[178], this single location would be built and managed in a way that leads to random meetings between researchers coming from as diverse backgrounds as possible. Using a metaphor from physics, if researchers are molecules and the temperature indicates the innovation potential of a system, there is a need to maximise the molecular collision to create thermal agitation and thus increase temperature. This agitation can be facilitated both actively and passively. The architecture of the building itself and the working environment can passively encourage 'collisions' as diverse as possible. A specific position[179] could moreover be dedicated to this function of agitation to actively provoke such 'collisions', putting in contact researchers from various fields with very different perspectives to encourage cross-fertilization. Finally, a culture of networking could be instilled by organising

174. David Ewalt, "The world's most innovative research institutions", *Reuters*, 08 March 2016.
175. Source: International Mathematical Union.
176. Information coming from informal conversations between the authors and ERC grants' practitioners.
177. To illustrate, patent lawyers from the Bell Labs tried to figure out what made some Bell Labs researchers more productive than others. The only common element those lawyers found was that the more productive ones tended to sometimes share lunch or breakfast with Harry Nyquist, a Bell Labs electrical engineer who appeared to be asking very relevant questions. Cf. C. Chapin Culter, *interview by Andrew Goldstein*, Palo Alto, 21 May 1993.
178. Jon Gertner, *The idea factory – the Bell Labs and the great age of American innovation*, Penguin Books, 2012.
179. Additionally, the EU could use the momentum around the European Innovation Council to implement this essential function of bridging Research and Innovation via passive and active agitation activities, applying it first to the ERC work, through incentives for granted researchers to create connections with innovators, to fully reap the benefit of this public funding.

regular and frequent events such as speed meetings or short presentations of ongoing projects inspired by *My PhD in 180 seconds* to further connect the existing research.

The idea of a single location is also politically important to clearly show EU citizens where the EU money is going. This point is certainly not important for the sake of research per se, but it is critical to ensure that there is enough public support for pouring billions of taxpayers' money into research, especially basic research.

3.2.3. Another string to Europe's bow: creating the European Climate-Energy Labs

Such a location could be named 'European Climate-Energy Labs'. ***European*** to signify the key role of the European Union in its creation and funding. ***Climate*** as to clearly state the over-arching goal that Europe pursues: developing all the technologies, concepts and ideas that might appear to be somehow related to climate change mitigation or adaptation, especially regarding ***Energy*** challenges. ***Labs***, not only as a reference to the 20th century Bell Labs that played a critical role to pave the way for the digital revolution[180], but also because the plural puts the emphasis on the idea that this institution should be as diverse as possible in terms of academic, social, gender and national origins of its researchers.

In operational terms, for such European Climate Energy Labs to reach a critical size, it should seek to hire **as many as 10.000 researchers**. This objective is achievable if the EU decides to spend one billion euros[181] every year on this project, as of 2021 with the entry into force of the yet non-adopted 2021-2028 EU Multiannual Financial Framework. All in all, it would represent an amount that is comparable with the cost of the ITER project[182], with the major difference that ITER focuses on one single and hypothetical technology to supply electricity while the European Climate Energy Labs would be more diverse and therefore would have greater chances to irrigate Europe's research & innovation.

In terms of management, those Labs could be either an *ad hoc* organisation, or an activity of the ERC as both the Labs and the ERC aim at fostering basic and applied research. For both strategic and operational reasons, given the current European political context, it may be advisable to consider creating this European Climate Energy Labs in one of the two following locations:

- **In the UK**, if it were to remain an EU Member State, as a way to answer two continuous British criticisms on the use of the EU budget, namely: (1) the EU budget is not sufficiently used to finance projects happening on British soil, and (2) the EU budget is not enough focused on 'policies for the future', like research & innovation. Moreover, in the current legal context where the UK benefits from a rebate[183] on its contribution to the EU budget, a UK-based European Climate-Energy Labs would end up being paid mostly by the UK rather than the EU budget and/or the other 27 EU Member States.
- In case the UK were to leave the EU, **a Central-Eastern European country**, such as Poland, not only to ensure that the least 'climate-friendly' government(s) do not oppose such project, but also as a demonstration of the EU's willingness to close the immense research & innovation divide that is actually worsening in Europe[184].

180. Jon Gertner, *The idea factory – the Bell Labs and the great age of American innovation*, Penguin Books, 2012.
181. As a benchmark, the INRIA has a budget of 230M€/year for 2.700 staff (including 1.200 PhDs and 600 other scientists). Cf. INRIA 2014 Activity Report.
182. According to information gathered on the ITER website, the average annual cost of ITER would be of around one billion euros a year, i.e. 13 billion to build ITER, 1 billion to deactivate and dismantle it, and 6 billion to operate it between 2019 and 2037.
183. The basic rationale of this rebate is to calculate British direct contributions to the EU budget, and compare them with the sum of the direct benefits of EU money on British soil. Two thirds of the difference between the two figures is then deducted from the UK contribution to the EU budget, currently representing around 6 billion euros a year that are actually paid back by other EU Member States, first and foremost by France and Italy. As long as this rebate exists, it also implies that any increase in EU money going directly to the UK (such as in the case of a UK-based European Climate-Energy Labs) would diminish the amount of the British Rebate as it would increase the second element of the calculation (i.e. the amount of EU money going directly on British soil).
184. Reinhilde Veugelers, "The European Union's growing innovation divide", *Bruegel Policy Contribution*, April 2016.

3.3. Democracy: citizens in the driving seat of the energy innovation process

Creating a system where European citizens are in the driving seat of energy innovations is first and foremost democratic and fully in line with the Energy Union's willingness to put "citizens at its core … [allow them to] take ownership of the energy transition … [and] empower consumers"[185]. It is also likely to be efficient as successful innovation increasingly originates in agile, dynamic and flexible relations. Institutionalised structure and stiff governance become less relevant as it becomes essential to overcome the divide between internal (e.g. within one company) and external (e.g. academia or competitors). Tensions on innovation are often stronger internally (e.g. between two departments: innovation and production) while staying ahead in terms of innovation requires to be able to animate a multi-stakeholder (e.g. academics, entrepreneurs, venture capitalists) ecosystem where internal and external boundaries do not matter much (see Part 1.2).

Adopting an open innovation approach does not discard the expertise of innovation firms, researchers and laboratories, but highlights the value of citizens as innovators and **provides them with an immense playground** to share their ideas, bring their skills, while rewarding them for doing so, both tangibly (if the idea is turned into a commercial success) and intangibly (self-esteem of contributing to something large, reputation on the platform and recognition from others).

Our proposal therefore wishes to put citizens at the centre of the energy innovation process, to allow them to co-create ideas, to select them, to finance them and foster their implementation.

3.3.1. Generating through crowdsourcing

An innovation first needs to be generated for instance through crowdsourcing: a collaborative process involving a very significant number of people[186]. Applied to Innovation, crowdsourcing can be used for the ideation phase where ideas are co-created. The original idea is proposed by someone, to allow others to collaborate, share their own comments or proposal to improve the original idea. This is usually done via a digital platform that has a varying degree of openness, for instance, when crowdsourcing is done by a company, openness can be: limited to some employees (e.g. within a specific department of the company), open to any employees, or open to anyone (internal and external contributions).

A few companies have already implemented crowdsourcing platforms. Siemens[187] has an in-house creative ideas competition called *Quickstarter*, where employees directly decide which ideas should be brought to life. Other examples are Engie's OpenInnov, EDP's Co-Creation platform, or ENEL's Eidos market and Endesa energy challenges[188].

Our proposal is one of **a platform where all ideas can be freely co-created by anyone**. It seeks to have a large number of **heterogeneous participants**. Involving very different individuals, coming from various backgrounds and having distinct cultural traits, especially national cultures, in the EU context, is a great opportunity to foster "outside the box" thinking and is more likely to lead to breakthrough ideas. This diversity of profiles is even more positive when individuals can collaborate on the same topic in a multidisciplinary manner as it favours creative thinking and cross-fertilization of ideas, and can produce unexpected valuable outcomes. Academic literature indeed suggests that such an open approach may decrease the average quality of proposed ideas, but increases the quality of the top ideas[189], which is the objective here to allow top innovations to ease the European and global energy transition.

185. European Commission, *Energy Union Framework Strategy*, 25 February 2015, p. 2.
186. The most famous example of crowdsourced project is Wikipedia. Another famous example of crowdsourcing is the "Captcha", which is used to distinguish human from non-human (a bot) on a website, using characters that have to be recognized, assuming that bots cannot (easily) execute this task. It is a massive online collaboration, because the input from humans (the answer to the picture of characters) can be used to train algorithm in Optical Character Recognition (OCR).
187. A Harvard Business case has been dedicated to the Open Innovation at Siemens. See Karim R. Lakhani, Katja Hutter, Stephanie Healy Pokrywa, and Johann Fuller, "Open Innovation at Siemens", *Harvard Business School Case 613-100*, June 2013. (Revised March 2015.)
188. The key question remains whether those platforms are to be mostly understood as marketing actions (i.e. a company portraying itself as open and driven by the willingness to tackle societal challenges), or whether collective intelligence, and collaborative actions will truly impact those companies' choices.
189. Andrew King and Karim R. Lakhani, "Using Open Innovation to Identify the Best Ideas", *MIT Sloan Management Review*, fall 2013, pp.41-48.

Opening the innovation process to the broadest spectrum also creates higher value through a form of 'IKEA effect'[190]: **people overvalue things which they have contributed to**, regardless the objective quality of these things. Put differently, it participates to the appropriation.

3.3.2. Selecting through democracy

Once an idea is soundly formulated, it can go through a process of democratic selection on the 'one citizen – one vote' principle. To promote multidisciplinary approaches, the selection could be structured in a way that promotes an idea backed by a diverse audience in terms of professional background.

This selection can be quick, much quicker than for instance H2020 projects. It moreover can ensure a **very good adequacy between the market needs** (represented by the citizens themselves) **and the ideas** and projects co-created on the platform. However, there are certainly many challenges to address in order to make it successful. One of these challenges is to engage citizens on this platform. Obviously, even if the platform is open to anyone in the EU, it is highly unrealistic to engage a large share of citizens into this process, and it is more likely to have mainly the **community of innovators** interested and participating to it in a first time. Through engaging methods, in particular gamification, this share can be extended to a broader range of citizens. Contrary to a game, which is made to entertain users, gamification is made to engage them, using gaming mechanics such as collaboration, competition and rewarding, to channel and coordinate participants. Besides, the gamification dimension could be used to institutionalise the multidisciplinarity and social diversity in the platform, through the use of various badges (for the socio-economic background, the gender, the age, the type of professional background etc.).

In our proposal, once a project is democratically selected, it can be proposed to crowdfunding.

3.3.3. Financing through crowdfunding

Crowdfunding[191] is about funding a project through financial contributions from a large number of people[192]. It is a booming sector: the volume of online European alternative finance market grew by 144% between 2013 and 2014, to reach 3 billion euros in 2014[193]. Crowdfunding is not a niche market anymore and could even **become more important than venture capital in 2016**[194].

Beyond being a promising way to finance energy innovation, crowdfunding can also effectively **empower citizens by involving them directly**, both in the innovation process and in the energy system, building on the success of already existing crowdfunding platforms dedicated to renewable energy projects, such as Lendosphere in France, Windecentrale in the Netherlands, abundance in the UK, or Econeers in Germany[195] and also on the success of direct democracy experiments like the direct allocation by citizens of half a billion euros of public money of the City of Paris[196].

From a more practical standpoint, crowdfunding also brings other benefits. First, it is a convenient and effective way to have a **market validation** of a project, to check the adequacy between a product or service and the market, and to put the end-user at the centre (since he/she should be convinced by the innovation in order to put his/her own money on a high risk project), thus enhancing the likelihood of successful adoption. Second,

190. Michael I. Norton, Daniel Mochon and Dan Ariely, "The'IKEA effect': When labor leads to love", *Harvard Business School Marketing Unit Working Paper*, 2011, (11-091).
191. This paper will not discuss the regulation of crowdfunding in the EU. The reader can refer to the report from the JRC Science and Policy Report to get insight on this aspect. Garry Gabison, *Understanding Crowdfunding and its Regulations*, Joint Research Centre, 2015.
192. For instance, in the USA, democratic senator Bernie Sanders finances his campaign to become the democratic nominee mostly through an important number of donations. More than 2 million people allegedly made 5,7 million donations amounting to a total of 154 million USD as the average donation allegedly of 27 USD. Cf. Philip Bump, "How is it that Bernie Sanders still averages $27 per donation?", *Washington Post*, 18 April 2016.
193. Robert Wardrop, Brian Zhang, Raghavendra Rau, and Mia Gray, *Moving Mainstream. The European Alternative Finance*, Benchmarking Report, 2015.
194. Chance Barnett, "Trends show crowdfunding to surpass VC in 2016", *Forbes*, 09 June 2015.
195. Crowdfunding schemes varies depending on the platforms, as it can be equity-based crowdfunding (energy cooperative) or lending-based crowdfunding with a guaranteed return on investment. Whatever the scheme, this approach enhances the appropriation of energy infrastructure, mitigating the NIMBY effect and contributing to transform it into a PIMBY effect. Cf. Kristiaan Versteeg, *Tracking renewable energy crowdfunding*, Solar Plaza, 15 September 2015.
196. More on the website Paris Budget Participatif.

it helps to **identify and build the community of users**[197] (e.g. individual consumers, SMEs, local authorities) who can actively support the innovation project or even play an ambassador role[198]. Thirdly, it can be fast and therefore **reduce the time to market**. Last but not least, the platform approach is a suitable solution to coordinate multi-level, multi-discipline and multi-national players, **simplify the governance** and improve the funding of innovation by avoiding overlaps and gaps.

In our proposal, there would be four categories of crowdfunders:

- First and foremost: **EU citizens** who can use their personal money to crowdfund the project they like best,
- **EU public money** (coming from the EU budget, EIB loans or EIF investments) would be allocated to projects successfully[199] crowdfunded by EU citizens rather than being chosen by EU-selected experts or EU civil servants. The amount of EU money invested into the project would also be directly determined by EU citizens as for each euro invested by a citizen into the project, the EU would pour one euro into it. This literally means that **EU funding allocation would be decided by EU citizens.**
- **Business angels** and venture capitalists should also be involved, to increase the leverage effect of EU money and to demonstrate that citizens-chosen projects can be good investment opportunities.
- **Local authorities**, especially cities, can co-finance a project, especially those having an urban dimension (e.g. urban mobility innovations such as Smart Halo) or requiring to engage local communities to test the innovation before full deployment or commercialization. In this regard, EU stakeholders such as Eurocities or the Covenant of Mayors could be relevant partners to foster the cities' onboarding.

3.3.4. Valorisation, walking on two legs: start-ups and intrapreneurship

"Corporate entrepreneurship is envisioned to be a process that can facilitate firms' efforts to constantly innovate and effectively cope with the competitive realities that companies encounter when competing in world markets."[200]

Once an idea is produced, selected and financed, it still has a long way to go to truly fulfil its economic potential and become an innovation. To do so, it can follow **two entrepreneurship routes: start-up and intrapreneurship**[201].

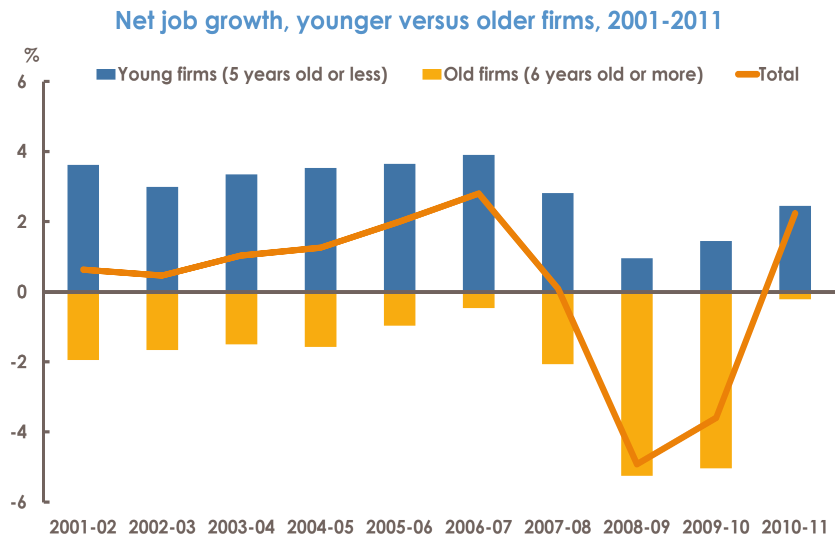
While there is much enthusiasm for start-ups in the EU debate, this policy paper's take is that **start-ups may constitute adequate tools but are not panacea**. In this regard, many decision makers may arguably be over-enthusiastic about start-ups and may seek to promote intrapreneurship as well as start-ups instead of focusing only on the latter.

At first glance, it could seem paradoxical that well-established companies try to bring breakthrough innovations in their market, as a breakthrough innovation, by definition, disrupts the market and could endanger their current business model and profits. However, the point is not whether the market will be disrupted, but by whom. Thus, intrapreneurship is a decent opportunity, so long as they adapt their business culture to create an environment prone to entrepreneurial initiatives (e.g. flexibility, openness, promotive environment, and collegiality) **and genuinely embrace the concept of "active innovation"**[202].

197. See for instance, Peter Hesseldahl, "The new normal: from products to platforms and processes", InnovationManagement.se, 10 September 2014.
198. This element exemplifies one of the similarity of dynamics between a disruptive innovation and a military insurgency. Both need the support of their environment, an end-user community for innovation, and the local population for the military insurgency. Cf. Alex Ryan and Michael Dila, "Disruptive Innovation reframed: Insurgent design for systemic transformation", *Relating Systems thinking and Design 2014 working paper*, 2014.
199. The meaning of "successfully" implies to adopt indicators to assess the success of a fundraising campaign. These indicators could involve not only the amount raised (with a certain threshold) but also elements such as the geographical origin of the investors, the EU-wide approach, or the velocity of the fundraising.
200. Donald Kuratko, "The entrepreneurial imperative of the 21st century", *Business Horizons*, 2009, p. 422.
201. Intrapreneurship is the fact of acting as an entrepreneur while being employed in an existing company.
202. Dirk Meissner and Maxim Kotsemir, "Conceptualizing the innovation process towards the 'active innovation paradigm' - trends and outlook", *Journal of Innovation and Entrepreneurship*, 5(1), 2016.

There are several paths to corporate venturing[203], stretching from a purely inorganic venturing (e.g. acquisition of start-ups through venture capital investment programmes) to an organic one (i.e. intrapreneurship). Intrapreneurship is here understood as the implementation of internal processes to promote creative and innovative ideas in a company, and enabling entrepreneurial employees to transform these ideas into breakthrough innovations (i.e. bringing them to the market), with the support of the company.

FIGURE 18 ► **Net job growth from young and old firms between 2001 and 2011 (data from OECD DYNEMP project**

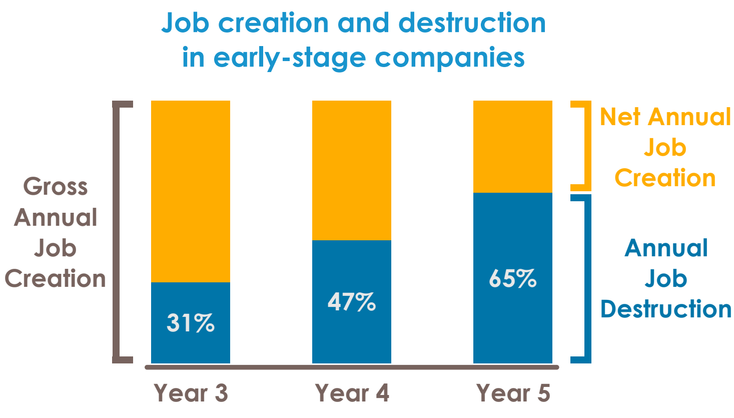


Source: data from OECD DYNEMP project

As shown on Figure 18 young firms (5 years old or less) were responsible for the net job growth between 2001 and 2011, while the older firms were destroying jobs in the meantime, so that entrepreneurship (which encompasses but is not limited to the innovative ones) seems to have a positive impact on employment[204]. However, a closer look on early stage companies should be taken.

According to Davila et al.[205] 65% of the gross amount of jobs created by early-stage companies over the 5th year are destroyed (see Figure 19). It also appears that only a small share of these companies is responsible for a large share of the jobs created and destroyed[206]. On top of that, this study shows that only 7.5% of the companies from the sample have a positive growth of their headcount in years 3, 4 and 5. This dynamic might be seen as the sign of an intense effervescence in the economy, the consequence of the Schumpeterian "creative destruction"[207], however it is also a waste of time, human and capital resources.

FIGURE 19 ► **Job Creation and Destruction in Early-stage Companies**



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute, data from Davila et al.

203. Corporate venturing and strategic entrepreneurship are the two pillars of what is called corporate entrepreneurship. The latter can be seen as the integration of entrepreneurial mind-set into the processes, values, mission, and structure of organisations, while the former deals with the addition of new businesses to these organisations. c.f. Donald Kuratko, "The entrepreneurial imperative of the 21st century", *Business Horizons*, 2009, p.421-428.
204. This data does not specify the dynamics between these two categories of firms, in particular whether there is a causal relationship, the young firms creating jobs thanks to the destruction in the old ones.
205. Their paper is an analysis about the job creation and destruction phenomenon in over 158.000 early stage companies from the UK, France, Italy, Spain, Belgium, Sweden, Norway, Finland, Japan and South Korea. See Antonio Davila, George Foster, Xiaobin He, and Carlos Shimizu, "The rise and fall of startups: Creation and destruction of revenue and jobs by young companies", *Australian Journal of Management*, Vol 40 (1), 2015 pp.6-35.
206. As an example, one can read that 10% of the companies are responsible for 80% of job creation, and 10% are responsible for 86% of job destruction.
207. We recall that the article does not focus on innovation but on early-stage companies.

Davila et al. attempt to explain this phenomenon of quick growth and decline of jobs by identifying 8 different possible explanations. In our view, at least three of them would probably not exist –or exist at a much more limited extent- if the underlying innovations were developed inside or under the responsibility of a well-established company rather than within a start-up. Those three explanations are: 1- start-ups that open new markets, in which **established players** subsequently enter and **aggressively compete with deeper pockets**, even acquiring some of these start-ups to catch up the pace. 2- some start-ups can grow rapidly on **non-profitable long-term business models**, which corresponds to a temporary revenue transfer from the incumbents to the newcomer, until the latter stops being supported by investors. 3- **litigation risks** can compromise fundraising by reducing the interest of potential investors.

An additional argument in favour of intrapreneurship concerns the very high Return-On-Investment (ROI) requirements set out by venture capital firms, which start-ups directly depend on (see Box 2). Too high ROI requirement can push early-stage companies to grow as quickly as possible, regardless their own ability to manage this growth, and sometimes favouring growth over economic and business rationality. As established companies in industry are less risk taking than venture capitalists, their expected ROI expectation would be lower and therefore make intrapreneurship a better suited path for innovation in some cases.

Intrapreneurship may also have the capacity to scale-up at a faster pace than start-ups as the intrapreneur can rely on the financial, legal and commercial backing of its company. However, benefitting from these resources should not expose intrapreneurs to the hurdles of private bureaucracies, but should rather be a way to circumvent them and to foster the roll-out of breakthrough innovations, thus allowing Europe to stay ahead of the low-carbon global race.

Last and most importantly, **intrapreneurship can be a channel to unleash the dormant innovative potential** present in many individuals currently employed in well established companies, which could serve two objectives. First, the exploitation of this untapped potential would make European companies more competitive and not harnessing it is an opportunity cost. Second, this would help to retain employees and especially the "talents" in Europe. Talent management (acquisition, development and retention of talents) in organisations is indeed a growing concern (especially the retention of talents), and a key strategic aspect today[208]. The implementation of an intrapreneurship programme can provide a feeling of accomplishment, fulfil the desire of having a useful work and can be used to reward employees according to their involvement[209].

In operational terms, releasing some time for employees to train and develop their creativity, and then to implement its outcome, is certainly one core building block of an intrapreneurship strategy. One of the most famous initiative in this direction is probably the "20% time" programme implemented by Google, which allows the employees to spend 1 day a week on a personal idea they have. Before Google, 3M Corp. created such a policy in 1948[210], which led to the well-known product Post-It. Beyond that, "Hackathons" are another kind of initiative implemented by some companies to harness creativity and valorise the entrepreneurial initiatives of the employees[211].

This could be complemented by incentives for companies to get to the next step, which is the fast prototyping of the best ideas, preferably via external infrastructure, in order to circumvent the potential rigidity of private bureaucracies. They could be sought among the Fab Labs[212] and similar workshops.

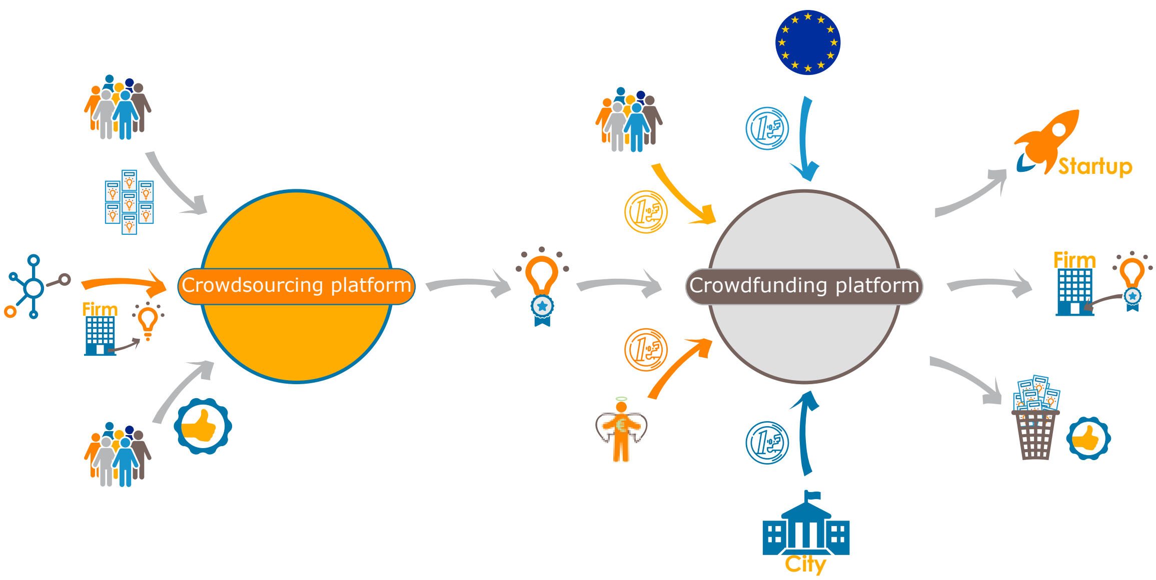
208. Jack Phillips and Lisa Edwards, *Managing talent retention: An ROI approach*, John Wiley & Sons, 2008. p. 1.
209. "A powerful employee value proposition includes tangible and intangible elements, such as an inspiring mission, an appealing culture in which talent flourishes, exciting challenges, a high degree of freedom and autonomy, career advancement and growth opportunities, and a great boss or mentor." from Günter Stahl, et al. "Six principles of effective global talent management", *Sloan Management Review 53*, no. 2, 2012.
210. It is a permitted bootlegging policy in which employees can spend 15% of their time to work on their own ideas.
211. Internal hackhatons are used by companies such as Facebook, Google, or Microsoft. The well-known button "Like" popularized by Facebook is arguably the most famous outcome of a hackathon.
212. A Fab Lab is a workshop where machines, materials and electronic tools are available for people to design and produce unique goods through digital fabrication. A bottom-up approach to technology, Fab Labs aim to unlock technological innovation and promote social engineering.

Rather than carelessly following the trend of start-ups, one needs to have a pragmatic –rather than a fetishist- approach to entrepreneurship. The EU can learn from the US, but should not seek to copy its system. **The EU should create its own innovation way that walks on two legs: start-ups and intrapreneurship**.

To conclude this section, Figure 20 visually summarises the several players and steps of our proposal, including the need to demystify failure. If well implemented, this citizen-centred proposal would yield important strategic results: more and better energy innovation projects co-created thanks to crowdsourcing and democratic selection, a quicker and efficient use of EU public and private finance to speed-up innovation, a concrete way to promote intrapreneurship and therefore help big firms to become enablers of incremental and disruptive innovation. It would also show European citizens that the EU administration is at the forefront of innovative thinking and wishes to give European citizens a greater and more direct say in concrete decisions, such as allocation of EU funding for energy innovation projects.

In operational terms, the European Commission can launch a pilot-project to be operational as soon as 2017. This would give the project more than a year to start working and, if successful, be scaled-up in view of the next Multiannual Financial Framework 2021-2028, for energy innovation as well as maybe for other EU policy areas.

FIGURE 20 ► **A citizen-centric energy innovation process in tune with the times**



Source: T. Pellerin-Carlin & P. Serkine, Jacques Delors Institute

CONCLUSION

"Be not too tame neither, but let your own discretion be your tutor:
suit the action to the word, the word to the action"[213]. Hamlet, Act III scene II

Europe has already done a lot to bring to life some of the innovations necessary to enable a global energy transition. The EU policy however focuses too much on technologies. A much more holistic approach is needed to put the citizen at the centre of the Energy Union, allow innovation to be the driver of a renewed European approach to competitiveness, and kick-start a genuine global energy transition in a post-Paris world.

The EU recently made steps in the good direction, and they now need to be amplified. The EU support to research, already well backed by the ERC, should be complemented by the creation of a European Climate-Energy Labs to foster both basic and applied research for a global energy transition. Some EU actions need to be re-directed to foster not only transnational but also transdisciplinary exchanges to enhance the multidisciplinary approach that is needed to understand how best to deliver energy services to end-users. The Horizon 2020 programme made the welcomed move to create a pillar dedicated to tackling societal challenges and we should go further with the full integration of social sciences.

This policy paper also suggests a disruptive innovation for innovation policy itself: the EU should walk its talk and concretely put the citizen in the driving seat of EU energy innovation. This could be done by creating an *ad hoc* platform meant to allow citizens to co-create new and better innovations, adopt a citizen-based democratic selection of energy innovations, offer citizens to crowdfund energy innovation as well as triggering EU public money allocation.

All those elements are concrete proposals for EURICS to articulate ideas that are both of strategic importance (democracy, climate change, competitiveness) and operationally feasible in the months and years to come. Once EURICS is adopted, the real challenge will start for Europe: ensuring that innovation rimes with action. European decision makers and civil society could thus follow Hamlet's advice: suit the action to the word, the word to the action.

All in all, the EU ship has a capable crew of entrepreneurs and researchers, and enough public and private investment capacity that can blow in its sail to safely navigate towards a carbon-neutral future. The Energy Union provides the right compass, but EURICS should allow Europe to set its own course, placing the citizen at the helm to keep the heading, ignoring the US Sirens' songs and avoiding the reefs of immobilism. Only then can Europe lead the global energy transition race.

213. William Shakespeare, *Hamlet*, 1603, Act III scene 2.

REFERENCES

AIGINGER Karl, BÄRENTHALER-SIEBER Susanne, VOGEL Johanna, "Competitiveness of EU versus USA", *WWWforEurope Policy Paper*, n°29, November 2015.

ANDOURA Sami, VINOIS Jean-Arnold, "From the European energy community to the energy union – a new policy proposal", *Studies & reports n° 107*, Jacques Delors Institute, January 2015.

BANKOFF Greg, "No Such Thing as Natural Disasters", *Harvard International Review*, 23 August 2010.

BAREGHEH, ROWLEY, SAMBROOK, "Towards a multidisciplinary definition of innovation", *Management Decision*, 2009.

BARNETT Chance, "Trends show crowdfunding to surpass VC in 2016", *Forbes*, 09 June 2015.

BARRE-SINOUSSI Françoise *et al.*, "Coupes budgétaires dans la recherche : huit grands chercheurs dénoncent 'un suicide scientifique et industriel", *Le Monde*, 23 May 2016.

BERTONCINI Yves, "European elections: the abstention trap", *Policy paper No. 110*, Jacques Delors Institute, 13 May 2014.

BIHOUIX Philippe, *L'âge des low-tech: Vers une civilisation techniquement soutenable*, Broché, 2014.

BOLDRIN Michele, LEVINE David, "The case against patents", *Journal of Economic Perspectives*, Vol 27, n°1, 2013.

BOSTROM Nick, YUDKOWSKI Eliezer, *The Ethics of Artificial Intelligence*, The Cambridge Handbook of Artificial Intelligence, 2014, pp. 316-334.

BURGER Paul et al., "Advances and understanding energy consumption behaviors and the governance of its change: outline of an integrated framework", *Frontiers in energy research*, Vol 3, Article 29, June 2015.

CAIT Climate Data Explorer, Washington, DC: World Resources Institute, 2015.

Capgemini Consulting, *Scaling up innovation in the energy union to meet new climate, competitiveness and societal goals*, 2016.

CHESBROUGH Henry, *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press, 2003.

CLAEYS Grégoy, LEANDRIO Alvaro, "Assessing the Juncker Plan after one year", *Blog Post*, Bruegel, 17 May 2016.

CULTER C. Chapin, *Interview by Andrew Goldstein*, Palo Alto, 21 May 1993.

DAVILA Antonio, FOSTER George, XIAOBIN He, SHIMIZU Carlos, "The rise and fall of startups: Creation and destruction of revenue and jobs by young companies", *Australian Journal of Management*, Vol 40 (1), 2015, pp.6-35.

DE JONG Jacques, PELLERIN-CARLIN Thomas, VINOIS Jean-Arnold, "Governing the differences in the European energy union: EU, regional and national energy policies", *Policy paper n°144*, Jacques Delors Institute, October 2015.

DERDEVET Michel, *Energie – l'Europe en réseaux,* La documentation française, Février 2015.

DI MANNO Sylvain, *La transition énergétique, entre histoire politique et politique de l'histoire*, Ecole thématique de l'Institut francilien recherche innovation société, 2014.

DIAMOND Jared, *Collapse: how societies choose to fail or succeed*, 2005.

DIAMOND Jared, "The ends of the worlds as we know them", *New York Times*, 01 January 2005.

DU PREEZ Niek, LOUW Louis, ESSMANN Heinz, "An Innovation Process Model for Improving Innovation Capability", *Journal of High Technology Management Research*, 2009.

EDGERTON David, *The shock of the old – technology and global history since 1900*, Profile Books, 2008.

EDQUIST Charles, ZABALA-ITURRIAGAGOITA Jon Mikel, "The Innovation Union Scoreboard is flawed: The Case of Sweden – not the innovation leader of the EU – updated version", Papers in Innovation Studies of CIRCLE Lund University, *Paper n. 2015/27*, 2015.

EHRLICH Paul, EHRLICH Anne, "Can a collapse of global civilization be avoided?", Proceedings of the Royal Society B, 9 January 2013.

EIT, *The EIT at a Glance,* November 2012.

ENSMENGER Nathan, *When good software goes bad – the surprising durability of an ephemeral technology,* Indiana University, 2016.

Eurobarometer, *Climate Change Report*, March 2014.

European Commission, *A European Strategic Energy Technology Plan,* 22 November 2011.

European Commission, *Energy Technologies and Innovation communication*, 02 May 2013.

European Commission, *Working Document on Technology Assessment*, 02 May 2013.

European Commission, *Energy Union Framework Strategy*, 25 February 2015.

European Commission, *Innovation Union Scoreboard 2015*, 2015.

European Commission, *Towards an Integrated Strategy Energy Technology Plan*, 15 September 2015.

European Commission, *Monitoring progress towards the Energy Union objectives*, 18 November 2015.

European Commission, *State of the Energy Union Communication*, 18 November 2015.

European Court of Auditors, *The European Institute of Innovation and Technology must modify its delivery mechanisms and elements of its design to achieve the expected impact*, Special Report n°4/2016, April 2016.

European Defence Agency, *Defence Data 2013*, 2015.

European Parliament, DG for internal policies, *Horizon 2020 : key enabling technologies, booster for european leadership in the manufacturing sector*, European Parliament, 2014.

European Parliamentary Research Service, "Overview of EU Funds for research and innovation", *Briefing*, September 2015.

European Research Council, *Science behind the projects*, 2014.

EWALT David, "The world's most innovative research institutions", *Reuters*, 08 March 2016.

FORD Henry, *My life and work*, 1922, p. 29.

FRANKLIN Benjamin, "Letter to his friend A. B.", 1748, *in* Benjamin Franklin, *Memoirs of Benjamin Franklin*, Volume 2, 1834, p. 480.

FRASCATI Manual, *Proposed standard practice for surveys on research and experimental development*, OECD, 2002.

FRESSOZ Jean-Baptiste, "Pour une histoire désorientée de l'énergie", *Entropia* n°15, 2013.

GABISON Garry and PESOLE Annarosa, "An overview of models of distributed innovation", *JRC Science and Policy Reports*, 2014.

GABISON Garry, *Understanding Crowdfunding and its Regulations*, Joint Research Centre, 2015.

GERTNER Jon, *The idea factory – the Bell Labs and the great age of American innovation*, Penguin Books, 2012.

Global Challenges Foundation, *Global Catastrophic Risks 2016*, 2016.

HESSELDAHL Peter, "The new normal : from products to platforms and processes", InnovationManagement.se, 10 September 2014.

Joint Research Centre, *EU industrial R&D investment scoreboard*, 16 January 2015.

KANDER Astrid, MALANIMA Paolo, WARDE Paul, *Power to the people*, Princeton University Press, 2013.

KIC InnoEnergy & Questel Consulting, *Top 10 Energy Innovators in 100 Energy Priorities: A unique report mapping industrial and academic players in global competition*, January 2015.

KING Andrew, LAKHANI Karim R., "Using Open Innovation to Identify the Best Ideas", *MIT Sloan Management Review*, fall 2013, pp.41-48.

KNOWLES Scott Gabriel, *Maintenance deferred: slow disaster and the politics of infrastructural decay*, 4 April 2016.

KROES Neelie, *Speech to the Villa d'Este Forum*, September 2nd 2006.

KRUGMAN Paul, "Competitiveness: A dangerous Obsession", *Foreign Affairs*, March/April 1994.

KURATKO Donald, "The entrepreneurial imperative of the 21st century", *Business Horizons*, 2009.

LAKHANI Karim R., HUTTER Katja, HEALY POKRYWA Stephanie, FULLER Johann, "Open Innovation at Siemens", *Harvard Business School Case 613-100*, June 2013 (Revised March 2015.)

LEMLEY Mark, SHAPIRO Carl, "Patent Holdup and Royalty stacking", *Texas Law Review*, Vol 85, 2007.

MAGNAN Alexandre, "Addressing the risk of maladaptation to climate change", *Wiley interdisciplinary reviews: Climate Change*, 2016.

MAZZUCATO Mariana, *The entrepreneurial state: Debunking public vs. private sector myths*, Anthem Press, 2015.

MEISSNER Dirk, KOTSEMIR Maxim, "Conceptualizing the innovation process towards the 'active innovation paradigm'—trends and outlook", *Journal of Innovation and Entrepreneurship*, 5(1), 2016, p.12.

MITCHELL Timothy, *Carbon Democracy – political power in the age of oil*, Verso, 2013.

MOEDAS Carlos, European Commissioner for Research, Science and Innovation, in the context of the Call for Ideas for the project of European Innovation Council (EIC).

MORRIS Craig, "Why is UK wind power so expensive?", Energy Transition – The German Energiewende, 29 April 2015.

NAIMS Henriette et al., "CO2 recycling – an option for policymaking and society?", *Institute for advanced Sustainability Studies Working Paper*, Potsdam, December 2015.

NORDHAUS William D., "A review of the 'Stern review on the economics of climate change'", *Journal of economic literature*, 2007, pp.686-702.

NORTON Michael I., MOCHON Daniel , Dan ARIELY, "The'IKEA effect': When labor leads to love", *Harvard Business School Marketing Unit Working Paper*, 2011, (11-091).

O'SULLIVAN David, DOOLEY Lawrence, *Applying Innovation*, 2009.

OECD & Eurostat, *Oslo Manual*, Third Edition, 2005.

OVANS Andrea, "What is Strategy Again?", *Harvard Business Review*, May 2015.

PELLERIN-CARLIN Thomas, "How can the Juncker Plan unlock energy efficiency investment in the short and long term?", *in* RUBIO Eulalia, RINALDI David, PELLERIN-CARLIN Thomas, "Investment in Europe : Making the best of the Juncker Plan", *Studies & Reports No. 109*, Jacques Delors Institute, March 2016.

PEREZ Carlota, "Technological revolutions and techno-economic paradigms", *Cambridge journal of economics*, 2009.

PHILIPPS Jack J., EDWARDS Lisa, *Managing talent retention: An ROI approach*, John Wiley & Sons, 2008. p.1.

POIZE Noémie, RUDINGER Andreas, *"Projets citoyens pour la production d'énergie renouvelable : une comparaison France-Allemagne"*, *IDDRI working Papers*, 2014.

RADJOU Navi, PRABHU Jaideep, *Frugal Innovation – how to do more with less*, The Economist Books, 2015.

RAWLS John, *Justice as fairness: A Restatement*, 2001.

REICH Robert, *American Competitiveness and the President's new relationship with American Business*, 21 January 2011.

REILLON Vincent, *Horizon 2020 budget and implementation – a guide to the structure of the programme*, European Parliamentary Research Service, November 2015.

ROTHWELL Roy, "Towards the fifth-generation innovation process", *International marketing review*, 11(1), 1994, pp.7-31.

RUSSELL Andrew, VINSEL Lee, *Hail the maintainers*, Aeon Essays, 2016.

RYAN Alex, DILA Michael, "Disruptive Innovation reframed: Insurgent design for systemic transformation", *Relating Systems thinking and Design 2014 working paper*, 2014.

SCHWAB Klaus, *The global competitiveness report 2015-2016*, World Economic Forum, 2015.

SCHWARTZ COWAN Ruth, *More work for Mother: the ironies of household technology from the open hearth to the microwave*, New York, Basic Books, 1983.

SMIL Vaclav, *Energy Transitions: History, Requirements, Prospects*, Praeger, 2010.

STAHL Günter, et al. "Six principles of effective global talent management", *Sloan Management Review 53*, no. 2, 2012.

SUPEKAR Sarang, SKERLOS Steven, "Reassessing the efficiency penalty from carbon capture in coal-fired power plants", *Environment Science & Technology*, 2015.

TAINTER Joseph, *The collapse of complex societies – new studies in archaeology*, 1990.

TOL Richard S., "Adaptation and mitigation: trade-offs in substance and methods", *Environmental Science & Policy*, n° 18, 2005, pp. 572-578.

VERSTEEG Kristiaan, "Tracking renewable energy crowdfunding", Solar Plaza, 15 September 2015.

VEUGELERS Reinhilde, "The European Union's growing innovation divide", *Bruegel Policy Contribution*, April 2016.

WARDROP Robert, ZHANG Brian, RAU Raghavendra, GRAY Mia, *Moving Mainstream. The European Alternative Finance Benchmarking Report*, 2015.

WAUTERS Robin, "Fail Better", Tech.eu, 11 May 2015.

WEBER Matthias, ANDREE Dan, LLERENA Patrick, *A new role for EU research and innovation in the benefit of citizens: towards an open and transformative R&I policy*, European Commission, 2015.

WINNER Langdon, *Autonomous technology – technics out of control as a theme in political tought*, MIT Press, 1978, p. 183.

WINTERHALTER Stephan, *Resource-Constrained Innovation and Business Models in Emerging Markets*, PhD diss., University of St. Gallen, 2015.

World Economic Forum, *Energy Vision 2013*, 2013, p.5.

WRIGLEY E. A., *Energy and the English Industrial Revolution*, Cambridge: New York, Cambridge University Press, 2010.

YAGO Glenn, *The decline of transit : urban transportation in German and US cities 1900-1970*, Cambridge University Press, 1984.

YELLA Aswani, "Porphyrin-sensitized solar cells with cobalt (II/III)-based redox electrolyte exceed 12 percent efficiency", *Science*, November 2011.

ZACHMANN Georg, "Making low-carbon technology support smarter", *Bruegel Policy Brief*, 2015.

ŽIŽLAVSKÝ Ondrej, "Past, Present and Future of the Innovation Process", *International Journal of Engineering Business Management*, 2013.

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info@delorsinstitute.eu
www.delorsinstitute.eu
19 rue de Milan, F – 75009 Paris
Pariser Platz 6, D – 10117 Berlin