The Energy transition & the European Innovation ecosystem

A case study: EIT InnoEnergy

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Abstract

Europe has repeatedly demonstrated its commitment to tackle climate cha(lle)nge, which is one of the greatest threat of mankind, imposing a shift from our carbon intensive sociotechnical and economic system.

It is thus time to kill three birds with one stone: beyond a moral duty imposed by climate change, the Energy Transition is a tremendous industrial opportunity for Europe bringing growth, jobs and competitiveness, as well as a genuine project for the whole society offering a second youth to the old continent and reviving a sense of pride and action in the European peoples to ultimately demonstrate that the European Union is undeniably a positive sum game.

For this vision to materialise, the European Union can count on first class Research in clean energy technologies, a strong industrial base, a dense entrepreneurial ecosystem in clear reinforcement, a full commitment of the public sector via programmes and instruments, as well as novel own approach to de-risk and accelerate the time to market of technological, business model or social innovations in sustainable energy, based on the Knowledge Triangle integration via the Knowledge and Innovation Community for Energy, EIT InnoEnergy.

All in all, to make a positive impact in society, there is no better time than 2018, no better place than Europe and no better field than innovation in energy.

Keywords: Innovation, energy transition, entrepreneurship, knowledge triangle.

The energy transition supported by the Member States, the European Parliament, and the European Commission, notably with the Energy Union launched in February 2015, is an opportunity to boost the European economy, to show effective European leadership in implementing the planet commitments coming out of COP21, while meeting ambitious greenhouse gas emission reductions.

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It is also a means to relaunch the European project while securing Europe's global position in the clean energy race. To reach such an objective, increased investment in clean energy research and innovation – from both the private and the public sectors– and ensuring the scale-up and widespread deployment of technologies and services are necessary, and will contribute to the European decarbonisation by 2050, delivering in the meantime sustainable growth and jobs.

The energy transition is thus a *genuine project for the whole society* with the vision of a decarbonised world by the end of the century, and the potential to create a new momentum, to provide a second youth to the old continent and, as such, represents the perfect opportunity to be seized by the European Union (EU).

For this vision of the European Union leading the clean energy race to materialise, it is necessary to understand what vital role the European Union can play, notably on the Innovation side of the picture as energy transition is the realm of innovation par excellence, and how to play it. As shown by the evolution of the management of innovation with the emergence of Open Innovation (2003) and of Active Innovation paradigm (2016), it seems that entrepreneurship and intrapreneurship, *i.e.* harnessing the value of each individual empowered to take part in the innovation process, progressively became a business imperative. This sensibly raises the question of the specific initiatives of the EU in supporting entrepreneurship and in fostering the emergence of network-based innovation in the field of energy, which is the raison d'être of EIT InnoEnergy.

In this context, after a first section introducing few elementary definitions around innovation as well as the evolution of the management of innovation, and describing why energy transition and innovation closely work hand-in-hand, the second section of this paper presents the European innovation landscape, the specific policies implemented at EU level to support clean energy uptake, and the role the EU has to play to bring the clean energy leadership to life, which is threefold: to set a clear strategy to move forward, to provide suitable tools to implement the strategy, and to play an essential diplomatic role on the international scene. Finally, the last section is the occasion to take stock of the first seven years of operation of the Knowledge and Innovation Community

for Energy, EIT InnoEnergy, and to provide key facts and figures from these seven years.

1. INNOVATION & ENERGY TRANSITION

1.1. Innovation is the throttle of the European economic engine

Innovation is the action of introducing something new to a given organisation. It differs from invention, which is "the generation of newness or novelty, while innovation is the derivation of value from that novelty"[1]. *Research* and *Innovation* are also closely related, but differ from each other. Indeed, "Research is the transformation of money into knowledge. Innovation is the transformation of knowledge into money." as described by the Post-It's father, Geoffrey Nicholson from 3M. Innovation is usually associated with the private sector and even more specifically to technological companies, but it is actually critical for both private and public sectors, as well as for technological and non-technological companies.

The management of innovation and its objectives have drastically evolved, from the first model of innovation process in 1950s, characterised by a sequential one-way linear process from research to sales, to the recent *open innovation paradigm* proposed by Chesbrough in 2003[2]. More recently, Kotsemir and Meissner suggested to complement the model of innovation with *a human resources dimension*[3]. The Exhibit 1 shows a timeline of the apparition of the main innovation models from 1950s to nowadays. This evolution has also been influenced by the technological development, notably by the potential of and role played by *digital technologies in our societies,* which progressively enabled and shaped communication and exchange of information between entities and between individuals.

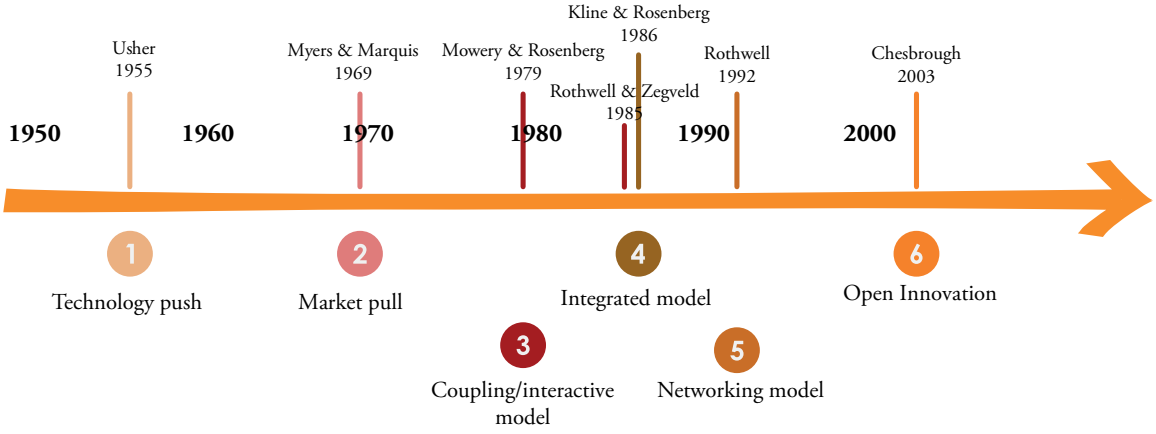
1 Du Preez, Niek, Louis Louw, and Heinz Essmann. "An Innovation Process Model for Improving Innovation Capability." *Journal of High Technology Management Research,* 2009: 1-24.

2 Chesbrough, Henry. *Open Innovation:* The New Imperative for Creating and Profiting from Technology. Harvard Business Press, 2003.

3 Meissner, Dirk, and Maxim Kotsemir. "Conceptualizing the innovation process towards the 'active innovation paradigm'—trends and outlook." *Journal of Innovation and Entrepreneurship,* 2016: 1.

Exhibit 1

Timeline of the apparition of the main innovation models, with founding authors



Source: EIT InnoEnergy, adapted from Meissner and Kotsemir.

Synthetically, the innovation process management in organisations has evolved. Initially, by acknowledging that innovation was not the exclusive realm of the research department, and that each department or function within the organisation had to play a role in the innovation process. Then, the importance of maintaining links in the ecosystem, through formal and informal interactions with external entities, has been recognised as essential to develop and valorise innovation.

We should make the *distinction between incremental, breakthrough and disruptive innovation.* Incremental innovation is usually seen as the incremental improvement of a product, a service or a process that already exists. For instance, adapting the manufacturing process of a technology to make it more efficient (in terms of material, of energy, of time, of money, of space,…) can lead to an overall cost reduction of the corresponding technology. If the change is significant enough, the entity implementing it will gain a competitive advantage which might secure its position on the longer run, but it will not drastically reshuffle the cards. We talk about *breakthrough innovation* when the newness implies a high-risk/high-reward scheme, and might endanger the competition due to a substantial improvement. The newness can come from a new business

model opening up new markets for instance. Finally, disruptive innovation is increasingly popular in political discourse, and can be defined as an innovation that "makes it impossible for existing players to compete on their own terms"[4].

The popularity for disruptive innovation can be seen as *a side-effect of digitalisation*[5], which is a mega-trend impacting all aspects of the economy, disrupting every industry, in particular with the rising of sharing economy (or "crowd-based capitalism"[6]). The technological layer of this transformation comes from the fifth and most recent technological revolution and led to the ubiquity of the underlying technologies (Information and Communications Technologies) in our lives[7]. There is another revolution rising in the wake of this fifth revolution, which could be coined the "Bot Revolution". Enabled by Artificial Intelligence (AI) and Deep Learning, fuelled by big data, and materialised in our daily life by Internet of Things and the distributed ledger technologies (or blockchain)[8], *this revolution is profoundly reshaping our economies.* It also represents a potential threat for those who will simply deny its existence and decide not to engage in this direction.

1.2. From entrepreneurial to intrapreneurial imperative

For companies in place, the question is not whether they have a sword of Damocles hanging over their heads, but who is holding the arm. That is the reason why well-established companies *should try to disrupt themselves,* instead of experiencing each of the five stages of grief (namely Denial, Anger, Bargaining, Depression and Acceptance). Notwithstanding, this revolution entails a legitimate concern of "*technological unemployment*" for society as a whole and for middle class white collar employees in particular (*i.e.* "unemployment due to our discovery of means of economising the use

4 Ryan, Alex, and Michael Dila. "Disruptive Innovation Reframed: Insurgent Design for Systemic Transformation." Working paper, Relating Systems Thinking and Design, 2014.

5 Digitisation and digitalisation are often used interchangeably. However, digitalisation goes beyond digitisation, which is only to use digital tools to perform existing activities, while the former is the creation of new revenue streams via digital channels, based on new activities.

6 Sundararajan, Arun. *The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism.* MIT Press, 2016.

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

8 The distributed ledger technology is the disintermediation technology which the famous "Bitcoin" is based on.

of labour outrunning the pace at which we can find new uses for labour"[9]), which demonstrates that this transformation is definitely not a mere technological change, but truly a societal mutation with profound impact on social structures.

This worry must not be muffled or overlooked, but adequately addressed via two distinct approaches: a *philosophical reflection* on the respective roles of work and leisure in our lives, and an emphasis on developing new activities leveraging innovation. The former opens the field to debates on the appropriate amount of working time, to the age of retirement, and even to ideas such as Universal Basic Income (UBI). These debates are not recent. Talking about the future 100 years ahead, Keynes wrote in 1930 that "we shall […] make what work there is still to be done to be as widely shared as possible. […]. For three hours a day is quite enough to satisfy the old Adam in most of us!"[10]. Contrary to dividing philosophical reflections, the positive economic impact of *harnessing the creativity of people's minds* to develop new activities is not debatable.

Today, the individuals populating organisations appear as prominently vital for innovation. *The individual became the fundamental building block* to find, develop, assess, and implement internal and external knowledge into an innovation process, but also to further valorise its outcome externally. In this regard, organisations face the issue of attracting and retaining highly skilled individuals. From acquisition to development and retention of talents, talent management is a growing concern and a key strategic aspect[11].

As rightly stated by Donald Kuratko[12], *innovation and entrepreneurship are not simply options, but an imperative for companies*[13] to keep an edge on competitors and stay in the game. Although, companies must truly walk this talk made of entrepreneurship and innovation, and not only adopt a narrative grounded on

9 Keynes, John Maynard. Economic possibilities for our grandchildren (1930). Essays in persuasion, 1933, 358-373.

10 Ibid.

11 Phillips, Jack, and Lisa Edwards. *Managing talent retention: An ROI approach.* John Wiley & Sons, 2008.

12 Kuratko, Donald. "The entrepreneurial imperative of the 21st century." *Business Horizons,* no. 52, 2009: 421-428.

13 This comment is also relevant at the countries' level, when discussing about international competition and industrial leadership.

these two dimensions. This indeed requires to dramatically upgrade the business culture and to implement profound changes to create a working environment prone to entrepreneurial initiatives, based on collegiality, openness, flexibility, but also proactivity and responsibility. Only then, EU businesses embracing this challenge will be more competitive, *i.e. able to do what no one else can do,* and not to do what everyone does while spending less.

To foster this transformation, the EU should indeed *harvest the dormant innovative potential* present in many individuals currently employed in well established companies (large firms and SMEs), through a *fully-fledged intrapreneurship approach.* Intrapreneurship is usually seen as a specific type of corporate venturing, which stretches from a purely inorganic venturing (such as the acquisition of start-ups through a dedicated capital venture funds) to an organic one (*i.e.* intrapreneurship). Corporate venturing and strategic entrepreneurship are the two pillars of what is called corporate entrepreneurship. In this document, *intrapreneurship means the implementation of internal processes to promote creative and innovative ideas in an organisation,* and enabling employees to transform these ideas into breakthrough innovations with the support of this organisation.

This could serve two objectives. Firstly, the exploitation of this untapped potential would make European companies more competitive and not harnessing this potential would bear an opportunity cost. Secondly, this would help to retain employees and especially the "talents" in Europe. Implementing an intrapreneurship programme can indeed provide a feeling of accomplishment, fulfil the desire of having a meaningful job and can be used to reward employees according to their involvement (*e.g.* financial rewards, dedicating a share of the benefits to the active contributors). As Günter Stahl *et al.* argue, "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."[14] Consequently, intrapreneurship represents a suitable way to propose a *high value proposition to employees,* and could thus significantly contribute to talents retention in Europe.

14 Stahl, Günter, *et al.* "Six principles of effective global talent management." *Sloan Management Review,* 2012: 25-42.

Bringing intrapreneurship-based strategy to life requires to support and *promote the entrepreneurial mind-set while demystifying failure.* Adopting the corresponding mind-set is the sine qua non as the individual is the fundamental element of innovation. In this vein, the European Union has created the European Institute of Innovation and Technology (EIT) in 2008[15], to reinforce entrepreneurship in Europe and facilitate entrepreneurial initiatives, based on an open innovation model made of synergies between Research, Higher Education and Industry.

European policy makers and civil society should reinvigorate this approach and implement "active innovation" policy measures, incentivising companies to move towards *the individuals' empowerment in and ownership of the changes in their organisation.* Successful innovation increasingly originates in agile, dynamic and flexible relations, while institutionalised structure and stiff governance become less relevant as it becomes crucial to overcome the divide between internal (*e.g.* within one company) and external (*e.g.* academia or competitors). Staying ahead in terms of innovation means to be able to *animate a multi-stakeholder ecosystem where internal and external boundaries do not matter much,* but where individuals (*e.g. academics, entrepreneurs, venture capitalists*) transform the score into music. In this perspective, the role played by organisations like the Knowledge and Innovation Communities (KICs) is instrumental in building regional and national innovation ecosystems, connecting them at the pan-European scale, while adopting a strategic vision at the EU level.

In practical 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, which led to the well-known product Post-It. Other initiatives like "Hackathons" are implemented by some companies to harness creativity and valorise the entrepreneurial initiatives of their employees. The well-known button "Like" popularized by Facebook is

15 The reader can find a more detailed development about the EIT in section 3.

arguably the most famous outcome of a hackathon. Beyond the time released to train, develop and implement creativity and its outcome, organisations could be incentivised to get to the next step, which is the *fast prototyping* of the best ideas, preferably via (or in collaboration with) an external infrastructure, to circumvent the potential rigidity of bureaucracies. They could be sought among the Fab Labs[16] and similar workshops, which are existing local players integrated in an innovation ecosystem, in partnership with network-based players. *Some fiscal incentives* for intrapreneurship measures could be implemented at the national level, such as a fiscal abatement on profits generated with products and services stemming from an intrapreneurship programme, or an abatement on social contribution proportional to the time released for employees. Similarly, the various direct and indirect costs related to fast prototyping could be eligible for a corporate tax rebate.

1.3. Energy transition: more than a duty for the European Union

There is no doubt in Europe about the necessity to fight climate change, which is a civilizational challenge that must be taken up. The commitment taken in Paris in December 2015 by all the parties on reaching the state of a carbon neutral economy by the end of the century, has been repeatedly demonstrated in Europe, notably in the context of the Energy Union priorities of the current Commission, published in February 2015. The Energy Union, based notably on Research and Innovation and Decarbonisation of the economy, brought a new political momentum at the EU level.

This political vision has been translated into legislative proposals, notably with the Clean Energy for All Europeans package, issued in November 2016, and with the Mobility Package end of 2017. Among the various documents authored by the European Commission, the Accelerating Clean Energy Innovation (ACEI) strategy further insists on the essential and instrumental role to be played by Innovation in Europe, in an industrial leadership perspective, with jobs,

16 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.

growth and competitiveness at the core. In the same vein, the EU industrial Policy Strategy published by the European Commission in September 2017 provides a vision to build a competitive European Industry, based on 6 core dimensions, notably the Circular and low carbon economy, Innovation and the International Dimension. In addition, the President of the European Commission Jean-Claude Juncker has clearly stated the ambition for Europe: to become the world leader in renewables.

Consequently, the energy transition is not a mere driver to reindustrialise Europe and improve its competitiveness, but a *genuine project for the whole society* with the vision of a decarbonised world by the end of the century, the clear mission for Europe to power this transition by providing the low-carbon solutions to the world, while promoting the European core values. This project has the potential to create a new momentum, to provide a second youth to the old continent and, as such, represents the perfect opportunity to be seized by the European Union. In addition, energy is an essential production factor of our modern economy. Consequently, energy transition is *also crucial for our industrial cost competitiveness*[17] (to do what everyone else does while spending less).

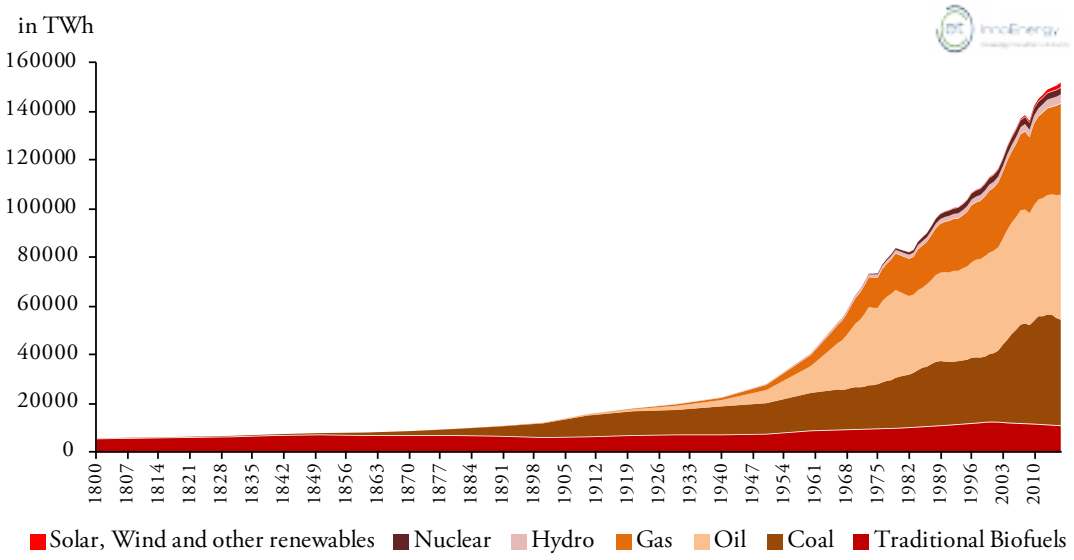
Energy Transition is the realm of Innovation par excellence

On the one hand, energy transition usually refers to the substitution of primary energy sources, such as the substitution of fossil fuels by renewable energy sources. Such phenomenon never occurred over the past centuries (see Exhibit 2), which have only seen additions of successive energy sources, from traditional biofuels (wood) to coal (enabling the massive use of steam engine as of 1850s and the Industrial revolution), and successively to oil, gas and eventually to nuclear and variable renewable energy sources. If Europe wants to bring a *genuine energy transition* to life, it will require to do something that has never been done so far, *i.e.* it *will require to innovate*.

17 European Commission. "Helping firms grow: European Competitiveness Report 2014." Commission Staff Working Document-SWD(2014)277 final, DG for Entreprise and Industry, European Commission, 2014.

Exhibit 2

Global energy consumption by primary energy source, from 1800 to 2016



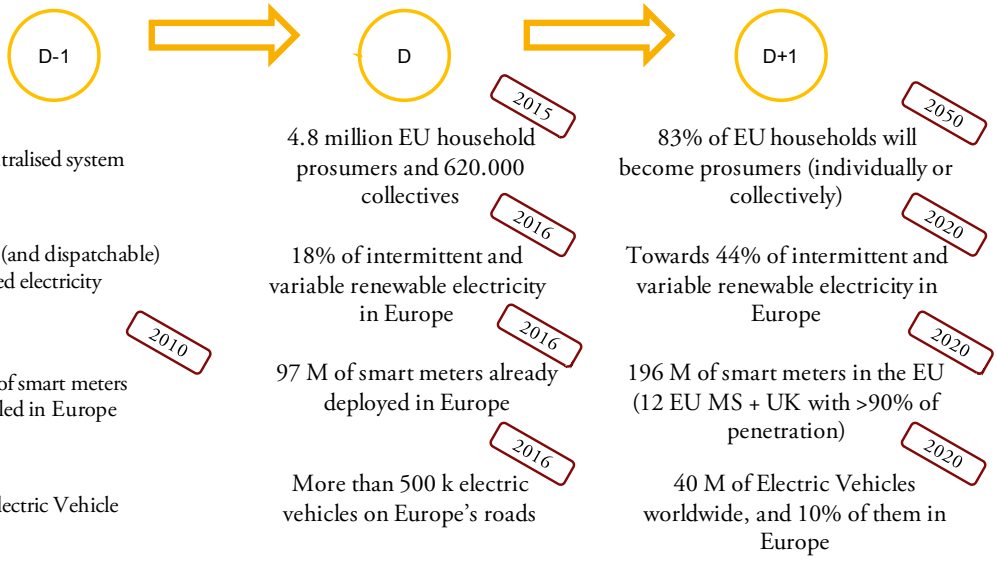
Sources: Data Valclav Smil (2017). Energy Transitions: Global and National Perspectives. & BP Statistical Review of World Energy.

On the other hand, European energy incumbents are currently struggling with *outdated business models*, which cannot cope with the current decrease of both the EU primary energy and electricity consumptions. This trend is embedded into a broader picture characterised by features like the electrification of energy uses (especially mobility), the growing penetration of Variable Renewable energy sources (and the falling wholesale prices), the increasing decentralisation of the electricity system, and the deployment of smart metering infrastructure. This context relates to the concept of "death spiral" and endangers utilities' survival and is one sound driver to *transform their activities via innovation.*

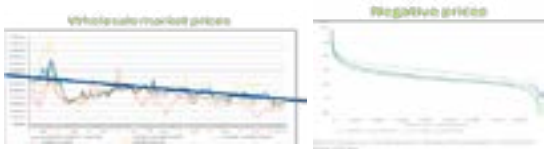
In this perspective, *the European utilities landscape is already evolving,* for instance via the various *acquisitions* made by Total (notably of Saft in batteries, Lampiris and Direct Energie in electricity retail activities, and Greenflex in energy efficiency), the planned *asset swap deal* between RWE and E.on in Germany, the new positioning of several European electric utilities in aggregation and new energy services (acquisition of EnerNOC by Enel, of REstore by Centrica, development of Sowee and of Agregio by EDF), the *new organizational structure* at ENGIE as of 2016 based on 24 Business

Exhibit 3

Key contextual changes for Utilities – Dashboard



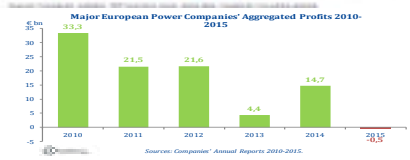
Symptoms
- Falling wholesale prices (but retail prices are increasing)
- Early plant closures (more than ½ of the 619 coal-fired power plants in Europe lose money)
- Financial problems for utilities
- Negative prices



→The current markets are designed to suit the cost structure of conventional assets, and optimise the dispatch of power plants, not to accommodate VRES or to send a long-term signal.

Death Spiral: erosion of profits and decline of revenues, endangering the traditional business models (volume-based revenues).

Drivers of this spiral:
↘ of wholesale prices
↗ of VRES
↗ of self-production & self-consumption
↘ of overall consumption
+ the concern about air pollution



Source: Prepared by EIT InnoEnergy.

Units and 4 "Métiers", the *creation of Enel X* for e-solutions by Enel Group around 4 fields (e-Mobility, e-Home, e-City and e-Industries) and more generally the emphasis of "Digital" in Utilities' strategy. Beyond the inclusion of digital as a

Exhibit 4

Lately published strategies by key utility players

Source: Prepared by EIT InnoEnergy from publicly accessible information.

topic into their strategies, a recent study from PwC[18] based on interviews of senior-level executives from 29 leading utilities shows that 70% them said their companies want to be digital leaders (and 20% envisioning a day when they will match the capabilities of leading digital players across all industries).

Besides, climate change is a global challenge that has to be addressed globally, which implies that *leapfrogging* of emerging countries (*i.e.* avoiding the carbon intensive path of economic prosperity, directly jumping to low carbon development) has a key role in the energy transition, but also represents *business opportunities* for EU industry.

All in all, Europe can conceive Energy transition as a one-off opportunity to tackle a civilizational threat, to *relaunch the European Project,* and to boost its competitiveness with a renewed industrial strategy leveraging both domestic and international markets, and not merely as a duty imposed by climate change.

18 PwC, The digitalization of utilities: There is a will, but is there a way?, Strategy&, September 2016.

2. THE EUROPEAN CLEANTECH INNOVATION LANDSCAPE

Europe has undeniably many strengths and assets to claim: a front-running research community, a well-positioned energy industry in corporate venturing, a vibrant ecosystem to accompany innovative SMEs, attractive public programmes to support innovation, as well as fora already in place at the EU level (*e.g.* the ETIPs and the SET Plan) which can provide a good preliminary analysis in terms of technological priorities in Europe.

There are also obstacles to the European leadership in Cleantech, such as an apparent lack of Venture Capital funding compared to Europe's competitors, an inherent unsuitable investment profile (*e.g.* the need of patient capital) leading to the reluctance of some segments of the innovation value chain (such as the VC community or the large corporates), or a policy framework sometimes perceived as insufficiently stable, which could frighten investors. Among the pre-identified potential obstacles to the global leadership, the "Valley of death", which is a general phenomenon characterising the difficulty to move from the lab to the market stage of innovation, is already clearly targeted by several EU initiatives.

However, for the leadership (notably in renewables) to materialise, Europe has to move towards an industry-oriented innovation strategy, to improve and accelerate the exploitation of the qualitative assets on its soil, notably coming from universities and research centres among the best in the world, especially by further leveraging the multi-scale and multi-stakeholder network-based and open innovation organisations like EIT InnoEnergy.

2.1. R&D&I expenditure: Europe is behind other regions, in Cleantech as well

As the recently "LAB-APP-FAB" report published by the High Level Group headed by Pascal Lamy clearly states, *a strategic plan in favour of R&I is really needed in Europe.*

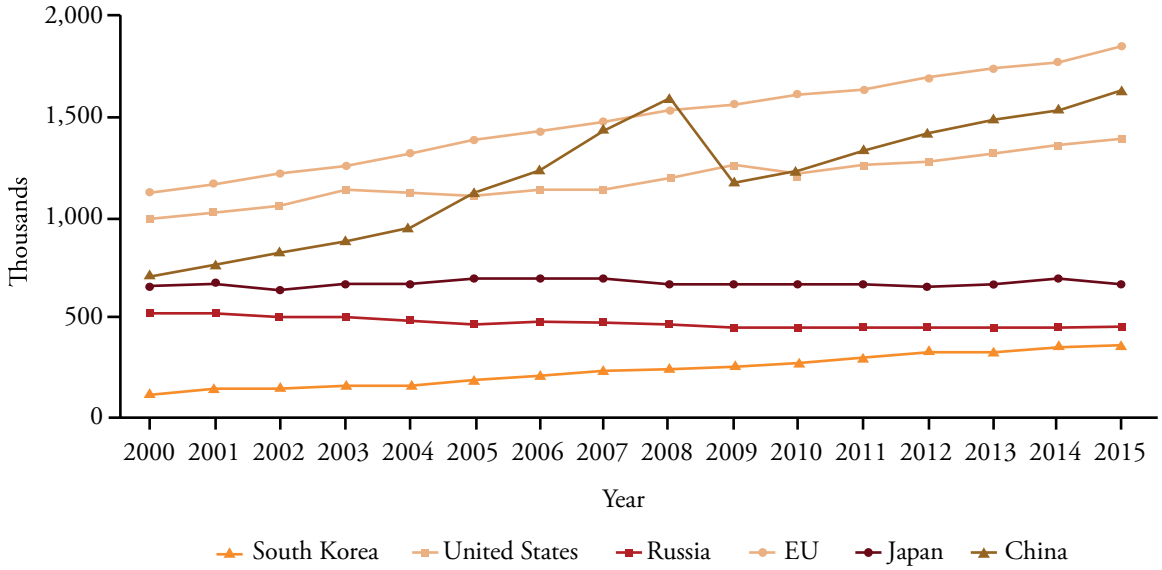
Even though Europe has a prosperous research ecosystem, interconnected research infrastructures, inventive start-ups and promising innovators, Europe has a growth deficit and is *lagging behind other regions when it comes to innovation*. According to the report, this can be explained by different factors, including *an insufficient investment in R&I.*

While the EU has indeed a large community of researchers (Exhibit 5) and a significant amount of R&D expenditures in absolute terms, the picture is different when we consider the R&D intensity (Exhibit 6), despite one of the largest R&D *programme* worldwide (H2020 and previous Framework Programmes). In addition, the EU has a small amount of Venture Capital investment compared to the rest of the world (Exhibit 7).

Put differently, Europe is very good at creating knowledge with money, but struggles when it comes to make money with its knowledge, notably due to a relatively less intensive corporate R&D in Europe compared to the rest of the world (Exhibit 8 and Exhibit 9).

Exhibit 5

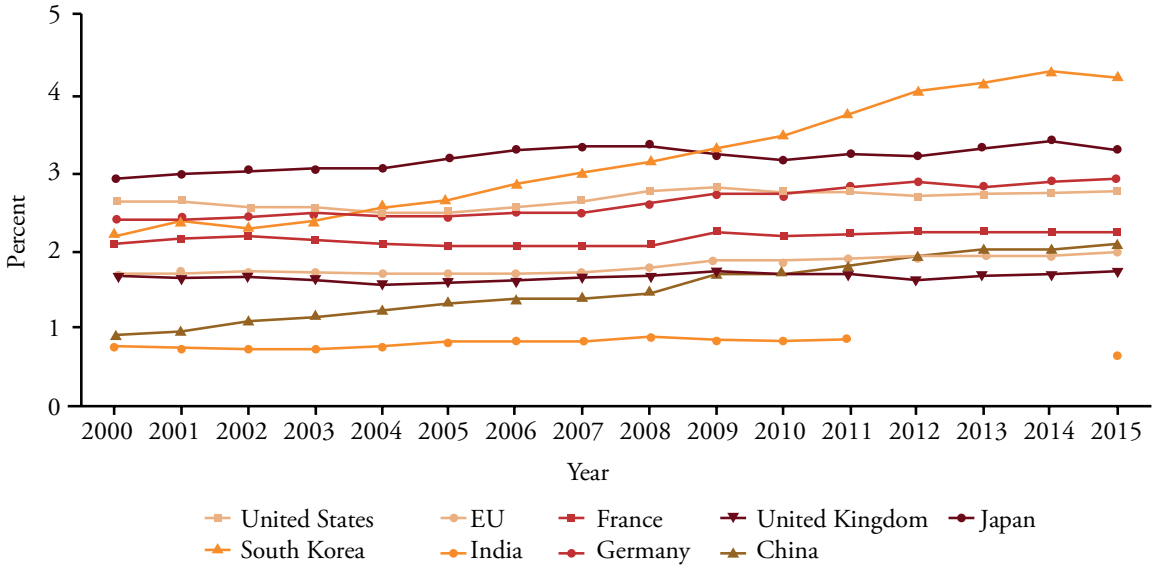
Estimated number of researchers in some selected regions or countries, 2000-2015



Source: National Science Board of National Science Foundation.

Exhibit 6

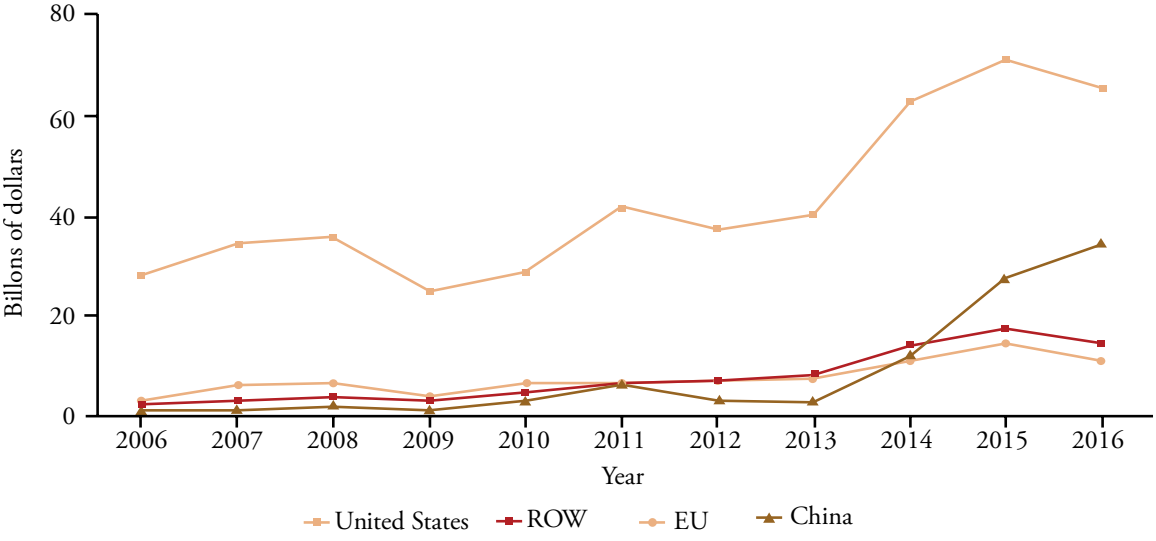
R&D intensity, by selected region, country, or economy: 2000-15



Source: National Science Board of National Science Foundation.

Exhibit 7

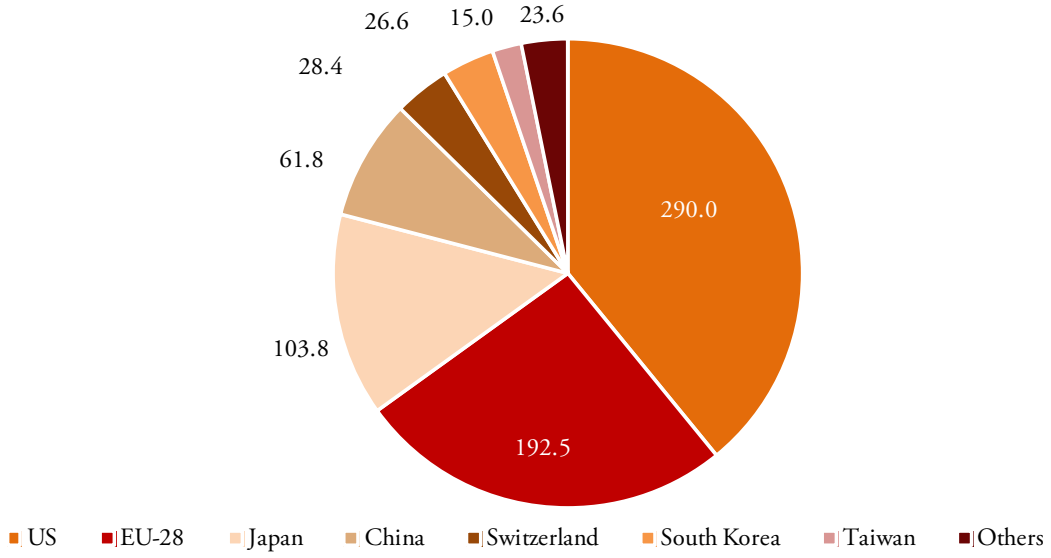
Early- and later-stage venture capital in some regions or countries, 2006-2016



Source: National Science Board of National Science Foundation.

Exhibit 8

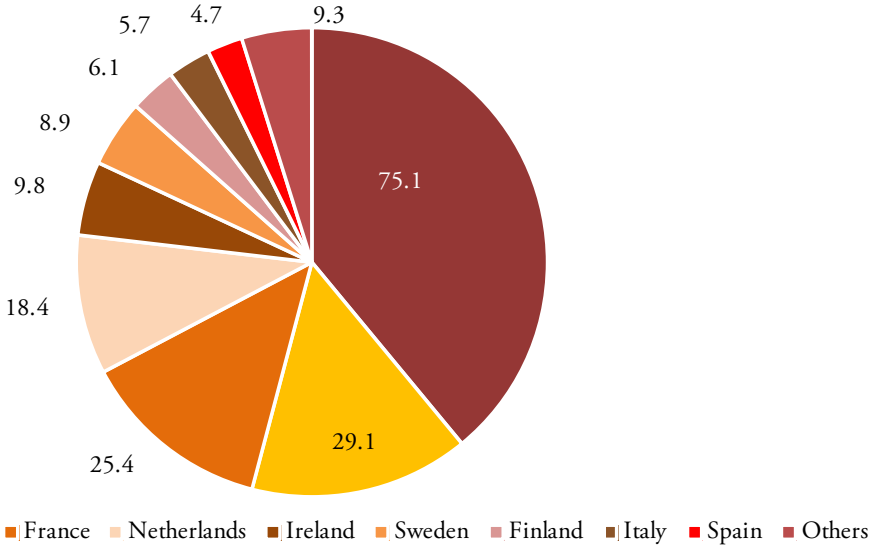
Corporate R&D expenditure in the world in 2016-2017 from top 2,500 companies (in b€)



Sources: Data from the JRC, EU Industrial R&D Investment Scoreboard.

Exhibit 9

Corporate R&D expenditure in the EU-28 in 2016-2017 from top 2,500 companies (in b€)



Sources: Data from the JRC, EU Industrial R&D Investment Scoreboard.

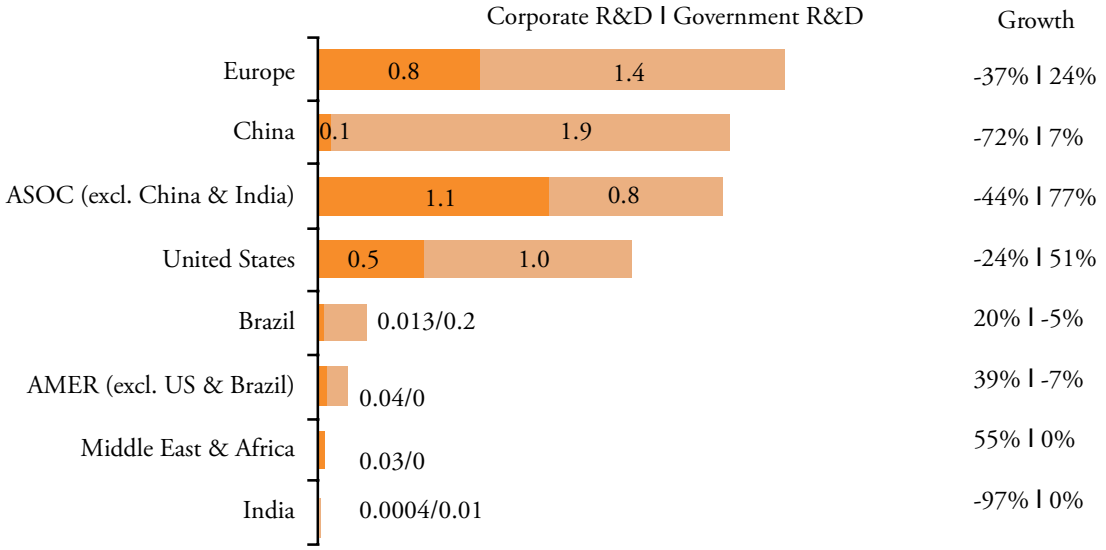
In this regard, Cleantech[19] is an illustration of this situation. As a matter of fact, the data available demonstrates that *Europe is indeed at the top of the ranking in terms of R&D expenditures dedicated to renewable energy* (which represents a large share of Cleantech), notably thanks to the crucial role played by European governments (Exhibit 10[20]). Public sector in Europe increased its financial effort (+24%) between 2015 and 2016. Nonetheless, over the same period, European companies decreased their effort (-37%).

Despite this huge effort in R&D (both from the public and private sectors), Cleantech investments[21] in Europe are lower than in other regions of the world, as shown on Exhibit 11.

Exhibit 10

Corporate and government renewable energy R&D by region in 2016, and growth on 2015

(B$)



Sources: Frankfurt School-UNEP Centre & BNEF, Global Trends in Renewable Energy Investment 2017.

19 It corresponds here to the following scope: Wind (onshore & offshore), Solar (PV & CSP), Biofuels, Biomass & Waste, other renewables like small hydro (< 50 MW), geothermal or marine technologies, and energy smart technologies (smart grids, power storage, hydrogen and fuel cells, advanced transportation and energy efficiency).

20 Frankfurt School-UNEP Centre/BNEF. 2017. Global Trends in Renewable Energy Investment 2017.

21 See footnote 19 for the scope.

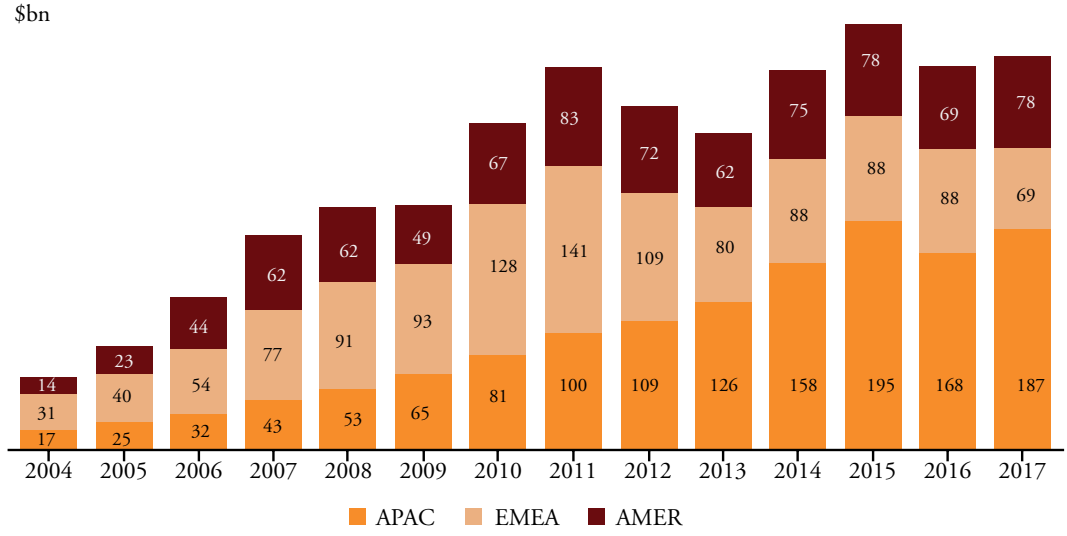
Part of the reasons for this insufficient investment from the private sector is linked to the fact that the cleantech industry requires *significant and patient capital* (longer-term investment, between 10 and 15 years)[22].

Compared to other sectors with similar investment profile (such as the pharmaceutical industry, see Table 1), large corporates of the field do not sufficiently sustain this ecosystem, and VCs are more and more reluctant to fund high-risk, capital-intensive ventures, and progressively disengage from "deep technology" companies.

Exhibit 11

Global new investment in clean energy by regions from 2004 to 2017

(in B$)



Source: Bloomberg New Energy Finance.

In addition, the regulatory framework which had initially primed the pump of Cleantech (especially via *Feed-in-Tariffs* for technologies of renewable electricity), has maybe not been sufficiently stable and homogenous to provide long-term visibility to investors. In the same vein, a more integrated European market would have provided larger markets in size.

22 At the same time, we cannot deny that, as far as renewable energy is concerned, deploying new capacities is a challenge due to the stagnating European energy demand and the overall overcapacity in the electricity system. This is a crucial point considering that 216.1 b$ are related to renewable energy Asset Finance (ie the financing of new build renewable assets), out of the 333.5 b$ of new investment in clean energy in 2017.

The reluctance of private investors to sustain clean energy deep techs is one of the issue. *But are we really sure that the European and national R&I policies are designed to capture the economic value (jobs, growth, competitiveness) of the subsidised research, by transforming it in innovations that will find their way to the market, and create jobs and growth?* As underlined in the "Accelerating Clean Energy Innovation" Communication, "*over €10 billion in energy funding is dedicated to clean energy research and innovation*" in the period 2014-2020. This represents a massive European investment, but there is no evidence that we make the best use of that money. *In addition to focusing on how to fix the private investments, we must also focus on how to optimise the efficiency of the R&I public policies in Europe.*

Table 1

Comparison of 3 sectors in terms of Innovation

	Pharmaceutical	Software & IT	Energy
Time Required to Innovate	10-15 years	1-5 years	10-15 years
Capital Required to Innovate	Medium to High	Low to Medium	High
New Products Primarily Differentiated By	Function/Performance	Function/ Performance	Cost
Actors Responsible for Innovation	Large Firms Reinvesting in R&D; Biotech startups, often VC & govt. funded; Govt. (NIH, NSF)	Dynamic Startups, often VC-funded; Large Firms Reinvesting in R&D	Various: Utilities, Oil & Gas Co.s, Power Tech Co.s, Startups, Govt.
Typical Industry Risk Tolerance	High	High	Low
Innovation Intensity	High	High	Low
Intellectual Property Rights	Strong	Modest	Modest

Source: Breakthrough Institute, *Bridging the Clean Energy Valleys of Death,* 2011.

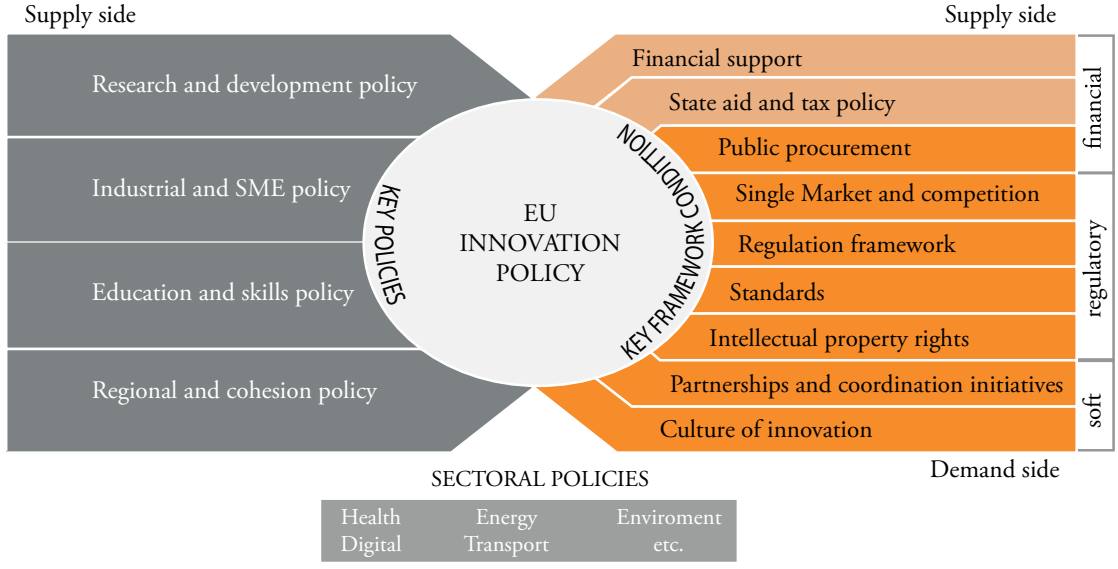
2.2. The role of the European Union in innovation

"You cannot buy the ticket to bridge the valley of death". Indeed, public support to innovation cannot be reduced to the financial resource made available, especially when it comes to the role that the EU level can play[23]. The funding coming from the EU budget in terms of R&D, although it represents significant absolute figures and has to play a decisive leveraging role, is only a small share of the money poured on the continent overall. This implies that the European Union has *an essential role to play in steering the EU R&I strategy,* and to steer it with an obsession for market uptaking, notably by improving the lab-to-market phase.

Just like the heart and the brain only weigh few hundred grams, the EU should create the brain of a fully-fledged policy-driven European innovation policy committed to address the grand challenges, making sure that innovation, the beating heart of modern economies, brings competitive advantage to Europe.

Exhibit 12

The EU innovation policy mix



Source: EPRS.

23 The average annual budget of H2020 is around 12 b€ for R&D expenditure of 302.2 b€ in 2016 in the EU.

The EU is resourceful and can play with several levers to create the suitable framework conditions (notably via regulatory measures and softer elements) and unleash the innovative potential of the continent, instrumental for a renewed European industrial strategy in tune with the times.

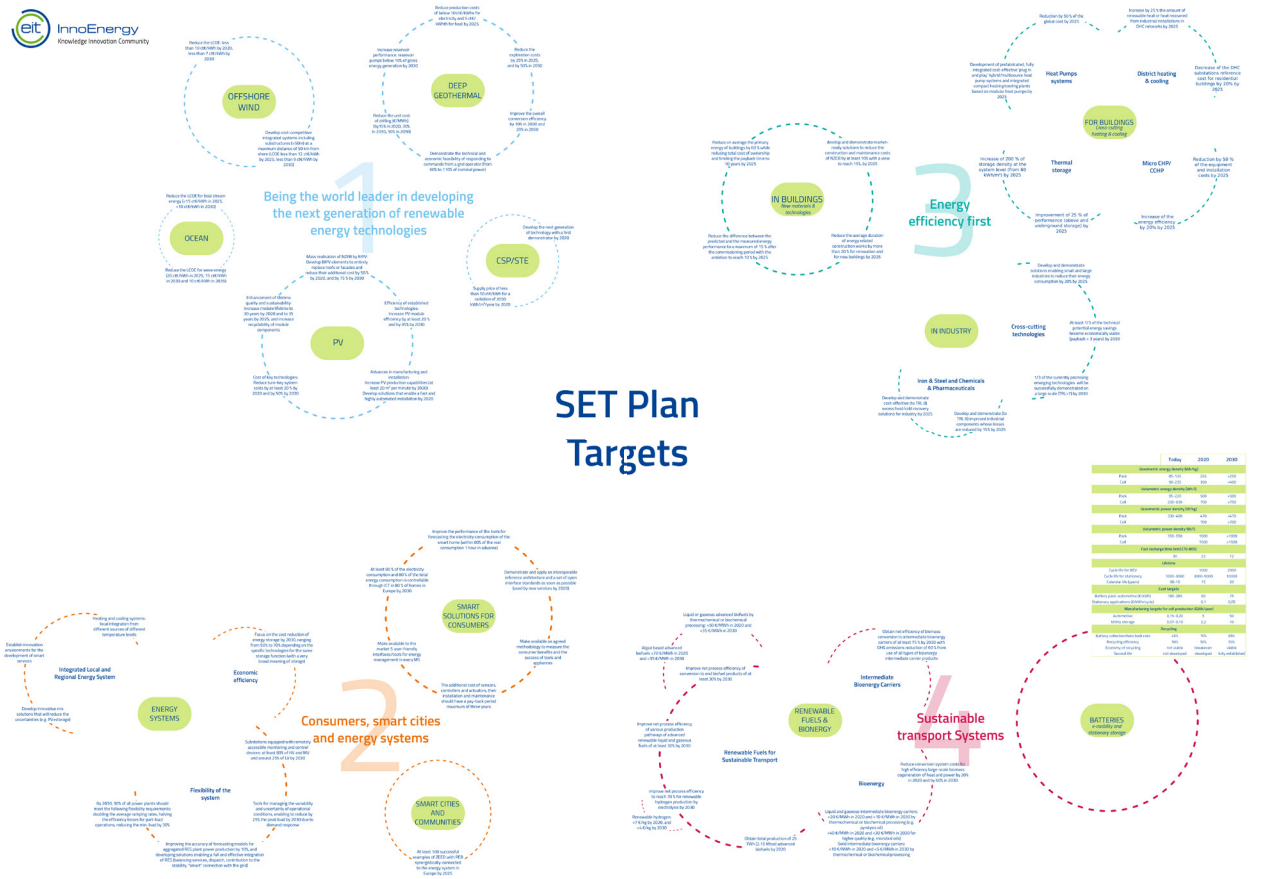
In this regard, the EU action can be summarised by 3 *main features*: 1) a clear strategy to move forward, 2) the tools to implement the strategy, and 3) an international diplomacy strategy.

Regarding *the strategy to move forward*, the EU has designed an entire strategy through the Energy Union policy and actively engaged political and technical actions. In particular, the EU builds up a comprehensive and coherent approach, as exemplified by the creation of the SET Plan in 2007. The SET Plan promotes research and innovation efforts across Europe by supporting the most impactful technologies in the EU's transformation to a low-carbon energy system. It also promotes cooperation amongst EU countries, companies, research institutions, and the EU itself. In September 2015, the European Commission adopted a Communication named "Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation", that identified the "10 actions to accelerate the energy system transformation and create jobs and growth":

- Sustain technological leadership by developing highly performant renewable technologies and their integration in the EU's energy system
- Reduce the cost of key (renewables) technologies.
- Create technologies and services for smart homes that provide smart solutions to energy consumers.
- Increase the resilience, security and smartness of the energy system.
- Develop new materials and technologies for, and the market uptake of, energy efficiency solutions for buildings.
- Continue efforts to make EU industry less energy intensive and more competitive.
- Become competitive in the global battery sector to drive e-mobility forward.

Exhibit 13

R&I targets from the 10 key actions clustered into 6 pillars in the Integrated SET Plan, adapted from the publication jointly prepared by European Commission's DG ENER, DG RTD and the JRC (NB: 2 pillars are not represented on the exhibit , namely CCS & CCU, and nuclear safety)



Source: Based on the Integrated SET Plan, Progress report, 2016.

Pierre Serkine and Diego Pavía

- Strengthen market take-up of renewable fuels needed for sustainable transport solutions.
- Step up research and innovation activities on the application of carbon capture and storage (CCS) and the commercial viability of carbon capture and use (CCU).
- Maintaining a high level of safety of nuclear reactors and associated fuel cycles during operation and decommissioning, while improving their efficiency.

In addition, it has been decided to make the SET Plan more integrated, by:

- Addressing the whole innovation chain, from research to market uptake, and tackling both financing and the regulatory framework.
- Adapting the governance structures under the umbrella of the SET-Plan to ensure a more effective interaction with EU countries and stakeholders.
- Proposing to measure progress via overall Key Performance Indicators (KPIs), such as the level of investment in research and innovation, or cost reductions.

More recently, and as a full part of the "Clean Energy for All Europeans" package, the European Commission has adopted a Communication named "Accelerating Clean Energy Innovation" (ACEI), aiming at making clean energy innovation support the transformation of the European energy system. The ACEI Communication includes a set of very concrete actions that intend to boost clean energy innovation, including policy signals and regulatory frameworks, boosting private sector investments, funding energy science and technology and its market adoption, leveraging Europe's global role, and identifying key actors of the energy transition. In addition, in the annex to the Communication, *4 key priorities are clearly mentioned:*

- decarbonising the EU's *building stock* by 2050,
- strengthening EU *leadership in renewables,*
- developing affordable and integrated *energy storage solutions,*
- and electro-mobility and a more integrated *urban transport system.*

When it comes to *the tools to implement this strategy,* at the EU level, the Multiannual Financial Framework (MFF) defines the financial resources dedicated to all the European instruments for a 7-year period, including the budget dedicated to R&I and energy instruments. Decision on MFF is taken by the European Member States (unanimity) and the European Parliament (consent procedure). For the current period (2014-2020), the overall budget of the EU is €960 billion, including €80 billion dedicated to R&I in Horizon 2020 (H2020), the 8th Framework Program for Research and Innovation (FP 8). The total EU-level R&I budget (covering all research areas) represents around 5% of the total European R&I budget (from both public and private sectors)[24]. The goal of H2020 is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation. The main programmes and instruments supporting the clean energy transition at the EU level are summarised on Exhibit 14, and further described after the exhibit.

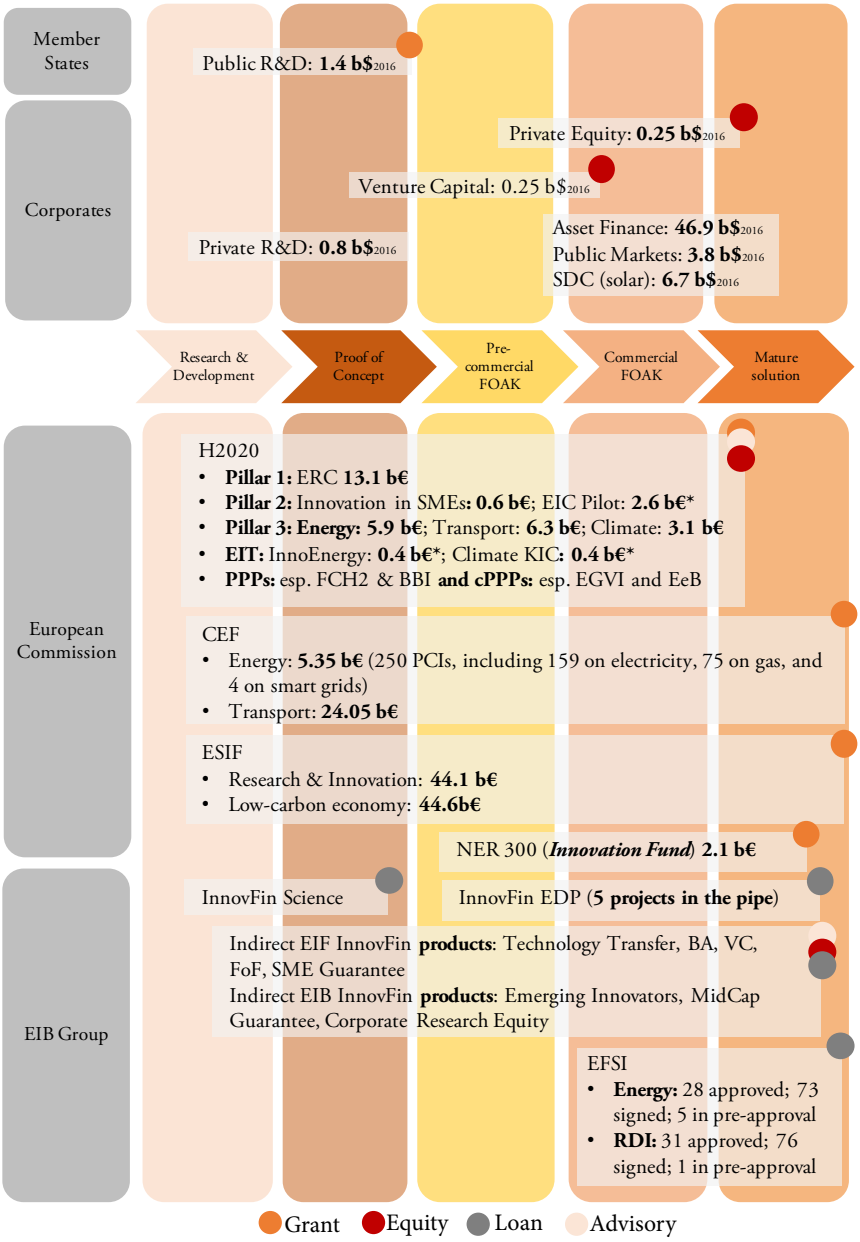
H2020 remains the main EU instrument to support R&I in the cleantech sector, with a dedicated budget of 5.9 b€ (2014-2020) for the "Societal Challenge" called "Secure, Clean and Efficient Energy" in Pillar 3 (see Exhibit 14), and a remaining budget of 1.6 B€ for 2018-2020. In addition, the *European Structural and Investment Funds* (ESIF – 351.8 b€ 2014-2020) are providing significant amount of money for Research & Innovation and support to low carbon economy (around 44 b€ for each of them from the EU for the 2014-2020 period). The specificity of ESIF compared to H2020 is that the use of financial resources is decided at the Member State's level, and not at the European Union level. H2020 as well as the ESIF provide support to innovation under the form of grants.

In addition to these instruments, the European Commission also grants money via the "*Connecting Europe Facility*" to infrastructure projects in energy, telecom and transport, in order to *improve the flow of people, electrons and information in Europe* and enable a fully functioning internal market (5.35 b€ dedicated to Energy via the list of *Projects of Common Interest* - PCIs). By essence, infrastructure is necessary to facilitate the energy transition, notably to allow the increasing penetration of intermittent renewable energy sources. 4 smart grid projects and 106 electricity transmission and storage projects are on the list of the CEF PCIs.

24 See footnote 23.

Exhibit 14

Overview of the European innovation landscape in Cleantech



Note: *The figures related to the EU level are for the period 2014-2020, except for the EIC Pilot which is for 2018-2020, and for the EIT which is for 2014-2018. The other figures correspond to 2016.

Sources: EIT InnoEnergy, based on public data and Frankfurt School-UNEP Centre & BNEF, Global Trends in Renewable Energy Investment's report, 2017 Frankfurt School-UNEP Centre & BNEF, Global Trends in Renewable Energy Investment's report, 2017.

The European Commission can also allocate the funds received via the allowances for the EU Emissions Trading Scheme – ETS to support the deployment of clean energy technologies, via the *NER 300 (and in the future, the Innovation Fund).* This fund specifically targets *demonstration projects of Renewable Energy technologies* (such as bioenergy, CSP, PV, geothermal, wind, ocean or hydropower), but also *smart grids and CCS*, and intends to leverage money from private sources. With the first 2 decision awards, 39 demonstration projects have been selected (38 of renewable energy technologies, and 1 of CCS). The *NER 300 is directly managed by the European Commission*, but the projects are assessed by the EIB and approved by the Member States.

Granting is not the only form of the support that the European Union employs to accelerate clean energy transition. There are indeed other EU-funded instruments intending to increase the synergies and *collaborations between the public and the private sectors, and leverage private resources.* This is notably the case of *contractual Public-Private Partnerships* (cPPPs) like the European Green Vehicles Initiative (EGVI-750 m€ on 2014-2020 from H2020 budget) and the *Energy-efficient Buildings* (EeB – 600 m€ on 2014-2020 from H2020 budget). Other PPPs are also noteworthy, also named *Joint Technology Initiatives* (JTIs): the JTI for *Fuel Cells and Hydrogen* (FCH-JU – 665 m€ from the H2020 budget and an industry contribution of 700 m€) dedicated to accelerate the commercial deployment of hydrogen-based solutions across Europe, and the *JTI for Bio-Based Industries* (BBI – 975 m€ from the H2020 budget and an industry contribution of 1.8 b€) dedicated to develop new bio-refining technologies. On top of that, the *European Institute of Innovation and Technology* – EIT – whose the mission is to bring to life the "knowledge triangle" made of Higher Education, Business and Research & Technology, is also a noteworthy initiative launched by the European Commission in 2008 to accelerate the lab-to-market in various sectors[25].

Beyond the European Commission, other EU institutions have a crucial role to play in the clean energy transition landscape, notably the *European Investment Bank Group* (made of the EIB and of the EIF). Beyond the indirect products

25 Activities of EIT and of the Knowledge & Innovation Community for Energy, EIT InnoEnergy, are further discussed in the next section.

which are mainly equity-based products, such as the InnovFin Venture Capital, InnovFin Business Angels, via financial intermediaries like SET Ventures or Daphni, or the recent Funds-of-Funds programme named *VentureEU* created by Commissioner in charge of R&I, Carlos Moedas, to boost VC investment in the EU, the EIB has created a loan-based instrument specifically dedicated to *Energy Demonstration Projects called InnovFin EDP.* This instrument, which is guaranteed by some H2020 budget, provides loans between 7.5 m€ to 75 m€ to energy demonstration projects. As of April 2018, 5 projects have been selected, notably a 52.5 m€ loan to Northvolt AB for the construction and operation of a first-of-a-kind demonstration plant for the manufacturing of li-ion battery cells, in Sweden.

Finally, *regarding the international diplomacy strategy of the EU,* the European Union provides a political support to innovation in clean energy at the international level, via the official partnership with Mission Innovation, the global initiative of 22 countries and the European Commission partnering to reinvigorate and accelerate clean energy innovation launched at COP 21 in 2015, notably by seeking to commit to double their government investment in clean energy research and innovation over five years to 2021. The European Union is chairing Mission Innovation in 2018, and will have a leading role at the 9th Clean Energy Ministerial end of May 2018.

To conclude, the EU has designed its strategy, through the Energy Union policy, and is on the path to a comprehensive and coherent approach, as exemplified by the creation of the Strategic Energy Technology (SET) Plan in 2007, which is also well aligned with the Energy Union political ambition, one of the 10 political priorities of the European Commission. In addition, the EU institutions (EIB Group and the EC) can count on *a full set of programmes and instruments*, and are clearly committed to accelerate the energy transition and to leverage innovation in Europe. Furthermore, we can acknowledge the commitment taken within the context of Mission Innovation by the EU institutions, which is clearly a very positive initiative. This leadership is provided by showcasing European success stories in international fora, which in turn contributes to create a sense of pride and self-confidence in Europe and can help in attracting brains and investment into Europe, and by leading this initiative, the EU commits itself to

maintain a high level of funding to support cleantech in Europe in the coming years.

3. CASE STUDY : INNOENERGY (2010-2017)

3.1. What is the EIT?

The *European Institute of Innovation and Technology* (EIT) is an independent body of the EU, set up in 2009, to address the EU's innovation paradox: *Europe has a lot of top-notch publicly funded research, while the translation of knowledge into innovation that can be marketed and be commercially successful creating growth and jobs is seriously lagging behind.* The *uniqueness of the EIT* is to bridge that gap, and also the method to fulfil that goal: the *knowledge triangle integration.*

3.2. What is a KIC?

A KIC (*Knowledge Innovation Community*) is a long term (minimum 15 years) public private partnership, that fully integrates the so-called 'knowledge triangle 'of business, education and research. The Commission approved in 2009 plan is to launch, sequentially, one KIC per societal challenge identified. So far there are six KICs running: for Energy, ICT and Climate since 2010; Raw Materials and Health since January 2015; and one for Food since 2017.

The KICs are awarded under public competition. The *financial model of a given KIC is that 1€ of public EIT support leverages at least 3€ of private investment;* and that in the *medium term a KIC should be financially autonomous,* and thus independent from EIT/EU funds.

3.3. What is KIC InnoEnergy?

KIC InnoEnergy[26] was the winner in 2010 of all the proposals for becoming the selected KIC in sustainable energy.

26 In this section, KIC InnoEnergy, EIT InnoEnergy and InnoEnergy are used interchangeably and refer to the same organisation.

Strategy, mission, vision and objectives

Our *vision is* "*To become the leading engine in innovation and entrepreneurship in sustainable energy*".

Our mission is "*to build a sustainable long-lasting operational framework amongst the three actors of the knowledge triangle in the sustainable energy sector: industry, research and higher education. And ensure that the integration of the three is more efficient and has higher impact in job creation, growth and competitiveness of the European energy system* than the three standing alone".

The three *strategic objectives* of any activity *we invest* in are:

- Reduce the cost of energy (c€/kwh).
- Increase security (autonomy of supply, intrinsic operability of energy assets).
- Reduce greenhouse gas emissions (GHG/kwh).

Totally aligned with the objectives of the Energy Union and of the "Clean Energy for All Europeans" package.

3.4. What does InnoEnergy do?

We risk-invest in three types of assets, operationalized through three distinct business lines:

- *Education programmes* (Specialized Master School, PhD School and Executive programs), which *create the future game changers* (Masters, PhDs, mid-term professionals) in sustainable energy;
- *Innovation Projects*, which focus *on producing incremental – and a few disruptive – innovations (technological, business model or social),* that contribute to the above mentioned energy strategic objectives.
- *Business Creation services*, where we create *innovative high potential start-ups, and grow them.*

All our activities focus on *eight thematic fields* that evolve with the energy market changes, and that are fully aligned with the *current SET Plan (European Strategic Energy Technology Plan)*, where we have been heavily contributing:

- Clean Coal & alternative fuels Technologies
- Smart Grids
- Smart Cities and Efficient Buildings
- Energy from Chemical Fuels
- Convergence Nuclear-Renewables
- Energy Efficiency
- Storage
- Renewables

3.5. InnoEnergy unique approach to innovation in Energy

3.5.1. Multidimensional approach, not only technological

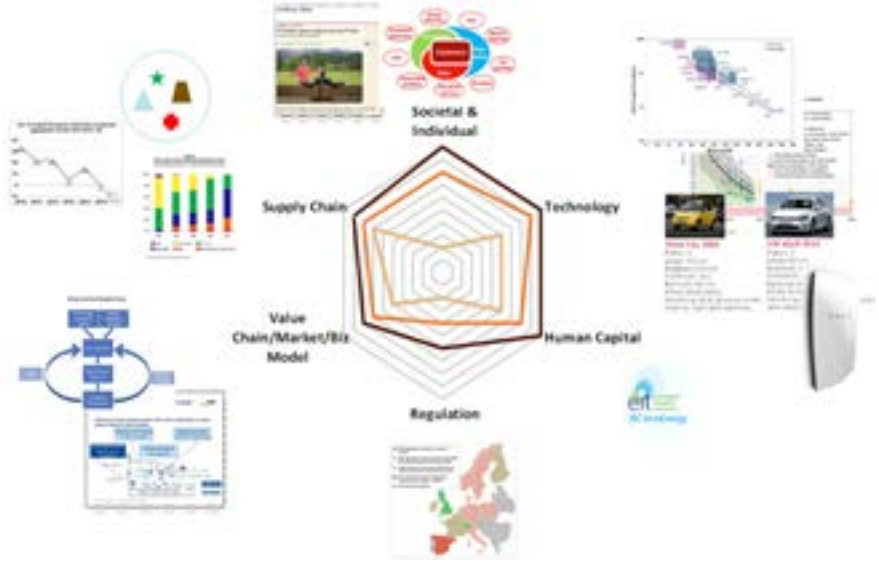
InnoEnergy approach to innovation is following three guiding principles, which we follow both when selecting the investment cases, as well as when operating those:

- The challenge is *multidimensional* (*i.e.* technology, business models, supply chain, human capital, regulation, …) and requires a multidimensional approach. And all dimensions should be addressed at the same time, because they are interlinked. From a traditional *TRL* (technology Readiness Level) to an *IRL*© (Innovation Readiness Level) approach.
- The challenge is *European*, and requires a *European solution.*
- The challenge –the energy transition– is a *systemic* problem that requires a systemic solution

Let´s elaborate on the first one (multidimensional approach) because it is what makes InnoEnergy truly different.

Exhibit 15

EIT InnoEnergy's view of the Energy Union challenges



Source: EIT InnoEnergy.

Getting more into the details, in the diagram we distinguish three curves (InnoEnergy judgment):

- The nude: that is the contribution of each dimension as of 2015 to the energy transition
- The orange: the contribution by 2020
- The red: by 2025

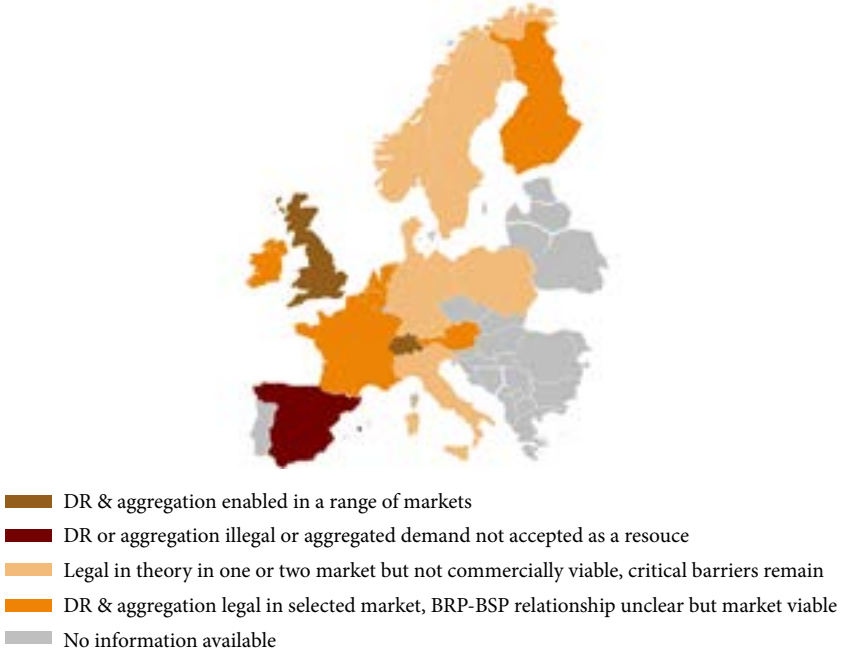
As we can see the dimensions that need to evolve more to contribute to the energy transition are *regulation and societal appropriation*, where the gradient between today and in 10 years' time is higher, and where Europe, and all the key stakeholders like KIC InnoEnergy should make a special effort. Addressing all the six dimensions briefly, KIC InnoEnergy focus in the period 2016-2022 is to *contribute* to bring each dimension from the nude curve to the red curve, by:

As far as *regulation* is concerned, the Commission itself has "counted" 700 interventions (Oettinger report in 2014) that are polluting the final price of the energy paid by the consumer (industry or retail) and making it double or triple compared to competing economies like the USA. At the same time, the European market is fragmented, with in many occasions as many transpositions of the Directives as member States exist. One key criterion when InnoEnergy decides to invest in a given innovation is to check whether the market uptake will be easy (same regulation all across Europe) or different regulations. The more homogeneity, the easier the Innovation will be uptake by the market. As an example, please see underneath the different regulations in Europe for demand response (DR), aggregators. The more different colours, the worst for innovators, the worst for the energy transition.

As far as *societal appropriation* is concerned, buzz words like *demand response, prosumer, distributed generation, autarkic islands, energy efficiency*… are populating the state of affairs. They all capitalize into the ability of the consumer to become

Exhibit 16

Consumer access to Demand Response markets in EU-28

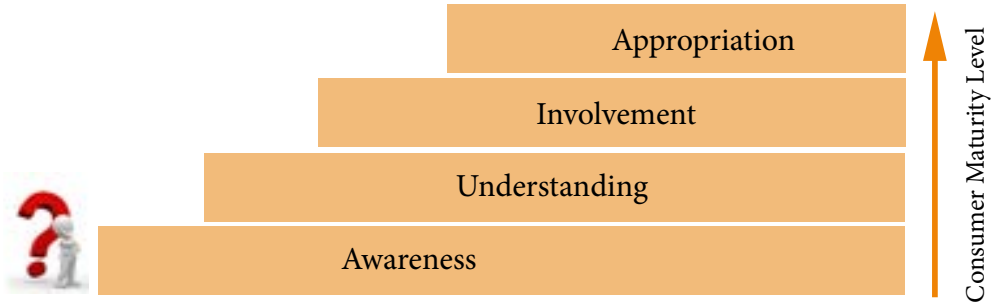


Source: From a technical report to the European Commission prepared by Sweco, Ecofys, Tractebel and PwC, April 2015

an active, responsible, knowledgeable player in the new value chain. *But is the consumer (the one paying the bill) prepared, or willing to become active? Are price signals the only key incentives? Does the consumer link his individual energy world to the big picture?* Our answer is no, because the consumer is at the bottom of the pyramid, but we are asking him/her to engage in the fourth level.

Exhibit 17

The 4 successive phases of the Societal Appropriation process



Source: EIT InnoEnergy.

KIC InnoEnergy believes that in order to reach the fourth level, necessary to actively contribute to and enable the energy transition, the consumer has to sequentially progress first to awareness, then to understanding, then to involvement, finally to appropriation; and it is a (long) *journey* with no shortcuts recommended. In our understanding, the first two levels are responsibility of the *public administration*, and the third and fourth level to the *private sector*, offering competitive services where the consumer can be involved and actively leading. We will play a leading role in this challenge.

As far as *Supply Chain* is concerned, we have the duty (as President Junker has clearly expressed) to re-industrialize Europe, bringing the contribution of industry from 15% to 20% of the EU GDP. We can not make the mistakes that we did with the PV industry, and we should capitalize along all the value chain so the wealth is kept in Europe. In InnoEnergy an investment in a given innovation also takes into account whether the supply chain for the innovator exists in Europe, whether the innovator is able to fill the gaps, and engage upstream and downstream in its supply chain.

In the same dimension we need to be aware that the main private investors (Utilities, Equipment Manufacturers) have seen their balance sheets shrinking by 4 or 5 in the last 5 years; and their credit rating deteriorate several notches, so the available money for research and innovation is going to be less, much more prudent, and much more looking at the payback and return.

As far as *Value Chain* is concerned the future will be totally different: the traditional world (top-down approach, centralized big production, ..) is gone for ever; the new regulation ("Clean Energy for All Europeans") is fertile for new business models (*e.g.* aggregators, local energy communities, storage operators, ….); incumbents of the past face future scenarios that are gloomy at least; the new entrants are risk averse because it is still a CAPEX intensive sector in many steps of the value chain; digitization and digitalization is an enabler of new business models …. Over the last two years more than 50% of the funnel of innovation opportunities coming to InnoEnergy are based on OPEX driven business cases where the innovation is not technological but social or business model innovation.

As far as *Human Capital* is concerned, we need to understand that the basics of the business have changed, the traditional engineers are not anymore "fit for purpose", so new profiles (with innovation, entrepreneurial, anthropological, humanistic skills, ..) are required to drive and implement the change. This is InnoEnergy corner stone: to feed the market with the *game changers* that will change the game, being equipped with the skills and competences (entrepreneurship, innovation, business, multidisciplinary approach, ..) that are taught in our education programs.

Finally *Technology* that was in the past the key dimension, but that is not anymore. Still fundamental, but in total coordination and systemic approach with the other 5 dimensions.

This multidimensional approach has allowed InnoEnergy to de-risk the innovations we are supporting; and our method is today being piloted by the European Commission to eventually adopt it for all the innovation based instruments to be deployed in the upcoming FP9 (Horizon Europe).

3.5.2. An Innovation engine based on the Knowledge Triangle Integration

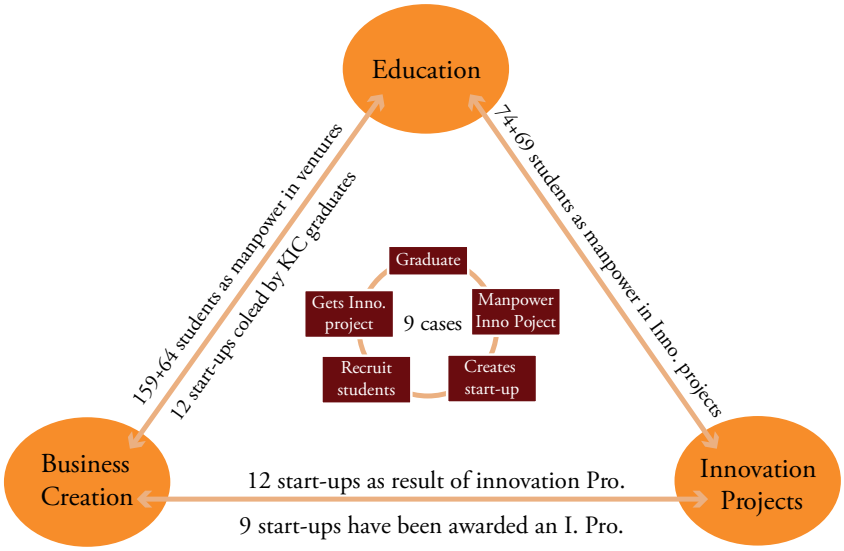
As expressed in the mission statement, InnoEnergy uniqueness is to demonstrate that an innovation ecosystem based the structural integration of the knowledge triangle actors (Business, Higher Education and Research Organizations) will give more throughput (quantity) and different outcomes (quality, type of innovation) that traditional innovation instruments.

This has to be demonstrated, and a proxy way to do it has been to measure the liquidity of the "output" of what we do, namely:

- how many graduates are manpower to new start-ups and to innovation collaborative projects
- how many start-ups have been created by newly graduates
- how many start-ups have been created as commercial vehicles of a given collaborative project
- how many start-ups, in a very selective process, have been awarded innovation projects

Exhibit 18

Knowledge Triangle Integration liquidity 2010-2017



Source: EIT InnoEnergy.

This of course only proves the quantity, benchmarked with the same measures in a traditional established environment. The quality will be tackled in the next chapters.

The result is graphically explained underneath, and proves that the ecosystem created is much more fertile in those KPIs than any other known to date.

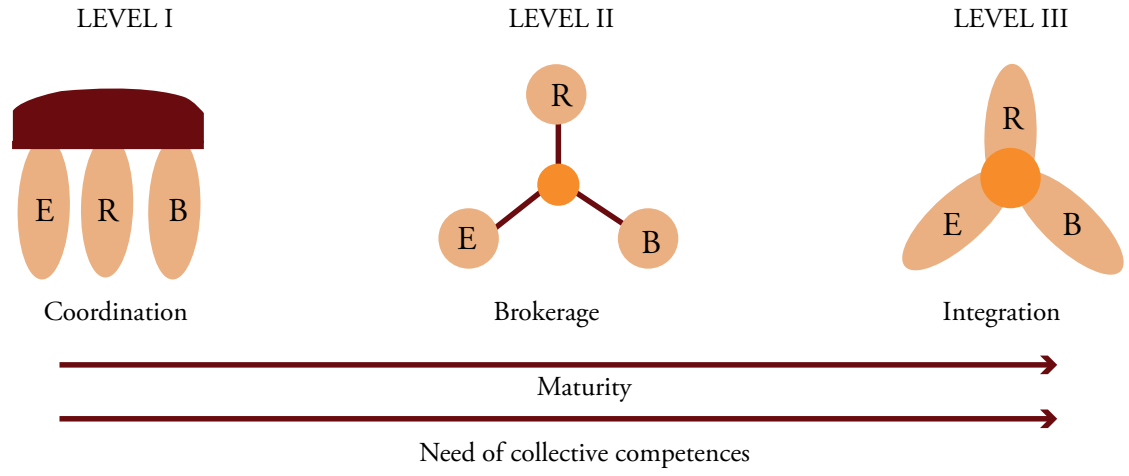
3.5.3. An enhanced "integrated" innovation model

A vehicle like InnoEnergy could follow three of the possible Innovation models (Coordination, Brokerage or Integration), which implement different levels of integration (see Exhibits 19 and 20).

Because we are innovators, we also innovate in this dimension and have created a fourth, more demanding model of innovation, which is an extension of the (*Level III or Integration model*) as shown in the Exhibit 19, where Research (R), Education (E), and Business (B) need to evolve, migrate and create a NEW space (the KIC with full KT –Knowledge Triangle– integration), is ambitious and requires a strategic approach from the partners, a long term vision and the ambition to explore outside the "Business as Usual". It takes longer but is structural.

Exhibit 19

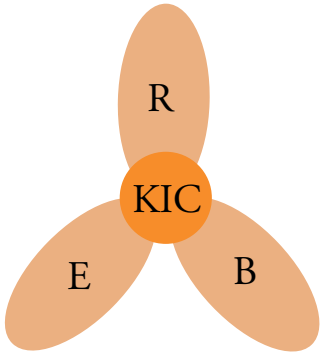
Innovation models, depending on their degree of integration



Source: EIT InnoEnergy.

Exhibit 20

InnoEnergy model



Source: EIT InnoEnergy.

3.6. The trusted ecosystem of top innovators created since 2010: InnoEnergy shareholding structure and partnership

KIC InnoEnergy *is a company* (SE: Societas Europaea), *for profit and not for dividend (all profits are reinvested),* with *24 European shareholders* from the three dimensions of the *knowledge triangle:* Industry, Research and Higher Education. Those shareholders have signed for a 7+7 years company plan; and intend to be financial independent from EIT/EU in the medium term (202x).

Since 2010 *more than 370+ additional partners* –mainly SMEs– have joined our activities, and now we have activities in 17 of the 29 EU Member State.

Which has resulted after 7 years in a *trusted innovation ecosystem* of partners:

- across all the value chain: Generation, TSO, DSO, ESCO, aggregators, pools, municipalities, ..
- across all the supply chain: utilities, equipment manufacturers, research institutes, universities, Venture Capitals, Business angels, business schools, …
- covering all energy carriers: heat, electricity, gas, biofuels, …
- challengers and incumbents
- trading in 11 different regulations across 17 countries

Exhibit 21

Key facts on InnoEnergy ecosystem

A stable shareholding structure

In the field in 17 countries

Partnership as Dec 2017

	Shareholders Formal Partners	Associated & Project Partners	Total
Industry	8	253	261
Research Centers	5	33	38
University	10	48	58
Business School	1	3	4
Public Authorities		1	1
Investors		1	1
TOTAL	24	339	363

A micro European Energy System

Partners across all the Value Chain
Partners across all the Supply Chain
All energy carriers
Changers and incumbents
11 country regulations
210 Million end-customers

Source: EIT InnoEnergy.

- with accessibility to 120 end energy customers through the partner utilities

3.7. The results achieved and some examples:

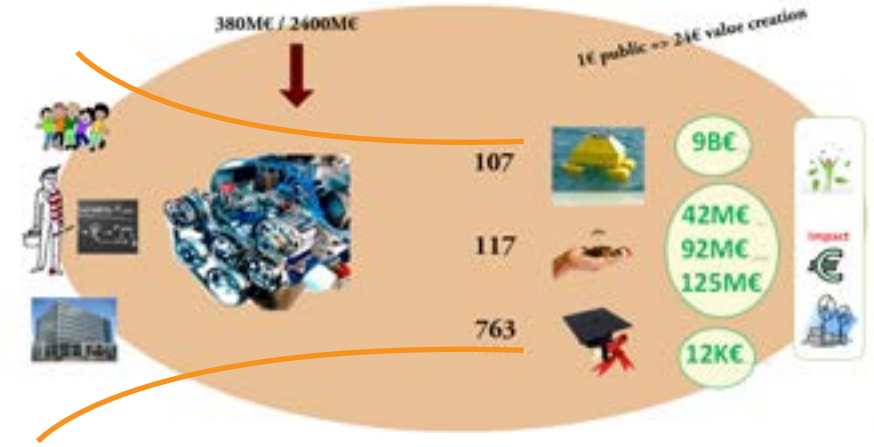
All the previous descriptions have a real meaning if the achievements, results and impact prove that InnoEnergy model has delivered to the strategic objectives set. The graphical representation of the achievements for the period 2010-2017 is:

Where we highlight:

- 763 "game changers" graduates populating today the energy institutions (94% work in energy related matters), out of more 14.000 eligible applicants. Three

Exhibit 22

InnoEnergy quantitative and qualitative outputs 2011-2017



Source: EIT InnoEnergy.

(3) of them hold CXO positions in medium or big business institutions. In 2016 we repositioned the Ms School, and in 2017 10% of the intake (30 students) have paid the 12K€/year each to attend our Master programs.

- 117 new start-ups, after screnning 3000+ early stage business ideas. These start-ups, up to December 2017, have raised more than *92M€ of private and public investment* (78% of our start-ups have raised external financial support); and combined they have invoiced *42M€*. Their valuation (let´s remind that they are early stage) is north of *125M€,* based on the last investment rounds successfully closed. InnoEnergy VC Community, created in 2013 and now holding 14 members, has invested in *7 of our start-ups*. In all these start-ups InnoEnergy has equity.

- *107 innovative products and services, all of them with a Return on Investment (ROI) term sheet signed.* These innovative products have facilitated the construction or expansion of *eight manufacturing facilities. The past and future revenues of these 107 innovations are forecasted at 9B€.*

Overall 133 patents have been filed and today more than *260 industries (80% SMEs) are actively participating in our programs.*

All InnoEnergy actions and assets created have a *potential impact* in:

- *energy* (decrease cost of energy, increase the operability of the energy system, decrease the GHG emissions), being fully aligned with the Energy Union goals
- in *economy* (job creation or maintenance, growth, increase of competitiveness of industry)

Financially, InnoEnergy has invested 380M€ from the European Commission, and mobilized 2,4B€ of the ecosystem [500M€ cash, 1,9B€ in-kind]. All in all, 1 € of public tax payers money has created 24€ of value.

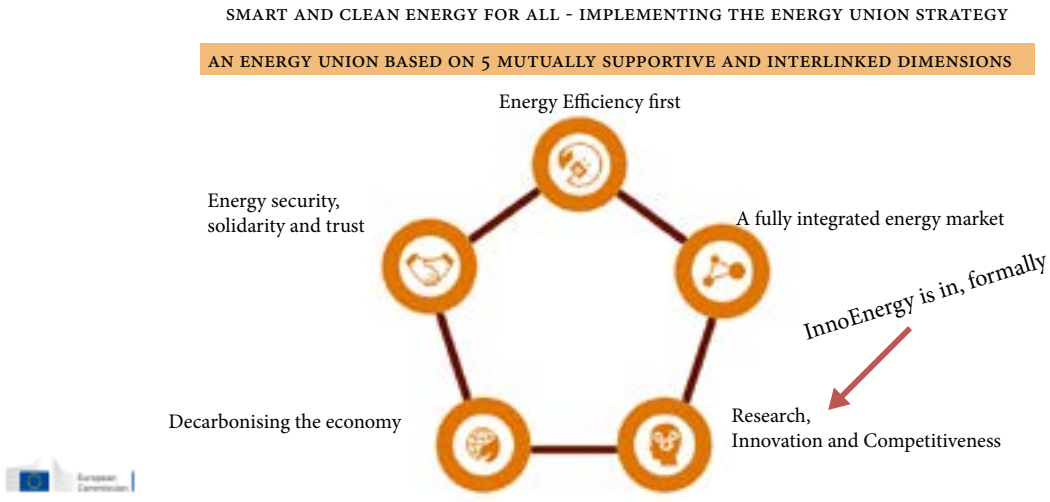
3.8. Anchoring in the institutions: Our added value confirmed

A final verification of the contribution of InnoEnergy to the Energy transition is having been nominated formally in two structural papers of the European Commission:

- as the "market uptake" instrument in the SET Plan communication done by the Commission in September 2015
- as a key instrument for the implementation of the "Clean Energy for all Europeans" package known as Winter Package (Exhibit 23).

Exhibit 23

The 5 dimensions of the Energy Union



Source: European Commission.

A special structural strategic InnoEnergy achievement: *The European Battery Alliance*.

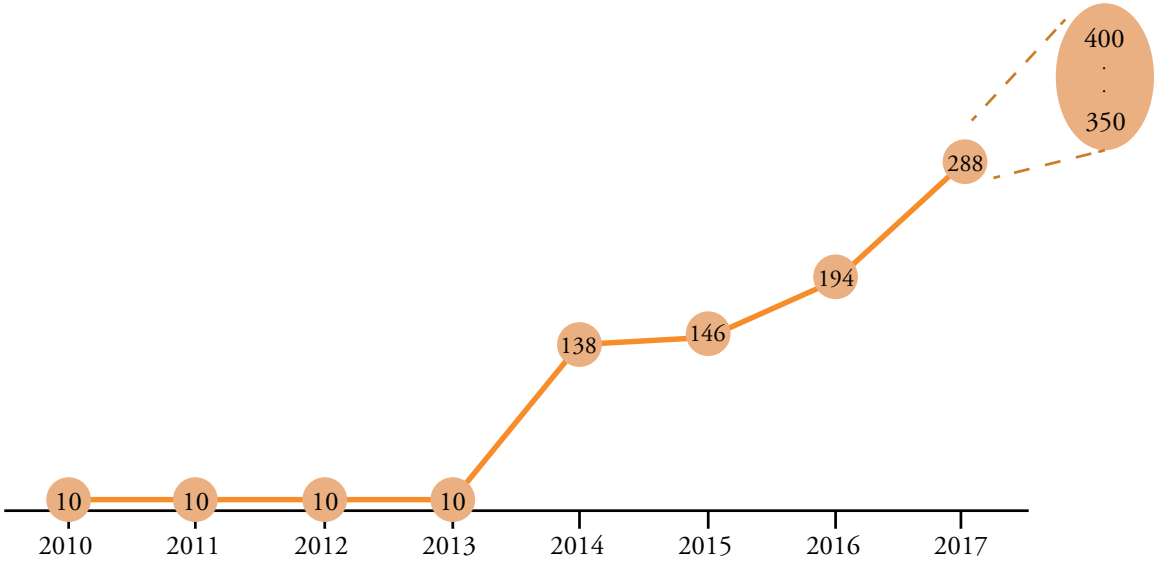
- In October 2017 *Vice President Sefcovic mandated* InnoEnergy to lead the industrial stream of the *European Battery Alliance* (the strategic move of Europe to become the Fast Follower in Batteries and capture the maximum of the annual 250B€ of new business 2025 onwards), which demonstrates *the perfect symbiosis of InnoEnergy with the policy making*.

A final conclusive proof of *value creation* along the period is the price of the InnoEnergy share value. Whereas the initial shareholders paid 10K€ for one share back in 2010, the last transaction (June 2017) has been at *288K€ a share*, so InnoEnergy company value has multiplied by 28 over the last 7 years.

We also need to verify if these achievements are better, worse or comparable to other innovation engines. For this we attach the next table (Table 2), with some *benchmarks and partners testimonials.*

Exhibit 24

InnoEnergy's share price evolution in k€



Source: EIT InnoEnergy.

Table 2

InnoEnergy achievements 2010-2017

	Achievements	Benchmark/Impact	
Game Changers The future CXOs 	More than *14.000* applicants screened *1072 students* follow or have followed our specialized Master programs and PhD School *573 have graduated* and are populating today the energy companies, equipped with a unique competences and skills	*96% have found a job 6* months after graduating Our graduates *earn 15% more* than their peers from traditional courses When competing in international contests (i.e. Iberdrola Grand Challenge) *our students beat the "theoretical" references* *3 have CXO positions in big corporations*	
The Googles of Energy 	More than *3000 business ideas* screened 250+ ventures supported *117 new start-ups, all post revenue, created* Four start-up has crossed the 1M€ revenue	Those start-ups have raised *92M€ of external investors* *They have invoiced 42M€ to customers* Their market cap, as per last round, is *125M€* 5 ventures in the *TOP Forbes under 30*	
Innovative products and services adopted by industry 	*107 innovative or disruptive technology products or services* have been produced and adopted by industry. *200 new industries* (mainly SMEs) have joined KIC InnoEnergy since 2011, co-investing *2100M€* of their own resources *133 patents* have been filled	*The forecast sales of these 107 is 9B€ in the period 2016-2022* *8 new manufacturing sites* have been built to produce KIC products The first European GigaFactory (32GWh) – NorthVolt, is one of those 107 assets	

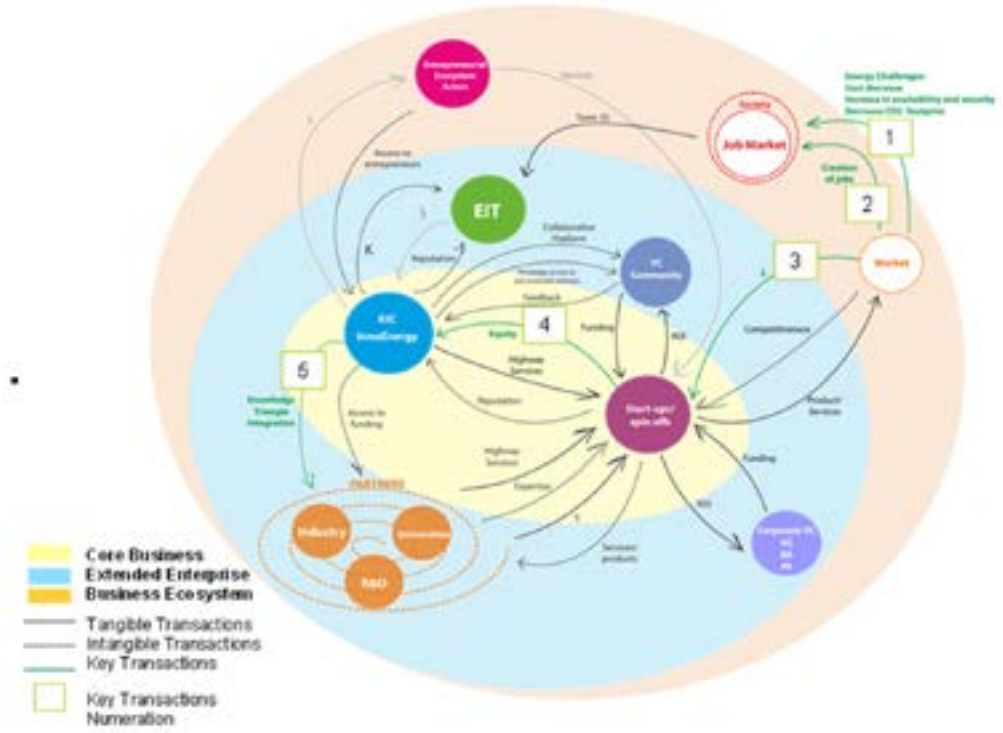
Source: EIT InnoEnergy.

3.9. Impact modelling

Just as an appetizer that will require a full additional paper, please find attached the graphical representation, for one of our business lines (business creation) of the impact modelling of what we do, with: all the entities, the services, the KPIs to measure the impact created and the different ecosystems.

Exhibit 25

Impact modelling of Business Creation, one of the business lines of InnoEnergy



Source: EIT InnoEnergy.

4. CONCLUSIONS

The Clean energy for All Europeans package has delivered the political and regulatory impulse that our economies need. Europe is through this package showing to the world what should be done for not only fulfilling the pledges

from COP21 but also going beyond that, delivering to our next generations a more sustainable world.

Research and innovation are un-doubtfully identified as key enablers for the journey. Europe is well positioned again, and has the will also, to leverage these assets to be the early mover or fast follower in all the areas required.

But we need to keep on progressing on HOW we do innovation, HOW we install, defend and support a culture of entrepreneurship and innovation, all across the value chain, starting at school and never ending.

InnoEnergy was an early mover in different ways of doing different innovation. Our lessons learnt are today formalized in practices (neither good nor bad, just practices) that are being used by other ecosystems, which is good for all. Our track record over the years proves that (1) open innovation is fundamental to address systemic challenges, and that (2) a multidimensional approach where technology is just one of the 6 key dimensions of management is the winning card.

The authors, combining a 30 year old man inherently driven by his unwavering dedication to fight climate change and the utopian ambition to change the world for the better, and a 55 year old man having created 7 companies in his life, with a European education and a European family, believe that there is no better place to make a positive impact in society than to be in innovation in energy in 2018.