



Assessing the European clean energy finance landscape, with implications for improved macro-energy modelling

Deliverable D3

*Study on the Macroeconomics of Energy and
Climate Policies*

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Executive summary

An urgent challenge to better understand and mobilise the required additional finance for Europe's clean energy transition

Given the urgent challenge to secure sufficient investment for the clean energy transition of the European economy in order to meet the EU's climate and energy targets and broader commitments under the Paris Agreement, numerous estimates have been made to size up the investment needs up to 2020, 2030 or 2050. The use of different underlying policy scenarios, data sources, as well as definitions of what is included in the respective figures makes it difficult to compare, or potentially sum up all various sources to work towards.

Still, when comparing estimated needs and current investment levels, it indicates that Europe is facing a major investment challenge. Though there is no agreed single figure regarding the investment needed for the European clean energy transition, the various figures elaborated in the literature indicate investment needs in the order of €180-300 billion per year between now and 2050.¹

The most recent estimations from the European Commission confirm this order of magnitude, suggesting that the mobilisation of an extra €177 billion from public and private investment sources is needed annually from 2021 to 2030 to reach the 2030 climate and energy goals as set out in the 'Clean Energy for All Europeans' package.²

When tackling the financing challenge that arises with implementing the clean energy transition, a very complex set of financial interactions from numerous financiers of different sizes and origins, i.e. "sources of finance" is at play. These "sources of finance" aim their investments to the multiple sectors of the economy and numerous technologies, projects, businesses, i.e. the "clean energy investment opportunities", which can play a role in contributing to the mitigation of multiple sources of GHG emissions.

Objectives of the study

To improve the current understanding of these interactions, **the main goal of this report is to map and explain the 'sources of finance' and corresponding 'clean energy investment opportunities' that are interacting in the European clean energy finance landscape.**

The intention is then to provide suggestions on how to usefully incorporate such findings in existing macro-economic models to assess the macroeconomic implications of climate and energy policies.

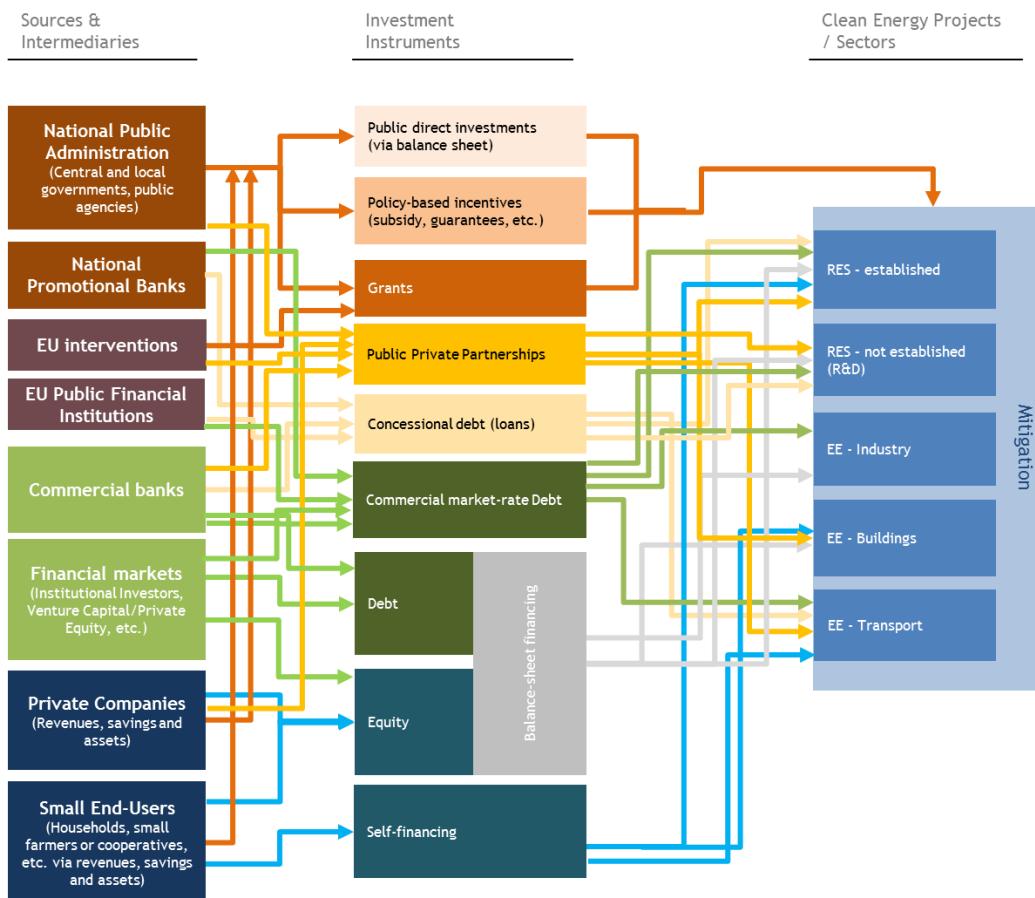
Consequently, the report is structured around explaining the relevant actors, sectors and interactions across the European clean energy finance landscape. The next figure visually maps these financial flows and interactions between 'sources of finance' and their 'relevant investment instruments' all the way through to the renewable energy and energy efficiency projects in sectors relevant to tackling Europe's clean energy transition challenge (i.e. 'clean energy investment opportunities'). While Chapters 2

¹ It should be noted that these are the additional investment needs that need to be channelled specifically towards clean energy sources. These are in addition to future investment costs for replacement of ageing energy infrastructure.

² <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

and 3 focus on describing the roles the right-hand side ('clean energy investment uses and sectors') and left-hand side ('sources of finance') columns play in the clean energy finance landscape, Chapter 4 then focuses on describing 'how' they interact, i.e. what influences the direction and size of the flows ('the arrows in the diagram').

Figure 0-1 European clean energy finance landscape (no values attached)



[Source: Trinomics own development, 2017]

[Note: for this project adaptation finance is excluded from the analysis and the focus is exclusively on mitigation aspects, i.e. renewable energy and energy efficiency activities and related climate services]

In essence, the report presents a first attempt to map the various interactions which exist and are at play between

- "the sources of finance" and "their financial instruments used";
- "the clean energy investment uses and sectors" (clean energy technologies); and
- "the influencing factors" at micro and macro levels that play a role in determining the size and direction of financial flows.

The end purpose is the integration of such clean energy finance mapping in the (macro-)modelling of the broader economy.

Clean energy investment opportunities

Chapter 2 introduces the various clean energy investment opportunities, focusing on renewable energies and energy efficiency. Per technology type and sector, the chapter briefly summarises (if information is available): (a) some background information on the technology and (b) an indication of the order of magnitude of the investment challenge. As such, the chapter explains the right-hand side column of the European clean energy finance landscape diagram.

The table below summarises the sectoral contribution to the financing challenge of €177 billion (which is the difference between the needed trajectories to achieve the EU's climate and energy targets (EUCO30) and the spending trajectories based on current trends (REF2016)). As can be seen, what is needed in addition for reaching the 2030 climate and energy targets primarily falls on demand-side activities around direct energy efficiency measures and improved energy equipment in the buildings, transport and industry sectors.

Table 0-1 Sectoral decomposition of average annual investment expenditures (in billion EUR'13)

		REF2016 ³	EUCO27	EUCO30	Financing challenge
TOTAL		938	1036	1115	177
Demand side ⁴	Industry	15	17	19	4
	Buildings - households	127	168	214	87
	Buildings – tertiary sector	23	40	68	45
	Transport ⁵	705	731	736	31
Supply side ⁶	Grid	34	39	36	2
	Power generation	33	42	42	9

[Source: based on Table 22 (p. 66) of SWD(2016) 405 final/2 (Impact Assessment accompanying the Proposal for a Directive of the European Parliament and of the Council amending Directive 2012/27/EU on Energy Efficiency; Part 1)]

³ Whereas the EUCO scenario achieves the 2030 targets for RES ($\geq 27\%$), GHG ($\geq 40\%$) and energy efficiency ($\geq 30\%$), the REF2016 does not achieve these targets.

⁴ Investments on the demand side include energy equipment (covering appliances in households and tertiary sector, vehicles, industrial equipment etc.) and direct energy efficiency investments (covering renovation of buildings improving their thermal integrity).

⁵ The high numbers for transport are due to the fact that this includes investments in transport equipment for mobility purposes (e.g. rolling stock but not infrastructure) and energy efficiency. They exclude investments in recharging infrastructure. However, the largest part of the additional investment needs (last column) between current versus needed investment levels for the transport sector can largely be attributed to clean energy investment needs.

⁶ Investments on the supply side (power generation) include grids as well as power generation (power generation plants and industrial boilers).

Sources of clean energy finance

Chapter 3 introduces the different public and private sources of clean energy finance in Europe. *WHO* provides the money, i.e. the various public and private sector actors who take the investment decisions? And *HOW* (via which key investment instruments/tools) do these actors channel the money towards the clean energy investment opportunities?

On the one hand, **public finance** is typically needed to support the early stages of technology innovation, as well as to speed up investments from various private sources. Public finance stems from the following sources/actors:

- National Public Administrations (central and local governments, public agencies, etc.) and National Promotional Banks, such as the German KfW or the UK's Green Investment Bank;
- European Commission's *EU Budget* and EU Public Financial Institutions (PFIs), such as the European Investment Bank (EIB), the European Bank of Reconstruction and Development (EBRD).

On the other hand, the **private sector** has a range of actors providing clean energy finance:

- Commercial Banks;
- Financial market actors, including Institutional Investors (pension funds, insurance companies, investment managers, foundations and endowments, sovereign wealth funds, non-fund pension assets), Venture Capital / Private Equity investors, and other financial market investors (incl. high net worth individuals and angel investors, etc.);
- Private Companies' own resources; and
- Small end-users (households, farmers, small cooperatives, etc.).

One of the most important aspects to better understand about the different 'sources of finance' (both for improved modelling, but also for any wider discussions around the clean energy finance landscape) is their *investor attitudes* in terms of the types of considerations they take into account when making investment decisions for clean energy investment opportunities. Rate of return considerations, as well as specific project characteristics play crucial roles in investment decisions across most actors. Considerations such as the technology readiness level (TRL) plays a much more prominent role in the investment decision of some actors than others, and the preference regarding the TRL of the project of concern is highly dependent on the specific investor type. For instance, venture capitalists are more keen on investing in a high risk / high return innovative new energy technology that is about to enter the market, whereas institutional investors are often much more risk-averse choosing for investment in well-established technologies already on the market.

In a nutshell, Chapter 3 discusses the left-hand column (and corresponding middle column on 'investment instruments') of the European clean energy finance landscape diagram.

Mapping the interactions throughout the European clean energy finance landscape

Having gained an understanding of the possible 'clean energy investment project opportunities' (chapter 2) and different 'sources of available finance' (chapter 3), **Chapter 4** maps the interactions between them and the impact on clean energy

finance. In essence, this chapter explains what influences the size and direction of the flows from sources to investment opportunities in the European clean energy finance landscape.

As a first step, the chapter (section 4.1) provides a description of what the European clean energy finance landscape looks like today (synthesis of findings from Chapters 2 and 3). Next, a mapping of the main influences on the clean energy finance landscape is provided (section 4.2), grouping relevant topics into **seven categories of influencing factors**, based on a thorough literature assessment (see also Annex A and B). These are:

- I. Policy design, regulatory risk and public incentives uncertainties⁷;
- II. Commercial necessities⁸;
- III. Technology⁹;
- IV. Country's enabling framework to support clean energy transition¹⁰;
- V. Governance, and accountability factors¹¹;
- VI. Macro-economic factors¹²; and
- VII. Shortage of good investment projects and opportunities¹³.

Each of these influencing factors is analysed in terms of its relevance and importance per 'source of finance' and 'clean energy investment sector' (Section 4.3). Section 4.4 brings together the main findings from the analysis of the seven influencing factor groupings. The figure below summarises which influencing factors are most important per type of investor. What can be seen from this analysis is that for almost all types of investors, 'policy design/regulatory risk', 'commercial necessities', 'technology risk', as well as 'country's enabling framework to support clean energy transition' make up key factors in their investment decisions. For large institutional investors, the 'shortage of good investment project opportunities' and their attention to 'governance and accountability' factors further limits their clean energy investment choices. Seed capital/angel investors are the group being least susceptible to influencing factors across the board.

⁷ This includes all public regulations and public incentives at Member State or European levels; such as FITs, subsidies, grants, tax incentives, (etc.), which are put in place for the purpose of boosting the development of clean technologies and RES.

⁸ This comprises all indicators of financial health and success common to all businesses (such as ROI), irrespective of being from the clean technology industry or any other industry. It also encompasses the relative ease with which finance can be accessed to grow a business (debt condition and requirement, due diligence elements, etc.).

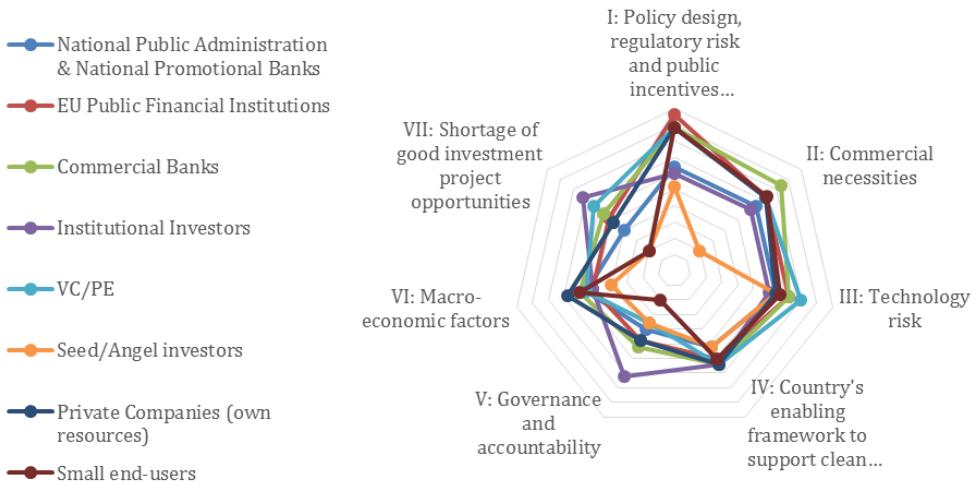
⁹ This factor refers to elements specific to particular technologies; for instance, the timing of the revenue from solar or wind energy technologies.

¹⁰ : encompassing the ability of the infrastructure in a country to cater for new generation or new clean technology, where electricity grid infrastructure is particularly crucial.

¹¹ This factor refers generally to all "soft" indicators linked to the governance of an investment. Factors such as so-called 'Environmental, Social and Governmental (ESG)' criteria are increasingly important for investors, especially long term large investors. This can drive investors to opt for clean energy investments for compliance with environmental and sustainability indicators or simply to present a "green friendly" image. It should be noted that legislative changes (see factor 1 above) are closely interlinked with this factor in the sense that legislation can have a strong impact on the governance of investments, such as the capital requirements (Basel).

¹² This factor includes all aspects linked to the external macro-environment which are relevant to the investment. For instance, economic factors such as international price of raw fossil fuels, interest rates, etc. or other societal trends such as public opinion, have a noticeable influence on investment decisions.

¹³ This factor refers to the lack of good (bankable) investment projects and/or companies in the clean energy sectors. This is a fact brought forward by numerous investors at most stages of investment but especially at the early and later stages. This is only partially dependent on the other factors and is decisive enough for investors that it constitutes a factor on its own.

Figure 0-2 Ranking of influencing factor importance per type of investor

[Source: own analysis based on score tables presented above]

In summary, these findings show what (potentially) influences the quantity and direction of flows through the European clean energy finance landscape. These are the factors that can be reviewed in terms of finding a suitable policy option to overcome current restrictions or encourage positive flows in the landscape (see Chapter 5).

Implications for modelling

Having described the various actors and areas involved in the European clean energy finance landscape, the report then moves on to discussing the implications of these findings for updated macro-economic modelling (Section 4.5). The following illustrative intervention logic is the starting point for translating findings into updated modelling:

- 1) The principal influencing factors of most importance to clean energy sector (x) are (i) and (j).
- 2) This explains why financing sources (a) and (b) are more prominent in funding clean energy sector (x) (because they are better adapted to managing or bearing the risks, or they are less sensitive to influencing factors (i) and (j)).
- 3) If policy could do something to de-risk or address factors (i) and (j) this could trigger greater investment, including from sources that are not currently much interested in this sector/technology.
- 4) Finally, these three preceding steps are be captured in the modelling, typically collapsed into a single WACC indicator (but now with insight into the policies/drivers that could most reduce the WACC for this sector, and incorporating other, macro, influences on the cost of capital), or possibly also as a quantitative limit on finance going into this sector.

Possibilities for influencing the European clean energy finance landscape

Given the availability of the macro-economic modelling as a tool to guide policy-making, **Chapter 5** discusses *HOW* it is possible to influence the European clean energy finance landscape. The assessment here is primarily based on comparing and contrasting the differences/similarities from the domestic climate finance landscapes

implemented in Belgium, France and Germany. The comparative analysis aims to highlight those methodological choices, policies and enabling factors that can help explain differences in volumes and directions of flow between the various existing financing landscapes. This analysis emphasises important reasons to track clean energy finance flows, including:

- Clean energy/climate finance landscapes can help many different stakeholders (and especially policy makers) to have a better understanding about the financial flows (i.e. the financial sources, the intermediaries, the instruments and the final destination of the financial flows – in which clean energy activity has been invested) – as such, policy makers can improve the interactions between the different players in the financial value chain.
- Clean energy/climate finance landscapes are a powerful tool for policy makers to better understand what is needed to reach the energy and climate targets and where to put priorities, to identify strengths and weaknesses; it helps them see the bigger picture.
- Clean energy/climate finance landscapes could eventually trigger a better regulatory framework to support project developers with their investments.

As such, the European clean energy finance landscape as presented in this report, when linked firmly into the macro-economic modelling process, should become a powerful policy tool, helping in taking stock of progress made towards mobilising public and private finance in support of the European (and national) climate and energy policy objectives (if updated on a regular basis).

At the same time, it is important to keep in mind that only three countries have done this type of in-depth analysis so far (and only one country is doing it on a regular basis) and even for these three countries, data availability and accuracy remains a big issue. As such, it is crucial to realise that current data gaps still very much hamper the detailed understanding – and drafting of – a European clean energy finance landscape.

The analysis showed that for some specific estimations it is possible to fall back on EU-level statistics and accessible data; however, for many of the quantified financing streams across the European landscape it would be crucial to have a good understanding of the financing flows and interactions in each of the Member States.

Hence, there is a need to improve the data and information availability on both European and Member State level. Without the necessary data behind the boxes and arrows depicted in the European clean energy finance landscape diagram, it will be impossible to tell the full story and have the full overview on clean energy finance for Europe. Such an overview would help to keep track of progress as to whether or not Europe is managing to mobilise sufficient public and private sector finance to meet its ambitious climate and energy targets.

In the meantime, while such efforts need to be undertaken to close current data gaps, the integration of the qualitative information and logic behind the European clean energy finance landscape can be a first powerful step to already improve the forward-looking policy assessment tools in form of macro-economic modelling.

1 Introduction

Chapter at a glance

This chapter introduces the broader context within which the analysis and findings of this report are framed. Next, the specific objective and scope of this report are presented. The reading guide allows the reader to gain a quick overview of the entire report and what information each of the chapters contains and how it links to the wider objectives.

1.1 Setting the scene

1.1.1 Policy context

As regards climate change mitigation, at the Paris climate conference (COP-21) in December 2015, 195 countries agreed to keep the increase in global average temperature to **well below 2°C** above pre-industrial levels, with the aim to limit it to 1.5°C.¹⁴

In parallel with this far-reaching international commitment, the European Union has published its latest updates to European targets and corresponding policy measures in the policy package accompanying the Communication 'Clean Energy for All Europeans' (COM(2016) 860 Final)¹⁵. With this new policy package the European Commission shows its firm commitment for the EU to take leadership in the clean energy transition. The EU remains committed to cut GHG emissions by at least 40% by 2030 and to achieve three key goals:

1. putting energy efficiency first (the European Commission has now proposed to commit to achieving a binding target of at least 30% energy efficiency by 2030);
2. achieving global leadership in renewable energies (the EU has set itself a binding target to collectively reach a share of at least 27% renewables in final energy consumption by 2030); and
3. providing a fair deal for European consumers.

These targets follow on the 20/20/20 targets of the 'EU 2020 climate & energy package'. The corresponding long term goal of the EU is to achieve 80-95% emission reductions by 2050¹⁶.

Overall, the European Commission's 'Clean Energy for All Europeans' proposals demonstrate that the clean energy transition is a key European growth sector of the future.

¹⁴ UNFCCC (2015). Paris Agreement. <http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>

¹⁵ COM(2016) 860 Final. http://eur-lex.europa.eu/resource.html?uri=cellar:fa6ea15b-b7b0-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF and for all related documentation, see <http://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

¹⁶ COM(2011) 112. A Roadmap for moving to a competitive low carbon economy in 2050

1.1.2 Introducing Europe's clean energy transition investment challenge

Given the urgent challenge to secure sufficient investment for the clean energy transition of the European economy in order to meet the above mentioned climate and energy targets, numerous estimates have been made to size up the investment needs up to 2020, 2030 or 2050. The use of different underlying policy scenarios, data sources, as well as definitions of what is included in the respective figures makes it difficult to compare, or potentially sum up all various sources to work towards.

Still, comparing estimated needs and current investment levels indicates that Europe is facing a major investment challenge. Though there is no agreed single figure regarding the investment needed for the European clean energy transition, the various figures elaborated in the literature indicate investment needs in the order of €180-300 billion per year between now and 2050. It should be noted that these are the additional investment needs that need to be channelled specifically towards clean energy sources. These are in addition to future investment costs for replacement of ageing energy infrastructure.

The most recent estimations from the European Commission confirm this order of magnitude, suggesting that **the mobilisation of an additional €177 billion from public and private investment sources is needed annually from 2021 onwards** to reach the 2030 climate and energy goals as set out in the Communication 'Clean Energy for All Europeans'.¹⁷ In turn, this investment in the EU's clean energy transition would likely generate up to a 1% increase in GDP over the next decade and create 900,000 new jobs.¹⁸

The following table provides a summarised overview of the latest investment needs estimations from the 'Clean Energy for All Europeans' policy package and related impact assessments. The table presents (a) the overall investment needs (based on EU CO30 scenario), and (b) the additional investment needed compared to business-as-usual conditions (i.e. the difference between EU CO30 and REF2016 scenario results).

Table 1-1 Estimated investment needs for the European clean energy transition up to 2030

	Investment needs (replacement of ageing infrastructure, etc.) under BAU conditions continued until 2030	Total investment needs for achieving the EU's 2030 climate and energy targets	Additional clean energy investment effort needed compared to BAU
Associated scenario	REF2016	EUCO30	EUCO30 - REF2016
Estimated cumulative investment need, 2021-2030	9,380 bn EUR'13	11,150 bn EUR'13	1,770 bn EUR'13
(Average) annual investment needs (in bn EUR'13)	938 bn EUR'13	1,115 bn EUR'13	177 bn EUR'13

[Source: own development based on SWD (2016) 405, Impact Assessment on Energy Efficiency accompanying the EC Communication 'Clean Energy for All Europeans'.]

¹⁷ <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

¹⁸ <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

A real challenge – but theoretically doable..

In a recent study¹⁹, researchers conclude that the additional investments needed (2% of GDP annually) are a substantial amount, but is not impossible given the historical fluctuations in investment rates across Europe. In macro-economic terms, when looking at total annual investments into the European economy (gross capital formation), 10% of these would need to be in clean energy.²⁰ For comparison, the annual military expenditures of EU Member States between 2005 and 2014 corresponded with 0.5-2.5% of their respective GDPs.²¹

The publication of the European Commission's proposed package to boost clean energy (2016 'Clean Energy for All Europeans' Package)²² offers a comprehensive set of revisions and updates to existing policies and programmes combined with the introduction of some new initiatives in order to achieve the Union's energy and climate targets set for 2030. The results of the accompanying impact assessments suggest that these measures would allow for a successful support of the clean energy transition and the associated investment challenge. In particular, the impact assessment concludes that the 'Clean Energy for All Europeans' policy package will help tackle investor uncertainty, increase cost-effectiveness, intervene against market failures, update the existing regulatory framework and increase citizen buy-in.

The EEA report on the 'Trends and Projections in Europe 2016: Tracking progress towards Europe's climate and energy targets' confirms that to achieve the more ambitious longer-term energy and decarbonisation goals set by the EU for 2050, current efforts will have to be considerably stepped up. Further, the report confirms the "EU can achieve its 2030 target on renewables if the current pace across Europe is maintained. However, this will require additional efforts because regulatory changes affect investors' confidence in renewables, while market barriers persist. Similarly, achieving the 2030 target on energy efficiency will require effective implementation of energy efficiency measures as well as a rapid change in consumer behaviour."²³

When tackling the clean energy transition finance challenge, a very complex set of financial actions from numerous financial parties of different sizes and origins, i.e. "sources of finance" is at play. These "sources of finance" aim their investments to the multiple sectors of the economy and numerous technologies, projects, businesses, i.e. the "clean energy investment opportunities", which can play a role in contributing to the mitigation of multiple sources of GHG emissions.

1.2 Objectives of this report

The main goal of this report is to map European clean energy investment flows and corresponding finance challenges. The intention is then to provide suggestions on how to usefully incorporate such findings in existing macroeconomic models to assess the macroeconomic implications of climate and energy policies.

¹⁹ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P.26

²⁰ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P.26

²¹ SIPRI (2015). *Military Expenditure Database*, Stockholm: Stockholm International Peace Research Institute (SIPRI).

²² <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

²³ EEA (2016). Trends and Projections in Europe 2016: Tracking progress towards Europe's climate and energy targets.

The report is structured around the European clean energy finance landscape (figure 1-3). This landscape maps the financial flows and interactions between 'sources of finance', 'relevant investment instruments' all the way through to the project developers who use the financial resources to implement 'renewable energy and energy efficiency projects' in sectors relevant to tackling Europe's clean energy transition challenge.

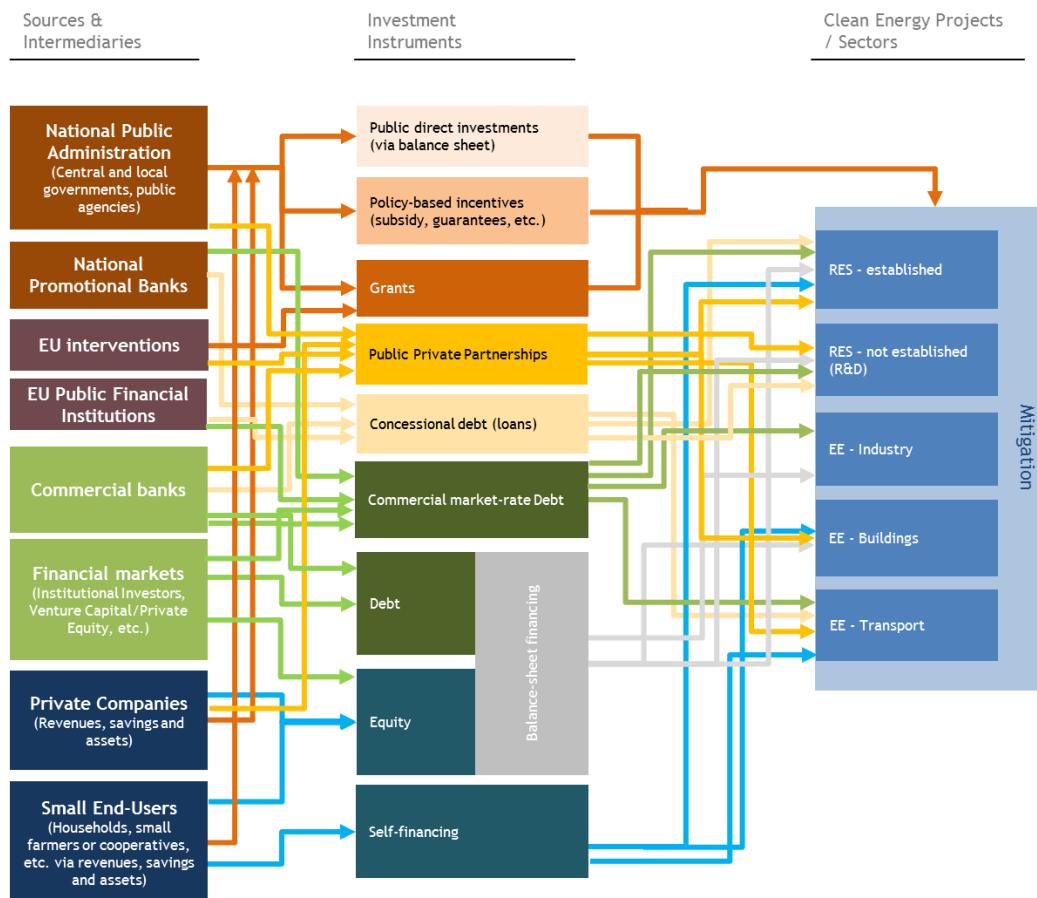
This means that the report presents a first attempt to map all the various interactions which exist and are at play between

- "the sources of finance" and "their financial instruments used";
- "the clean energy investment uses and sectors" (clean energy technologies); and
- "the influencing factors" at micro and macro levels that play a role in determining the size and direction of financial flows;

with the end purpose of modelling such clean energy finance mapping across the broader economy.

The next figure visually presents these different players involved in the European clean energy finance landscape (sources of finance, their financial instruments, and clean energy investment uses and sectors), as well as 'how' they are interacting. The report is structured around explaining this clean energy finance landscape, as explained in the reading guide (Section 1.3) below.

Figure 1-1 European clean energy finance landscape (no values attached)



[Source: Trinomics own development, 2017]

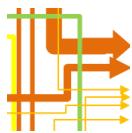
[Note: for this project we exclude adaptation finance from the analysis and focus exclusively on mitigation aspects, i.e. renewable energy and energy efficiency activities and related climate services]

1.3 Reading guide: the storyline in a nutshell

Clean Energy Projects / Sectors

Sources & Intermediaries

Investment Instruments



The storyline begins (**Chapter 2**) on the right hand side of this diagram introducing the different clean energy (renewable energy and energy efficiency) investment opportunities in terms of the types of technologies involved, an overview of current financial flows, the sectors' investment growth potential, as well as key investment drivers.

Chapter 3 then details where these project developers go to secure the financing of their clean energy projects. The chapter provides an overview of the different 'sources of finance' - both public and private - and the 'investment instruments' they can use to make their investment.

The report then moves on to describing the interactions between the 'sources of finance', their 'instruments' and the 'clean energy investment opportunities' in **Chapter 4**. The interactions are described in terms of the seven key influencing factors that can have an impact (barriers vs enabler) on the direction and size of investments flowing through the landscape.

The previous chapters have described all components of the European clean energy finance landscape. The next chapter (**Chapter 5**) then focuses on explaining 'how to influence the landscape', i.e. how can financial flows from a specific source be increased, or how can more investments arrive at a specific end use, etc. This is done by carrying out a comparison of the European clean energy finance landscape developed in the preceding chapters with the existing detailed domestic climate finance landscapes for the three Member States (Germany, France and Belgium). With the available data, drivers and barriers to clean energy investments, as well as opportunities for 'influencing' flows via policy instruments can be explained.

1.4 Scope and definitions

The report links with the wider European Commission, Directorate-General for Energy, Contract no. ENER/A4/2015-436/SER/S12.716128²⁴ in the sense that it builds on the literature review carried out for Work Package 2 and it delivers vital inputs for updating the macroeconomic models with the relevant financial flows in order to carry out the remaining work packages under the contract.

With this in mind, this section presents definitions and scoping of the key terminologies, including how to define the European clean energy finance landscape, what to track, etc.

²⁴ For the Terms of Reference of this study, see the DG Energy website of the European Commission where calls for tender are listed: <http://ec.europa.eu/energy/en/funding-and-contracts/calls-tender#> (the call for this "Study on the Macroeconomics of Energy and Climate Policies" was closed on 22nd of June 2015).

How do we define the European clean energy finance landscape?

There is not one single agreed international definition on climate / energy transition finance. Instead, various international institutions, research groups or national governments have been developing their own definition based on the specific objectives their respective publications have intended to pursue.

For the purpose of this report, therefore, domestic clean energy finance in Europe can be understood as those renewable energy and energy efficiency investments that are made within Europe (EU Member States (MS)), i.e. the public and private investment flowing into national climate mitigation projects (or climate component of projects) within Member States, as well as relevant investments from the EU institutions to the MS. The landscape captures these interactions in a visual mapping of the financial flows.

The original idea of mapping climate finance stems from Climate Policy Initiative (CPI)²⁵ who started to develop global mapping exercises in relation to tracking the pledged \$100 billion per year in increased climate finance flows from developed to developing countries by 2020 under the United Nations Framework Convention on Climate Change (UNFCCC)²⁶. CPI argued that building a comprehensive picture of climate finance flows is an important step towards better understanding how much and what type of support is being made available to advance action on low-carbon, climate-resilient development, how these types of support correspond to countries' needs, and whether financial resources are being spent productively.

So far, studies on *domestic* climate finance have been carried out only in Germany²⁷ (2012), France²⁸ (2014, 2015, 2016 upcoming) and Belgium²⁹ (2016). One can observe certain differences in their definitions and methodologies. These domestic landscapes are used in Chapter 5 of the report to carry out a sensitivity analysis of the European clean energy landscape.

It should be noted that the European clean energy landscape for this report excludes climate adaptation (e.g. land use, water management) and wider climate services (e.g. ICT, consulting services) from the analysis, while some of the existing global and/or domestic climate finance landscapes have attempted to include them. The reason for exclusion is simply because the focus of the wider contract is on innovative sustainable energy technologies and as such, adaptation projects are not relevant.

What clean energy investment project uses and sectors are covered?

The common definitions for climate and energy transition finance leave room for interpretation on which sectors and technologies can be considered. This varies considerably between different studies and tracking methodologies.

In Europe, the energy (power), industry, buildings, transport and agricultural sectors are responsible for more than 95% of all greenhouse gas (GHG) emissions. Therefore, the analysis carried out for this report covers renewable energy and energy efficiency investments across these five sectors.

²⁵ www.climatepolicyinitiative.org

²⁶ UNFCCC (2009), Copenhagen Accord, <http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf> \

²⁷ Juergens et al (2012). The landscape of climate finance in Germany. Climate Policy Initiative.

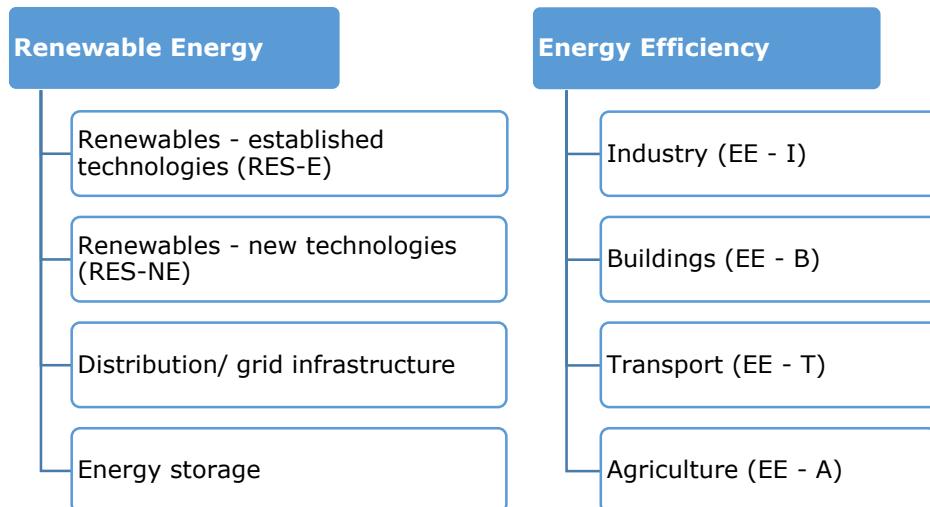
²⁸ Hainaut et al (2015). Landscape of climate finance in France 2011-2014. I4CE Institute for Climate Economics.

²⁹ Rademaekers et al (2016). Landscape of climate finance in Belgium. Federal Public Service (FPS) Health, Food Chain Safety and Environment, Belgium.

The 'clean energy investment opportunities' can range across the technology readiness chain from R&D, to manufacturing scale-up and the investment into roll-out of proven technologies. The analysis highlights differences between well-established technologies (e.g. solar PV) and not yet established technologies (e.g. tidal energy) whenever relevant.

The following figure provides an overview of the sectors and uses considered as clean energy investment opportunities in this report.

Figure 1-2 Clean energy investment technologies / sectors



[Source: Trinomics own development, 2016]

Chapter 2 of this report describes each of these clean energy investment opportunities in more detail.

Here it should just be noted that distribution and grid infrastructure, as well as energy storage are not covered in as much detail due to lack of available data and information.

What 'sources of finance' and corresponding 'investment instruments' are covered?

Multiple 'sources of finance' are at play to finance the clean energy transition. They include both the public and private sector.³⁰

Public finance is typically needed to support the early stages of technology innovation, as well as to speed up investments from various private sources. Public finance stems from the following sources and corresponding investment instruments:

1. **National Public Administrations** (central and local governments, public agencies, etc.): the financial instruments for investing in clean energy projects

³⁰ Aaron Atteridge, Clarisse Kehler Siebert, Richard J. T. Klein, Carmen Butler and Patricia Tella (2009) „Bilateral Finance Institutions and Climate Change: A Mapping of Climate Portfolios”, Stockholm Environment Institute for the Climate Change Working Group for Bilateral Finance Institutions Submitted to the United Nations Environment Programme (UNEP) and the Agence Française de Développement (AFD), Stockholm Environment Institute, p. 4.

- include **public direct investments, policy-based incentives** (guarantees, subsidies, etc.), **grants**, as well as **public-private partnerships**;
2. **National Promotional Banks**, such as the German KfW or the UK's Green Investment Bank: NPBs typically provide finance via a **commercial market-rate debt** or **concessional loans**;
 3. **European Commission**: the **EU Budget** includes provisions such as **grants** and **funding programmes**;
 4. **EU Public Financial Institutions (PFIs)**, such as the European Investment Bank (EIB), the European Bank of Reconstruction and Development (EBRD): The financial instruments at their disposal range from providing **subsidies/grants, equity** to classic **concessional lending** or **guarantees**.

The **private sector** has a range of actors that provide clean energy finance:

1. **Commercial Banks**: the instruments used include **debt** (such as regular loans, non-recourse loans, mezzanine, guaranteed loans & cash loans leasing and bonds) and **equity**;
2. **Financial market** actors, including **Institutional Investors** (pension funds, insurance companies, investment managers, foundations and endowments, sovereign wealth funds, non-fund pension assets), **Venture Capital / Private Equity** investors, and **other financial market investors** (incl. high net worth individuals and angel investors, etc.): making investments in clean energy via **commercial market-rate debt** as well as **balance-sheet finance**;
3. **Private Companies' own resources**: via **balance-sheet investment** of their private equity, (e.g. large utilities remain an important source of equity finance for renewable energy projects, in particular at the development and pre-construction stage); and
4. **Small end-users** (households, farmers, small cooperatives, etc.): using self-financing via their savings.

When to track?

The scope in terms of timeline focuses primarily on financing needs up to 2030 and up to 2050, whenever relevant or possible.

2 Clean energy investment opportunities

Chapter at a glance

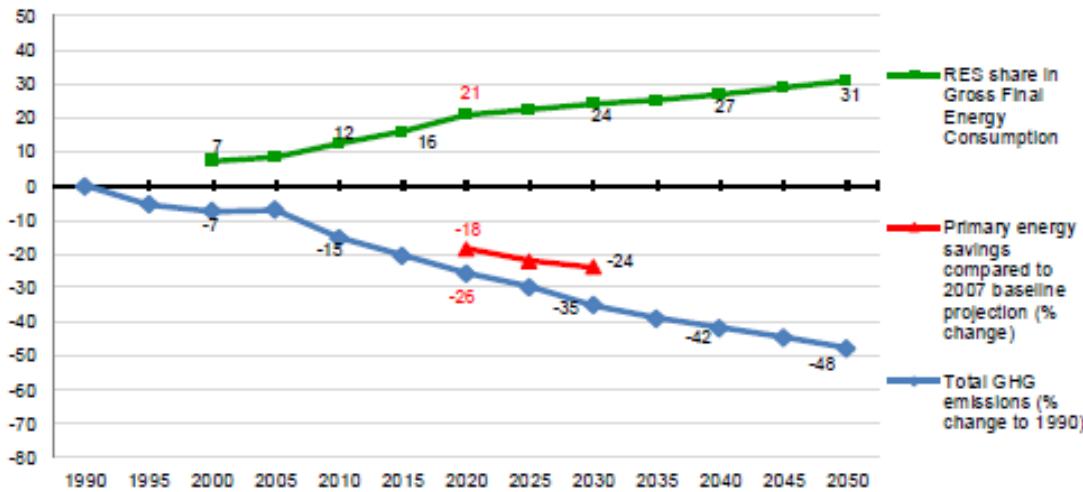
This chapter introduces the various clean energy investment opportunities, focusing on renewable energies and energy efficiency. Per technology type and sector, the chapter briefly summarises (if information is available): a) background on the technology, and b) an indication of the investment challenge. As such, the chapter explains the right-hand side column of the European clean energy finance landscape diagram (Figure 1-3).

From a modelling perspective, information provided in this chapter allows for better insights into the current investment volumes per sector/technology compared to what is necessary to meet the emission reductions targets. It also helps to gain a better understanding of where the highest financing challenges are. In addition, modellers can extract a better understanding of the investment characteristics (e.g. involved risks) of clean energy projects per sector/type.

The clean energy investment field focuses on those sectors where emissions reduction can be achieved by investing in low-carbon technologies (in our definition, we do exclude nuclear and other fossil fuel related technologies). Clean energy investment opportunities therefore primarily include projects within the fields of renewable energy sources and energy efficiency for industry, buildings and transport.

The most up-to-date EU Reference Scenario 2016 (REF2016), see figure 2-1, while set up to meet the binding energy and climate targets for 2020, shows that current policies and market conditions will not be able to deliver the 2030 targets nor the long-term 2050 objective of 80-95% GHG emission reductions. In addition, based on current market trends and adopted policies, the energy efficiency 2020 non-binding target is not met in REF2016. Instead, the scenario is projecting a reduction in primary energy savings (relative to the 2007 baseline) of 18% in 2020, and, respectively, 24% in 2030.

Figure 2-1 Projection of key policy indicators: GHG, RES, EE under PRIMES REF2016 scenario



[Source: DG ENER, DG CLIMA, DG MOVE (2016). EU Reference Scenario 2016. Energy, transport and GHG emissions – trends to 2050.]

In order to still try and reach the EU's climate and energy goals for 2030 and 2050, all clean energy sectors therefore would need to see significantly increased investment flows. The following table provides an overview of the size of these additional investment needs within the various sectors. As can be seen, the finance challenge is particularly difficult for the European power sector where a 100% increase of the current annual investment levels is required, as well as the carbon-intensive industry where an even greater 200% increase of current annual investment levels is required.

Table 2-1 Comparison of historic investment levels with estimated additional investment needs in the 2°C degree policy scenario

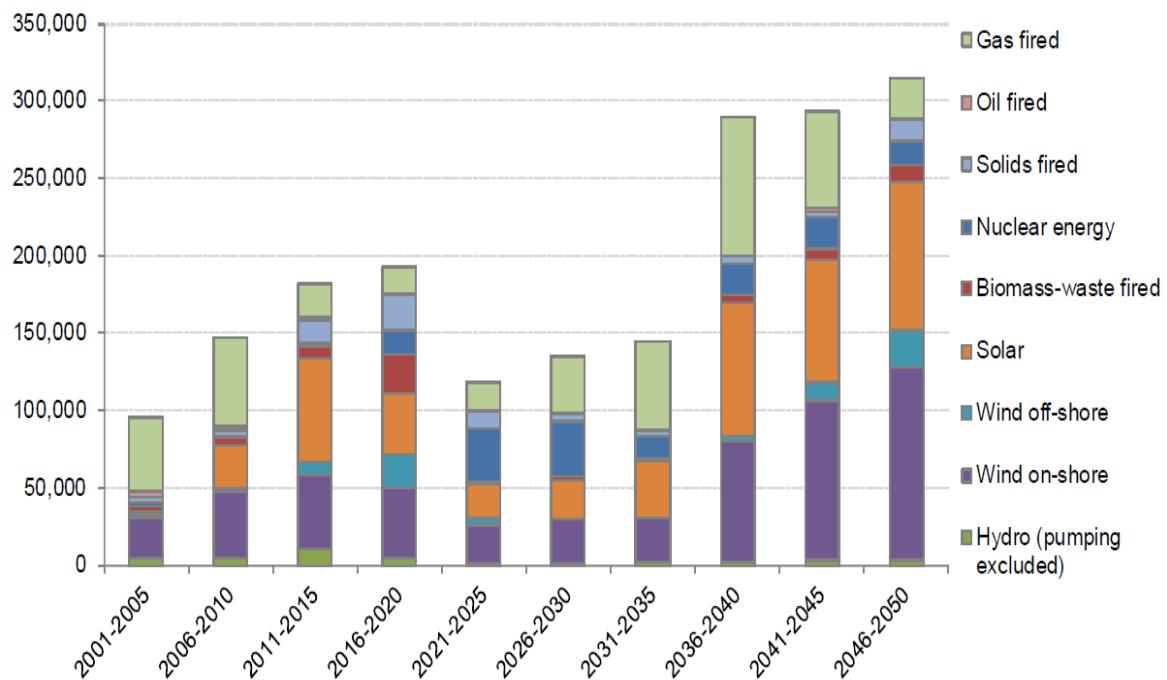
Additional to BAU	Historic annual investment level (€bn)	Target for 2030	Target for 2050
Power	40	+30%	+100%
Industry	350	+10%	+30%
...of which carbon intensive industry	40	+70%	+200%
Transport	575	+20%	+50%
Building (commercial only)	650	+10%	+20%

[Source: based on De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P.30]

When focusing on the power sector, and returning to REF2016, we see in figure 2-2 that investments should increase substantially to add nearly 200GW of new power generation capacity between 2016 and 2020, notably in view of reaching the EU's and Member States' binding renewable energy targets (mainly in wind, solar and biomass). From 2020 up to 2035, in a context of no new additional policies, the level of investments could reduce only to increase drastically afterwards (by approx. 300GW

every 5 years) 'due to increasing ETS carbon prices reflecting a continuously decreasing ETS cap'.

Figure 2-2 Net power capacity investments by plant type (MW – for five year period)



[Source: COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT *Accompanying the document* Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast) -part 3]

In the following sections, we introduce the different RES and EE technologies/sectors with clean energy investment opportunities.

2.1 Renewable energy

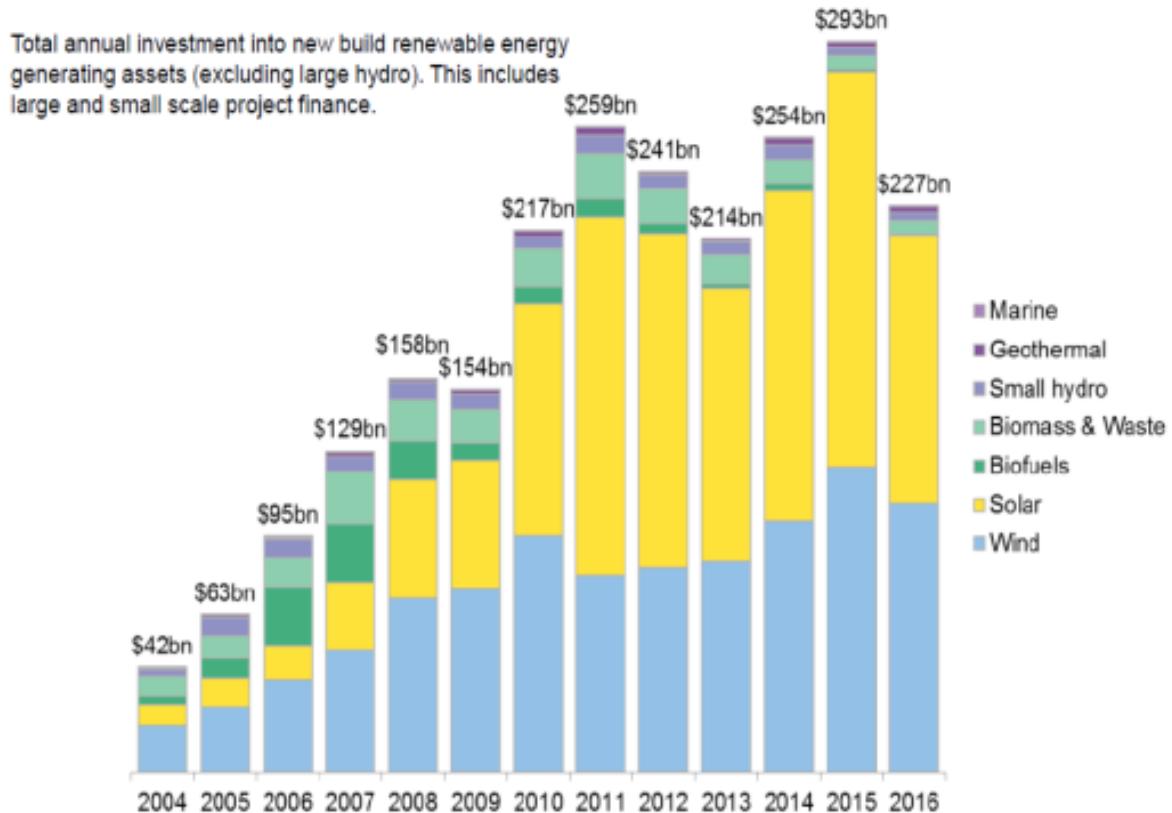
Renewable energy is often seen as being central to reduce carbon emissions, in particular in terms of its contribution to power generation. It is also expected to have a major impact on the transport sector as electric vehicles (powered from renewable sources) are seen as one of the main solutions for low-zero carbon road transport.³¹ Biofuels are expected to support the transition of the aviation and shipping sectors. Other credible long-term options for transport include hydrogen and synthetic fuels.

Within the renewable energy sector, over the past years, a clear trend can be seen between the rapid expansion and cost reduction of solar and wind on the one hand, and on the other hand, the much slower development of other renewable energies. Worldwide, new investment in solar and wind have been growing considerably lately when other renewable energies, such as small hydro, biofuels, biomass & waste-to-energy, geothermal and marine (wave and tidal), seem to be struggling and have even gone down in size. Global investment data, see Figure 2-3 below, shows that

³¹ For road transport hybrid vehicles are a transition phase, while fuel cell appears to be more complex and less efficient and still requiring vast amount of electricity to produce its fuel.

most RES investments flow to mature technologies in the solar and wind sectors. The EEA concludes that both technologies experienced policy support (though to varying extents) and experienced rapid technological learning that have led to growing investors' confidence.³² Investment flows have been much smaller to biomass and biofuels technologies, followed by small hydro and geothermal technologies.

Figure 2-3 Global RES capacity investment trends, excl. large hydro (US\$ bn)



[Source: Bloomberg New Energy Finance]

[Note: Total values include estimates for undisclosed deals]

Of course, it should be noted that this is a picture of past investment trends, which does not necessarily mean that the future has to follow the same path. Investments in other RES can accelerate if/when their LCOE becomes attractive, and/or if the current leading technologies become "overcrowded".

In the following sections, we discuss the major renewable energy technologies, following the definition of European Commission's Directive 2001/77/EC³³. The renewable energy technologies/sources are defined as renewable non-fossil energy sources i.e. solar, wind, geothermal, wave, tidal, hydropower, biomass and biogases. This definition is extended with 'renewable energy uses in heating and cooling' with a special focus on heat pumps.

³² EEA-report, Renewable energy in Europe 2016

³³ DIRECTIVE 2001/77/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market

2.1.1 Solar

Solar PV

Solar photovoltaic technology has proven in recent years that, with the appropriate framework conditions in place, it can be a major contributor to the EU energy system.^{34³⁵} Technological improvements and economies of scale have spurred steady cost reduction, which will continue in coming years as the solar industry progresses toward competitiveness with conventional energy sources. The International Energy Agency estimates that the price of solar systems has been declined by a factor of three in six years in most markets, and that the cost of solar electricity could decrease by another 65% by 2050.³⁶

Already today, solar PV is a cost-effective and an increasingly competitive source of energy in locations that receive moderate-high solar insolation. In the coming years, the technology will become even more cost-effective and competitive in nearly all locations. Cost-competitiveness with grid electricity is progressively being achieved in the retail market and, with the right policy and market conditions, it will spread across the continent in the different market segments by 2020.

SolarPower Europe scenarios show that solar could provide between 10% and 15% of Europe's electricity demand in 2030. On the other hand, according to the EU reference scenario published in 2016 using PRIMES models, solar electricity may produce 5% and 7% of EU power generation in 2020 and 2030 respectively³⁷, in a context of no new additional policies post-2020. Assuming 2030 targets are met, the share of solar electricity might increase to 9% in 2030. Hence, given current market trends and without major changes of policy, a share between 7% and 11% of solar in European electricity demand in 2030 appears realistic.

A lot of different incentive schemes apply to solar modules. For renewable electricity from solar modules, there are three types of subsidy schemes that are widely applied in European countries, (i) the net-metering scheme, (ii) the Feed in Tariff (FiT) with self-consumption stimulation and (iii) the FiT without self-consumption stimulation.

What is the investment challenge?

Two different types of investments can be distinguished, investments in the PV demand sector and investments in the PV supply sector. The former aims to fulfil PV deployment projects, while the latter aims to expand existing or build new PV manufacturing capacities at global level. PV demand and supply sector investments are highly correlated and depend on the overall evolution of PV electricity generation. Still, even for a given energy scenario estimations for PV investment have turned out to not be very accurate since the Levelised Cost of Electricity (LCOE) of PV electricity is declining very rapidly (an overview and comparison of LCOEs across energy technologies is provided in chapter 4, figure 4-2). Therefore, existing scenarios provide only rough ideas of investment needs, as technological progress influences the amount of investment expenditure, even for a given increase in installed capacity. According to IRENA's 2016 "Letting in the light how solar photovoltaics will revolutionise the electricity system" report, in 2015, investments in the PV

³⁴ European Photovoltaic Industry Association, EPIA (2015)

³⁵ DG RTD, Assessment of Photovoltaics, ongoing study

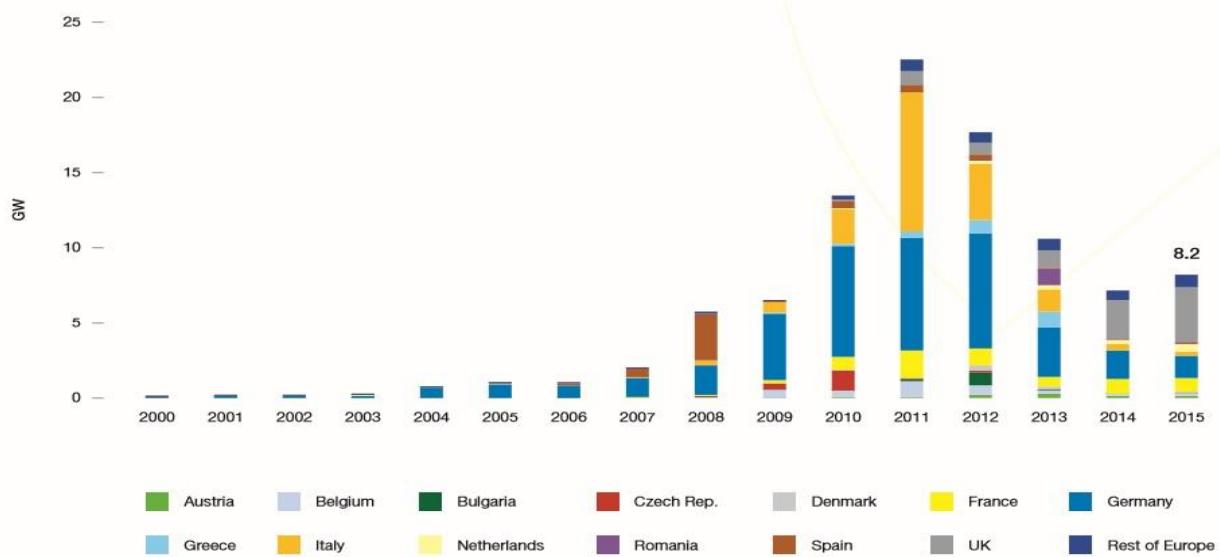
³⁶ IEA, Technology Roadmap Solar Photovoltaic Energy, 2014

³⁷ European Commission, EU Reference Scenario 2016 Energy, transport and GHG emissions Trends to 2050. https://ec.europa.eu/energy/sites/ener/files/documents/ref2016_report_final-web.pdf

deployment projects were around US\$250 billion, while the projections for 2030 oscillate between around US\$800 billion and US\$2 500 billion³⁸.

Photovoltaic power is becoming one of the biggest power generation sources worldwide as it doesn't stop growing year to year. Current global installed capacity is around 229GW and is expected to reach 300GW by 2016-2017. In terms of cumulative installed capacity, Europe remains the leading region with around 42.5% of the world's cumulative capacity in 2015. However, the installation rate has drastically decreased since peaking in 2011, due to changes in countries' policies. Europe had led the PV growth during the last decade with Germany, Italy and Spain as the most important destinations. Although the annual installation capacity has reduced for these countries, Europe continues its commitment to this technology through significant growth in new installations in other countries, led by the UK and France.

Figure 2-4 Evolution of European new grid-connected PV capacities 2000-2015



[Source: SolarPower Europe, Global Market Outlook, 2016]

Overall, it is expected that from among all Member States, Germany and Italy will continue adding an important part of the new PV capacity while other countries will introduce new policies to boost the installation rate. The prospects for continued PV deployment are for the time being not limited with current installed capacities (100 GW) substantially below the average electricity demand (300 GW) and a moderate growth rate of installed capacity (8 GW/year). Furthermore, installed capacities only rarely approach their maximum generation output. Further down the line, supportive technologies would be necessary, however, to accommodate the usage of excess PV generation at peak times.

³⁸ IRENA, "Letting in the light how solar photovoltaics will revolutionise the electricity system", 2016, http://www.irena.org/DocumentDownloads/Publications/IRENA_Letting_in_the_Light_2016.pdf

Solar thermal

EURObserv'ER findings show that in 2014, the European solar thermal market for producing heat, domestic hot water and heating, contracted for the sixth year. It dropped below the 3 million m² threshold and settled at an installation level comparable to that of 2007. The total installed area in the EU stood at 47 million m² (32 987 MWth).

Reasons for this decline are:

- competition from alternative technologies: thermodynamic hot water tanks and condensing gas boilers which are also eligible for incentives and offer lower installation costs;
- strong competition from solar photovoltaic that is currently also addressing the domestic hot water segment;
- furthermore, the plunge in the price of oil and gas in 2014 and 2015 had a discouraging effect on home owners to invest in solar thermal; and
- solar thermal promotion policies have been blunted.

ESTIF, the European Solar Thermal Industry Federation (ESTIF)³⁹ confirms that also in 2015, the European market suffered a contraction in newly installed capacity, which totalled 1.9 GW (approximately 2.7 million m²). This represents a decrease of 6.6% in comparison with 2014. The total installed capacity reaching 33.3 GW (47.5 million m²), equivalent to an increase of 4.4% year-on-year of the total installed capacity.

What is the investment challenge?

The turnover by the sector is estimated by ESTIF at €1.9 billion in 2015.⁴⁰ Considering that most experts believe to see a stable newly installed capacity of 3 million m² annually, we could estimate the annual investment requirement at approx. €2 billion. As financing in solar thermal installation is predominantly provided by the home owners, it seems plausible that most of these investments are financed by their savings and through bank loans.

2.1.2 Wind

Onshore wind

The results from the latest PRIMES model (EU Reference Scenario 2016) show that wind will deliver 14.4% of the total net electricity generation by 2020 (with an installed capacity of 207 GW). Total wind capacities will increase to 255 GW in 2030, increasing from 86 GW in 2010, assuming no new additional policies post-2020. Onshore wind capacity will have a share of 76% of total wind capacity in 2020, this takes account of both the development of new sites and the progressive replacement of older wind turbines with new turbines which are assumed to have higher installed capacity and higher load hours.

Project finance with debt capital is the most common form of financing in mature wind markets. The loan term is in the range of 14 to 16 years with equity between 20% to 40% of the total project's capital cost. There are three main types of equity finance:

- On balance sheet – for which the rate of equity return is usually significantly lower than for off-balancing-sheet financing.

³⁹ <http://www.estif.org>

⁴⁰ ESTIF, solar thermal markets in Europe, trends and market statistics 2015, Nov 2016

- Institutional investors, such as insurance companies, pension or investment funds – for large wind farms or wind farm portfolios.
- A private limited partnership – which was very typical in the German wind energy market in the earlier years, the so-called "Bürgerwindparks" ("citizen's wind farms").

Other forms of finance exist, but are less widely used than the above and regarded as "niche" applications.

Onshore wind costs have fallen by more than a third over the past three decades. Current onshore wind LCOE is between 40 and 100 EUR/MWh, with a midpoint near 60 EUR/MWh. The large range is a function of site-specific cost variance (e.g. due to differing wind speeds and associated capacity factors). In Brazil and South-Africa for example, onshore wind is outcompeting new build fossil fuel generation.

What is the investment challenge?

The estimated investment needs for wind energy deployment projects depend on a continuing decrease in the LCOE of wind electricity as well as on the energy scenario considered. Investments of around €343 billion by 2030 are estimated to be needed for onshore wind under the central scenario of the European Wind Energy Association.

Offshore wind

According to WindEurope⁴¹, the EU has been at the forefront of offshore wind power for decades, having as of 30 June 2016, cumulatively, 3,344 offshore wind turbines with a combined capacity of 11 538 MW fully grid connected in European waters across 82 wind farms and 11 countries. This includes demonstration sites.

According to the 2016 EU Reference Scenario, in 2020, 24% of the total wind generation will be produced from offshore wind capacities with 33 GW of installed capacity, although this percentage is declining thereafter, because offshore wind will grow relatively slowly compared to onshore wind due to its high cost which will limit market penetration. Other aspects influencing offshore wind deployment include the development of floating solutions, which are at a very early stage today, as well as the possible limits for onshore wind development through crowding out of windy sites and increasing difficulties with permitting.

Average expenditure for one MW of offshore capacity declined from €4.5 million to €4.2 million between 2013 and 2014. The LCOE of offshore wind is between 110 and 208 EUR/MWh.⁴² The LCOE is showing a downward trend, as stated by Bloomberg Finance. Interestingly, a recent tender for a Dutch offshore wind farm was even awarded at a rate implying an LCOE of 68 €/MWh.⁴³

From the EUROBSERV'ER report we can state that both in 2013 and 2014, investments in wind power are financed about one third off-balance-sheet (34.8% in 2013 and 34.4% in 2014). This confirms the observation from previous years that the role of bonds and other asset financing types is still rather limited. In 2015, WindEurope indicated that the reduced risk perception for offshore wind projects has

⁴¹ <https://windeurope.org/wp-content/uploads/files/about-wind/statistics/EWEA-European-Offshore-Statistics-2015.pdf>

⁴² Commission staff working document impact assessment accompanying the document proposal for a directive of the European parliament and of the council on the promotion of the use of energy from renewable sources (recast) {com(2016) 767 final} {swd(2016) 419 final}.

⁴³ <http://www.offshorewind.biz/2016/10/28/borssele-tender-revealed/>

led to projects getting financed by bonds (€1.5 bn was raised through project bonds). WindEurope⁴⁴ also stated that the offshore wind sector has also witnessed a growing demand for off-balance sheet financing: in 2015, 44% of the new capacity in offshore wind was financed on a non-recourse basis (as opposed to 70% in onshore wind).

Total investments in 2015 for the construction and refinancing of offshore wind farms and transmission assets hit a record level of €18 bn.

What is the investment challenge?

The estimated investment needs for wind energy deployment projects depend on the decreasing LCOE of wind electricity as well as on the energy scenario considered. Investments of around €131 bn are estimated to be needed for offshore wind under the WindEurope central scenario until 2030.

2.1.3 Biomass

Biomass can be defined as organic, non-fossil material of biological origin, which may be used for heat production or electricity generation; it comprises wood and wood waste, biogas, municipal solid waste and biofuels; includes the renewable part of industrial waste.

Biomass (or bioenergy) exists in 3 forms: solid biomass, gaseous biomass (biogas) and liquid biomass (biofuels).

According to the Eurobserv'ER report, from 2010 to 2014, bioenergy sector turnover grew 32% reaching €55 billion in 2014. The solid bioenergy segment had the most increase with 46% growth from 2010 to 2014.

The 2015 JRC report⁴⁵ for EU funding in R&D showed that the total commitment to bio energy technologies was of the order of €1.2 billion (in the 2007-2013 programming period). Around €651 million from this commitment was dedicated to developing sustainable advanced biofuels, €549 million was dedicated to other forms of bioenergy like biomass / biogas.

What is the investment challenge?

The EU Reference Scenario 2016 indicates that an annual investment of €527 million is needed for biomass (as a whole), from 2021 to 2030. No further details on the solid, gaseous or liquid biomass were given.

Solid biomass

Following the definition of the Eurobserv'ER report solid biomass are all the solid organic components to be used like fuels: wood, woodwaste (wood chips, sawdust, etc.), wood pellets, black liquors, straw, bagasse, animal waste and other plant matter and residues.

⁴⁴ <https://windeurope.org/policy/topics/finance/>

⁴⁵ Lepsa, Bianca-Nicole (2015). EU R&D funding for Low Carbon Energy Technologies: Analysis of the distribution of 2007-2013 commitments. JRC Science for Policy Report.
<http://publications.jrc.ec.europa.eu/repository/bitstream/JRC99158/commitmentanalysis2007-2013bnl09122015.pdf>

The capital costs for biomass electricity plants are high because of the poor combustion and the environmental restrictions. The technology learning potentials are also considered poor. For a calculation of the LCOEs, the costs are dependent on future feedstock prices which may offset technical learning possibilities.

The World Energy Outlook 2016 of the IEA gives us a view on the global average cost for this technology, which is around US\$2000/kW installed capacity. The LCOE, which takes into account the typical operating pattern for bioenergy-based power plants, varies in the range of US\$100-US\$180/MWh (based upon feedstock costs of US\$30-US\$100/MWh per tonne). For the European Union, projects in 2015 the report gives a LCOE for bioenergy of around €200/MWh (from US\$220/MWh).

Eurobserv'ER reports that between 2013 and 2014, a moderate decline in asset finance for utility-scale biomass could be observed. EU-investments shrank from almost €1.74 billion in 2013 to €1.53 billion in 2014, a decrease of 12.5%. The number of biomass plants with secured financing dropped slightly stronger by 22.7% from 22 in 2013 to 17 in 2014. Hence, the average project size increased between both years from €79 million to €89 million. In comparison to the drop in investments of 12.5%, the decline in capacity added seems surprisingly large at first sight. The increase in new capacity decreased by more than 34% from 1.06 GW in 2013 to 0.7 GW in 2014. However, this stronger decrease in capacity additions is mainly driven by the fact that the data also includes investments in converting existing power plants, e.g. coal, into biomass power plants. In these cases, the investment costs per MW are significantly smaller. Once these conversions of existing power plants are completed, one can therefore expect an increase in capacity additions again if new biomass production plants are set up.

When taking a closer look at what sort of asset finance took place for solid biomass plants between, Eurobserv'ER shows us that between 2013 and 2014 balance sheet finance increased in number of projects from 54.5% to 64.7%. Off-balance-sheet finance decreased in number of projects from about 40.9% to 35.3%. Bond financing on its turn decreased from about 4.5% to 0%.

Biogas

Eurobserv'ER distinguishes between biogas produced by wastewater treatment plants (that produce methane from sewage sludge), landfill biogas whose output is directly captured inside the landfills (not produced by an industrial plant) and "Other biogas" being anaerobic digesters specially designed to recover energy produce most of the biogas across the European Union.

In 2014, the EU biogas energy output was estimated at around 173.3 TWh (14.9 Mtoe), or a 6.6% growth compared to 2013. The "other biogas" category accounted for about 72.4% of this output in 2014 (69.8% in 2013), which is a long way ahead of landfill biogas at 18.4% (20.2% in 2013) and 9.2% for sewage plant biogas (9.9% in 2013).

Electricity production, regardless of whether or not it is produced in cogeneration plants, is still the main outlet for biogas energy recovery. It accounted for approximately 57 TWh (4.9 Mtoe) of output in 2014. Heat sales to district heating networks amounted to 6.5 TWh (555.9 ktoe) in 2014, i.e. 19.6% growth. Self-consumed heat (used directly on production sites), was 28.2 TWh (2429 ktoe) in 2014 (6.1% more than in 2013).

As the very fast growth in production of the leading countries for agricultural methanisation has been achieved by wholesale recourse to energy crops, the

European Commission has insisted that biogas production should be primarily based on the use of by-products and organic waste. On-going discussions about European Commission's Proposals on biomass sustainability and on limiting the use of energy crops will have an impact on the biogas sector's growth potential. National Renewable Energy Action Plans (NREAPs) defined by the individual Member States, indicated input from the biogas sector of up to 51.8 TWh (4456 ktoe) in heat output and 64.2 TWh (5423 ktoe) of electricity, giving combined final energy consumption of 114.9 TWh (9879 ktoe) for the EU-28.

Between 2013 and 2014, overall asset financing for biogas collapsed. While investments in biogas – including biogas power plants as well as biogas production plants – amounted to €331 million in 2013, asset finance amounted only to €33.4 million in 2014. Consequently, also the average investment size decreased from €36.8 million per project in 2013 to only €11.1 million in 2014.

Fraunhofer⁴⁶ estimated the LCOE from biogas of power plants in Germany (spec. investment between 3 000 and 5 000 EUR/kW) between 0.135 EUR/kWh (substrate costs 0.025 EUR/kWh, 8 000 full load hours) and 0.215 Euro/kWh (substrate costs 0.040 EUR/kWh, 6 000 full load hours). However, heat usage is not considered in these calculations.

Biofuels

In the NREAP, Member States were required to outline the expected trajectories of their national RES shares from 2010 up to 2020⁴⁷. Countries also had to report biennially on national progress towards indicative RED and expected NREAP targets. National progress reports were submitted to the European Commission in 2011, 2013 and in December 2015. The possible negative environmental consequences of indirect land-use change (ILUC) caused by some types of biofuels, led to the RED's amendment in 2015. In 2015, a political agreement was reached to cap the biofuels produced from energy crops grown on agricultural land to maximum 7% of all final transport energy consumption in 2020. National targets for advanced biofuels were to be set by the Member States according to this agreement.⁴⁸

EUROBSERV'ER⁴⁹ states that the development of biofuels was held back during those three years. Although the first-generation biofuels were the main subject of this reform, the general regulatory uncertainty also hindered the development of the second-generation biofuels. This kind of regulatory uncertainty has logically had a negative impact on (potential) investors.

Globally, the 2016 global trends in renewable energy investments report, confirms that in 2015, biofuels (the second-biggest sector behind wind) experienced a 35% drop to US\$ 3.1 billion⁵⁰.

The World Energy Outlook 2016 of the IEA indicates that the cost for conventional biofuel (ethanol) ranges from US\$ 0.60-1.30 per litre of gasoline equivalent. Population growth and economic development are likely to put the market for agricultural commodities under pressure (OECD-FAO, 2016). Those developments are expected to keep the cost of conventional biofuels from decreasing substantially over the outlook period.

⁴⁶ Levelized Cost of Electricity Renewable Energy Technologies (2013)

⁴⁷ EEA in the Renewable energy in Europe 2016 - Recent growth and knock-on effects.

⁴⁸ EU, 2015a; EU, 2015b

⁴⁹ The state of renewable energies in Europe, 15th edition 2015, EurObserv'ER Report.

⁵⁰ For reference, the euro value of any USD values can be closely approximated for 2015 and 2016 by subtracting 10% from the USD value.

Bearing in mind that about 65-90% of the levelised cost of conventional biofuels is dependent on the feedstock used, the feedstock presents significant price risks to biofuel producers. The capital cost element in the total cost of biofuel production can vary significantly: from around 5% (in the case of ethanol production from wheat and ester biodiesel in the European Union) to 20% (for sugar-derived fuels). The costs of advanced biofuels are on average high due to the whole process (feedstock cost i.e. harvest, collection, storage and grower payment, feedstock logistics i.e. handling, size reduction and moisture control and finally the conversion cost) and due to the large amounts of biomass required for production at an industrial scale. Advanced biofuels stay capital intensive, although co-processing of non-food biomass in existing plants, such as oil refineries or conventional ethanol plants, could help reduce the cost. In the long run, the prospects for advanced biofuels costs will largely depend on further technological progress. The Outlook confirms that in the long term, with cheap biomass costs and low capital costs, the LCOE of lignocellulosic ethanol and biomass-to-liquid diesel could be reduced respectively to US\$ 0.4 per litre of gasoline equivalent and US\$ 0.5 per litre of diesel equivalent.

What is the investment challenge?

Aviation and consequent consumption in jet fuels have been experiencing steady growth. Biofuels for aviation (aka bio-kerosene) is currently undergoing the piloting test phase and therefore technical feasibility should be established rather soon. However, bio-kerosene may still only start gaining traction in the jet fuel mix after 2035 under influence of higher ETS-prices (depending on future scenario choices).

The EBTP concludes that advanced biofuels technologies are available at industrial scale and finance is potentially available to construct the facilities demonstrating integration of these technologies and commercial operation of value chains (from feedstock supply to end product) on a single site. However, the uncertainty of consistent long-term policies in support of biofuels markets after 2020, offering clear opportunities to profit from this high-risk technology investment in future pushes investors to invest out of Europe for the same technology or in a different technology.

The Impact Assessment accompanying the proposal for a recast of the Renewable Energy Directive indicates to what extent, and depending on the policy option considered, the annual investment need varies. Given that advanced facilities have higher capital costs than conventional facilities, a full phase out of conventional biofuels would lead to the highest additional capital costs, in the range of €1.5 billion per year. This would correspond to the installation of 200 additional advanced biofuel plants, assuming an annual production capacity of 1.2 TWh (100 Ktoe). For the other policy options considering a gradual phase out of conventional biofuels, additional investments costs are reduced by more than 40%, down to €0.9 billion/year.

2.1.4 Geothermal

Whereas low/medium enthalpy geothermal systems are generally used for heating buildings, a high enthalpy surface installation uses steam to drive a turbine which generates electricity. Low to medium enthalpy installations are common throughout larger parts of Europe. High enthalpy installations occur mostly in areas having favourable geothermal gradients like encountered in Iceland, the Rhine Graben (Soultz-sous-Fôrets), Italy (Larderello), Turkey, etc.

The European Geothermal Energy Council's (EGEC) Market Report in 2015⁵¹ offers an update on the latest developments in the geothermal heat and electricity markets in Europe. According to this study, the EU counted 177 geothermal district heating plants in 2015 with a total installed capacity of 1551.8 MWth. For electricity, the EU had 52 geothermal power plants in operation with a total installed capacity of 991 MWe.

The development of the shallow⁵² geothermal market is steady, yet underperforming. The main hindrances identified are a persisting lack of awareness about the advantages of the technology, regulated gas prices, a lack of a level playing field in the heat market and low renovation and construction rates. Sweden, Germany, France and Switzerland continue to be the main players, accounting for 64% of the market, although high growth rates can be seen in Italy, Poland and the Czech Republic.

The 2016 global trends in renewable energy investments report⁵³ of FS and UNEP, confirms that shallow and deep geothermal investments in 2015 declined by 23% to \$2 billion. The Renewable Energy in Europe 2016-report from the EEA, revealed that geothermal electricity grew by only 1 % per year in the period 2005–2013 to arrive at 5.8 TWh (0.5 Mtoe), and no significant change was expected in 2014. Reductions in costs have been lower than expected.

The IEA reports that for recently completed projects (2015), the global average capital costs for geothermal is around \$2 600/kW. Taking into account the typical operating pattern of geothermal projects, which tend to generate electricity in most hours of the year, the range of LCOEs for recent geothermal projects tends to be between the range of \$40-90/MWh.

What is the investment challenge?

In the various scenarios used in the Impact Assessments accompanying the various initiatives of the clean energy for all Europeans package, the investment for renewables other than wind, solar and biomass (thus tidal, hydro and geothermal respectively) only accounts for 5%, 3% and 1% of the investment expenditures all together.

Nonetheless, in the newsletter from January 2016, EGEC confirms the need for a system which brings liquidity into the energy services and heat markets and for energy efficiency obligation schemes to be strengthened. Only the most efficient and renewable technologies should be eligible when it comes to the replacement of heating systems, therefore it should exclude the installation of new oil boilers. EGEC urges the Commission to review EU public accounting and finance rules in order to promote investments from the public sector in geothermal technology.

2.1.5 Hydropower and ocean energy

Hydropower

In the 450-scenario of the IEA⁵⁴ (up to 2040), hydropower remains the most important contributor to low-carbon power globally, with the output increasing by more than half

⁵¹ EGEC 2014 Market Report Update available at <http://egec.info/wp-content/uploads/2011/03/EGEC-Market-Report-Update-ONLINE.pdf>

⁵² Shallow geothermal activities are mostly defined as activities between 20m and 400m depth using geothermal resources - <http://www.geothermalcommunities.eu>

⁵³ Frankfurt School-UNEP Centre/BNEF. 2016. Global Trends in Renewable Energy Investment 2016, <http://www.fs-unep-centre.org> (Frankfurt am Main)

⁵⁴ IEA (2016). World Energy Outlook.

in all scenarios. For the hydro-technology we distinguish between large hydropower and small hydro power (SHP). For SHP, there seems to be no international consensus on a clear definition. Nonetheless, a capacity of 10 MW total is becoming accepted in Europe. Small hydro plants generate electricity or mechanical power by converting the power available in flowing waters in rivers, canals and streams with a certain fall (the 'head') into electric energy at the lower end of the scheme. At the lower end of the scheme the powerhouse is located. The power of the scheme depends on the flow and on the head. Small hydropower schemes are mainly run off-river with no need to create a reservoir.

The findings of WSHPDR 2013⁵⁵ show that globally SHP is estimated at almost 173 GW, of which 16% is in Europe.

EUROBSERV'ER⁵⁶ shows that the output from both small- and large-scale hydropower increased slightly between 2013 and 2014. Small-scale hydropower output reached 50.1 TWh in 2014, i.e. 0.9 TWh (1.8%) more than in 2013. Large-scale hydropower output, not including pumped-storage output, was 323.9 TWh in 2014 (an increase of 3.7 TWh).

The small hydro section monitored by EurObserv'ER, is the most static one of all renewable technologies. The reason for this is that most suitable sites are already utilized and new constructions being hindered by numerous legislative or environmental obstacles and regulations. EurObserv'ER monitors a small increase in total installed hydro capacity from 13.64 GW in 2013 to 13.65 GW in 2014. The sector turnover remains around the €4.9 billion mark taking into consideration different country specific investment costs.

The JRC report⁵⁷ on 'EU R&D funding for low-carbon technologies' describes hydro, as a mature technology, and despite the fact that there is room to increase the availability and productivity of hydropower equipment and plants, there seems to be little interest in the sector in terms of R&D support at European level. For the period analysed in the present report, only the FP7-Energy research theme line has offered support.

The IEA⁵⁸ reports that for recently completed projects (2015), the global average capital costs for large hydropower and bioenergy-based power plants were around \$2 000/kW, less than the average costs for geothermal (\$2 600/kW) and CSP (\$5 000/kW). The IEA further indicates that the range of LCOEs for recent projects (2015) tends to be between \$50-140/MWh, where in Europe this is around \$110/MWh. However, no distinction is made for Small Hydro Power.

What is the investment challenge?

In the NREAPs, limited growth from 349 TWh to 369.8 TWh (30.0 to 31.8 Mtoe) is expected for 2013–2020. In 2013, the five countries with the most hydropower (Sweden, France, Italy, Austria and Spain) had a share of 71% of all hydropower in the EU-28. Hydropower capacities change only slowly across Europe. Therefore, rainfall patterns are often a larger determinant of annual changes in hydroelectricity production.

⁵⁵ World Small Hydropower Development Report 2013; see also www.smallhydroworld.org

⁵⁶ EurObserv'ER, 2014.

⁵⁷ Lepsa, Bianca-Nicole (2015). EU R&D funding for Low Carbon Energy Technologies: Analysis of the distribution of 2007–2013 commitments. JRC Science for Policy Report.

<http://publications.jrc.ec.europa.eu/repository/bitstream/JRC99158/commitmentanalysis2007-2013bnn09122015.pdf>

⁵⁸ IEA (2016), World Energy Outlook.

Investments in large-scale hydropower schemes (>10 MW) were mainly made before 2000⁵⁹, and most of the potential in the EU has already been realised. To a considerable extent, this also applies to small and medium run-of-river hydro plants (< 10 MW), for which most viable sites are already being utilised.⁶⁰ New constructions need to be assessed against the risk of a resulting decline in the quality of European river environments.

While there are very limited prospects for new dams, there still is potential for investment on existing dams, for example increasing the peak power, increasing the flexibility, or installing pump storage between existing basins. Therefore, despite the low total growth rate anticipated up to 2020 at the EU level, the importance of hydropower may grow, because it brings flexibility that allows the integration of high levels of renewables.⁶¹

EUROBSERV'ER⁶² finds that the development of small hydropower over the next five years hangs in the balance because it is increasingly running up against the Water Quality Framework Directive implementation and lack of political support. The sector players believe that considerable development potential could still be realized. A very comprehensive roadmap has been drawn up that factors in the sector's potential as part of the European Stream Map⁶³ project coordinated by European Small Hydropower Association. The report estimates that installed small hydropower capacity could rise to 17.3 GW by 2020 yielding 59.7 TWh of energy, which is higher than the NREAP forecasts.

Ocean energy

Ocean Energy includes the energy captured from ocean waves (generated by wind passing over the surface), tides, currents, salinity gradients, and ocean temperature differences. The focus of this section is on tidal stream, tidal lagoons and wave energy, as all three are close to deployment. Salinity gradient systems are at an earlier stage, though there is R&D activity and potential in the EU. Temperature gradient systems are better suited to deep sea areas with high insolation – to offer higher gradients, thus sites outside the EU have greater potential.

What is the investment challenge?

The Renewable Energy Report in Europe 2016 shows that electricity generation from tidal, wave and ocean energy was still only 419 GWh (36 ktoe) in 2013 and, according to an EEA estimate, increased to only 523 GWh (45 ktoe) in 2014. The 2016 'Global trends in renewable energy investments' report of FS and UNEP confirms a decline in investments in marine (wave and tidal) energy of 42% to just \$215 million.

Although the EU remains a market leader interest in ocean energy is increasing outside Europe, with the USA, Canada and Australia as key markets.

A new initiative in ocean energy launched by the European Commission (Ocean Energy Forum) may help in stimulating market confidence and investment, giving a further push towards industrialisation.

⁵⁹ ECOFYS, Subsidies and costs of EU energy, 2014.

⁶⁰ EurObserv'ER, 2014.

⁶¹ IRENA, Renewable power generation costs in 2014

⁶² EurObserv'ER, 2014

⁶³ European Stream Map Project. <https://ec.europa.eu/energy/intelligent/projects/en/projects/shp-streammap>

2.1.6 Renewable energy uses in heating and cooling & heat pumps

Renewable energy in heating and cooling

The share of renewable heating and cooling (RES-H&C) in the EU-28 was 17.7% in 2014 with a gross final consumption of renewable heating and cooling of 1017.6 TWh (87.5 Mtoe) in 2014. In 2013, according to the Renewable Energy Report in Europe 2016⁶⁴, the largest contributions came from solid biomass 878 TWh (75.5 Mtoe, or 86% of all RES-H&C), heat pumps 86 TWh (7.4 Mtoe, or 8% of all RES-E) and biogas 29 TWh (2.5 Mtoe, or 3% of all RES-H&C). Over the period 2005–2013, the compound annual growth rate of RES-H&C amounted to 5% per year.

In REF2016, the renewables share in heating and cooling is projected to increase from 17% in 2015 to 22% in 2020, reaching 25% in 2030.

Based on the 2016 Reference Scenario, the use of renewables in final demand for heating and cooling is the main driver of RES-H&C increase in the short term, but its contribution first decreases and then stagnates in the long term. Final consumption of renewable energy in the industrial sector (excluding derived heat) is the second contributor to renewable energy in the heating and cooling sector. In the long-term, renewables in CHP and heat plants (e.g. district heating), as well some deployment of heat pumps, drive further increases of the RES-H&C share. In terms of district heating fuel input, the share of solids and oil decreases considerably, as well as the share of gas. Biomass and waste as well as other renewables and electricity in fuel input increase, representing almost 42% of fuel input in 2020 and 88% in 2050 (in comparison to 31% in 2010) – excluding heat from CHP. Energy efficiency, implying lower demand for heat in all sectors, is also an important driver in the medium and long term, as it tends to reduce demand for renewable heating and cooling, all else equal.

Under scenarios in line with the 2030 and 2050 climate and energy objectives, on the other hand, the RES share in the heating and cooling sector is projected to increase further (26 to 27% by 2030). In the case of a scenario reflecting an increase in energy efficiency of 30% by 2030, the main determinant to the increase in RES H&C is heat pumps, followed by heat demand savings. This suggests that higher ambition in energy savings lead to, all else being equal, lower needs for additional investments in RES in final heat sector.

What is the investment challenge?

In one of its recent reports ECOFYS states⁶⁵ that the most important step Europe can make – with respect to heating systems – is to develop dedicated policies to accelerate the replacement rate of the 80 million old and inefficient heaters installed in EU homes. This acceleration combined with an energy need reduction will bring the EU on course to meet the carbon dioxide reduction goals set for 2030. For moving towards 2050 targets (-90% carbon dioxide emissions), exchange rates need to be kept high after 2030 with more or less exclusive implementation of low-carbon/renewable energy systems and supply.

⁶⁵ ECOFYS, EU pathways to a decarbonised building sector: How replacing inefficient heating systems can help reach the EU climate ambitions, 2016. <http://www.ecofys.com/files/files/ecofys-2016-eu-pathways-towards-a-decarbonised-building-sector.pdf>

Although the heating and cooling sector is moving to renewable energy, in 2012 some 75% of the fuel it uses still came from fossil fuels, and heating and cooling accounted for 68% of the EU gas imports.⁶⁶ Heating and cooling is responsible for about half of the EU's final energy consumption and represents the largest energy end-use sector, ahead of transport and electricity. Meanwhile, in 2014 renewables only accounted for 17.7% of energy in the heating and cooling sector. The use of renewable energy in the industry sector is limited to biomass, despite the market maturity - at least for low temperature heat - of heat pumps, solar and geothermal. Significant potential for energy efficiency and renewable energy use remains.

The financing in the industry depends on the financing of the different technologies that are used: biomass, heat pumps, solar or geothermal. For the replacement of old heaters in EU homes, public intervention to support such a replacement (e.g. labelling policies for heaters) seems the logical way to go forward and scrappage policies, providing subsidies for replacement of boilers older than a certain age, have been successful in some Member States such as the UK.

Heat pumps⁶⁷

We can distinguish three kind of heat pumps (HP), namely air source (ASHP), ground source (GSHP) or hydrothermal (HTHP).

According to EurObserv'ER⁶⁸, the HP market contracted in 2014 with recorded sales of 1.7 million units compared to 2 million in 2013. The contraction to the market was mainly due to the drop in the Italian and French markets on the reversible air-to-air HP segment. In total, the EurObserv'ER market assessment arrives at a sector turnover of €13.8 billion for heat pumps as important renewable heating technology.

The water source HP market segment (using underfloor heating or low- or high-temperature radiators), experienced a positive growth with practically 270 000 systems sold in 2014 (an annual increase of 3.6%). Looking closer, the segment was divided between an increasing air-to-water ASHP HPs market (10.1% up on 2013) and a decreasing GSHP market with 81 340 units sold (8.8% down on 2013).

In the ASHP segment, momentum is positive for air-to-water HPs, along with exhaust air HPs. The air-to-air market alone stayed constant. However, this technology has the largest part in the air source segment, with about 88% of all units sold.

According to Euroconstruct⁶⁹, after seven years of crisis and stagnation, the European construction market's growth should be about 1.8% in 2015, 2% in 2016 and 1.7% in 2017. EU directives are also contributing, by enforcing more stringent energy performance regulations in the building sector. HP heating solutions are strongly encouraged. EurObserv'ER puts HP energy output at 91.9 TWh (7.9 Mtoe) in 2014, and estimate this could increase to 147.7 TWh (12.7 Mtoe) by 2020, which is along the lines of the NREAP plans. An EHPA policy note finds the figure of 61 million HPs installed by 2030 realistic. At this capacity level, heat pumps would be capable of producing close to 700 TWh (60 Mtoe) of renewable energy annually and of reducing GHG emissions by 181 million tonnes.

⁶⁶ COM(2016)51 final - "An EU Strategy on Heating and Cooling", 16 February 2016.

⁶⁷ Heat pumps are devices that apply to heating, ventilating and air conditioning. We can distinguish ground source heat pumps from shallow geothermal as shallow geothermal starts in general at a depth of 15 to 20m.

⁶⁸ EurObserv'ER, 2014

⁶⁹ Euroconstruct, the 79th Euroconstruct conference, June 2015

This vision will be reliant on European governments' determination, because HP solutions are costlier than traditional technologies. If the market is to grow, a possible answer could be increased taxation of fossil energies. Additionally, the renewable energy obligation for new build could be enlarged to include the renovation segment, which offers ample growth prospects.

From 2020 onwards, heat pumps (ground-source and air- source) should become a cost competitive option in the European Union, despite their higher upfront costs, since operating costs are relatively low. Heat pumps run on electricity so the power price can affect the economic attractiveness of the option. For instance, some electricity tariffs embed charges, such as support for renewables that are not part of the cost structure of natural gas supply. On average, electricity prices for households in the New Policies Scenario in the European Union increase slightly to 2020, while gas prices decrease by 1.1%. Renewable solutions, especially ground-source heat pumps, are likely to be most suitable for new buildings, due to the extensive installation work needed. Even though electric resistance space heating is not cost competitive in the European Union it represents a good option in highly efficient buildings where the need for space heating is low.

The cost comparison between solar PV and solar thermal hinges on the technology costs and regional climate. Generally, in warm, sunny climates, solar thermal systems can produce most of a building's hot water needs at low cost while a solar PV-heat pump or electric water heater is likely to be more expensive. In India, the LCOH of SWH today can be as low as \$60/MWh while it is closer to \$100/MWh for a combined solar PV and electric water heater. The same comparison can be made in other developing countries and the result can be quite clear in some cases, such as Brazil where the LCOH of solar PV is about double that of SWH.

What is the investment challenge?

The National Renewable Energy Action Plans (NREAPs) indicated a RES contribution of heat pumps by 2020 is 141 TWh (12.1 Mtoe). This corresponds to 5% of the overall targeted share of RES in final energy consumption by 2020 (245 Mtoe). In 2014, heat pumps contributed with approximately 95.4 TWh (8.2 Mtoe).

2.2 Energy efficiency

Energy efficiency (EE) is most commonly defined as 'using less energy to deliver the same service'. EE represents a key element in the EU's endeavour to reach its climate objectives. The recent Commission Proposal on a revision of the Energy Efficiency Directive includes a 30% mandatory target for 2030 at EU level.

EE investments can be distinguished between sectors: buildings (where 40% of the EU final energy consumption occurs), the transport sector (33%) and those taking place in the industry (26%).⁷⁰

The EE impact assessment released gives an overview of the expected energy related investments (which is a wider term than only energy efficiency). Energy related investments are defined in this impact assessment as, on one hand, investments on the supply side, namely in grids, power generation plants and industrial boilers (and as such are dominantly out of the scope as these don't fall under the definition of clean energy); and, on the other hand, investments on the demand side, which

⁷⁰ Eurostat

include energy equipment (covering appliances in households and tertiary sector, vehicles, industrial equipment etc.) and direct energy efficiency investments (covering renovation of buildings improving their thermal integrity). In this section, we will focus on the demand side.

When discussing the investment challenge in the different subsections, we will refer on one hand to REF2016 - which does take into account the currently adopted EE policies up to 2020 – and, on the other hand the EU CO30⁷¹ – which does take into account all necessary measures to reach the 2030 RES and EE targets.

2.2.1 Industry

According to the World Bank, industry has been decoupling its energy use from value generation. In ten years' time (2001-2011), manufacturing doubled its value added while its energy consumption only increased by 36%. Within the industrial sector, energy consumption is made up of 24% electricity, 71% fuels and 5% from heat generated at other sites.

The EU industrial sector already makes significant EE gains, with an average increase of 1.3% every year and is a renowned world leader in terms of industrial EE.⁷² There are however still immense gains to be seized⁷³, especially since the 2008 economic crisis has slowed down private investment, including in EE. These gains can be found particularly in four categories of business:

- *Electricity production*. The business of generating electricity is a sector where significant gains can be achieved, mostly by improving the energy conversion efficiency rate of thermal power plants.
- *Energy intensive businesses* are businesses for which energy consumption represents a significant cost (e.g. more than 3% of the overall costs). Such companies are usually well aware of the importance of EE.
- *Non-energy intensive big companies* are big companies for which energy costs play a marginal role. They tend not to engage in EE projects but have the financial capacity and sometimes the technical expertise (often outsourced) to do so.
- *Non-energy intensive SMEs* are small companies for which energy represents a small share of their overall cost. Such companies tend to have a very limited awareness of their potential EE gains and would therefore strongly benefit from advisory support and technical assistance. They also tend to have a limited access to equity and rely mostly on self-financing, loans and/or public subsidies to perform EE investment.

What is the investment challenge?

The energy efficiency investments for the industry under REF2016 is estimated at €15 billion annually (between 2021 and 2030) and at €19 billion annually under EU CO30. The small difference between REF20016 and EU CO30 implies that the industry should not increase their ongoing investments drastically to achieve the 2030 EE target.

⁷¹ See Table 22 on investment expenditure in EED Impact Assessment, Part 1 v7.

⁷² Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

⁷³ Energy Efficiency Financial Institutions Group (EEFIG) (2015)

2.2.2 Buildings & appliances (residential & tertiary)

The types of investment projects and investment needs vary depending on the type of building to be renovated:

- *Public buildings* (owned or operated by a public entity) represent 12% of the EU's building stock. EE Investment in these buildings typically takes the form of direct public investment. Member states are legally obliged to achieve an annual 3% renovation rate for this category of building (i.e. those buildings owned and occupied by central governments).
- *Private residential buildings* (owned by a private entity for residential purposes) account for around two thirds of final energy consumption in European buildings. They can be highly inefficient and often have economically attractive EE investment returns for private investors, yet this market segment is highly fragmented and requires a low-cost retail strategy to engage investment on a large scale. Besides, when the residence is not owner-occupied, investment is subjected to the problem of split incentives.
- *Private non-residential buildings* (owned by a private entity for a non-residential purpose) mainly consist of commercial buildings such as offices, restaurants, stores or shops. They are often managed like financial assets and have their own facilities managers. They are often larger and more energy intensive than residential building. Investment decisions are often based on short-term horizons. They tend to be affected by the problem of split incentives because the business that uses the commercial building often does not own it.

Building thermal insulation can deliver important EE gains as two-thirds of the EU building stock was built at a time without energy requirements in building codes and therefore often without, or with poor quality, insulation. It should be noted that buildings are expected to last for more than 50 years, and that new buildings built every year represent only 1% of the existing stock. The challenge in the building sector is therefore to increase the renovation rate of buildings, currently 1.2% to, for instance, 3%.

What is the investment challenge?

The energy efficiency related investments needs in the residential and tertiary sectors increase drastically between REF2016 and EU2030. For the residential sector, investments increase from €127 billion to €214 billion annually and for the tertiary sector these investments increase from €23 billion to €68 billion annually. The main reason for these significant increases is because 'the majority of energy efficiency policies to achieve the 30% energy efficiency target by 2030 focus on these two sectors'.

2.2.3 Transport

Clean and energy efficient vehicles have an important role to play in achieving EU policy objectives of reducing energy consumption, CO₂ emissions, and pollutant emissions. Despite improvements in energy efficiency, transport still depends on oil for the large majority of its energy needs. By 2050, the EU must cut transport emissions by 60% compared with 1990 levels, if we are to limit global warming to an increase of just 2°C.

The key drivers for the reductions in the transport sector should come from the more stringent CO₂ standards, firstly for light duty vehicles, secondly, heavy duty vehicles and thirdly, due to modal shift from motorised to non-motorised transport.

What is the investment challenge?

For the transport sector, the overall investments are much higher than for other sectors (€705 billion annually under REF2016). The reason is that 'for transport, total investments associated to the turnover of the rolling stock are reported'. As, such, it is better to only look at the additional annual investments needed to reach the 2030 targets which is €31 billion annually.

2.3 Conclusions regarding clean energy investment opportunities

When comparing the 2016 EU Reference Scenario and the EU CO30 scenario, the following conclusions can be drawn regarding the overall investment challenge and how this is split between renewable energy, energy efficiency and grid investments required.

As can be seen from the table below, the additional financing needs of €177bn (thus the difference between what is needed for reaching the 2030 climate and energy targets and the spending trajectory based on current trends), primarily fall on **energy efficiency**: within the energy efficiency field, the largest additional efforts need to come from measures in the buildings and transport sectors.

Table 2-2 Sectoral decomposition of average annual investment expenditures (in billion EUR'10)

		REF2016 ⁷⁴	EUCO27	EUCO30	Additional financing needs
TOTAL		938	1036	1115	177
Demand side ⁷⁵	Industry	15	17	19	4
	Buildings - households	127	168	214	87
	Buildings – tertiary sector	23	40	68	45
	Transport ⁷⁶	705	731	736	31

⁷⁴ Whereas the EUCO scenario achieves the 2030 targets for RES ($\geq 27\%$), GHG ($\geq 40\%$) and energy efficiency ($\geq 30\%$), the REF2016 does not achieve these targets.

⁷⁵ Investments on the demand side include energy equipment (covering appliances in households and tertiary sector, vehicles, industrial equipment etc.) and direct energy efficiency investments (covering renovation of buildings improving their thermal integrity).

⁷⁶ The high numbers for transport are due to the fact that this includes investments in transport equipment for mobility purposes (e.g. rolling stock but not infrastructure) and energy efficiency. They exclude investments in recharging infrastructure. However, the largest part of the additional investment needs (last column) between current versus needed investment levels for the transport sector can largely be attributed to clean energy investment needs.

Supply side ⁷⁷	Grid	34	39	36	2
	Power generation	33	42	42	9

[Source: based on Table 22 (p. 66) of SWD(2016) 405 final/2 (Impact Assessment accompanying the Proposal for a Directive of the European Parliament and of the Council amending Directive 2012/27/EU on Energy Efficiency; Part 1)]

Nevertheless, there is no doubt that **renewables** will continue to play a major role in the transition to a clean energy system. To further encourage this transition, Europe has set itself a target to collectively reach a share of at least 27% renewables in the final energy consumption by 2030. The analysis presented in Ch. 2.1 confirms that Europe has successfully turned solar and onshore wind technologies from niche technologies into central players in the European power sector. Other types of clean energy sectors are likely to follow in these footsteps over the next decades to enter the market as fully established clean energy technologies. The 'Clean Energy for all Europeans' package has been notably set up to help further boost the investment in renewables over the coming years.

⁷⁷ Investments on the supply side (power generation) include grids as well as power generation (power generation plants and industrial boilers).

3 Sources and instruments for clean energy finance

Chapter at a glance

This chapter introduces the different public and private sources of clean energy finance in Europe. The chapter is sub-divided into three parts.

The first section introduces *WHO* provides the money, i.e. the various public and private sector actors who take the investment decisions.

The second part then introduces *HOW* (via which key investment instruments/tools) they channel the money towards the clean energy investment opportunities.

The third part explains *investor attitudes* in terms of the types of considerations they take into account when making investment decisions for clean energy investment opportunities.

In a nutshell, this chapter introduces the left-hand side of the European clean energy finance landscape diagram.

3.1 Public sources of finance

Public sources of finance are funds provided from European, national, regional or local government budgets or public financial institutions. Finance from public sources is currently necessary to stimulate investments in the clean energy space.

For example, for the initial RES/EE technology development stages (R&D, pilot phases of the technology innovation chain) not enough private sources of finance currently invest. This can partially be explained by the investments typically being deemed high risk due to the very high level of uncertainty involved with early stage projects. And even more generally speaking, moving into clean energy opportunities comprises many risks and unknowns such as, a steep learning curve, no historical financial data, unusual patterns of investment and return on investment, new technology risk, etc. When these elements are lacking, public finance intervention becomes necessary. On the one hand, public finance is thus typically needed to support the early stages of technology innovation.

On the other hand, public finance is also used to speed up and/or mobilise investments from various private sources in the clean energy sectors. In new areas of investments especially when prices do not give a compelling signal, public financial interventions are usually necessary to get things started. Equally important to the price signal, knowledge that such investment has access to a history of success stories are deciding investment factors for private sector sources. Especially at a time where crude fossil energy prices are very low, private investors have little incentives to embark in venturing out of their Business-As-Usual investments in sectors such as energy, industry, and transport.

Depending on the investment situation and the country's local government, public sources for climate and energy finance typically take the following forms:

- **National public administrations and EU intervention;**
- **National promotional banks (NPBs) (e.g. German KfW, French CDC, UK Green Investment Bank) and EU public financial institutions (e.g. EIB).**

These are presented in more detail in the subsections below in terms of the role they play in European clean energy finance.

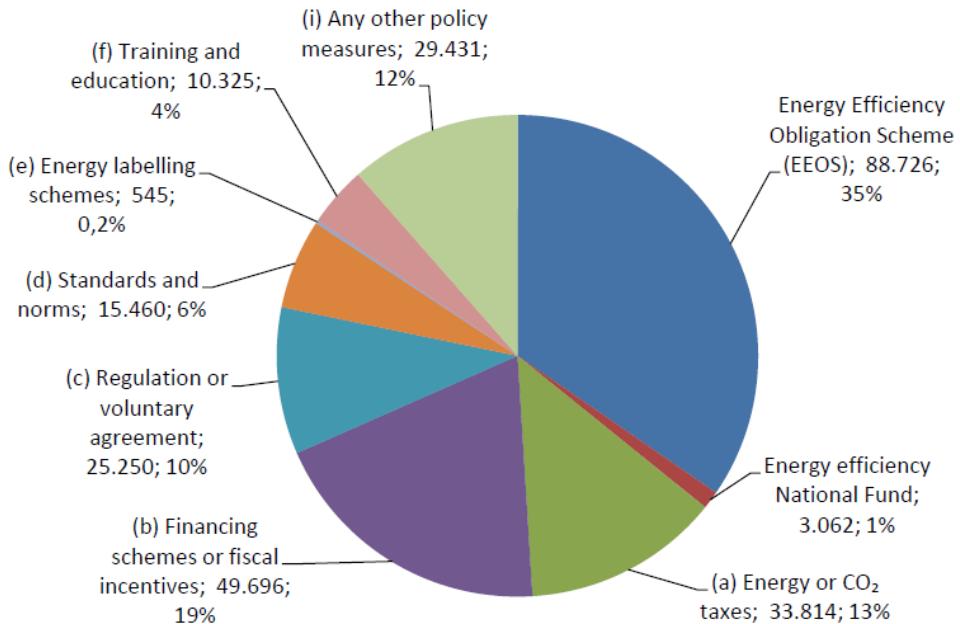
3.1.1 National public administration

National public administrations include national, local, regional governments as well as public agencies in the individual Member States. They primarily use public direct investment, grants, or public-private partnerships as their main investment instruments.

Following whatever national climate and energy goals have been set, public administrations can also support these goals by greening traditional interventions of the public sector.

In addition, they apply policy-based incentives (e.g. subsidies, tax incentives) as a way of encouraging private sector finance towards specific topics, such as clean energy sectors. The following figure provides an indicative breakdown of expected energy savings by type of policy measure as an illustrative example of how public administrations can influence the clean energy transition via supportive policy measures.

Figure 3-1 Breakdown of expected energy savings by type of policy measure (in ktoe)



[Source: Ricardo AEA/ CE Delft as presented in SWD(2016) 405]

In most European countries, national public administrations represent a significant amount of the total financial flows to clean energy investments. They directly invest in EE in the transport and buildings sectors and support the development of EE in industry, as well as R&D for non-established, innovative RES and EE technologies.

3.1.2 National promotional banks

The EC Communication on the role of national promotional banks in supporting the EU investment refers to NPBs as “legal entities carrying out financial activities on a professional basis which are given a mandate by a Member State or a Member State entity, to carry out development or promotional activities”.

The key role of public banks in the financing of clean energy projects is to lever in private finance, by sharing risk and giving some level of assurance to private lenders that the project is sound. Given the direct or implicit policy-oriented mandates under which these institutions operate, PFIs are, under certain circumstances, both able and willing to provide financing at below-market returns, typically paring with commercial investors to draw in additional financing.

The landscape of NPBs in Europe is very heterogeneous. All of them are fully or mostly owned by public governments, which also provide strategic direction and are often involved in the selection of board members. They differ however in terms of size, mandate, sources of funding and business models. Some NPBs are sizable, both by global standards and relative to the size of national banking systems (German KfW, Italian CDP), whereas others are relatively small (e.g. Latvia Allum, Estonia's KredEx). NPBs can have a broad mandate (“promoting economic development”) or be designed to fulfil a specific mandate (e.g., UK green development bank). Some countries have several national institutions, each one with a dedicated promotional task (e.g., French CDC and BPI), whereas others have bundled different activities within a single entity. Some entities (e.g., KfW, the new British Business Bank) have a commercial arm alongside the promotional arm.⁷⁸

In terms of funding, most NPBs rely on a mix of funding sources, but some (French CDC, Italian CDP) are mostly funded via deposits, whereas others (German Kfw, Spanish ICO) raise money through capital markets on the basis of a public guarantee. Finally, NPBs channel promotional funds through commercial banks (second-tier lending) or lend directly to end-customers (first-tier lending). Second-tier lending is particularly dominant in countries where the banking system is strong (Germany, Spain). In other countries (e.g., Bulgaria), greater emphasis is placed on direct lending.⁷⁹

In terms of investment instruments, most public promotional banks use a mix of commercial-rate and concessional debt to provide finance for RES and EE investments.⁸⁰

The dominant instrument in terms of financial volume is concessional lending⁸¹. The loans provided by national promotional banks are typically aimed at projects that have commercial prospects, but would not have happened without the public bank's intervention. The market failure for private finance of these projects mostly centres on risk levels associated with these projects and uncertain ROIs. Hence, NPBs main functions and instruments to support low-carbon projects can be summarised as follows:

⁷⁸ Wruuck, P. (2015). Promoting investment and growth: the role of development Banks in Europe. EU monitor, Deutsche Bank Research, 23 December 2015.

⁷⁹ Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

⁸⁰ Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

⁸¹ It should be noted here that concessional lending is often also strongly linked to support provided by governments in form of government guarantees, interest rate subsidies, etc. Therefore, concessional debt is also an investment instrument used by national public authorities, not only national promotional banks (as can be seen in Figure 1.1 (European climate finance landscape)).

Table 3-1 Overview of main functions and instruments of NPBs to support low-carbon projects

Role	Functions	Tools and instruments
Facilitate access to capital	<ul style="list-style-type: none"> • Providing long-term capital • Facilitating access to private capital 	<ul style="list-style-type: none"> • Concessional and non-concessional lending • Equity investment • International climate funds • Public private partnerships
Reduce risk	<ul style="list-style-type: none"> • Risk sharing • Credit enhancement mechanisms 	<ul style="list-style-type: none"> • Guarantees • Public private partnerships • Junior debt/mezzanine financing
Fill the capacity gap	<ul style="list-style-type: none"> • Aiding project development • Reducing project risks 	<ul style="list-style-type: none"> • Technical assistance • Capacity building • Information tools (GHG quantification, energy certificate tracking, etc.)

[Source: adapted from Cochran et al (2014)]^{82]}

In order to illustrate the composition of NPB commitments, the following table provides an overview of NPB financing for low-carbon infrastructure investments in the period 2010-2012.

Table 3-2 NPB's self-reported low-carbon infrastructure investment levels vs. total commitments for investment activities, 2010-2012

	Sector	2010		2011		2012		Period total	
		M€	%	M€	%	M€	%	M€	%
CDC ⁸³	Sustainable transport (loans)	548	72%	3 660	84%	1 500	55%	5 709	73%
	Total loans sustainable infrastructure	757		4 365		2 727		7 849	
	Energy efficiency (loans)	233	2%	380	3%	453	4%	1 066	3%
	Total loans social housing and urban programme	13 699		12 657		12 362		38 723	
	Total 'low-carbon' projects (loans)	782	5%	4 040	24%	1 953	13%	6 775	15%
	Total lending commitments	14 456		17 022		15 089		46 572	
	Renewable energy (equity)	40	12%	38	12%	53	16%	131	13%
	Total annual equity	337		318		324		979	

⁸² Cochran et al. (2014). Public Financial Institutions and the Low-Carbon Transition: Five Case studies on Low-Carbon Infrastructure and Project Investment, OECD publication, Paris.

⁸³ French Group Caisse des Dépôts

	investment								
KfW⁸⁴	Sustainable transport	-	-	-	-	-	-	-	-
	Renewable energy	9 591	15%	7 017	14%	7 937	16%	24 545	15%
	Energy efficiency	10 315	16%	9701	19%	13 697	27%	33 713	20%
	Total 'low-carbon' projects	19 906	31%	16 718	33%	21 634	43%	58 258	35%
	Total domestic commitments	64 442		50 927		50 629		165 998	
UK GIB⁸⁵	Sustainable transport	-	-	-	-	-	-	-	-
	Renewable energy	-	-	-	-	200 M£	-	200 M£	
	Energy efficiency	-	-	-	-	145 M£	-	145 M£	
	Total estimated investment to 2016						3 800 M£		

[Source: Adapted from http://www.keepeek.com/Digital-Asset-Management/oecd/environment-and-sustainable-development/public-financial-institutions-and-the-low-carbon-transition_5jxt3rhpgn9t-en#page39]

3.1.3 EU interventions

Similar to the role of national public administrations, on a wider European level, EU interventions include finance provided via the EU budget, funding programmes, grants, public-private partnerships, etc. 20% of the total EU budget should go towards climate-related expenditure. This means that climate action (mitigation and adaptation) is mainstreamed across all relevant budget lines of the European Commission's multi-annual funding programme.

A forthcoming DG CLIMA study on 'Climate mainstreaming in the EU Budget: preparing for the next MFF' will provide the basis for an overview how these 20% climate-relevant spending have been estimated for the current MFF. This will include budget areas under direct management by the Commission, such as the LIFE Programme, as well as budget areas under shared management with Member States, such as the European Structural and Investment Funds.

In addition to these areas of the EU budget with climate-relevant spending, the following table provides an overview of existing EU financial instruments that can finance RES and/or energy efficiency investments. It should be noted that some of these are entirely earmarked for EE/RES, while others only partially. Additionally, some of them finance projects directly, while others only indirectly. Therefore, amounts available cannot all be counted in the same way when tallying up overall RES/EE finance flows.

⁸⁴ German KfW Bankengruppe

⁸⁵ UK Green Investment Bank

Table 3-3 Overview of main RES/EE relevant EU financial instruments

Financial instrument	Funding period	Managed by	Available budget	Instrument type	Type of management	Eligible projects
European Fund for Strategic Investment (EFSI)	2015 - 2018	EIB Group (EIB & EIF)	€16 billion EU guarantee and €5 billion EIB capital contribution	Loans, guarantees, equity	Indirect	Transport, energy, environment and resource efficiency, research, development and innovation, support to SMEs and mid-caps
Private Financing for Energy Efficiency instrument (Pf4EE) (under the LIFE Programme)	2014 - 2017	EIB	€80 million from LIFE (plus €480 million long term finance EIB)	Credit risk protection (risk sharing), long-term financing (EIB Loan for Energy Efficiency)	Indirect	Energy efficiency
InnovFin – EU Finance for Innovators (under Horizon 2020)	2014-2020	EIF	€2.7 billion (EC contribution)	<i>InnovFin SME Venture Capital:</i> equity (risk capital financing to enterprises in their seed and start-up stage); <i>InnovFin SME Guarantee, InnovFin MidCap Guarantee:</i> guarantees & counter-guarantees on debt financing; <i>InnovFin MidCap Growth Finance:</i> long term senior, subordinated or mezzanine loans; <i>InnovFin Large Projects:</i> loans/guarantees	Indirect	Innovative sectors including eco-innovation, clean energy
Project Development Assistance (PDA EASME)/ELENA⁸⁶ (under Horizon 2020)	Ongoing	EIB & EASME	EUR 38 million (grants for TA) in 2017	Project Development Assistance	Indirect	TA for buildings energy refurbishments, RES, CHP, urban transport, local energy infrastructure. Typically, >EUR 7 million for PDA EASME per project and > EUR 30

⁸⁶European Local ENergy Assistance (ELENA) facility (part of Horizon 2020 budget) & Mobilising Local Energy Investments (MLEI-PDA) (integrated in Horizon 2020 from 2014)

							million for ELENA EIB
Connecting Europe Facility (CEF Energy, CEF Transport)	2014-2020	DG MOVE, DG ENER ⁸⁷	€22 billion (total CEF budget, of which 1.5 billion available for FIs ⁸⁸)	Project Bonds, LGTT, debt or equity instruments, etc.	Direct		Infrastructure projects of common interest for trans-European transport and energy networks
Financial instruments under the European Structural and Investment Funds (ESIF)	2014-2020	National Managing Authorities ⁸⁹	€450 billion (total ESIF budget)	loans, guarantees, equity	Shared		Innovation, ICT, SME competitiveness, low-carbon economy, climate change adaptation and risk management, environment and resource efficiency, sustainable transport
• European Regional Development Fund (ERDF)	2014-2020	DG REGIO	€196 billion (total ERDF budget) ⁹⁰	loans, guarantees, equity	Shared		Research and innovation, ICT, SME competitiveness, low-carbon economy
• Cohesion Fund (CF)	2014-2020	DG REGIO	€63.4 billion (total CF budget)	loans, guarantees, equity	Shared		Investment in the environment, including areas related to sustainable development and energy which present environmental benefit; trans-European transport networks
European Energy Efficiency Fund (EEEFF) (co-financed by EEPR)	2011-ongoing	DG ENER, managed by: Deutsche Bank	€265 million (€125 mln EU; €75 mln EIB; €60 mln CDP; €5 mln DB)	senior and junior loans, guarantees, or equity	Indirect		Energy efficiency, renewable energy and clean urban transport (for local or regional public authorities)

[Source: Based on data from: Multiannual Financial Framework 2014-2020; European Commission (2015) Activities relating to financial instruments, SWD(2015) 206 final; Commission webpages on the respective instruments. For an updated list and analysis, see forthcoming DG Energy report on the evaluation of the MFF with respect to energy]

⁸⁷ Assisted by Innovation and Networks Executive Agency (INEA).

⁸⁸ http://www.shortsea.be/html_nl/publicaties/documents/Matthieu_20150618SSSconferenceKPH.pdf

⁸⁹ National Managing Authorities (MA) oversee the use of available resources. MAs place ESIF allocations in FIs through a Fund of Funds or a financial intermediary from which eligible projects can be financed.

⁹⁰ During the 2007-2013 programme period, the EU contribution to financial instruments represented 5 % of the total EU funding for the ERDF (European Court of Auditors, 2016).

What can be learned from this overview is that a multiplicity of public finance sources for both RES and EE investments exists. However, since they are much dispersed, it is not always easy – in particular for EE project developers – to access these sources. Furthermore, many of these public sources provide finance only to a specific type of EE or for a specific part of the overall investment needed (e.g. technical assistance). This means, that in most cases also private sources of finance have to be mobilised in order to make the clean energy project happen.

3.1.4 EU public finance institutions

Similar to the National Promotional Banks, the EU's public finance institutions (PFIs) play an important role in catalysing and mobilising private investment in renewable energy and energy efficiency across the European Union. There are a number of PFIs providing clean energy investment support in the EU. This includes primarily (but is not limited to) the European Investment Bank. The EU PFIs work very closely together and in a similar manner as their national counter-parts: the national promotional banks.

Similar to the NPBs, PFIs also use a combination of commercial-rate and concessional debt, as well as guarantees to support clean energy finance. Additionally, and again similar to their national counterparts, they often engage in public-private partnerships as a channel for making clean energy investments viable.

For example, the European Investment Bank is one of the most important PFI actors in the clean energy field. It has an available budget of EUR 7.5 billion/year in energy (based on 2014).⁹¹ Since 2011, EUR 45.95 billion have been signed for EU energy related loans.⁹² The EIB invests via different financial instruments including subsidised or guaranteed loans. It should be noted that investments made by the EIB that contribute to EU clean energy policy objectives typically focus on larger (> EUR 20 million) projects.

In addition, The European Commission runs or initiated several joint programmes together with the European Investment Bank that aim to promote clean energy investments. These include:

Table 3-4 Overview of clean energy relevant joint EC-EIB initiatives

Funding programme	Funding period	Available budget	Financial Instruments (FI) and/or grants	Eligible projects
<i>InnovFin – EU Finance for Innovators⁹³</i>	2014 – 2020	€24 billion ⁹⁴	Loans and guarantees to innovative businesses. Financing of research & development projects. Equity (early and start-up phase).	All H2020 sectors (i.e. Transport, energy, telecoms, manufacturing, life science, research infrastructure)

⁹¹EIB (2015), *Investing in infrastructure for a growing economy*

⁹² EIB website:

<http://www.eib.org/projects/loan/list/index.htm?from=2011®ion=1§or=1000&to=&country=>

⁹³ Please note that this initiative has also already been included in the listed EU financial instruments above (see table 3-4).

⁹⁴ <http://www.eib.org/products/blending/innovfin/>

Private Finance for Energy Efficiency (PF4EE) instrument	Ongoing	€80 million ⁹⁵ €480 million	Credit risk protection (cash-collateral); long-term financing via EIB loan	Targets projects which support the implementation of National Energy Efficiency Action Plans or other energy efficiency programmes of EU Member States. One PF4EE operation per Member State.
European Energy Efficiency Fund (EEEF)	Ongoing	Not defined	Direct investments ⁹⁶ ; Investments into financial institutions ⁹⁷	The final beneficiaries of eef are municipal, local and regional authorities as well as public and private entities acting on behalf of those authorities such as utilities, public transportation providers, social housing associations, energy service companies etc. Energy efficiency, renewable energy and clean transport projects are eligible.

The joint EC and EIB “InnovFin – EU Finance for Innovators” fund consists of a series of integrated and complementary financing tools and advisory services offered by the EIB Group, covering the entire value chain of research and innovation (R&I) in order to support investments from the smallest to the largest enterprise. All H2020 sectors are eligible under InnovFin. By 2020, InnovFin is expected to make over EUR 24bn of debt and equity financing available to innovative companies to support EUR 48bn of final R&I investments⁹⁸. Within the framework of InnovFin “InnovFin Energy Demo Projects enables the EIB to finance innovative first-of-a-kind demonstration projects in the fields of renewable energy, sustainable hydrogen and fuel cells. These may include first-of-a-kind power, heat and/or fuel production plants and first-of-a-kind manufacturing plants. The EIB provides loans of between € 7.5m and € 75m⁹⁹. Moreover, the EIB and InnovFin sign partnerships with national investment banks, like the French bpifrance in order to boost equity investments in the industry of the future

⁹⁵ The European Commission provided €80 million to fund credit risk protection and expert support services. The EIB leverages this amount making at least €480 million available for long-term finance. For more information, see PF4EE website: <http://www.eib.org/products/blending/pf4ee/index.htm>

⁹⁶ Direct investments can include projects from project developers, energy service companies (ESCOs), small scale renewable energy and energy efficiency service and supply companies that serve energy efficiency and renewable energy markets in the target countries. <http://www.eef.lu/eligible-investments.html>

⁹⁷ These include investments in local commercial banks, leasing companies and other selected financial institutions that either finance or are committed to financing projects of the Final Beneficiaries meeting the eligibility criteria of eef. Selected partner financial institutions will receive debt instruments with a maturity of up to 15 years. These instruments include:

- senior debt
- subordinated debt
- guarantees
- No equity investments in financial institutions

Financial institutions lend to the beneficiaries of the Fund meeting the eligibility criteria to finance energy efficiency and/or renewable energy projects. <http://www.eef.lu/eligible-investments.html>

⁹⁸ <http://www.eib.org/products/blending/innovfin/>

⁹⁹ http://www.eib.org/attachments/documents/innovfin_energy_demo_projects_flysheet_en.pdf

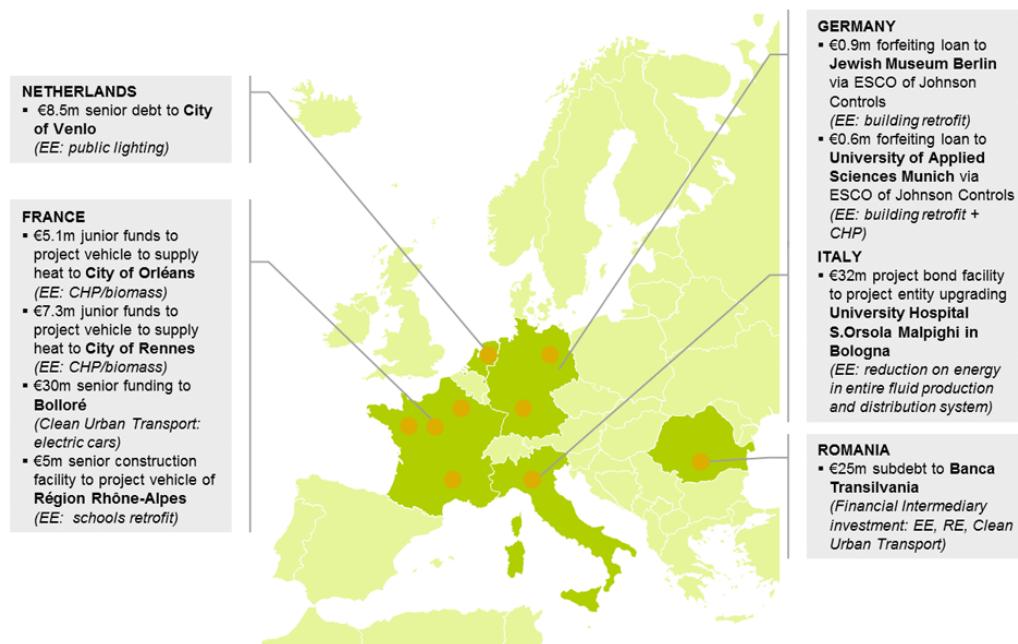
and increasing the volume of loans to innovative small and medium-sized enterprises (SMEs) and midcaps¹⁰⁰.

The PF4EE¹⁰¹ is a joint agreement between the EIB and the European Commission which aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments. The PF4EE instrument's two main objectives are: (a) to make energy efficiency lending a more sustainable activity within European financial institutions, considering the energy efficiency sector as a distinct market segment; and (b) to increase the availability of debt financing to eligible energy efficiency investments. PF4EE therefore targets projects which support the implementation of National Energy Efficiency Action Plans or other energy efficiency programmes of EU Member States.

The European Energy Efficiency Fund (EEEF)¹⁰² aims to support the goals of the European Union to promote a sustainable energy market and climate protection. The EEEF was initiated by the European Commission in cooperation with the European Investment Bank. The initial capitalization provided by the European Commission was increased with contributions from the sponsors European Investment Bank, Cassa Depositi e Prestiti as well as the Investment manager of Deutsche Bank. The EEEF now invests via direct investment or via investments into financial institutions in energy efficiency, renewable energy or clean transport projects across European municipalities, local or regional entities.

The following figure depicts the projects that have reached financial closure and are currently funded under EEEF.

Figure 3-2 Current EEEF investments (accessed January 2017)



[Source: <http://www.eeef.lu/investment-categories.html>]

¹⁰⁰ <http://www.eib.org/infocentre/press/releases/all/2016/2016-232-plan-dinvestissement-pour-l-europe-le-groupe-bei-et-bpifrance-signent-deux-accords-pour-soutenir-l-industrie-durable-et-les-pme-innovantes.htm>

¹⁰¹ <http://www.eib.org/products/blending/pf4ee/index.htm>

¹⁰² <http://www.eeef.lu/home.html>

3.2 Private sources of finance

The main actors in private finance for sustainable energy investments are:

- **Commercial banks;**
- **Institutional investors** (incl. pension funds and insurance companies);
- **Other financial market investors** (incl. venture capital/private equity, high net worth individuals, angel investors, etc.);
- **Private companies** (i.e. company's own resources); and
- **Small end-users** (households, farmers, small cooperatives, etc.).

These are presented in more detail in the subsections below in terms of the role they play in European climate and energy finance.

3.2.1 Commercial banks

Commercial banks across Europe are playing an important role in the financing of climate friendly businesses and projects.

Private commercial banks are more comfortable with technologies more established such as solar and wind (mostly onshore), because they know they have been proven and technology risk is much lower than for more innovative technologies. Further, they typically prefer to invest in RES projects proposed by large companies, whereas investments requested by SMEs or individuals are often declined.

Recent investment trends in Europe indicate a higher proportion of debt across many of the RES projects. According to Frankfurt School-UNEP¹⁰³ this reflects the increased confidence of commercial banks in offshore wind. The experience gained in this particular market has spread across more and more lenders and some banks now prefer the large investment volume sizes available on offshore compared to the smaller ones on onshore wind or solar PV.

For smaller scale investments one of the major hurdles for unlocking more investment from commercial banks is the fact that they do not have dedicated RES/EE experts and the lack of knowledge about technologies/sectors specific to clean energy represents a real barrier for them to take investment decisions when climate/energy related project proposals apply for finance. Due to this lack of expertise in the field, banks (and other investors) often have difficulties trying to assess the real risk associated with energy efficiency investments. Most of them still do not consider energy efficiency as a specific market segment offering clear incentives and business opportunities. Often the credits offered by banks for energy efficiency measures rely solely on the creditworthiness of the borrower, and totally ignore the expected energy savings and increased value of the property.

A recent sign of commercial banks and other financial market players teaming up in the effort to scale private finance for the clean energy transition is the so-called Catalytic Finance Initiative¹⁰⁴ (CFI), originally launched by Bank of America in 2014 with a US\$ 1bn (EUR 881 million) commitment and now joined by a number of banks, asset managers and financial institutions including Crédit Agricole CIB, European Investment Bank, HSBC, International Finance Corporation (IFC) and Mirova to direct US\$ 8 bn (EUR 7bn) in total commitments towards high-impact sustainable

¹⁰³ Frankfurt School-UNEP Centre & BNEF (2016). Global trends in renewable energy investment. P. 49.

¹⁰⁴ <http://newsroom.bankofamerica.com/press-releases/environment/catalytic-finance-initiative-brings-together-banks-and-investors-directs->

investments. CFI partners bring expertise in a broad range of financial specialty areas including clean energy infrastructure finance, green bonds, project finance, green asset-backed securities, emerging markets investment and advisory assistance, and approaches to blending public and private finance.

3.2.2 Institutional investors

Institutional investors can be broken down into asset owners and investment managers. Asset owners pool money from individuals and organisations (beneficiaries) to act as professional investors on behalf of others. They include insurance companies,¹⁰⁵ pension funds,¹⁰⁶ investment managers,¹⁰⁷ foundations and endowments,¹⁰⁸ sovereign wealth funds,¹⁰⁹ and non-fund pension assets.¹¹⁰ Investment managers undertake the day-to-day management of these assets, either in-house or through external asset management companies.

Institutional investors are one of the largest sources of private capital investments with roughly EUR 63 trillion¹¹¹ of assets under management versus global financial assets of around EUR 190 trillion.¹¹² In Europe, institutional investors' assets under management amount to roughly EUR 13.5 trillion.¹¹³ While institutional investors are not the only relevant source for providing the capital needed for the low-carbon transition, their significant share of financial assets means they could play a key role as a source of capital for achieving climate goals.

As can be seen in the figure below, institutional investment in European renewable energy projects has been increasing steeply over the past 10 years.

¹⁰⁵ (i) Life insurance companies: provide life insurance, annuities and pension products and (ii) Non-life or property insurance companies.

¹⁰⁶ Collect money/contributions and invests it to generate stable growth over the long term, and provide pensions for employees when they reach the end of their working years and commence retirement.

¹⁰⁷ Intermediaries managing assets for pension funds, insurance companies or individual investors, use of segregated or co-mingled funds (e.g. mutual funds).

¹⁰⁸ Typically quite small, supporting activities of organisations over the long-run.

¹⁰⁹ Typically quite small; almost all assets are managed by Norges Bank Investment Management (NBIM) in Norway.

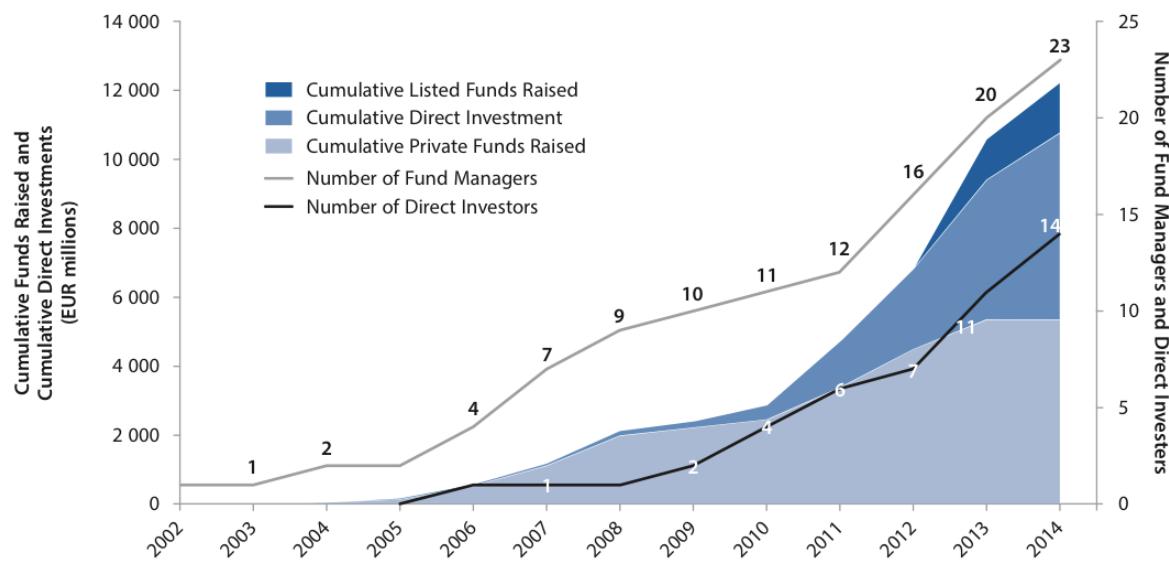
¹¹⁰ Pension related assets that do not fit in the above categories, are not managed by traditional pension fund. Some assets function as short-term liquidity or represent double counting of assets from the above categories. E.g. pension reserve funds, security reserves in risk-free assets, investment retirement accounts (IRAs), insurance contracts.

¹¹¹ Kaminker, Ch. et al. (2013), "Institutional investors and green infrastructure investments: selected case studies", OECD Working Papers on Finance, Insurance and Private Pensions, No.35, OECD Publishing.

¹¹² Estimates from the McKinsey Global Institute based on 2012 trends.

¹¹³ OECD Institutional Investor database.

Figure 3-3 Institutional investors are increasing their investment in renewable energy in Europe

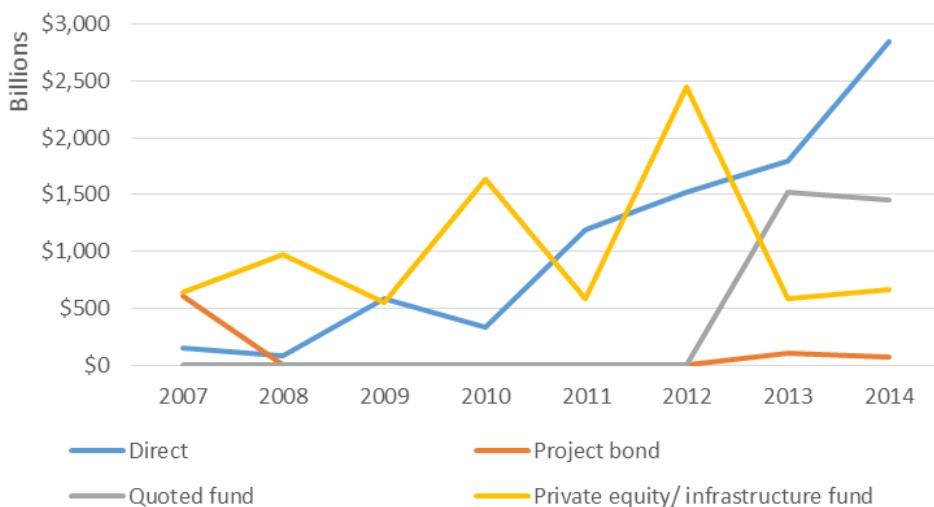


[Source: OECD (2014), Mapping Channels to Mobilise Institutional Investment in Sustainable Energy, Green Finance and Investment, OECD Publishing citing Murley (2014)]

While total investment in 2007 amounted to US\$1403 bn it had risen to US\$5046 bn by 2014.

The figure below shows in more detail which type of investment instrument has been used by institutional investors over time. As can be seen, for example, direct investment in renewable energy projects as well as the usage of quoted funds has risen steeply over the last years, whereas project bonds only represent a small share of institutional investment in the field of renewable energy.

Figure 3-4 Institutional investment in European renewable energy projects, 2007-2014 (in US\$ bn)



[Source: own development based on BNEF data]

However, despite this significant increase in absolute terms, sustainable energy investment still accounts for a very small share of institutional investors' assets under management; although how minor is difficult to quantify precisely. Using the limited data available, analysis find that the share of investment in the portfolios of pension funds and insurance companies is around 1-2% for green, between 5-10% for brown, and for high-carbon sectors around 20-25% (Figure 3-5 below).¹¹⁴ The rest of the portfolio was classified as "other". The highest share of climate-friendly is in the infrastructure funds of the alternative parts of institutional investors' portfolios and the lowest share in the bond portfolio. The high share of "other" - assets with an unknown climate impact - illustrates the difficulty in providing a full picture of institutional investors' current exposure to climate-friendly assets. Types of climate-friendly assets investments flow also vary by asset class.

¹¹⁴ The sectors used for the capital expenditure analysis come from the International Standard Industrial Classification of All Economic Activities (ISIC), Rev 3.1. The following categories were created:

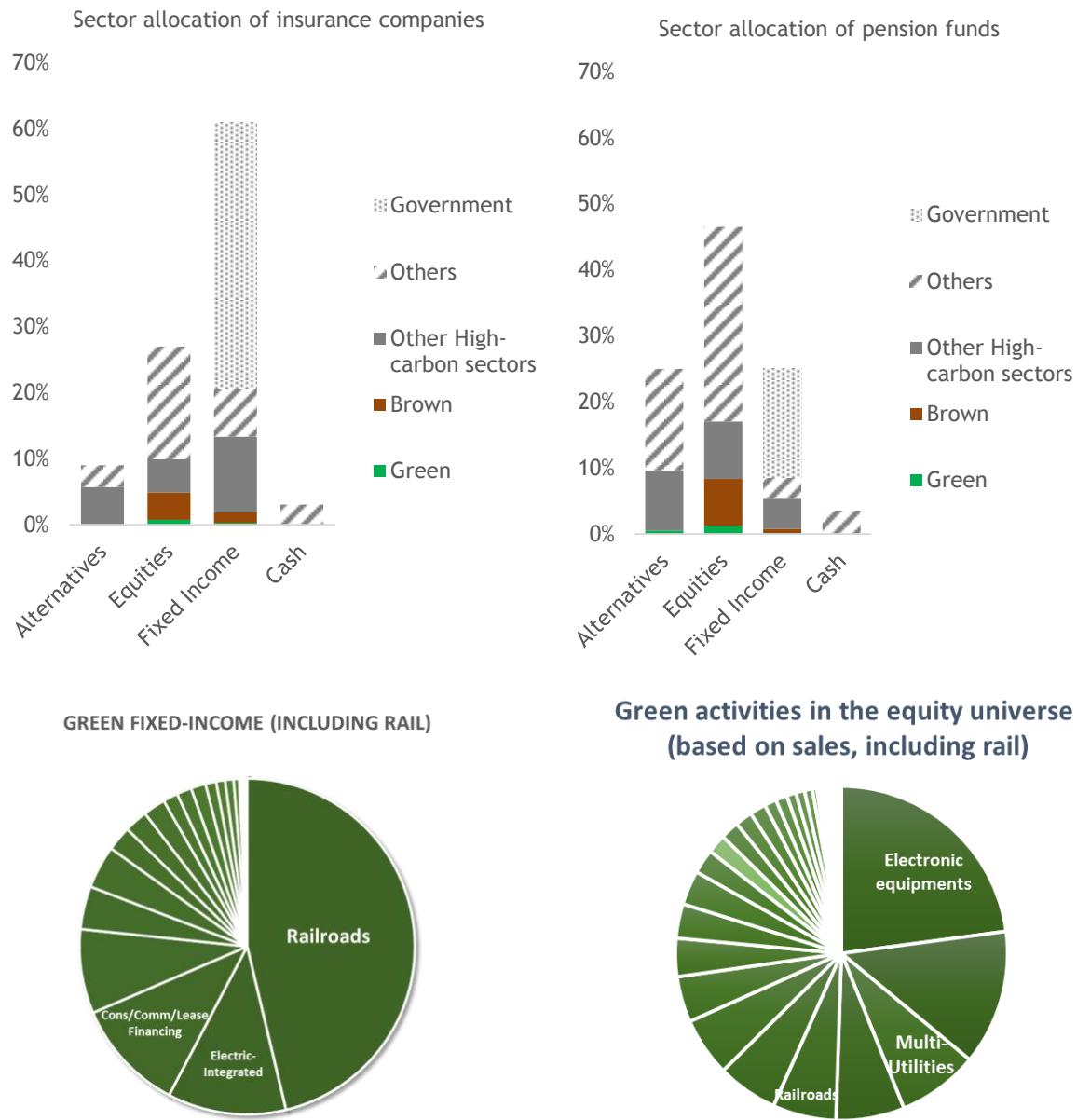
Green includes the green share of the green innovators list computed and published by MSCI. The rest of the 'green innovators' sales is included in those companies' own industry sector. Green also contains railroads.

Fossil Fuels & Power: Multi-utilities, Oil Equipment. & Services, Integrates Oil & Gas, Oil & Gas Exploration & Production, Gas Distribution, Coal, Pipelines.

Highly exposed to energy-efficiency challenges: Commodity Chemicals, Iron & Steel, Heavy Construction, Building Mat. & Fix., Electrical Equipment, Automobiles, Speciality Chemicals, Auto Parts, General Mining, Home Construction, Aluminium, Paper, Plat. & Precious Metal, Gold Mining, Electrical Office Equipment, Nonferrous Metals, Diamonds & Gemstones, Forestry, Transport Services, Bus. Train & Employment, Airlines, Communication Vehicles, Trucks, Trucking.

Other sectors: All other sectors not listed above.

Figure 3-5 The share of climate-friendly investment in institutional investors' portfolios by asset class



[Source: FtF, based on approach from 2° Investing Initiative 2014,¹¹⁵ Data from DataStream¹¹⁶, Towers & Watson 2014,¹¹⁷ Thomson Reuters 2014,¹¹⁸ AMP Capital 2014,¹¹⁹ MSCI ESG Research¹²⁰]

¹¹⁵ 2° Investing Initiative (2014). "Alignment of investment strategies with climate scenarios: Perspectives for Financial Institutions"

¹¹⁶ Thomson Reuters Datastream Professional – one source for complete cross-asset data and analysis. <https://forms.thomsonreuters.com/datasream/>

¹¹⁷ Towers & Watson (2014). Global Pension Asset Study. <http://www.towerswatson.com/en/Insights/IC-Types/Survey-Research-Results/2014/02/Global-Pensions-Asset-Study-2014>

¹¹⁸ http://share.thomsonreuters.com/PR/IB/Quarter_End/1Q2014_Global_Project_Finance_Review.pdf

¹¹⁹ AMP Capital (2014). "Building a Better Portfolio", *Institutional Investor Research Report*, Volume 3, May 2014. <http://www.ampcapital.com/AMPCapitalGlobal/media/contents/Campaign/IIR/Issue3/AMP-Capital-Institutional-Investor-Custom-Research-Group-Issue3.pdf>

[Note: pie graphs highlight the dominance of specific sectors; remaining labels have not been provided] The small percentage of overall investment dedicated to climate-friendly assets has a number of explanations which are further developed below and in Chapter 4 on "influencing factors" however these have mostly to do with the individual size, overall volume and the lack of historical data for such investments.

While there are large uncertainties with the estimates presented in the figures above, we can conclude from the analysis that:

- A robust definition for what is defined as a climate investment is not available. This makes it difficult to make an estimate of the share of climate-friendly assets in an institutional investor's portfolio.
- The order of magnitude of climate investment as a share of the overall portfolio is likely in the low single digits of trillions of Euros. While this represents an insignificant figure in terms of the share of the overall institutional investors' portfolios, this is still a very significant figure and untapped potential in terms of reaching the clean energy investment levels that are urgently needed to close the current investment gap.

However, institutional investors have an extremely conservative and prudent attitude because of their accountability to their mandate (match assets to liabilities) and the stringent regulations they are bound to. Additionally, they invested mostly large volumes (€100 millions), making smaller projects uninteresting. As it is further explained, aggregation (mostly via securitisation) is not an easy task mostly due to the lack of congruence between such projects. Further, in the field of energy efficiency, the lack of track record of e.g. payment default for energy efficiency loan portfolios is an additional issue.

These two factors make institutional investors less likely to invest in the developing clean energy sectors as they are still not very mature sectors or correspond to smaller projects. However, especially in more robust renewable energies such as wind and solar PV, there is a definite growing involvement of such institutional investors. Nonetheless, institutional investors invest also modest amounts in PE/VC via specialised vehicles.

Additionally, an increasing number of institutional investors are committing to exit any carbon intensive investments. Although this does not directly bring hard cash to clean energy project opportunities, this sends a clear signal to the markets that such reputable players do not see any long-term future in carbon intensive investments any longer. Institutional investors have joined forces under the 'Portfolio Decarbonisation Coalition' and committed to oversee the decarbonisation of US\$ 600bn of Assets under Management'.¹²¹

3.2.3 Other financial markets investors

Other financial investors (apart from institutional investors) falling under the broad umbrella of capital market investors include venture capital / private equity (VC/PE), seed/angel capital investors, as well as alternative finance.

Venture Capital/Private Equity

¹²⁰ MSCI ESG Research data and analysis available at http://www.msci.com/products/esg/about_msci_esg_research.html

¹²¹ unepfi.org/pdc

Venture capital and private equity (VC/PE) is all money invested by venture capital and private equity funds in the equity of specialist companies developing renewable energy technology. VC is usually originated from high worth individuals and as a small part of the portfolio of large institutional investors, like pension funds and insurance companies.

As can be seen in the table below, VC/PE investments had increased strongly in the 2006-2008 period in Europe and then dropped again and have remained stable at around US\$0.5 billion per year.

Table 3-5 VC/PE new investment in renewable energy, 2004-2014 (US\$ bn)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Europe	0.5	0.5	1.3	1.4	2.5	1.1	0.9	0.9	0.7	0.5	0.3

[Source: BNEF data]

Data analysis¹²²¹²³ allows for a further breakdown of this overall VC/PE investment figure for all renewable investments in the EU into four stages mapping directly to the technology innovation chain:

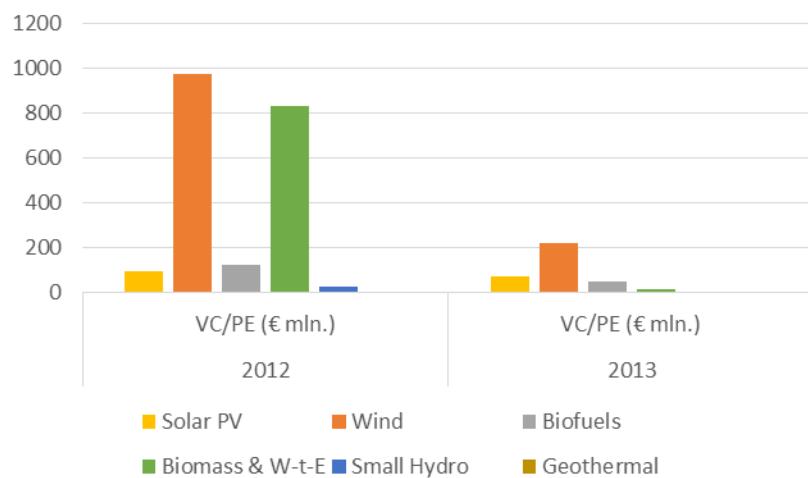
- I. **VC for early stage investments.** Early stage venture capital is provided to seed high-risk, early-stage / emerging young companies for, e.g., research and development in order to develop a product or business plan and make it marketable.
- II. **VC late stage.** Late stage VC is often used to, e.g., finance initial production capacities and marketing activities.
- III. **PE expansion capital.** PE expansion capital is typically aiming at more mature / established companies and hence is less risky.
- IV. **PE buy-outs.** PE buy-outs are investments to buy (a majority of) a RES company and often imply high investments compared to the other PE and particularly VC deals. It should be noted that this is, however, often not counted as new investment.

As regards the spread of VC/PE across the different renewable energy investment opportunities, there is a strong dominance of wind sector investments. VC/PE investments in other renewable energy technologies fluctuates with solar PV, biomass and waste-to-energy, as well as biofuels receiving most of the VC/PE investments that don't go to wind technologies.

¹²² EUObserveR (2015). The state of renewable energies in Europe. Edition 2015.

¹²³ TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

Figure 3-6 VC/PE investments in renewable energy per technology in the EU, 2012 and 2013



[Source: Own development based on EU Observ'ER (2015). The state of renewable energies in Europe. Edition 2015.]

Geographic differences show a predominance of most VC/PE investment deals (in terms of number of projects) happening in France, Germany and the UK, whereas Denmark ranks top of the list in terms of total VC/PE investment volumes.

As regards the future, De Bruyn et al (2016)¹²⁴ indicated that VC/PE may experience "an important bottleneck". This is based on the study's predicted investment needs for VC/PE of €30 billion per year between now and 2025. This would present a large challenge given current annual VC/PE investment volumes of under €1 million. This deficiency of VC/PE funding represents a large challenge not only in terms of volumes but also because it presents a barrier between the successful public investment into R&D and early stage development of innovative technologies and the failure and apparent lack of appetite to subsequently support development of young companies within Europe via private investment.

Seed capital, Angel capital

Seed capital, retained earnings and angel investments in Europe is heavily complemented by direct and indirect government support. Government support comprises grants, subsidies and expenditures in research and development (R&D) via universities or directly to the researchers. Also, European firms can attract funds from several EU funds to support the research, development and demonstration of innovative projects. The total average annual budget of these funds was around €25 billion in the period 2007-2013.¹²⁵

Overall, the level of initial capital in the EU is relatively adequate for the development of new technologies in the area of clean energy. Nonetheless, today this is mostly sourced out of public funding and this is unlikely to switch towards private funding in the future.

¹²⁴ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft.

¹²⁵ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft.

Alternative finance

Online alternative financing includes financial transaction platforms such as equity-based “crowdfunding”, which are quickly becoming a popular way for European SMEs and startups to access capital rather than going to banks for credit, or VC firms for seed funding. In less than a decade Europe has seen the progression of an internet driven retail equity holding tool (i.e. “crowdfunding”). This alternative finance amounted to roughly €3 billion total (not limited to clean energy) in 2014, although mostly in the UK (for 80%), and was estimated to almost double in size by 2015.¹²⁶ Climate-friendly investments have the potential to tap into such alternative finance channels in the future. However, this new mean of financing is designed to attract small scale financing and present much less assurance on the quality of investments for the investor. Countries such as Germany discourage individual investors to invest large amounts in “crowdfunding”. Therefore, we do not envisage it to play a decisive role for the financing of clean energy for the decades to come.

3.2.4 Private companies

One of the most important sources of finance for the clean energy transition challenge are private companies investing their own resources, e.g. large utilities or other companies investing from their balance sheets currently in RES or EE projects. It should be noted that most of the evidence discussed in this section focuses on RES, as much less information is available for EE.

Private companies primarily use their own equity (savings) and channel this towards clean energy investments via balance sheet financing. Or they combine their own equity with debt finance acquired via financial markets or bank lending.

2016 has shown the continuation in the trend of private companies aiming to make their operations more sustainable as a whole. This includes the trend of more and more companies purchasing renewable energy. For example, a BNEF Research Note¹²⁷ in early 2017 shows that 7 of the 10 largest quoted corporations in the world have committed to using 100% renewable electricity in their operations via a mixture of onsite solar and wind installations, purchasing renewable energy certificates, and power purchase agreements.

Large European utilities

Large European utilities continue to be an important source of equity finance for renewable energy projects; in particular at the development and pre-construction stage. Such projects are usually financed on the utilities' own balance sheet, which may be complemented with partial debt finance. In 2014, nine of the largest European utilities invested a total of US\$11.9 billion in equity for renewable energy.¹²⁸ This amount is 6% higher than in 2013 but 19% less than the US\$14.6 billion peak in 2010. There is no clear trend per utility company however: amounts committed by individual utilities have fluctuated significantly. In 2014, for example, Iberdrola and

¹²⁶ Wardrop, Robert et al (2015). Moving Mainstream The European Alternative Finance Benchmarking Report. University of Cambridge.

¹²⁷ BNEF (2017). BNEF Research Note. Accessible for clients at: <https://www.bnef.com/core/insight/15687>

¹²⁸ Frankfurt School-UNEP Centre & BNEF (2016). Global trends in renewable energy investment. P. 46. These figures are drawn from the annual reports of SSE, Iberdrola, Enel, E.ON, RWE, EDP - Energias de Portugal, EDF, Dong Energy and Vattenfall.

SSE were investing less than a third of the amount they did in 2010, whereas EDF invested about 40% more than in 2010.

3.2.5 Small end-users

Next to private companies, the small-end users, including individuals, households and SMEs, are a tremendously important source of finance for European clean energy transition efforts. Individual households – via self-financing from their own savings or small loans from banks – have already unlocked vast amounts of money, in particular for energy efficiency measures in buildings and transport, as well as established renewable energies.

As emphasised in the 'Clean Energy for All Europeans'¹²⁹ policy package, consumers, i.e. small end-users, are the drivers of the EU's clean energy transition. New technologies, including smart grids, smart homes, rooftop solar panels and battery storage solutions, as well as the emergence of electric vehicles have enabled small energy end-users to also become active players influencing the market with their purchasing decisions. To this end, the revised EU Renewables Directive also aims to further enable consumers to self-consume renewable energy without facing undue restrictions and a reassurance that they will be remunerated for the energy they might sell into the grid.

While it is not possible to quantify the role played by small end-users due to the lack of sufficient data, it is still important to highlight in a qualitative way that in particular for the energy efficiency in buildings area, small end-users are one of the most important sources of finance. For instance, dwellings represent around 90% of total investment by households. In most cases, it can be assumed that these investments have as one of their impacts an increase in the energy efficiency of the building stock.

3.3 Instruments for financing clean energy investments

Having introduced the main sources of finance, this section focuses on explaining the different investment instruments at their disposal for channelling the finance towards the various types of clean energy investment opportunities.

Many types of investment instruments can play a role in clean energy finance. They all serve different purposes and depend on the type of project and the type of actor involved. Some have the main purpose of mitigating the financial risk of an investment (guarantees, insurance, credit lines, equity, subordinate loans), others to provide capital/ increase return on investment (debt, venture capital, grants).

Two challenges arise when trying to track the financial flows from these different instruments. First, some instruments are not easily measured in monetary terms. A guarantee or insurance is only paid out if the investment defaults or has financial damage. Second, the effectiveness of the various instruments in delivering climate mitigation or adaptation is not captured in monetary terms: one euro spent through a guarantee may not mitigate the same amount of CO₂ emissions as one euro spent through equity, or debt.

¹²⁹ <https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition>

3.3.1 Public direct investment

Public direct investment is balance-sheet finance from national or local governments or public agencies. Public agencies may decide to spend their own resources as direct investment in clean energy to either support a specific type of technology that may not be able to get financed via private financial instruments, or to leverage additional private investment to come on board. Public agencies might also use public direct investment for clean energy measures, such as rooftop-solar installations or energy efficiency measures that would improve clean energy results of their own operations.

3.3.2 Policy-based incentives

Policy-based incentives include financial instruments such as subsidies, tax incentives and guarantees.

Tax incentives is a very strong tool in government public finance, which may focus on downstream investment decisions for households and companies. This has been used notably in the case of household energy efficiency.

Section 3.1 above has already introduced various policy-based incentives options on national and EU levels that are being applied as financial instruments to speed up the clean energy transition. It should be reiterated here that neither the ETS nor a carbon tax are part of the scope of this report and have consequently not been included in this discussion of policy-based incentives.

As described in Chapter 4 of this report, a stable and supportive policy design and related incentives measures represents one of the crucial keys to success for a rapid and successful clean energy transition in Europe.

3.3.3 Grants

Most EU and national funding currently works by using grants, subsidizing a particular project through the use of public money. Grants are a very adequate tool for addressing specific market barriers (e.g. when projects are not financially viable under the current market conditions) or when supporting the most vulnerable consumers who do not have access to savings or debt products. Yet, in some cases profitable EE investments can benefit from grants but are not undertaken by middle-income and high-income households as well as companies.¹³⁰ Conversely, some projects benefit from grants even though the returns of investments could have justified the use of loans instead, with then the potential to reuse initial public funds for other projects when the first project is paid back.

3.3.4 Public-private partnerships

Public finance can play an important role in leveraging to reach larger amount of private funding. This is usually done indirectly via subsidies and grants which are stepping stones for companies to reach more mature stages of developments where private funding is more readily available. However public funding can also be more directly deployed to a public-private mixed financing approach. In the context of this project, public-private partnerships (PPPs) can therefore be defined as a financing

¹³⁰ Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

instrument that combines investments from both public and private sources under a common umbrella that can then be accessed by various clean energy technologies depending on whether or not they fit that PPPs selection criteria.

Such a public-private partnership set-up is, for example, being employed within the European Fund for Strategic Investment (EFSI) launched in mid-2015. The fund provides risk-sharing through public funds to stimulate private funds within two windows of investments, "infrastructure and innovation window" and SME window". These innovative public tools offer for SMEs, guarantees supporting loans to compensate higher-risk profile and equity investment in venture capital and equity funds. For infrastructure and innovation this is provision of long-term debt, subordinated loans and Equity and equity financing. At least 40% of the infrastructure projects under EFSI should contribute to climate action, in line with the commitments under the Paris climate agreement.

However, such direct combinations of public-private funding are not a well proven concept yet and the public funding with a leverage factor of 15, as initially expected, may be too ambitious. In public-private partnership developing funds, for example, where such leverage has been tested for a number of years now, the actually achieved leverage factor is usually only between 3 and 5.¹³¹ On clean energy related investments, the leverage factor is rarely above 5.

Box 3-1 Potential risks for using EFSI as a public-private partnership vehicle for clean energy finance¹³²

There is a general expectation that EFSI not only serves to boost investment, jobs and growth in the short term but also contributes to attaining important long term EU goals, such as raising EU's growth potential, accelerating the transition towards a low-carbon economy or favouring the integration of EU financial markets. While in theory short-term and long-term goals are compatible, in practice there might be some tensions between them. A purely counter-cyclical approach recommends prioritizing the quick deployment of EFSI, and this implies focusing on mature, ready-to-be-implemented projects having significant short-term effects on growth and employment, at the expense of others requiring more efforts of structuring and providing important long-term benefits but weak short-term return.

This might be particularly penalizing for low-carbon projects. They provide important long-term benefits but not necessarily major short-term gains in terms of growth and jobs. Besides, markets for low-carbon technologies and projects are rather new; which means that the identification, preparation and structuring of those projects is longer and more complex than for ordinary projects. In addition to that, one should note that the attainment of the EU's climate objectives not only requires an increase in investment in low-carbon infrastructures and technologies, but also a stop to investment in high-carbon intensive infrastructures. As some of these infrastructures might have significant short-term economic returns, an EFSI purely inspired on a short-term logic might end up financing an important number of these projects.

It is difficult to assess the importance of this risk. If we look at the performance of EFSI so far, the picture is mixed. 17 out of the 42 EIB operations approved or currently under assessment for EFSI support are in the field of climate/ energy, and the overwhelming majority correspond to clean energy projects (see table).

Table 3-6 List of EIB operations approved or under assessment for EFSI on energy/climate (until January 2016)

	Renewable energy	Energy efficiency	Smart grids	Gas infrastructure
UK	3	2	1	
France	2	1		
Denmark	2			

¹³¹ https://www-cif.climateinvestmentfunds.org/sites/default/files/Assessing_leverage_in_the_CIF.pdf

¹³² Extract taken from Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

Italy		1	1	
Belgium	1			
Germany	1			
Ireland	1			
Spain				1
Sweden	1			
TOTAL	11	4	2	1

[Source: European Commission (2016). The Investment Plan for Europe. State of play 13 January 2016 – Energy and climate action.]

The balance however is less positive if one looks at the transport sector: the EIB has currently 8 transport projects under assessment: three of them consist into the construction/widening of a motorway and none is a “smart and sustainable urban mobility project”, despite the fact that the latter is a priority area for investment according to the EFSI regulation.

In any case, nothing guarantees that the Fund will provide a sustained support to clean energy projects over the whole investment period. A necessary condition for that to happen is the existence of sufficient demand for this type of investment over time and across countries, and capacity to structure bankable, high-quality projects. A combination of national regulatory reforms and targeted technical assistance in certain countries and sectors – such as energy efficiency and sustainable transportation – seems essential.

In addition to that, it should be noted that the procedures for the selection of EFSI projects are ‘carbon-neutral’. There are no sectoral pre-allocation quotas, and EFSI project proposals are appraised and selected by a committee composed of independent experts (the Investment Committee) using a ‘scoreboard’ defined by the Commission through a delegated act. The scoreboard values the contribution of projects based on the attainment of EFSI policy objectives but the list of EFSI objectives and priority areas is very large and projects in ‘low-carbon’ sectors (energy efficiency, renewables, sustainable transport) are not prioritized. Finally, as climate considerations are not mainstreamed in the appraisal and selection of all projects, projects having a significant carbon footprint can eventually receive EFSI support.

3.3.5 Concessional debt

Concessional debt are loans with favourable conditions, e.g. below-market rate loan conditions. For a given level of borrowing, lowering interest rates reduces annual debt payments. An important criterion in determining how much a project can borrow is the percentage of a project’s cash flows that are needed to service the debt. With lower interest costs, debt service costs fall, so more debt can be taken on without affecting the rating of the debt or raising its cost.

The majority of renewable energy project costs occur at the beginning of the project with the initial capital investment. The initial capital cost of wind, photovoltaic, and hydropower often comprise nearly 90% of total project costs (as compared to just under 70% for coal and only 24-37% for gas projects).¹³³ Most renewable energy projects use debt – either directly at the project level or on the balance sheet of the corporate owner – to reduce the cost of financing. Therefore, the availability of low-cost debt is a critical driver of renewable energy costs.

Concessional lending is used as an investment instrument in particular by national promotional banks and EU public financial institutions in order to leverage additional private finance for clean energy projects, which would otherwise not happen under

¹³³ Nelson, David and Gireesh Shrimali (2014). Finance Mechanisms for Lowering the Cost of Renewable Energy in Rapidly Developing Countries. A CPI Series. Available at: <https://climatepolicyinitiative.org/wp-content/uploads/2014/01/Finance-Mechanisms-for-Lowering-the-Cost-of-Clean-Energy-in-Rapidly-Developing-Countries.pdf>

market-rate conditions. Concessional debt is also supported by national governments via different supporting tools.

3.3.6 Commercial market-rate debt

Commercial market-rate debt includes lending in form of regular loans, non-recourse loans, more elaborate lending such as mezzanine, guaranteed loans & cash loans leasing and bonds. Most of the lending in Europe has been traditional lending by commercial banks especially in the areas of wind and solar energies.

Such loans can be to manufacturers as well as to specific project developers.

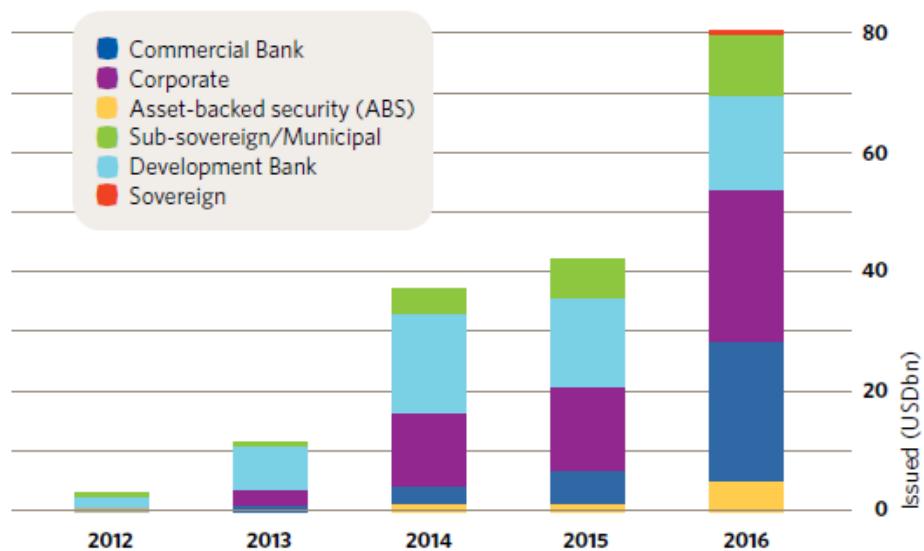
As expected, national promotional banks and EU public financial are very active in debt finance, in particular when sectors ramp up or are more "tricky" to finance currently, such energy efficiency projects.

More sophisticated with larger potential in the long run, bonds are much less developed today with private commercial banks. Mostly due to the size of debt issued for clean energy financing but also due to uncertainties on the revenues and the short history of such investment, today, most clean energy projects seek traditional debt via loans from banks and similar organisations rather than more complex bond issuances.

3.3.7 Green bonds

2016 marked a record year with global green bond issuance of US\$ 81 billion, an increase of 92% compared to 2015 figures. Given trends over the last years (see figure below), green bonds undeniably have the potential to be decisive for clean energy investments. Europe represents about 20% of this amount (almost US\$ 20 billion of issued green bonds in Europe in 2016).¹³⁴

Figure 3-7 Global green bond market, 2012-2016



[Source: Climate Bonds Initiative (2017). Green Bonds Highlights 2016.]

¹³⁴ <http://www.climatebonds.net>

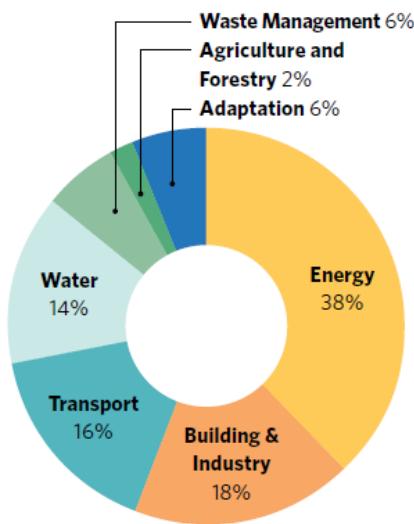
Outsides of institutional investors, banks and other investors do purchase green bonds which have lower grading. However, green bonds are issued for proven technologies on large projects, mostly restricting them to wind and solar at this stage. With over 85% of the bonds being of individual size larger than US\$100 millions.

However, 2016 has also seen the emergence of more and more sub-sovereign actors (in particular in Northern Europe) to engage in the development of municipal and city bonds: Nordic municipality debt aggregators were key players enabling small municipalities access to low-cost capital through the bond market despite their small size.

In 2016, Poland has become the first country in the world to issue a sovereign green bond of EUR 750 million. France has already followed suite by issuing a EUR 7bn green sovereign bond in January 2017 and other countries are also likely to start using this new financing instrument to leverage additional green debt finance for their clean energy transition.¹³⁵

In terms of the use of green bond proceeds, 2016 saw a more even spread across all seven sectors, giving an indication that the transition to a low-carbon and climate-resilient economy is taking place across all sectors.

Figure 3-8 Sectoral spread of green bonds proceeds in 2016



[Source: Climate Bonds Initiative (2017). Green Bonds Highlights 2016.]

Green bonds have a good potential in Europe however their growth is conditioned by various factors¹³⁶:

- the “integrity of the market” via the adoption EU wide of standards which guarantees the “green” aspect of the bond;
- wider strategic issuance from public entities;
- facilitation of aggregation of small projects via securitisation and other means to build on the current specificities of the market;

¹³⁵ Climate Bonds Initiative (2017). Green Bonds Highlights 2016.

¹³⁶ UNEP-Inquiry & 2° Investing Initiative (2016). Building a sustainable financial system in the European Union. P.23.

- improving risk/return profile via credit enhancement such as partial guarantees and subordinated debt. For instance, when a Green Bank or a development bank provides some sort of guarantee, or provides finance in the form of subordinated debt, to reduce the risk to other investors;
- Green bonds becoming part of the mandate of institutional investors' portfolios;
- International cooperation through mutual recognition of standards and improve market liquidity.

According to the Climate Bonds Initiative, the main trends to be expected for the years to come are three-fold:

- More issuance from sovereign and sub-sovereign issuers as governments try to mobilise green investment and support market liquidity.
- Policy developments will push green finance even further (e.g. via the European Commission's new Expert Group on Sustainable Finance) and the enabling environment for green bonds is expected to further improve.
- Over-subscription of green bonds and tight pricing will remain and more issuers from lower rating bands (e.g. commercial banks) are expected to enter the green bonds market.

3.3.8 Equity

Parallel to debt is over the counter (OTC) equity holding, often facilitated by banks and similar financial organisations. This plays an essential part in the development of clean energy technologies. A large range of organisations are able to provide opportunities for equity investments for the energy transition, this includes large utilities and energy plants developers. Via equity investments, investors from outside the energy sector, such as infrastructure funds, private equity funds, insurance companies and pension funds can take an interest in these new sectors. 2015 has seen innovations to convince institutional investors to invest debt and equity finance into renewable power notably in Europe. Platforms were established where institutional investors could access such investments with the reassurance of having a technically experienced bank involved alongside them. For example, in 2016, Swiss Life contributed €300 million to a platform with French bank Natixis.¹³⁷

One important point regarding such OTC equity is that financial investors' equity investment decisions are influenced by their risk perception of the investment opportunity. The DiaCore research report¹³⁸ showed that the cost of equity for onshore wind projects ranged between 6% (Germany) and more than 15% in Greece, and eastern European counties in 2014. While the cost of debt varied between 1.8% in Germany and 12.6% in Greece in 2014. This wide range is directly due to numerous factors, further explained later in this report. Onshore wind is representative of other matured renewable energies.

The same report looks at the cost of equity and the cost of debt in parallel to the cost of capital. This gives us a good idea of how financial institutions look at equity and debt. The cost of equity is influenced by risk perception of investors while the cost of debt is the remuneration for lending funds which a bank is ready to accept.

¹³⁷ Frankfurt School-UNEP Centre & BNEF (2016). Global trends in renewable energy investment.

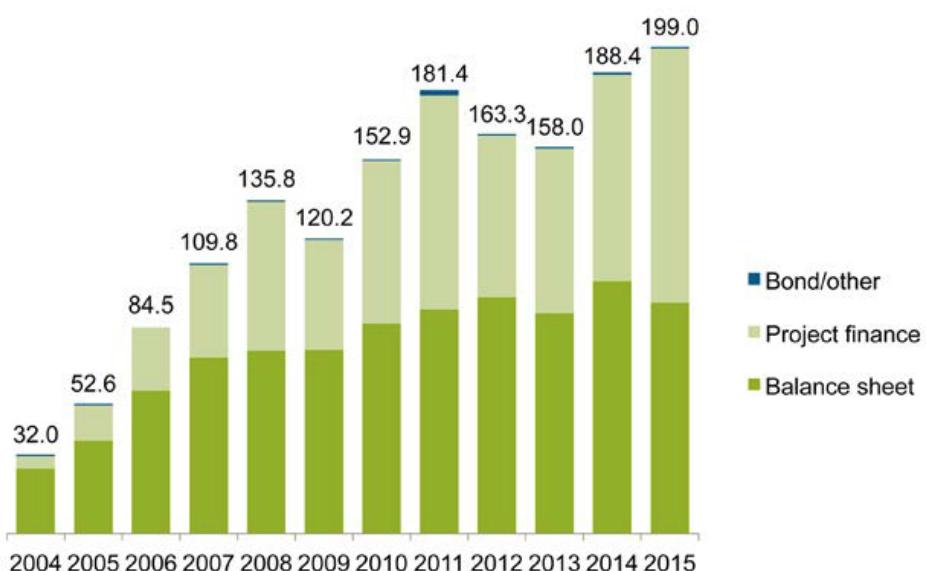
¹³⁸ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report.

3.3.9 Balance sheet financing

Balance sheet financing is an investment channel primarily used by private companies investing equity and/or debt via their company's balance sheets.

Utilities continue to be an important source of equity for renewable energy projects at the development or pre-construction stage. As can be seen in the figure below, the split in asset finance between on-balance-sheet funding by utilities and specialist developers, and non-recourse deals involving project-level debt and equity shows the important role balance-sheet financing has been playing in renewable energy investment worldwide.

Figure 3-9 Split in global asset finance between on-balance-sheet funding by utilities and specialist developers and non-recourse deals involving project-level debt and equity, 2004-2015, US\$ bn



[Note: Total values include estimates for undisclosed deals.]

[Source: Bloomberg New Energy Finance]

Yet, the fastest evolving aspect of equity provision for RES investments over the last years has been at a post-construction stage, when new and more risk-averse institutional investors have been keen to get involved in order to access the predictable cash flows of an operating-stage project.¹³⁹

3.3.10 Self-financing

Self-financing is the use of household/small end user savings invested in clean energy projects.

Self-financing has already unlocked vast amounts of money, in particular for energy efficiency measures in buildings, the uptake of electric vehicles, as well as roof-top solar installations.

¹³⁹ Frankfurt School-UNEP Centre & BNEF (2016). Global trends in renewable energy investment.

Self-financing is an attractive financing instruments for small-scale clean energy technologies that appeal to the consumer, e.g. smart home, smart metering, etc. These types of clean energy technologies will typically not receive finance from institutional investors or other larger investors looking for aggregated investment volumes. But on a European scale, if small end-users are mobilised via favourable policy incentives supporting or encouraging the self-financing of clean energy investments, there lies a large potential in self-financing as a means to access finance for particular types of clean energy technologies.

3.4 Investor attitudes

This section describes some of the key investor attitudes, i.e. how investors think through an investment decision. Whenever possible, differences in thinking for the various investor types are distinguished.

The role of 'Required Rate of Return'

Investments and risks are intricately linked to one another. Investment risks can be defined as the probability of certain risk factors occurring that can influence the investor's return on investment. The size of the perceived risk is therefore determined by two factors: (a) the likelihood of the factor occurring, and (b) the scale of the expected negative impact. The trade-off between the calculated risk and estimated return makes up the basis of financial decision-making.

Investors – depending on their risk preferences – will choose to invest in riskier or safer clean energy projects (or none at all). Since investors calculate their risks by setting discount rates, the height of these discount rates is extremely important for the investment decision. With a high discount rate, only those projects with a high internal rate of return (IRR) will pass the threshold for an investment decision, but this increases the costs for attracting capital and in turn the cost for clean energy projects. And if the discount rate is set too high, the investment in the clean energy project may even not be viable at all.

The main source to gain insight in the Required Rate of Return is the Diacore project¹⁴⁰ which has led to some conclusions about the WACC while at the same time looking at the debt/equity-ratio, cost of debt and cost of equity. Chapter 5 provides an in-depth discussion of differences between Member States in the underlying risk factors and the corresponding WACC discussions and how to apply this to the modelling process.

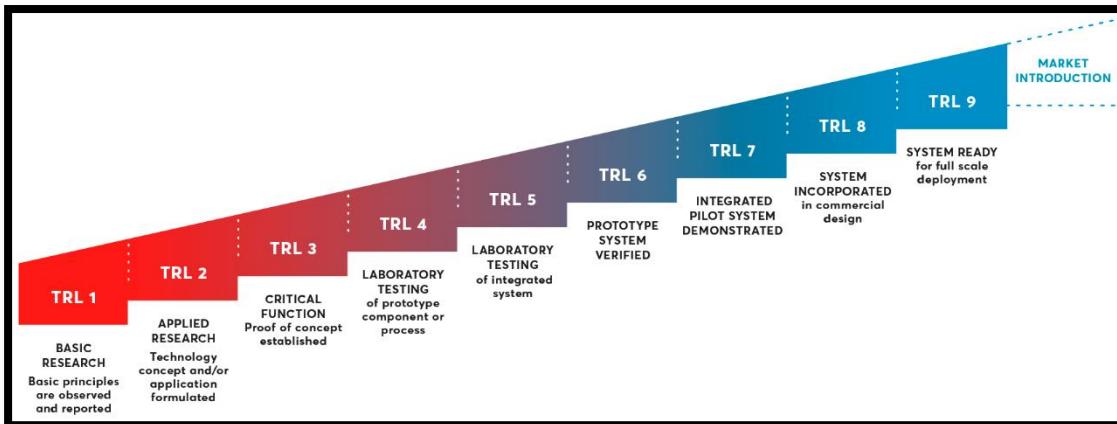
Every specific actor will establish his own required rate of return based upon the risk-free return (the inflation rate included) and a risk premium (which will depend on the maturity risk, default risk, seniority risk and marketability risk).

Understanding how the risk of projects is determined and the how it can be influenced is therefore central to this report. The next section provides further analysis regarding the role of individual project characteristics in determining investor appetite. Chapter 4 includes an in-depth analysis of influencing factors (often perceived risks) that shape the current size and direction of flows in the European clean energy finance landscape.

The role of the 'technology readiness level'

The technology readiness level (TRL) of a given technology heavily influences the availability of financing sources.

¹⁴⁰ <http://www.ecofys.com/files/files/diacore-2016-impact-of-risk-in-res-investments.pdf>

Figure 3-10 The 9 TRL levels

[Source: http://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf]

Basic R&D for new technologies, for example, is primarily financed by public sources and/or the companies' own resources. The further we move down the technology readiness chain, the less risky the investment becomes and the more private sources, such as venture capitalists, private equity, banks or institutional investors, will also become interested in the investment.

A number of avenues are available during the stages of 'Demonstration and Deployment' including a combination of public and private funding. However, these stages are the most difficult and where young businesses often disappear. The clean energy sectors are certainly no exception and these two stages are crucial to improvements in the mitigation efforts. TRL levels of 9 and higher are easier stages where viable businesses and projects can have access to plentiful private finance sources.

What can we learn about investor attitudes from this overview of different actors investing in different maturity moments of the low-carbon technology? These maturity moments are related to the perceived risk of each actor toward the concerned technology (and therefore his required rate of return), but as one can state in this table this is not the only influencing factor.

The financing sources described are private companies (own resources), new equity providers (consisting of VC/PE on the one hand and Institutional Investors on the other hand), private debt providers (split up in loans /bonds from commercial banks, Institutional Investors and VC/PE versus public debt providers via grants/guarantees or public loans / public equity).

Our aim is to gain insight on the issues for these actors and on which measures are needed to change certain attitudes and thereby attract more investments towards the different low-carbon technologies.

We have divided the low-carbon technologies into 3 sections:

- **R&D** because each actor looks differently to R&D in terms of risk. We have seen that only Business Angels and government supported university spin-offs are active in this sector. In this stage, the risk of failure is too high for other actors.
- **RES-Power Generation:** We have split the RES-power generation into RES-E (Renewable Energy Sources-Established being wind and solar) and RES-NE

(Renewable Energy Sources-Non-Established being biomass, tidal, wave) where we can see that different investors have different attitudes depending on the maturity of the technology. Each stage of maturity knows its own investors (after the Business Angels the VC/PE are stepping in, followed by the Institutional Investors in terms of maturity and risk).

- **Energy Efficiency:** we can distinguish the large industry, the buildings and the transport, each having their own specific challenges.
Our main source of information for the energy efficiency of buildings and industry sectors consisted of the Final Report of 'The Energy Efficiency Financial Institutions Group'. The conclusions provided in the report deliver key messages per group of investor type.

The role of individual project characteristics

When looking at what determines investment flows to the different clean energy sectors/technologies, the individual project investment characteristics also play an important role in the decision-making process of investors considering, whether or not to support the project.

The table overleaf presents our findings on the relative importance of different clean energy project characteristics on the decision-making process of potential investors.

As can be seen from the table below, R&D projects typically are characterised by high technology risk and are capital intensive. This excludes certain types of investors from investing in clean energy R&D. For established renewable energy technologies, on the other hand, the project characteristics of scalability (i.e. size of the project) and its policy environment are often the key determining project characteristics for an investment decision. For energy efficiency, there are quite some differences in function of the sectors. For buildings – where we distinguish between offices, factories, shops and hotels and public and private housing – technology risks are overall rather low. Only factories are indicated as highly capital intensive and where uncertainty of energy prices plays an important role. The indicator with the highest impact on investments flows in the build environment is the 'policy environment'. The last sector in the table below is the transport sector, which is divided into road, rail, air and water. Transport projects are overall characterised by high technology risks, are capital intensive, have high risks for construction cost overrun and are in general also sensitive for energy price uncertainty.

Table 3-7 Differences in investment characteristics of clean energy investment projects

		Type of clean energy project													
		R&D	Clean power generation		Energy efficiency / switching to renewable fuels										
			RES-E	RES-NE	Industry	Buildings					Transport				
						Offices	Factories	Shops and hotels	Public	Private	Technology	Infrastructure	Rail	Air	Water
	1. Technology risk	High	Medium	High	Medium	Low	Medium	Low	Low	Low	High	Medium	Medium	High	Medium
	2. Capital intensive	High	Medium	High	High	Medium	High	Medium	Medium	Medium	High	High	High	Medium	Medium
	3. Construction cost overrun risk	Medium	Medium	High	Medium	Low	Medium	Low	Low	Low	High	Medium	High	High	Medium
	4. Uncertain sales price (outputs)	Low	Medium	High	Medium	Low	Medium	Low	Low	Low	Medium	Low	Medium	Medium	Medium
	5. Uncertain energy prices (inputs)	Medium	Low	Low	High	Medium	High	Medium	Low	Low	High	Medium	High	High	Medium
	6. Socially unpopular	Low	Medium	Medium	Low	Medium	Low	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low
	7. Policy environment	Medium	High	High	Medium	High	Medium	Medium	High	High	High	Low	Medium	Medium	Medium
	8. Scale of project	Medium	Large	Small	Medium	Small	Medium	Small	Small	Small	Medium	Large	Large	Small	Medium

[Source: own development, 2017]

[Legend: high = high impact of project characteristic on investment decision; medium = might impact the investment decision; low = low impact of project characteristics on investment decision]

4 Mapping the interactions with European clean energy finance

Chapter at a glance

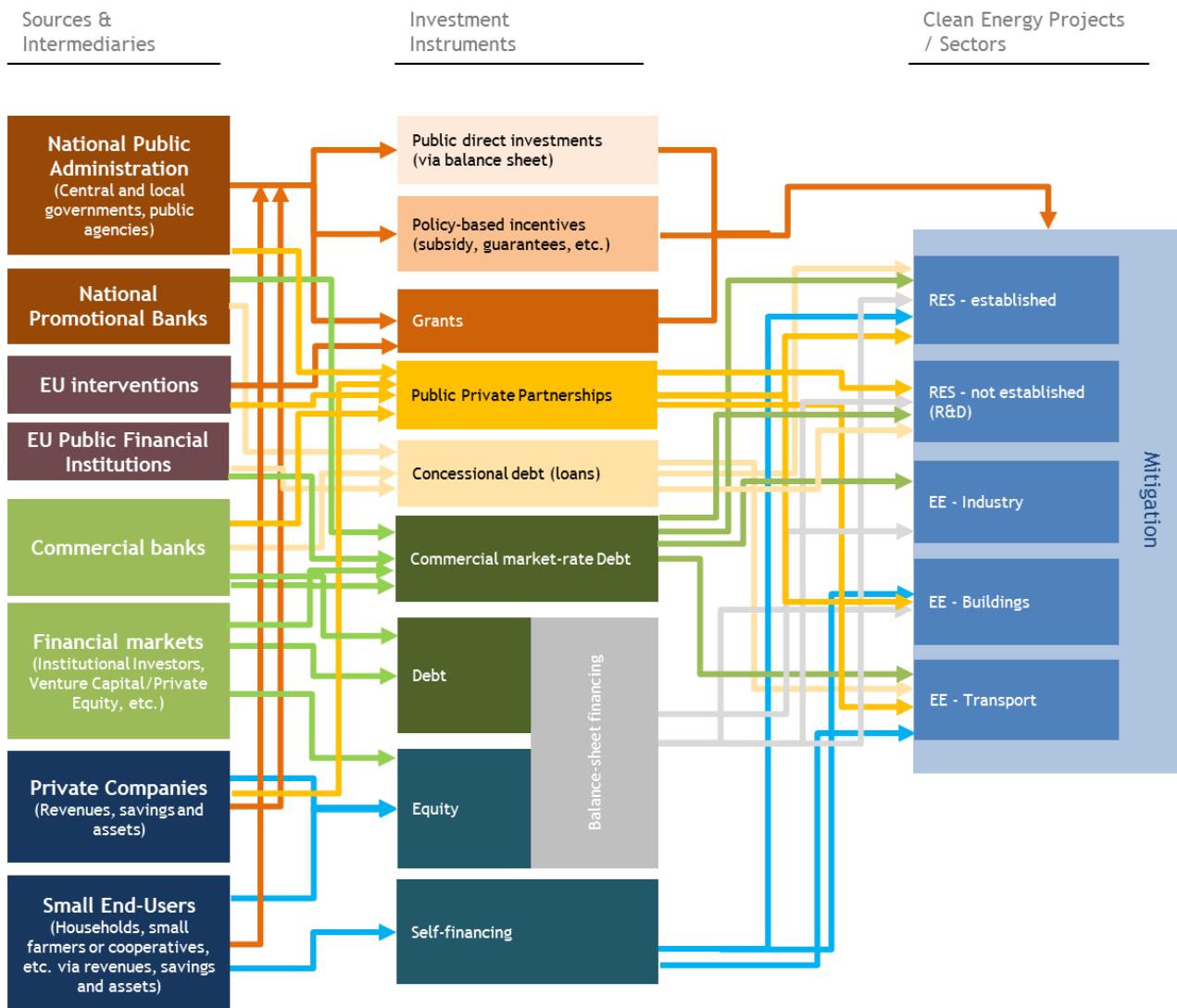
Having gained an understanding of the possible ‘clean energy investment project opportunities’ (chapter 2) and different ‘sources of available finance’ (chapter 3), this chapter maps the interactions between them and the impact on clean energy finance. In essence, this chapter explains what influences the size and direction of the flows from sources to investment opportunities in the European clean energy finance landscape.

As a first step, the chapter (section 4.1) provides a description of what the European clean energy finance landscape looks like today (synthesis of findings from Chapters 2 and 3). Next, a mapping of the main influences on the clean energy finance landscape is provided (section 4.2), grouping relevant topics into seven categories of influencing factors, based on a thorough literature assessment (see also Annex A and B). Following this, an analysis per influencing factor is presented (Section 4.3) which analyses the relevance and importance of the influencing factor per ‘source of finance’ and ‘clean energy investment sector’.

The concluding sections (4.4 and 4.5) of this chapter then bring together these different factors and discuss the European landscape that is characterised in this report and the implications for macro-economic modelling. As such, sections 4.4 and 4.5 provide the bigger picture and tie the whole analysis together.

4.1 What does the European clean energy finance landscape look like today?

This section brings together the discussions in Chapters 2 and 3 to present a mapping of the clean energy landscape. This mapping allows for the landscape to be integrated into macro-economic models. The principles that underpin the choice of financing source and instrument for each clean energy sector can be used to inform the way that the models determine the source of finance for each sector and potential scenarios. These can support the development of policies that can improve the attractiveness of each sector for the different sources of finance.

Figure 4-1 European clean energy finance landscape

[Source: Trinomics own development, 2016]

[Note: for this project, we exclude adaptation finance from the analysis and focus exclusively on mitigation aspects, i.e. renewable energy and energy efficiency activities and related climate services]

Based on the previous chapters the key elements that help explain the current look/shape of the European clean energy finance landscape, as illustrated in Figure 4.1 above, can be summarised as follows:

Sources of finance

- Public sources of finance are primarily used for direct investments or to mobilise/leverage additional private finance for established RES and EE projects.
- Commercial banks, institutional investors and other private investors primarily focus their investments on established RES technologies and/or EE in the industrial and transport sectors as well as EE in buildings (e.g. loans for building refurbishment).
- Small end-users are currently the main financiers of EE in the building sector.

- Currently the largest volume of clean energy finance is flowing from the private investors to established renewable energy technologies, namely solar PV and onshore wind.

Financing Instruments

- Public-private partnerships show a high potential in mitigating some of the investment risks that otherwise hinder private finance sources to invest in clean energy projects.
- Concessional loans can be a successful tool in steering private investment towards a specific sector/technology (e.g. KfW energy efficiency loans in Germany).
- Self-finance is the most important financing instrument used for EE projects in buildings.

Clean energy sectors' potentials

- The energy efficiency sector holds the highest potential for additional clean energy transition gains, if financial flows can be increased.
- Established renewable energy technologies (RES-E) currently receives the highest actual investment levels.
- Non-established renewable energy technologies (RES-NE) face the highest challenges attracting private sources of finance.
- EE projects struggle to attract significant involvement from institutional investors and other larger investors, such as VC/PE.

The following sections build upon this mapping and understanding of the clean energy finance landscape to more fully explore the interactions and linkages (i.e. the size and direction of the arrows in the landscape diagram) and the factors that can influence their shape.

4.2 What factors can influence the landscape?

This section introduces the various factors which influence and are holding back investors from being more bullish about clean energy sectors. These factors can impact at different levels, such as:

- the specific project level;
- the technology level, where we distinguish between;
 - RES-E: Renewable Energy Sources – Established (mature, above TRL 9 for any type of renewable energy technology)
 - RES-NE: Renewable Energy Sources – Not Established (below TRL 9 for any type of renewable energy technology),
 - EE-B: Energy efficiency in Buildings,
 - EE-I: Energy efficiency in Industry, and
 - EE-T: Energy efficiency in Transport.¹⁴¹

¹⁴¹ It should be noted that 'Land Use (Agriculture, Forestry)' is not covered in this report. Efforts in these sectors to mitigate emissions are limited at this stage. European regulations limit the amount of land which

- within an entire clean energy sector; or,
- more generally across the entire investment space.

Influencing factors vary considerably depending on the type of clean energy opportunity, for example a large scale solar PV project will face very different financing challenges than those faced by an innovative energy efficiency technology for the building sector. We have analysed the large number of factors which influence investments in the clean energy space, and have grouped them into seven categories:

- I. **Policy design, regulatory risk and public incentives uncertainties:** This includes all public regulations and public incentives at Member State or European levels; such as FITs, subsidies, grants, tax incentives, (etc.), which are put in place for the purpose of boosting the development of clean technologies and RES.
- II. **Commercial necessities:** This comprises all indicators of financial health and success common to all businesses (such as ROI), irrespective of being from the clean technology industry or any other industry. It also encompasses the relative ease with which finance can be accessed to grow a business (debt condition and requirement, due diligence elements, etc.).
- III. **Technology:** refers to elements specific to particular technologies; for instance, the timing of the revenue from solar or wind energy technologies.
- IV. **Country's enabling framework to support clean energy transition:** encompassing the ability of the infrastructure in a country to cater for new generation or new clean technology, where electricity grid infrastructure is particularly crucial.
- V. **Governance, and accountability factors:** refers generally to all "soft" indicators linked to the governance of an investment. Factors such as so-called 'Environmental, Social and Governmental (ESG)' criteria are increasingly important for investors, especially long term large investors. This can drive investors to opt for clean energy investments for compliance with environmental and sustainability indicators or simply to present a "green friendly" image. It should be noted that legislative changes (see factor 1 above) are closely interlinked with this factor in the sense that legislation can have a strong impact on the governance of investments, such as the capital requirements (Basel).
- VI. **Macro-economic factors:** which includes all aspects linked to the external macro-environment which are relevant to the investment. For

can be used to grow biofuels for energy. Also, there is currently a proposed regulation to reduce emissions for land use. This is based on several flexibilities to Member States to meet their "no-debit" commitment while maintaining environmental integrity. The "no-debit" rule "requires each Member State to ensure that accounted CO₂ emissions from land use are entirely compensated by an equivalent removal of CO₂ from the atmosphere through action in the same sector. This allows exchanges of carbon credits within the sectors between Member States. (http://europa.eu/rapid/press-release_MEMO-16-2496_en.htm)

instance, economic factors such as international price of raw fossil fuels, interest rates, etc. or other societal trends such as public opinion, have a noticeable influence on investment decisions.

- VII. **Shortage of good investment projects and opportunities:** refers to the lack of good (bankable) investment projects and/or companies in the clean energy sectors. This is a fact brought forward by numerous investors at most stages of investment but especially at the early and later stages. This is only partially dependent on the other factors and is decisive enough for investors that it constitutes a factor on its own.

4.3 Analysis of seven key influencing factors

This section presents each of the seven influencing factors describing what the influencing factor is about, how it is relevant for (a) the different clean energy sectors and (b) the attractiveness to different financing sources, and concludes with the factor's overall level of importance for modelling.

The analysis is based on a broad literature review which can be found in Annex A, and which we recommend reading prior to reading further in section 4.3. The analysis ranks the influencing factors based on expert opinion, providing an indication of the relative importance of factors for the different clean energy technologies and/or the financing sources respectively. The key questions the experts kept in mind were:

- How essential is the factor to different types of sources of finance (i.e. investors)? Is it an element looked at as a priority?
- Is it a factor which can counter-balance the other factors? (i.e. if this is a "GO" for this factor but a "NO GO" for the others, what would be the end decision?)
- How does the factor interact with other factors? Is it often coupled with other factors, or is it independent or works against other factors?

Differences between Member States are also taken into account in the following analysis, to identify when and how these should be taken into account when modelling sources of finance by Member State. Differences between Member States which can influence finance include factors such as:

- Regulatory frameworks for clean energy and different types of support schemes. A wide range of price supports for electricity systems exist: from FITs (incl. Austria, Ireland, Portugal, Romania, Greece), premium tariffs (incl. Germany, Finland), quota systems (incl. Sweden, Poland), auction tenders (incl. France, Italy, UK, soon Germany) and hybrids of these systems, to no support (Spain and the Czech Republic have close to no price support in place now). This also holds true for energy efficiency.
- Investment environments and country riskiness. Some countries like Germany, the UK or France have a very advanced, lower risk investment infrastructure while other European countries such as in eastern and southern Europe are less developed in this respect.
- Business and technical environments, in general, north-western countries are more efficient and have easier administrative requirements than others.
- Size and type of available finance can also differ across Member States.

More detailed analysis of these differences between Member States can be found in Annex B.

4.3.1 Influencing factor I: Policy design, regulatory risk and public incentives uncertainties

Policies, regulations and public incentives can be important determining factors to convince investors to commit (or not) funds to clean energy, especially in the initial years of an investment. A number of specific barriers such as the upfront investment required for clean energy investments, perceived inherent risks, lack of experience, etc. need to be compensated by public incentives (mix of subsidies and price instruments, taxes, etc.) so that investors are convinced to invest in the clean energy transition.

Given the potential power and influence of government intervention it is unsurprising that most studies place potential changes in regulations and public incentives as the most decisive factors for investors, e.g. a Taylor Wessing survey states “Uncertainty over government incentives and support mechanisms” is the most common obstacle to raising debt funding for the majority of surveyed corporates”.¹⁴²

As De Bruyn et al (2016) writes, “economic circumstances, governmental budget deficits or the pressure of lobby groups” or change of government can alter the conditions and policy instruments in place to stimulate the low-carbon technologies.¹⁴³ Multiple examples of this are available in Europe over the last decade as fiscal tightening following the financial crisis has led to significant policy changes and scaling back of incentives. This was particularly evident in Spain and the Czech Republic in 2013 (EEA, 2014). Investors in Spain experienced “particularly painful retroactive revenue cuts imposed by the government during the 2011-14 period, and the end of all support for new projects”,¹⁴⁴ which unsurprisingly caused the investments in the sector to collapse as they were much less attractive and confidence in the market reduced. In Germany “onshore wind saw a sharp fall in commitments, reflecting a tightening in planning rules, and uncertainty ahead of a move in 2017 from guaranteed tariffs to auctions”.¹⁴⁵ In France, “the existing tariff system for solar incorporated a decreasing mechanism that led to sharp reductions in support for new projects not taking part in the auction programme”.¹⁴⁶ Another example is Italy where a level of investments in PV peaked in 2011 at US\$31.7 billion to just under US\$1 billion in 2015 resulting from a retroactive cuts to FIT support for solar. Finally, Frankfurt School-UNEP Centre and BNEF in their report note that “Project financing of utility-scale solar in Europe dropped by more than half in 2015 from the preceding year, to a total of US\$3.7 billion, partly due to impending cuts to FIT support in the UK, and an upcoming transition to an auction-based mechanism in Germany”.¹⁴⁷

As a consequence, investors nowadays pay much closer attention to regulatory and country factors (country risks, political stability of government, etc.). A likely consequence of these numerous abrupt policy changes is that public incentives may become more costly to governments or additional guarantees will have to be provided

¹⁴² Taylor Wessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

¹⁴³ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft.

¹⁴⁴ Frankfurt School-UNEP Centre / BNEF (2016). Global Trends in Renewable Energy Investment 2016, p. 25.

¹⁴⁵ Frankfurt School-UNEP Centre / BNEF (2016). Global Trends in Renewable Energy Investment 2016, p. 25.

¹⁴⁶ Frankfurt School-UNEP Centre / BNEF (2016). Global Trends in Renewable Energy Investment 2016, p. 25.

¹⁴⁷ Frankfurt School-UNEP Centre / BNEF (2016). Global Trends in Renewable Energy Investment 2016, p. 50.

on the durability of incentives to investors. This explains why there is such a large disparity in the Weighted Average Cost of Capital (WACC) (or cost of debt or of equity in the sector calculated across Europe in the DiaCore project¹⁴⁸). The “WACC significantly varied across EU Member States between 3.5% in Germany and 12% in Greece for onshore wind projects in 2014”.

De Bruyn et al (2016)¹⁴⁹ mentions that, in the absence of incentives based on a carbon price signal (i.e. a high enough and widely used carbon price), the incentives from governments rest on a mixture of subsidies and tax. However, deciding on the appropriate level of subsidies is a difficult balancing act. Set too low, as was the case of renewable energy stimulation in the Netherlands and Switzerland (see EEA 2014) and not enough projects go ahead, but setting subsidies too high impacts significantly on the government’s budget or electricity prices passed on to final consumers. In some cases, governments may choose a high level of incentives as there is a competition between Member States for limited EU-wide investment funds. As expressed in De Bruyn et al (2016)¹⁵⁰ “Financiers are free to “shop” for the Member State with the most favourable energy policy. This may result in inefficient, unsustainable policies in the longer run (ECF, 2011).” Lobby groups in the energy or finance sectors can also substantially influence the level of incentives offered to particular technologies or types of finance.

De Bruyn et al (2016)¹⁵¹ also concludes that the current outlook on RES targets beyond 2020 foresees only the EU wide target to 2030, while the current policy of binding targets for 2020 at Member State level will not be continued after 2020 and “this could contribute to seriously hinder the continuity in the governments sets of policies”. This is currently being revisited as the Commission proposed a new renewable energy directive (REDII) for the period 2021-2030. De Bruyn et al (2016)¹⁵² further analysed that FITs may become too onerous to governments as the number of subscribers increases. However, the “Energy and Environmental State Aid Guidelines” specify that FIT tariffs should be progressively replaced by competitive bidding processes which will increase cost effectiveness and limit distortions of competition. Part of the reasoning of this change is to build in progressive reduction of policy subsidies for RES as it becomes more and more cost competitive with other power technologies. This is necessary to avoid cases where RES suppliers earn super-profits, which would undermine public support and divert money which could increase the total RES supported.

For energy efficiency investments, key EU decision makers and EE experts¹⁵³ agree that the optimal regulatory framework is still not in place although it is being actively worked on (in several Member States, public support schemes have been put in place to mobilise more investments in EE). An improved regulatory framework would focus on better internalising EE’s externalities, dismantling perverse incentives, and improving legislative predictability and end-user energy price predictability.

¹⁴⁸ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report.

¹⁴⁹ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P. 50-51.

¹⁵⁰ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P. 50-51.

¹⁵¹ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P. 62.

¹⁵² De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P. 50-51.

¹⁵³ Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

The EEFIG Final Report¹⁵⁴ clearly demonstrates for industrial EE the importance of public intervention and regulations, in particular the regulatory stability. According to the report, energy efficiency for industry has considerable potential and will need substantial investments from the private sector, which can only be unlocked through public sector involvement, regulations and/or financial intervention.

Relevance of the factor to specific sectors

Most RES, energy efficiency and transport (limited to electric vehicles) investments will be directly and significantly impacted by such factors. Nonetheless, sectors such as industry already have to comply with a range of other regulations and are not always able to access the same system of incentives as those in other sectors.

For energy efficiency in private housing and commercial building, "Member States have a clear role to play in pursuing the necessary structural reforms, exercising fiscal responsibility and providing regulatory certainty to boost investment"¹⁵⁵. EEFIG estimates that a five-fold increase in private energy efficiency investments in European buildings is required by 2030 based on a public-private collaboration. As stated by EEFIG, such large increase can only take place if governments implement adequate incentive schemes.

Relevance of the factor to the attractiveness of an investment to financial investors

Private, semi-private and even public investors make investments considering financial parameters. Progressively phasing out as the fixed price of electricity within a FIT, as mentioned above, can significantly impact the profitability of a project. Public incentives remain important throughout the investment cycle, however it these are most instrumental in the early stages of investment when projects/SMEs are very vulnerable to changes in cash flow patterns. When a technology is more mature, technologically proven and a price structure allows for successful commercialisation, public support becomes less useful and should be phased out progressively.

Factor's level of importance assessment

The following table summarises the relative level of importance of "policy design, regulatory risk and public incentives" as an influencing factor for clean energy

¹⁵⁴ Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

¹⁵⁵ Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

investment decisions in Europe. This is based on the various elements analysed above completed with our expert opinion.

Table 4-1 Summary overview of influencing factor I - Policy design, regulatory risk and public incentives uncertainties

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	VC/PE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	4	5	5	4	5	3	5	5
EE-B	4	5	5	3	5	3	5	5
EE-I	2	4	3	3	3	2	3	N/A
EE-T	2	5	4	2	4	2	4	4

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.2 Influencing factor II: Commercial necessities

One of the fundamental factors looked at by all investors irrespective of their size and stage of investment, are indicators of financial health of a business. These include:

- level of Return on Investments (ROI);
- future ROI projections, cashflows, business plan especially for early stage businesses;
- uncertainties over securing a satisfactory off-take / power purchase agreement (PPA);
- the risk of cost overrun;
- the risk of negative publicity and social acceptance;
- competition;
- personnel, management risks; and,
- other similarly essential micro-elements preconditions to business profitability.

We have grouped these elements under one single factor "Commercial necessities".

Relevance of the factor to specific sectors

Commercial necessities do not differ significantly from one sector of the economy to another. However, their importance differs depending on the stage of development of the clean energy technologies. In a nascent technology, such factors will be less important as these commercial indicators will not give a reliable picture of the health of a company when it is not yet operating on the market. The better established the sector and more mature the clean energy technology the more important standard commercial necessities and indicators become. Most RES technologies have not yet reached this point of full maturity although some, such as onshore wind, are getting close in some markets.

This factor can be especially important for technologies which are outside the core business or experience of a firm or investors. For instance, an investor will look at the

"commercial necessities" of a wind park differently dependent on whether the business stands-alone or if it is part of an overall large "conventional" energy company.

This is much less true for EE investments in housing as these are driven by energy savings and the additional benefits of energy efficiency such as comfort improvements. For private households "commercial necessities" are not a major driver. Therefore, even if there is a commercially attractive case for investing in EE for energy savings, the chance that this happens is much lower than if the same case was presented to a business as the mind-set and access to finance is much different. It is possible to circumvent this to some extent with ESCO models, where outside operators make the investment and take a proportion of the energy savings as revenue.

The importance of energy savings for investors will vary by company and sector. For energy producers, their carbon intensity of generation may have a tremendous importance. For instance, large institutional investors are increasingly reluctant to invest in electricity generators with a high share of coal power, and some are starting to divest from these types of investments. However, outside of the power sector and energy intensive industries, investors still attach much less importance to energy savings and emissions reduction, as these are not seen as core commercial concerns or risks.

For transport, very few EV companies are standalone EV car makers (main exception being Tesla in the US), therefore the commercial necessities, i.e. RoI, profitability, of the EV part of a car manufacturer has less impact on the investor's decision than if it was a standalone business. This factor will gain in importance as the decarbonisation part of the activities become an increasingly prominent part of the overall company.

Relevance of the factor to the attractiveness of an investment to financial investors

Commercial necessities are crucial to any business, but they have multiple dimensions and must also consider time, opportunity and risk. Short term necessities, i.e. immediate profits, are rarely the overriding factor in an investment decision. Initial stage investment deals (e.g. seed finance) are often done on the basis of the potential it has to contribute to medium-long term profitability or to reduce overall risks, accepting that early stage investments are usually very risky and often loss making. Also at later investment stages, once the business has reached a dimension which can attract large institutional investor's equity or debt. Such investors will look at things other than just the profitability and financial health of the business. This will include, the size, regularity and seasonality of cash flows, complementarity with other businesses, long term prospects of the business, etc.

However, at an intermediary stage of development, financial health indicators, particularly RoIs, and projections of such indicators, are heavily scrutinised and are central to investment decisions. In light of the above analysis this factor is an extremely impacting factor for some types of investors such as PE/VC while it may be less impactful for very large investors (institutional investors, banks) and even less at a seed capital, R&D development stage.

Factor's level of importance assessment

The following table summarises the relative level of importance of “commercial necessities” as an influencing factor for clean energy investment decisions in Europe. This is based on the analysis presented above and our expert opinion. RES and EE for building have been allocated a high level of importance across the categories of investors for reasons explained above, except for early stage seed and angel investors for whom the indicators of an attractive investment are not the conventional business indicators. This factor is of relatively mild importance to EE in transport and especially (non-energy intensive) industry where the efficiency gains are usually a small part of the overall business. We have classified as irrelevant small end users who cannot invest specifically in the EE component of Industries or in Transport.

Table 4-2 Summary overview of influencing factor II – commercial necessities

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	VC/PE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	4	4	5	4	5	1	4	3
EE-B	4	4	4	3	4	1	3	2
EE-I	2	2	3	1	1	1	4	N/A
EE-T	2	4	4	3	3	1	3	3

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.3 Influencing factor III: Technology risk

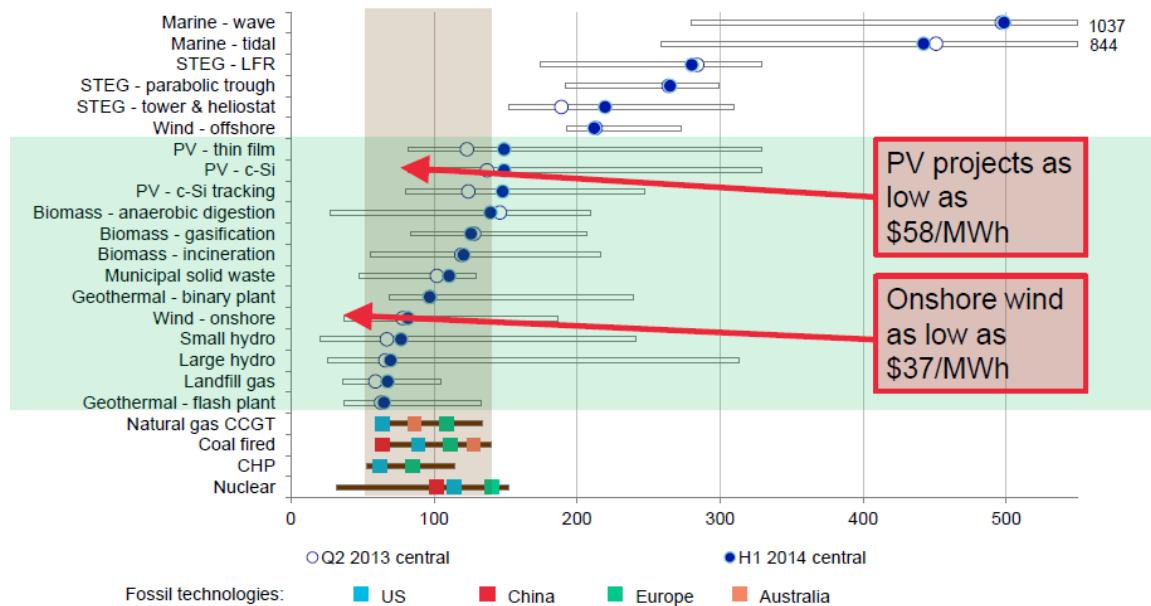
Investors take into account the specific characteristics of clean energy technologies when making an investment decision. Clean energy sectors or technologies have different:

- levels of cost and maturity, some clean energy technologies are well established and close to cost-competitive with fossil fuels, e.g. onshore wind and solar, while others are much less mature and more costly, e.g. offshore wind, marine energy, energy storage (see also Figure 4-2 below);
- investment patterns, mature RES such as wind and solar require heavy up front capital expenditure (CAPEX) requirements but have limited operational expenditures (OPEX), in contrast biomass has lower CAPEX but higher OPEX due to fuel costs;
- revenue patterns, by nature, wind and solar experience irregular income while EE has a steady stream of revenues;
- potential for revenues;
- long term prospects (electricity storage has a considerable long term potential despite current uncertainties); and,
- granularity of revenue streams (technologies such as EE has many small sources of revenues, when revenues from decarbonisation of industries tend to be much more concentrated).

As a result, investors do not consider clean energy investments as being equivalent or interchangeable. The attitude of investors will be very different depending on the technologies, the above factors and their own knowledge and experience with each. For example, on the point of the level of cost and maturity this is clearly a factor in solar PV becoming a major area of investment since it is now much more mature and

can produce electricity at an increasingly competitive cost compared to wind and even fossil fuel power, see Figure 4-2.

Figure 4-2 Levelised cost of electricity production, 2014 (\$/MWh)



[Note: LCOEs for coal and CCGTs in Europe and Australia assume a carbon price of US\$20/t. No carbon prices are assumed for China and the US.]

[Source: Liebreich, Michael (2016). Global trends in renewable energy investment – Bloomberg EMEA Summit Presentation. London. P.16.]

Relevance of the factor to specific clean energy sectors

The maturity of a technology may sound like an obvious factor in an investment decision, clearly investors will have more certainty and confidence in well proven, mature and competitive technologies such as solar and onshore wind, than younger and uncertain technologies such as Wave and Tidal. This is generally the case, more mature technologies being able to attract investors with much less adventurous risk profiles.

However, the maturity (and cost-competitiveness) of a technology are not always the decisive elements, as experience also shows that technologies that are less mature and proven can sometimes still attract large amounts of finance, for example offshore wind. This is a less proven and robust technology than onshore wind but has recently been attracting larger amounts of investment. The main reason being the size of individual investments (offshore wind projects are typically much larger than onshore) and the higher, under normal operating conditions, times of electricity production, e.g. 35% load factors for offshore wind compared to 25% for onshore wind. The larger investment size for offshore wind also allows for bigger and better structured deals, which are more attractive to larger investors, such as institutional investors. Europe's top 10 offshore wind farms reaching 'final investment decision' last year totalled almost 3GW – five in UK waters, four in German waters and one off the coast of

Belgium.¹⁵⁶ The risk of less mature technology may be outweighed, for investors, by the advantages of a larger project, the prospect of steadier revenues and lower operational risks.

The irregular and uncertain timing of production, for example over a year wind energy produces 20-35% of its rated capacity, and solar PV only 10-20%, but sometimes they will produce at close to full capacity, other times they will not produce anything. This then becomes an issue, as it can greatly impact grid stability (an important priority for EU countries), to the extent that managing these irregularities can involve curtailment of power from these sources when too much power is being sent to the grid. In the longer term this can also impact broader energy security as renewables weaken the business case for fossil fuel plants whose production also becomes more irregular as it is reduced more often to accommodate times of high renewables production.

The long-term prospects of a technology can play an important role, even if the current state of the technology is not commercially ready. One example of a promising clean energy technology attracting investment on this basis is electricity storage technologies, such as batteries, which have been attracting large amounts of initial stage financing, R&D and PE/VC without yet being able delivering a fully satisfactory and scalable solution. In contrast to storage, wave & tidal technologies have also a very promising potential and are at a similar stage of development but have much greater difficulties in attracting initial investment, often being unable to pass the initial stage of R&D and seed funding. On the other hand, more mature and proven technologies such as biomass and biofuel fail to attract large amount of investment mostly because of their limited supply of raw material in Europe and continuing concerns over the sustainability of other sources.

In the energy intensive industries, although technology is still relevant it is diminishing in importance in investment decisions as most efficiency improvement technologies are quite mature and widely known.

In terms of transport EE, the technology choice can be central to an investment decision. One of the main reasons why electric vehicles have not been taken up more widely at this stage is because of technological reasons as there remain challenges for electricity storage and the efficiency of engines is not optimal (although much more efficient than regular fuel engines).

These examples show that the different characteristics of a technology can be important to investors.

Relevance of the factor to the attractiveness of an investment to financial investors

Technology tends to be a more determinant factor in the early stages of investments, i.e. Seed capital, R&D or even PE/VC, than in the later stages where other factors become more crucial.

The timing of electricity production from RES (variable production during windy or sunny periods) can have a major negative impact for investors not specialising in the clean energy space such as institutional investors. For these investors, the specificities

¹⁵⁶ Frankfurt School-UNEP Centre/BNEF (2016). Global trends in renewable energy investment. P.52.

and irregularities of renewable energies are perceived as a hindrance, as it adds complications to the revenue streams. This is specific to renewable energy and does not impact Energy Efficiency, Transport and Industry.

For early stage investing, the Taylor Wessing report¹⁵⁷ mentions that “private equity investors are hardening their investment criteria” – they want to avoid technology risk (95% of surveyed private equity investors stated that low technology risk is an important or very important factor in their investment decision). This translates into investors increasingly relying on mature technologies and that confidence in the technology being deployed being paramount to a project investment decision. They are reducing their investments in companies with unproven technologies (including research and development, prototype testing and demonstrator projects), and commercially unproven or feedstock dependant technologies will continue to be handled with caution.

In the same report, it was noted that debt providers are interested in both mature technologies, such as onshore wind (78%), solar PV (67%) and energy efficiency (56%), and less mature technologies but where tangible assets (streams of foreseen revenues) are readily available as collateral, such as biomass (89%) and offshore wind (56%).¹⁵⁸ For energy projects, a PPA (Power Purchase Agreement) is a strong point as it brings greater confidence in the revenue streams. This is the case also of mature energy technology sources with secured revenue, where 100% of surveyed debt providers indicated interest.

Factor's level of importance assessment

The following table summarises the relative level of importance of “technology” as an influencing factor for clean energy investment decisions in Europe. This is based on the various elements analysed above and our expert opinion. For RES, technology factors are highly important for most categories of investors except for small end users. For EE for buildings (EE-B) the pattern of factors is similar but with a slightly lower level of importance attached to technology risks than for RES. Technology risk in Transport (EE-T) is evaluated as of less importance than these sectors and of least importance for EE in industry (EE-I) where utilisation of technology for efficiency gains is a standard part of business. We have classified as irrelevant small end users who cannot invest specifically in the EE component of Transport or Industry.

Table 4-3 Summary overview of influencing factor III – technology

	National Public & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	PE/VE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	4	4	4	4	5	4	4	3
EE-B	3	3	3	2	3	2	2	3

¹⁵⁷ Taylor Wessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

¹⁵⁸ Taylor Wessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

EE-I	3	3	2	2	3	3	2	N/A
EE-T	2	4	4	3	4	3	4	N/A

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.4 Influencing factor IV: Country's enabling framework to support clean energy transition

A country's enabling framework to support renewable energy and other clean energy investments includes important infrastructure elements which can vary considerably by country, these elements include:

- the efficiency of the electricity grid;
- access to the grid;
- administrative processes and permitting procedures; and
- EV charging station infrastructure.

These elements are important to finance a project. They are especially crucial for the early stages of financing, such as PE/VC where they can be an important failure risk. This is especially the case for grid access which is essential to renewable energy projects, as explained in the DiaCore study "This process includes the procedure to grant grid access, connection, operation and curtailment; the capacity of the current grid, the possibilities for expansion, inadequate grid infrastructure, suboptimal grid operation, lack of experience of the operator, and the legal relationship between grid operator and plant operator."¹⁵⁹ Also in some cases the administrative processes and permitting procedures can be a major hindrance, with the period of time to receive all authorisations (lead time), depending on the country and the project, ranging from 2 to 154 months.¹⁶⁰

Relevance of the factor to specific sectors

These infrastructure factors directly impact upon technologies dependent on authorisations and the electricity grid such as RES, EV and, to a lesser extent, energy efficiency. There are relatively few impacts for industry and transportation (except for EV).

Relevance of the factor to the attractiveness of an investment to financial investors

A favourable infrastructural situation and framework is a prerequisite for healthy development of RES in a country. Therefore, hindrances in this framework can have significant impacts for investors specialising in clean energy at all levels, from PE/VC through to even utility providers. Very early stage investors, R&D and development

¹⁵⁹ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report. P. 23.

¹⁶⁰ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report. P. 23.

stages are not directly impacted by such factor, but it becomes particularly crucial for the next (still early) stage investors as it negatively impacts the preconditions to start a business. For later stage investors (institutional investors, banks) or sources of finance such as bonds, it is a factor, but has less impact.

Factor's level of importance assessment

The following table summarises the relative level of importance of "country's enabling framework to support the clean energy transition" as an influencing factor for clean energy investment decisions in Europe. This is based on the various elements analysed above and our expert opinion.

Table 4-4 Summary overview of influencing factor IV – country's enabling environment to support clean energy transition

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	PE/VC	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	3	4	4	4	4	3	4	3
EE-B	3	N/A	N/A	N/A	N/A	N/A	4	3
EE-I	2	N/A	N/A	N/A	N/A	N/A	1	N/A
EE-T	2	N/A	N/A	N/A	N/A	N/A	3	N/A

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.5 Influencing factor V: Governance and accountability factors

Europe is at the forefront of global efforts to improve governance and accountability of financial systems. Out of the 14 jurisdictions globally which require pension funds to disclose information on their approach to ESG (Environmental, Social and Governance) issues, ten are located in Europe.¹⁶¹ A global survey looking at the views of more than 200 institutional investors on the use of non-financial information in making investment decisions stated that European institutional investors are leading the way globally when it comes to incorporating ESG risks into their investment decisions.¹⁶² Non-financial information is most likely to impact on an investment decision in Europe. Demand for such information is especially strong in the energy and polluting (GHG and other) industries, but it is also increasingly important across all sectors, considered relevant by 61.5% of those polled in 2015, compared to 34% of respondents in 2014.¹⁶³

¹⁶¹ UNEP-Inquiry & 2° Investing Initiative (2016). Building a sustainable financial system in the European Union. P.31.

¹⁶² Global Sustainable Investment Alliance (2015). 2014 Global Sustainable Investment Review. http://www.ussif.org/Files/Publications/GSIA_Review.pdf

¹⁶³ EY (2015). Tomorrow's Investment Rules 2.0'. Climate Change and Sustainability Services EY London.

According to the 2014 Global Sustainable Investment Review¹⁶⁴, 59% of European invested assets already are invested in a sustainable way, compared to 31% in Canada and 18% in the United States. European institutional investors see sustainable investing as part of their fiduciary responsibility.

ESG is generally linked to climate change mitigation. For instance, Dutch civil service pension fund, ABP, which has about EUR 350 billion in assets has concrete objectives, including cutting 25% of carbon-dioxide-related investments from its equity portfolio by 2020. This factor is not specific to any technology.

Relevance of the factor to specific decarbonisation sectors

Many investors, particularly large investors, take significant notice of governance and accountability factors. This influences the types of investment which will be impacted.

Governance and accountability factors are not specific to technologies. ESG factors take into account all the decarbonisation sectors in the same way whether they are RES (solar, wind, biomass etc.) or EE or other clean low-carbon technologies. However, these factors have less influence on large industries which mostly self-invest in energy and carbon efficiency improvements for commercial reasons rather than to satisfy ESG criteria. This is also true for firms in the transport sector, and is reflected in how these are perceived by institutional investors, these being less likely to invest in a car manufacturer who takes up an EV business orientation only for ESG reasons.

Relevance of the factor to the attractiveness of an investment to financial investors

This factor is especially relevant for institutional investors. For pension funds, this is motivated by their fiduciary duty to take into account long term risks such as climate change and other medium term sustainability and environmental issues. At the same time, there are also strong personal incentives for fund managers to take a shorter term view of investments to deliver immediate returns. However, this distortion is progressively changing under the pressure of governance and accountability specialised NGOs and is increasingly leading investors to take more medium and long term, and ESG factors, into consideration. Parallel to this, there is a clear trend for investors to be seen as being "green friendly" and a growing market for such investment funds, although this only a relatively minor factor for investors in clean energy.

Overall, although taking into account ESG as part of financial governance is a relatively recent development on the investment scene, these "soft" trends are gathering momentum and will favour further investments in clean energy as part of a long term move towards more sustainable investments. These governance and accounting factors have an increasing importance for large institutional investors and may act as a deciding factor to invest or divest from particular sectors, i.e. carbon intensive sectors such as coal. However, small investment firms, especially in seed

¹⁶⁴ Global Sustainable Investment Alliance (2015). 2014 Global Sustainable Investment Review. http://www.ussif.org/Files/Publications/GSIA_Review.pdf

finance and VC/PE, which often specialise in sectors such as RES or clean technologies, are much less driven by such "soft" factors.

Other large players such as industry and transport multinationals, have often adopted some ESG targets as part of their overall business or corporate social responsibility (CSR) strategies. Many are already actively reducing emissions or investing in clean technologies are part of complying with such targets.

Factor's level of importance assessment

The following table summarises the relative level of importance of "governance and accountability" as an influencing factor for clean energy investment decisions in Europe. This is based on the various elements analysed and our expert opinion.

Table 4-5 Summary overview of influencing factor V – governance and accountability factors

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	VC/PE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	2	3	3	4	2	2	3	1
EE-B	2	3	3	4	2	2	3	1
EE-I	2	1	2	3	1	1	1	N/A
EE-T	2	2	3	4	2	2	2	N/A

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.6 Influencing factor VI: Macro-economic factors

A number of macro-economic factors impact the sources of finance. These include, the general state of the economy, and other economic elements such as: interest rates, exchange rates, prices of fossil fuels but there are also concerns over stranded assets and public opinion.

The **general state of the economy** has a direct impact on the amount of funds committed by investors. As seen earlier, the financial crisis of 2008-2009 caused a steep slowdown in investments in the clean energy sectors.

Interest rate risks also directly impacts investments in clean energy and climate mitigation.¹⁶⁵ Clearly interest rates have a major direct impact on the cost of finance for both large and small clean energy investors. As noted previously, the weighted average cost of capital (WACC), in which interest rates play an important role, vary

¹⁶⁵ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft. P. 52.

significantly across Europe¹⁶⁶, as low as 1.8% in Germany, up to 12.5% in Greece. This invariably influences the decision of borrowers.

The **exchange rate** influences risks in an indirect manner. Disadvantageous exchange rates increase the price of fossil fuel and therefore provide an incentive for governments to favour clean energy investments. Over 55% of the fossil fuel used in Europe is imported. Also, any large fluctuation in fossil fuel imports would have an impact on trade balances and interest rates.

The **current and expected future price of fossil fuels** is an important factor for clean energy and decarbonisation investments as the two are in competition. Prices for oil have recently (since late 2014) fallen to levels last seen 15 years ago and are only slowly creeping back up. Similar trends have also been noticed for natural gas prices and coal prices. This could have a negative impact on the business cases for energy saving and renewable energy investments. However, as oil is not used in Europe for electricity generation, the relatively low prices do not seem to be impacting RE and EE in industry in Europe. Impacts from the other fuels are also low as coal continues to be progressively phased out in many Member States, while European gas prices are still much higher than US prices.¹⁶⁷

Stranded assets are a related issue and risk for fossil fuel generation with implications for clean energy investment, on the one hand positive for clean energy as it is an additional risk factor for new fossil fuel investment, on the other it creates greater pushback against clean energy. The closure of fossil fuel power generation units 10 to 20 years before their scheduled lifetime clearly imposes financial difficulties to the investors that planned their investment on the basis of an RoI over the full lifetime of the equipment. There is an argument to be made that this is simply the market at work and a normal business risk, but it also leads to a strong push-back from owners of these assets as they attempt to maintain a place in the market through various means. When fossil fuel prices are low and therefore more cost competitive with renewables this is easier. The transformation away from fossil energy can also have important social implications, for example in dealing with closing coal mines.

Other macro factors include **energy security** and **energy independence**. These are very important factors for Europe which is heavily reliant on energy imports from sometimes unstable or unfriendly regions. These factors work in favour of renewable energies as in most cases (except biomass) no fuel imports are required. The strong European presence in the value chain of many clean energy technologies also constitutes an additional reason for government to favour a transition to a clean energy economy.

This influencing factor also includes **external regulatory factors to clean energy investments** such as regulatory elements around capital adequacy for banks with Basel III and insurance companies with Solvency II. These regulations on capital and asset allocation are intended to prevent exposure to unsafe assets but can also act as a hindrance to investments with little historical track record such as clean energy assets. Alex Betts¹⁶⁸ explains: "Banks' balance sheets remain under pressure, and there are still discussions on banks' capital adequacy. These uncertainties still make banks cautious." A large proportion of corporations favour debt financing over equity financing. However, they are currently required to accept tough terms on required

¹⁶⁶ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report.

¹⁶⁷ Frankurt School-UNEP Centre / BNEF (2016). Global trends in renewable energy investment. P. 18.

¹⁶⁸ Alex Betts in TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy. P. 11.

margins, debt service coverage or loan-to-value, and interest rates which are between 200 bps and 350 bps over the prevailing base rate depending on the size and the maturity of their business.

Finally, we include here **Public opinion**, which despite the daunting future consequences of climate change, has not mobilised a majority to demand significant investments into a decarbonised future economy or more generally for matters related to climate change. These are more often seen as government and specialist areas in which the public opinion has little part to play, and that things are being taken care of. As De Bruyn et al (2016)¹⁶⁹ mentions "Why does the general public seem to have the feeling that what we are doing at present is the maximum possible and pleas for speeding things up by a factor 5 seem to be ridiculous?". At the same time, there is also a concern that pushing too far and too fast could turn public opinion against the large-scale investments needed.

Nonetheless there is a clear increase in public awareness, Notenboom and Boot (2016)¹⁷⁰ note that 'Citizen Movements' have contributed to the success of energy policy, in different ways. For example, in Denmark and Germany, it has been the fundamental basis for the transition policy; while in the Netherlands, while the jury remains out on its actual effectiveness, the Energy Agreement between 40 different groups within society has been a substitute for far-reaching government policy and has been an incentive for government to 'reinvent itself'.

Relevance of the factor to specific sectors

By their nature macro factors are not specific to any clean energy technology and will impact on all clean energy sectors. Nonetheless, more established technologies will tend to be less impacted than younger technologies. Therefore, impacts can be expected to be greater for early stage investments, most often within small structures, than the impacts for investments in more established technologies and/or larger structures such as those within transportation, building and industry energy efficiency and established renewable energies investments.

Relevance of the factor to the attractiveness of an investment to financial investors

Initial rounds of private investments from seed capital and VC/PE tend to be particularly affected when the economy slows down because of their limited resilience to economic shocks. Larger private players such as institutional investors are less vulnerable to such shocks but tend to reduce investments in areas which may not be core to their business, such as clean energy. Economic shocks are assessed to have least impact on investment from public sources as these are typically made over

¹⁶⁹ De Bruyn, Sander et al (2016). Investment challenges of a transition to a low-carbon economy in Europe. CE Delft.

¹⁷⁰ Notenboom, Jos and P.A. Boot (2016). An essay on the colourful scene for Europe's energy transition: modernising the energy system under pressure of supply and competitiveness concerns and the growing urgency to decarbonise. PBL Netherlands Environmental Assessment Agency. P. 25.

longer timeframes and with more secure funding, nevertheless economic ups and downs do influence the level of public finance available as is clear from the cutbacks resulting from the financial crisis.

Factor's level of importance assessment

The following table summarises the relative level of importance of the "macro-economic factors" in influencing clean energy investment decisions in Europe. This is based on the various elements analysed above and our expert opinion. The degree of maturity of a technology has an impact on the relative importance of the macro environment, as mentioned above this is especially the case for EE-B.

Table 4-6 Summary overview of influencing factor VI – macro-economic factors

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	VC/PE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	3	3	3	3	3	2	3	3
EE-B	3	4	4	3	3	2	4	3
EE-I	3	3	3	3	3	3	4	N/A
EE-T	2	1	3	2	2	2	3	N/A

[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.3.7 Influencing factor VII: Shortage of good investment project opportunities

When referring to shortages, we refer to two types of shortage, firstly, a shortage of good project (business cases) and secondly, a shortage of sizable projects. Investors at various stages generally find that there is still today a shortage of projects that are both good and of the right size.

Lack of good quality project opportunities

For investments at early stages, e.g. PE/VC, investment opportunities are insufficient in number and tend to concentrate on more mature renewable energy technologies such as solar PV and onshore wind. This is partly due to a lack of experience and historical data with the other clean energies but also because investors find that there is a shortage of projects meeting investors' requirements even with incentives schemes from governments. Returns for such projects are also perceived as high risk. The Taylor Wessing report¹⁷¹ focussed on early stage PE/VC investors, found strongly that there was a lack of investable projects, finding that a third of surveyed venture capital and private equity investors declined to proceed on deals. The reasons included

¹⁷¹ Taylor Wessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

the time forecast until revenue generation was too long and that projects were of too high a value which deterred investments.

Shortage of sizable projects

Larger investors such as institutional investors (insurance companies, pension funds), bond issuers or even commercial banks comment that there is a shortage of sizable projects to make it worthwhile for them to invest, in contrast to the needs of PE/VC investors. The pooling of such projects, usually done by using securitisation, is in practice not always easy to put in place due to the granularity of such underlying projects as they are not just small but very heterogeneous, this granularity is an important (negative) issue for institutional investors. International public finance organisations (EBRD, EIB, IFC, etc.) and national public finance institutions (German KfW, French CDC, etc.) have an important role to play for project aggregation and securitisation to take place.

For energy efficiency investments, the lack of sizable projects is even more pronounced than for established renewable energies. A key characteristic of EE projects is their small size and their distribution across a large number of sectors and entities (households, companies, etc.), leading to fragmented and heterogeneous markets where transaction costs are high. To counteract this investment barrier, the Jacques Delors Institute suggests “aggregating several small projects into one bigger pool is therefore critical to attract investors’ interest. To allow for cost-effective aggregation to take place, transaction costs ought to be lowered to encourage the emergence of low-cost retail models. This requires standardisation and easier access to data.”¹⁷²

Relevance of the factor to specific clean energy sectors

The impact of this factor is strong for RES (especially less established) and even more so for EE-B as they both suffer from significant granularity of their sources of energy or sources of energy saving. Taylor Wessing¹⁷³ states that, capital intensive industries, such as offshore wind and marine power, are forecast to face a continued struggle to secure the necessary funding to transform small-scale demonstration projects into full-scale commercial operations. Even after technological viability has been achieved”. As investors are concerned as to how these companies will scale up efficiently and leverage their size to become profitable. Although at least for offshore wind this factor has not been significant enough to stop many large wind farm projects being commissioned.

EE for transportation and industry is mostly a game of large players (manufacturers, large industries) and relies heavily on investment from their own capital base or on borrowing via bank loans or bonds issuances.

Relevance of the factor to the attractiveness of an investment to financial investors

¹⁷² Rubio, E. et al. (2016). Investment in Europe: Making the best of the Juncker Plan – with case studies on digital infrastructure and energy efficiency. Notre Europe Jacques Delors Institute. Studies & Reports #109.

¹⁷³TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

The shortage of investable projects is especially true for the VC/PE stages of investments. However, for larger investors such as institutional investors, the overall volume of investments in the clean energy sector is an important issue. The granularity and lack of good quality, large projects are especially detrimental to large investors who want to invest in equity or raise finance for corresponding bonds (green bonds).

The shortage of sizable projects has less impact for smaller, more specialised investors such as early stage investors. Utility providers are less impacted by these two factors as they tend to invest in specific dedicated projects, mostly in equity projects in industry, the energy sector or transport.

Factor's level of importance assessment

The following table summarises the relative level of importance of "shortage of good investment project opportunities" as an influencing factor for clean energy investment decisions in Europe. This is based on the various elements analysed above and our expert opinion. The high scores for EE-B reflect the shortage of projects of sufficient quality and size. EE-T and EE-I are only mildly impacted by this factor as investments are mostly by large organisations and in proven technologies.

Table 4-7 Summary overview of influencing factor VII – shortage of good investment project opportunities

	National Public Administration & National Promotional Banks	EU Public Financial Institutions	Commercial Banks	Institutional Investors	VC/PE	Seed/Angel investors	Private Companies (own resources)	Small end-users
RES	2	3	3	4	3	1	3	1
EE-B	2	4	4	5	4	1	2	1
EE-I	2	1	1	2	2	1	1	N/A
EE-T	2	1	2	2	3	1	2	N/A

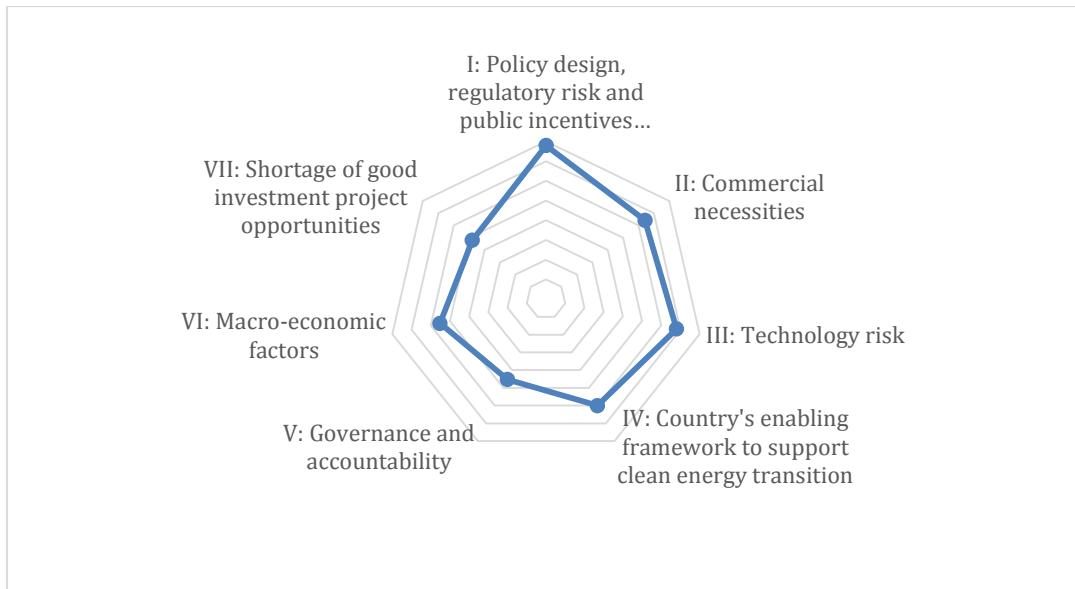
[Legend: Factors in the table are scored on a scale from 1 to 5 to provide a sense of the importance of each influencing factor. Ranking is interpreted as: 1 - little importance, 2 - somewhat important, 3 - rather important, 4 - very important, and 5 - extremely important.]

4.4 Synthesis of findings regarding the influencing factors

This summary section synthesises the findings of the various interlinkages at play between influencing factors, sources of finance and the various clean energy project opportunities.

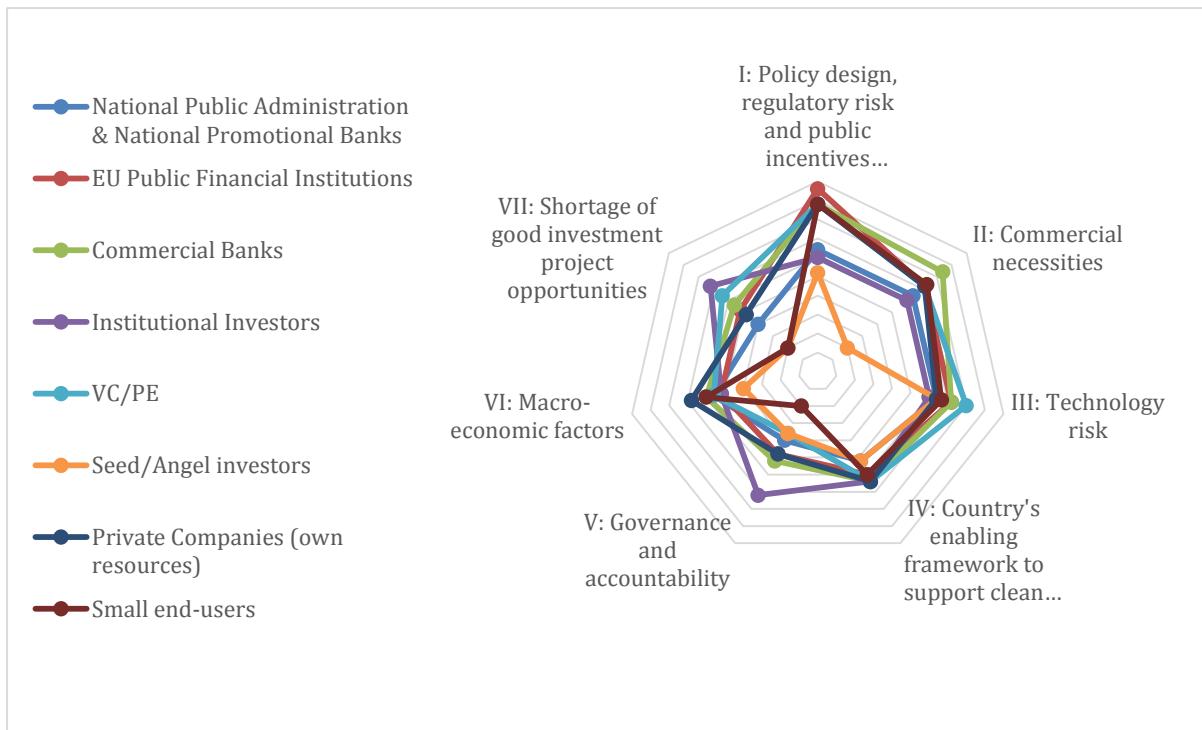
Figure 4-3 shows which influencing factors are most important on average. As can be seen, 'policy design/regulatory risk' ranks highest, closely followed in importance by 'technology risk', 'commercial necessities', and 'country's enabling framework to support clean energy transition'. When analysed as a whole, 'macro-economic factors', 'shortage of good investment project opportunities', and 'governance/accountability factors' are ranked as less important across financing sources and clean energy project sectors/technologies.

Figure 4-3 Ranking the importance of influencing factors on average across financing sources and clean energy sectors



[Source: own analysis based on score tables presented above]

Figure 4-4 shows which influencing factors are most important per type of investor. What can be seen from this analysis is that for almost all types of investors, 'policy design/regulatory risk', 'commercial necessities', 'technology risk', as well as 'country's enabling framework to support clean energy transition' make up key factors in their investment decisions. For large institutional investors, the 'shortage of good investment project opportunities' and their attention to 'governance and accountability' factors further limits their clean energy investment choices. Seed capital/angel investors are the group being least susceptible to influencing factors across the board.

Figure 4-4 Ranking of influencing factor importance per type of investor

[Source: own analysis based on score tables presented above]

In summary, these findings show what (potentially) influences the quantity and direction of flows through the European clean energy finance landscape. These are the factors that can be looked at in terms of finding a suitable policy option to overcome current restrictions or encourage positive flows in the landscape (see Chapter 5).

4.5 Implications for modelling

At this stage of the analysis, all parts of the European clean energy finance landscape have been explained separately and how they interact with one another. As a next step, we now explore what this analysis tells us for macro-economic modelling, and in particular where and how macroeconomic models would need to be amended to better reflect evolution and constraints in the clean energy finance landscape.

The following illustrative intervention logic is the starting point for translating these findings into updated modelling:

- 5) The principal influencing factors of most importance to clean energy sector (x) are (i) and (j).
- 6) This explains why financing sources (a) and (b) are more prominent in funding clean energy sector (x) (because they are better adapted to managing or bearing the risks, or they are less sensitive to influencing factors (i) and (j)).
- 7) If policy could do something to de-risk or address factors (i) and (j) this could trigger greater investment, including from sources that are not currently much interested in this sector/technology.
- 8) Finally, these three preceding steps will be captured in the modelling, typically collapsed into a single WACC indicator (but now with insight into the

policies/drivers that could most reduce the WACC for this sector, and incorporating other, macro, influences on the cost of capital), or possibly also as a quantitative limit on finance going into this sector.

4.5.1 General principles underpinning the adaptation of models to make them capable of using specific information about the availability and cost of finance

In a model that has its origins in a post-Keynesian approach, such as E3ME, the treatment of finance is based on the following principles:

- (1) Firms or households that have an opportunity to invest in clean energy base their decision on a variety of factors, not all of which are observable, and one of which is the availability and cost of finance.
- (2) Each particular type of clean energy investment has a 'typical' financing structure, in terms of own resources, new equity and debt (bonds or bank loan), and the debt element has a 'typical' amortization period. Among these, it is the debt element that matters for a potential constraint on future access to finance. These structures are formed as assumptions based on existing experience (and it is not currently envisaged that policy initiatives would focus on changing the broad structures).
- (3) Different borrowers face different interest rates depending on a) whether they are a firm or household; b) the strength of their financial balance sheet (the extent of their indebtedness); c) the sector/technology in which they wish to invest and the associated technology and policy risks; d) the country in which they are located, insofar as its macro conditions present additional risks; and e) general macroeconomic conditions which affect the appetite for risk (when investors are confident, the gap between more and less risky investments is smaller). These factors influence the premium that financial investors require above the relevant risk-free investment (typically government bonds, for countries where the risk of sovereign default is low).
- (4) The underlying risk-free interest rate (yield on sovereign bonds) depends on inflation expectations, liquidity preference (the extent to which investors prefer to hold money or near-money assets versus assets whose value is affected by market conditions), and on (as currently) interventions in the market to buy debt to push up bond prices. This long-term interest rate is less volatile than short-term rates which, except in exceptional circumstances, closely follow the policy rate (which, in turn, is assumed to be set by the central bank according to inflation-targeting rules).
- (5) Borrowers service their debt over time from the saving in annual energy costs (in the case of energy efficiency investment) or the income that they earn from the sale of electricity (in the case of power generation; it assumed that the regulation of electricity prices adapts as necessary to permit prices to cover the levelised cost of electricity including financing costs).
- (6) The level of short-term interest rates faced by households influences their consumption decisions, and hence the level of household saving. This rate is closely related to the policy rate, with an appropriate mark-up. But willingness to save does not influence interest rates (interest rates do not adjust in a 'market for saving' to bring about a match between the supply of and demand for 'loanable funds').
- (7) In any given year, the net effect of decisions to consume and invest and the international competitiveness of firms determines the level of GDP and the extent to which investment and the government budget deficit are financed from domestic savings or from abroad (by running a balance of payments current account deficit).

In a model that is founded on modern general equilibrium theory such as GEM-E3-FIT, the treatment of finance is based on the following principles:

- (1) Households or firms decide to undertake a clean energy expenditure either because it is profitable or because it is imposed via a regulation or a policy measure. Profitability depends on the cash flows that the clean energy expenditure both requires and generates.
- (2) The financing scheme of the expenditure determines the financial attractiveness of the potential expenditure and hence whether it goes ahead. 'Financing scheme' refers to the mixture of the own and loaned funds, to the horizon of the payback period and to the level of the interest rate.
- (3) Households or firms have three options to finance a clean energy expenditure: i) through own funds (disposable income, profits), ii) reducing their savings, iii) loan.
- (4) Depending on the choice of the macro closure of the model, loans can be provided by: i) Agents that are in surplus and provide the necessary financing to those in deficit so that at regional or world level total savings equal investments; a regional or global interest rate clears each market respectively; ii) previously-saved financial resources that, for reasons of risk avoidance are idle and have not entered the market; the supply of finance depends on the market interest rate; iii) financing via a fixed interest rate.
- (5) The accumulated debt and the current income flows of each agent determine their financial position and impacts the terms on which they can receive a loan (interest rate and payback period).
- (6) The final interest rate on which the loan is made available is determined by the macro closure, debt and project and country risk (the latter two are always set exogenously into the model).
- (7) The design of plausible long term financial schemes that take into account country and sectoral risks is set by assumption.

4.5.2 Specific adaptation of the models for particular types of decarbonising investments

Next, we provide illustrative examples demonstrating how this general logic then can be tailored for the different clean energy finance investment opportunities, such as established clean power generation (CPG) technologies, or energy efficiency measures applied in commercial buildings.

Power generation - established technologies

- (1) The principal influencing factors are: I (policy design, regulatory risk and uncertainties in public incentives); II (commercial necessities); III (technology risk); and IV (country's enabling framework to support clean energy transition).
- (2) This explains why, currently, the main financing sources are: private companies (own resources), commercial banks, financial markets (incl. institutional investors, VC/PE, etc.), as well as small end-users (for rooftop solar PV).
- (3) Policy action is currently expected to focus on promoting and facilitating the further market uptake of the established clean energy technologies across Europe, e.g. by making the investment more attractive (policy incentives), lowering barriers to access finance, etc.
- (4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this information will facilitate the design of the financing schemes used for investment in the established power generation technologies: i) how much of the new investment will be self-financed and how much will come from other sources; ii) debt financing will refer to specific interest rates and payback periods. Policy incentives such as tax credits will also be taken up into the modelling.

In E3ME, the various alternative technologies for power generation are all identified explicitly in the FTT modelling¹⁷⁴. At present, relative costs and the level of, and recent trends, in market share are key factors influencing future take-up; learning curves are included to capture the opportunities for cost reduction as the global market increases. Drawing on the analysis presented in this report, assumptions will be made for the interest rate spread above the risk-free rate, and this spread will be applied to the risk-free rate in each country as determined within the model. As with GEM-E3-FIT, 'typical' shares of different kinds of finance will be used to estimate the extent of borrowing by the power generation sector, so that its gearing can also influence the cost of capital.

Power generation - non-established technologies

(1) The principal influencing factors are: I (policy design, regulatory risk and public incentives uncertainties); III (technology risk); II (commercial necessities); IV (country's enabling framework to support clean energy transition).

(2) This explains why, currently, the main financing sources are: EU interventions and EU public financial institutions, national public administration and national promotional banks, VC/PE, seed/angel investors, and to a small extent private companies (own resources).

(3) Policy action is currently expected to focus on facilitating the transition from R&D and demonstration phases to turning the technologies into a bankable investment opportunities (e.g. this could be via financial support to demonstration phase/up-scaling; de-risking of the investment, etc.)

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this will facilitate the design of the financing schemes adopted by the non-established power generation technologies and allows, for example, for the representation of policies designed to reduce the risk of particular, less mature technologies. It will also allow for reducing the risk associated with R&D for specific technologies.

In E3ME, the treatment is the same as for conventional technologies described above; clearly the higher risks associated with technologies that are not so well-proven will be reflected in a higher cost of capital, and the greater scope for costs to fall (represented by the technology's learning curves) will also be captured, so that the possibility for a virtuous circle (cheaper financing, greater take-up, lower costs) can arise. As with GEM-E3-FIT, this treatment allows for the representation of policies designed to reduce the risk of particular, less mature technologies: the consequent reduction in the cost of capital will be reflected in the decision-making process modelled in the FTT treatment of power generation.

¹⁷⁴ E3ME-FTT is a global model that features both top-down (E3ME) and bottom-up (FTT) representations.

R&D (both RES and EE)

(1) The principal influencing factors are: III (technology risk); I (policy design, regulatory risk and public incentives uncertainties), II (commercial necessities).

(2) This explains why, currently, the main financing sources are national and EU-level budgets as well as to a lesser extent public financial institutions. Further, some companies invest their own resources into R&D of a new product; some receive support from VC/PE and seed/angel investors.

(3) Policy action is currently expected to focus on accelerating clean energy innovation (see recent Communication COM(2016) 763 final)142). This Communication lays out a comprehensive strategy for the three main policy levers the EU will likely deploy to boost private investment in clean energy innovation.

- a. The EU can set the political ambition and create the right business environment through targeted signals, policies, standards and regulations. This is about setting strong and consistent incentives for private investment in clean energy research, development and deployment.
- b. The EU can also deploy targeted financial instruments to lower the risk of private investments in untested but promising clean energy technologies or business models. This is about using public loans, equity investments and financial guarantees in projects that are unlikely to find full funding from the private sector due to market, technological or scientific uncertainty. With these EU instruments, as demonstrated by the 'Investment Plan for Europe', the risk for the private sector is reduced, enabling private investment that otherwise would fail to happen.
- c. The EU can focus its research and innovation funding, in particular through Horizon 2020, to push the frontiers of science and knowledge. This is about funding curiosity-driven research, mission-oriented research and demonstration projects in order to encourage and accelerate the transition from the lab to successful goods and services that create jobs and generate growth.

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, the decision on R&D expenditure depends on its return and associated risk. Policy design and public incentives targeted to reduce the uncertainty of R&D expenditures in terms of returns, will increase the amount of financing that is available for R&D. In modelling terms, risk will be reduced and financing availability will increase.

In E3ME, R&D spending is combined with physical investment spending to obtain an indicator of technological progress which affects a sector's trade competitiveness and labour productivity. Since investment spending is much larger in scale, this is the dominant influence. R&D is assumed to become effective when it is embodied in physical investment, and so it is not currently proposed to distinguish the factors that drive R&D spending from those that drive general investment, or to give R&D a distinct role in improving competitiveness.

Energy efficiency - Industry

(1) The principal influencing factor for energy efficiency in industry investments are factor I (policy design, regulatory risk and public incentives uncertainties), as well as factor II (business elements).

(2) This explains why, currently, the main financing sources are: companies own resources, complemented with some commercial bank/financial markets involvement (via market-rate debt finance), as well as some public-sector involvement (via concessional debt and/or grants/subsidies).

(3) Policy action is currently expected to focus on: unclear, but most likely either mandating or encouraging further EE investments in order to reach the 2030/2050 goals.

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this will allow for the integration of real life financing schemes adopted by the industry, taking into account the impact on the repayment interest rate that large financial undertakings have. It will allow for differentiation between domestic and international demand/supply for capital (i.e. part of the financing will be established from domestic resources and part will be from international markets at a different interest rate).

In E3ME, the present treatment includes the policy short-term interest rate (the central bank lending rate) as an influencing factor in the econometric equations for investment in industry, and higher investment leads to greater energy efficiency. On the basis of the analysis in this report, assumptions will be made for the interest rate spread above the risk-free rate that industry faces, and this spread will be applied to the risk-free rate in each country as determined within the model. The improved estimate of the interest rate can then be used in the econometric equations for industry investment. 'Typical' shares of different kinds of finance will be used to estimate the extent of borrowing by each sector, so that its gearing can also influence the cost of capital that the sector faces.

Energy efficiency - Commercial Buildings

(1) The principal influencing factors are: I (policy design, regulatory risk and public incentives uncertainties), II (commercial necessities), IV (country's enabling framework to support clean energy transition).

(2) This explains why, currently, the main financing sources are: private companies (own resources and/or debt finance via commercial banks).

(3) Policy action is currently expected to focus on encouraging further uptake of EE measures in commercial buildings to help reach the 2030/2050 EE targets.

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this will allow for integrating the design of real life financing schemes adopted by the industry, taking into account the impact on the repayment interest rate that large financial undertakings have. It will allow for the differentiation between domestic and international demand/supply for capital (i.e. part of the financing will be established from domestic resources and part will be from international markets at a different interest rate).

In E3ME, the same treatment will be followed as for energy efficiency in industry.

Energy efficiency - Housing

(1) The principal influencing factors are: apart from principal influencing factors I (policy design, regulatory risk and public incentives uncertainties) and II (commercial necessities), the influencing factor VII (shortage of good investment project opportunities) is currently also presenting a major hurdle to unlocking additional finance. Most EE projects for buildings are rather dispersed and small in size, making it difficult to get picked up by institutional investors or VC/PE looking for larger investment volumes.

(2) This explains why self-financing by small end-users and public finance are more prominent in funding EE projects in buildings because they better fit the size and risk profile of these clean energy projects.

(3) Policy action is currently expected to focus on a variety of measures as set out in the European Commission's latest Communication 'Clean Energy for All Europeans'. Amongst other actions, EU policy levers to support 'green securitisation' (i.e. pooling/aggregation of projects) will be promoted, which would increase the bankability of EE projects and – in turn – likely attract new types of sources of finance, namely institutional investors and VC/PE. This would lead to an increased investment volume flowing towards energy efficiency projects in the housing sector. Other relevant policy actions are discussed and assessed in detail via Case Study 4 of the overall research project.

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this will allow for integrating the design of real life financing schemes adopted by the industry, taking into account the impact on the repayment interest rate that large financial undertakings have. It will allow for differentiating between domestic and international demand/supply for capital (i.e. part of the financing will be established from domestic resources and part will be from international markets at a different interest rate)

In E3ME, the introduction of the FTT model for heating will allow an explicit representation of the alternative technologies that households choose between. Assumptions will be made for the interest rate spread above the policy rate, and this spread will be applied to the policy rate in each country. This rate will be included as a driver of take-up in the FTT model.

Energy efficiency - Transport

(1) The principal influencing factors are: I (policy design, regulatory risk and public incentives uncertainties); II (commercial necessities); VI (macro-economic factors).

(2) This explains why, currently, the main financing sources are: national and EU level administrations and/or financial institutions for energy efficiency investments concerning the public transport sector. Investments in electric vehicle production are financed via companies' own resources and/or debt finance. Electric vehicle purchases are financed primarily via small end-users own savings and/or their access to loans from commercial banks.

(3) Policy action is currently expected to focus on further improving energy efficiency in public transport. As stated in their Communication on 'Accelerating clean energy innovation' (COM(2016) 763 final), the Commission and the European Investment Bank will set up a 'Cleaner Transport Facility' to support the deployment of alternative energy transport solutions. EIB financial products and advisory services will be made available to public and private entities. Projects may also be eligible for the Connecting Europe Facility or the European Fund for Strategic Investment guarantee. Policy action

also will likely focus on encouraging the switch to electric vehicles (it should be noted that some Member States are progressing on this much faster than others, and hence their associated policy action differs quite drastically).

(4) The treatment in the modelling will be as follows:

In GEM-E3-FIT, this will allow for integrating the design of real life financing schemes adopted by the industry, taking into account the impact on the repayment interest rate that large financial undertakings have. It will allow for differentiating between domestic and international demand/supply for capital (i.e. part of the financing will be established from domestic resources and part will be from international markets at a different interest rate).

In E3ME, the inclusion of the FTT model for diffusion of alternative technologies in road transport allows for an explicit representation of alternative vehicle types. However, it is likely that finance is not the key factor holding back take-up of, for example, electric vehicles (as opposed to, say, the cost of the vehicle, the range of the vehicle and the availability of charging infrastructure).

4.5.3 Accounting for differences between Member States

At a Member States level, the factor analysis produced for renewable energy in sections 4.3 and 4.4 at EU level may be modified at a 'country level' or a 'countries grouping level' once fed into the macro-economic models.

For RES one possibility could be to derive some rough approximation coefficient between the groups of countries. Based on the average of the WACC indicator, the WACC in group 2 (see Annex B) was 60% above the WACC in group 1 and the WACC in group 3, in turn, was on average 30% above the WACC in group 2.

For EE-buildings, on the other hand, one could envision a grouping around more advanced north and north-western European countries versus other southern and eastern European countries. As seen in Annex B, a similar grouping could be set up for EE-transportation, while industries are assumed to be homogenous across Europe and therefore do not require grouping.

5 Influencing the European clean energy finance landscape

Chapter at a glance

This chapter focuses on discussing HOW it is possible to influence the European clean energy finance landscape.

The first section discusses the results of an analysis on the European landscape by looking at the differences/similarities from the domestic climate finance landscapes implemented in Belgium, France and Germany. The comparative analysis aims to highlight those methodological choices, policies and enabling factors that can help explain differences in volumes and directions of flow between the various existing financing landscapes.

The second section analyses the lessons learned from the three landscape studies

The third part presents an MS-level calculation exercise regarding the CAPEX costs associated with installed RES-electricity capacity throughout Europe.

5.1 Cross-checking European findings with data from existing domestic climate finance landscapes in Germany, France and Belgium

Having developed and explained the various boxes and interactions of the European clean energy landscape in the chapters above, this section attempts to put these findings into perspective, i.e. 'testing' them on the existing data and analysis for three Member States (based on climate finance landscape studies).

5.1.1 Overview of the three existing domestic climate finance landscapes

The information on domestic climate finance for Belgium, France and Germany, which can be seen in the tables compiled below, are extracted from three existing domestic climate finance landscapes at Member State level (Germany¹⁷⁵, France¹⁷⁶ and Belgium¹⁷⁷) produced independently for each of these countries. All these reports had roughly the same goal, namely mapping climate finance in each of these countries. However, their structure, level of detail and categorization is not identical to one another. In the German study (2012) the scope was the most restrictive (only tangible mitigation topics, basically, energy efficiency, non-energy related reduction measures and RES) were taken into account. In the French study (2015) also investments in

¹⁷⁵ Juergens et al (2012). The landscape of climate finance in Germany. Climate Policy Initiative.

¹⁷⁶ Hainaut et al (2015). Landscape of climate finance in France 2011-2014. I4CE Institute for Climate Economics.

¹⁷⁷ Rademaekers et al (2016). Landscape of climate finance in Belgium. Federal Public Service (FPS) Health, Food Chain Safety and Environment, Belgium.

new nuclear plants and GHG reductions in agriculture, forestry and industrial processes were taken into account. In the Belgian study (2016) also climate services and climate adaptation were part of the scope. As such, the overall figures are not easily comparable.

Unfortunately, the data in these studies were not organized in the way that suited the present project. This led us to go through these reports in order to collect information about investments in clean energy related projects and trace them back to their financial sources and objectives.

In order to guarantee comparability among the three countries, we generated tables that relate six types of projects with four sources of finance. The six types of projects are: climate related services (R&D), clean energy generation (CEG) and energy efficiency in the industrial, transport and buildings sector and in agriculture. The four types of financial sources are: private equity, private debt (market rate loans), concessional loans (supplied by public bodies) and direct public support (grants, subsidies, tax exemptions).

In order to fill in the table with the information gathered in the respective reports, we needed to make a few assumptions. This was necessary because the reports did not always allow for a direct mapping of the data into the format that we proposed. In the following lines, we would like to explain some of these hypotheses for each of the three countries.

A general point applies to all three countries: all reports divided the investments in climate related projects by economic sector, and often included different kinds of projects. However, in the present project we are more interested in two kinds of projects: energy generation and energy efficiency, the latter being sub-divided by sector. We have thus aggregated the figures on energy generation under one single figure, under the column "clean energy generation (CEG)". Moreover, this column also includes those investments made in energy infrastructure for generation, transmission and distribution. More details on the assumptions made for each of the three countries are summarized in Annex C.

5.1.2 GERMANY

According to the Landscape of German Climate Finance, approximately €37 billion were invested in climate related projects in Germany in 2010. A large portion of investments in climate related projects in Germany is related to generation of energy through renewable sources. However, the structure of the report is such that the investments are divided by sector (e.g. "buildings", "industry", etc.). In our tables, however, the columns for "industry", "buildings", etc. only contain those investments explicitly related to energy efficiency projects. Those amounts invested in the buildings sector that relate to installation of energy generating devices have been summed up under the column "clean energy generation (CEG)". This represented often large sums: for example, the "buildings" sector invested €16.3 billion, of which €5.8 billion referred to energy efficiency and the rest to clean energy generation.

Table 5-1 Total clean energy investment figures for Germany (in € bn)

GERMANY 2010 (in EUR bn)	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources		12.924	0.2	0.516	0.44		14.1
Market rates debt		5.3			0.043		5.3
Public grants and subsidies		0.5		0.2	0.076	0.012	0.8
Concessional Debt		11.3	0.1	5.084			16.5
TOTAL	0	30.024	0.3	5.8	0.559	0.012	36.7

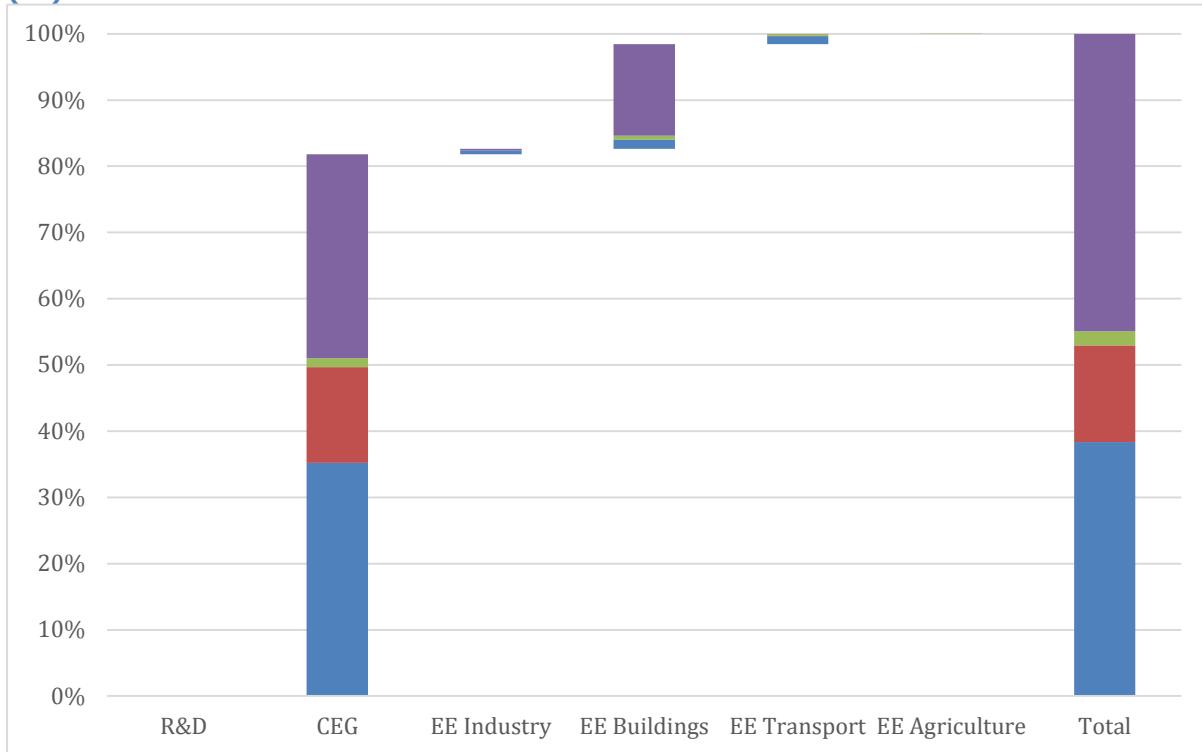
The importance of investments in RES is also clear from the table below. 82% of the total investments in 2010 were related to CEG investments. This figure seems to be high compared to the results in France and Belgium. It is also partly related due to an underestimation of the energy efficiency activities.

Table 5-2 Total clean energy investments for Germany, in relative terms (in %)

GERMANY 2010	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources		35%	1%	1%	1%	0%	38%
Market rates debt		14%	0%	0%	0%	0%	15%
Public grants and subsidies		1%	0%	1%	0%	0%	2%
Concessional Debt		31%	0%	14%	0%	0%	45%
TOTAL	0	82%	1%	16%	2%	0%	100%

The figure below shows the investments in relative terms with for each of the sources of finance a different colour. Blue stands for 'Equity and own resources', orange for 'commercial debt', grey for 'grants and subsidies' and finally, yellow for 'concessional debt'. For Germany, the role of concessional debt is very high due to the role of KfW and the other public banks (45% of total investments).

Figure 5-1 Investment volumes by 'source of finance' and 'clean energy investment opportunity' relative to the total amount of clean energy finance spent for Germany (%)



In most cases, it was possible to retrieve whether the investment had been funded by private equity, private debt, concessional debt or publicly funded. In some cases, however, this had to be assumed. The assumptions were made in order to approximate total figures cited in the report regarding each of these four financial sources: equity and own resources (€14.4 billion), private debt (€5.4 billion), concessional debt (€16 billion) or publicly funded (€0.7 billion).

One important observation regarding the German data refers to the German feed-in-tariff. Since this tariff does not pass directly through the public budgets (it is funded by the private sector via the FiT premium on electricity bills), it is not considered as a public grant or subsidy and as such it is not considered as an investment in renewable energy (also not to have double counting). However, as the Feed-In-Tariff paid to households and corporate renewable energy generators amounted to €13.1 billion in 2010 (or about 50% of the total RES investments) it is obviously a key instrument.

5.1.3 FRANCE

According to the French Landscape, France invested around €36 billion in clean energy related projects in 2013. This report was particularly detailed in what concerned the types of projects and less stringent assumptions had to be made in order to map the information back to the types of financial sources per type of projects. However, it was not always straightforward to separate those investments in the sector of buildings that referred actually to energy generation and this required making some assumptions about the data.

Table 5-3 Total clean energy investment figures for France (in € bn)

FRANCE 2013 (in EUR bn)	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources	1.6	0.266	8.2	0.2	0.045		10.3
Market rates debt	2.627	1.09	5	3.6	0.075		12.4
Public grants and subsidies	0.956	0.091	1.3	7.6	0.066		10.0
Concessional Debt	1.5	0.107	1.4	0.6			3.6
TOTAL	N/A	6.683	1.554	15.9	12	0.186	36.3

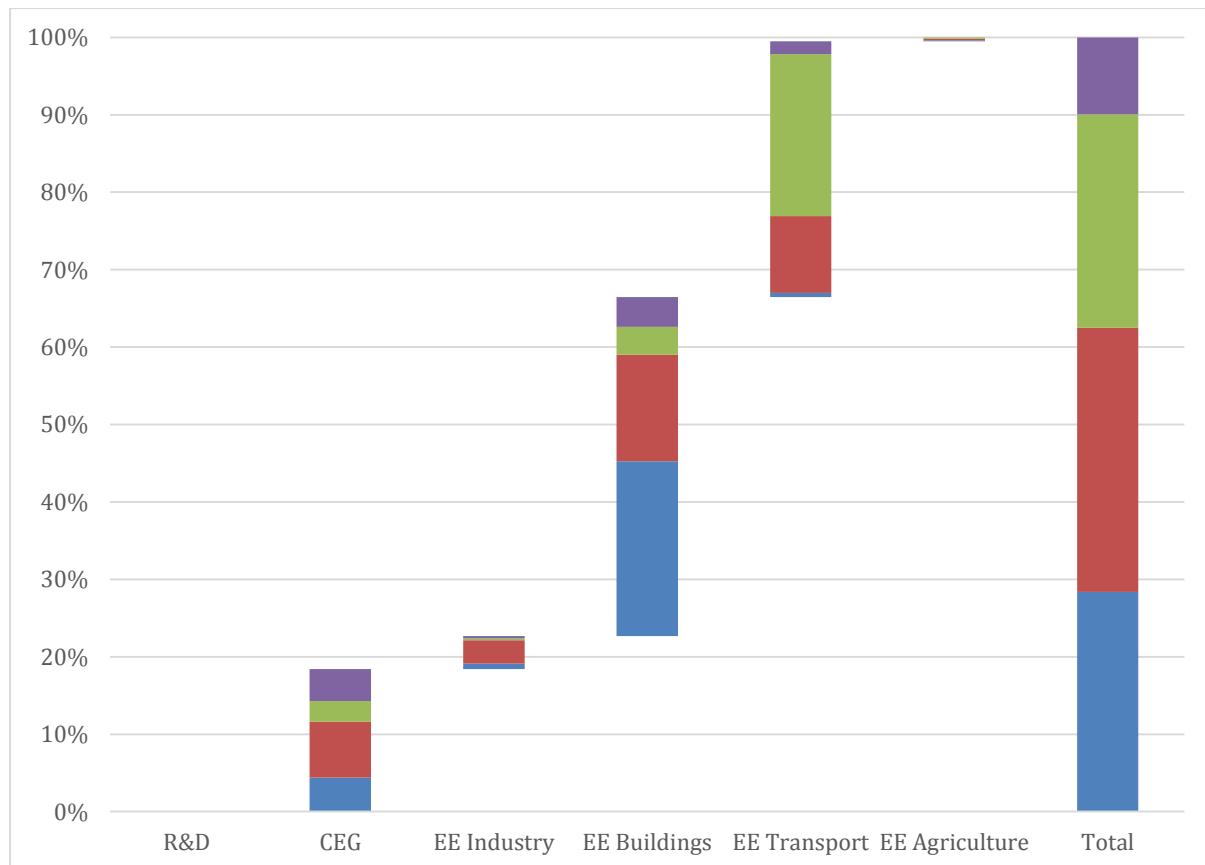
The following table shows the investments in relative terms. It is not unexpected that RES investments are much smaller in France than in Germany. However, it is a surprise that EE-related investments count for 82% of the total investments (with focusing more and more on RES as an alternative for nuclear, this pattern should slowly change in the future).

Table 5-4 Total clean energy investments for France, in relative terms (in %)

FRANCE 2013	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources	4%	1%	23%	1%	0%		28%
Market rates debt	7%	3%	14%	10%	0%		34%
Public grants and subsidies	3%	0%	4%	21%	0%		28%
Concessional Debt	4%	0%	4%	2%	0%		10%
TOTAL	N/A	18%	4%	44%	33%	1%	100%

The below figure shows the investments in relative terms with for each of the sources of finance a different colour. Blue stands for 'Equity and own resources', orange for 'commercial debt', grey for 'grants and subsidies' and finally, yellow for 'concessional debt'. For France, overall, the financial sources are more or less equally spread between own resources, commercial debt and grants and subsidies. The latter is very important for EE investments in the transport sector. Differently from Germany is that concessional debt is rather low at 10% (indicating that if the state intervenes it is rather by using grants and subsidies – nearly one third of total investments).

Figure 5-2 Investment volumes by 'source of finance' and 'clean energy investment opportunity' relative to total amount of clean energy finance spent for France (in %).



5.1.4 BELGIUM

According to the Belgian Landscape, about €6.4 billion were invested in climate related projects in 2013, of which approximately €2.9 billion were invested in RES and €2.5 billion in energy efficiency. Of the three reports, Belgium was the only one that contained information on R&D, which is reflected in the table below. The figures of the table actually refer to investments in "climate services", but a big part is related to R&D, another part to consultancy.

Table 5-5 Total clean energy investment figures for Belgium (in € bn)

BELGIUM 2013 (in EUR bn)	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources	0.844	1.15	0.217	0.915	0.04	0.039	3.2
Market rates debt		0.98					1.0
Public grants and subsidies	0.085	0.56	0.026	0.547	0.755		2.0
Concessional Debt		0.20					0.2
TOTAL	0.929	2.893	0.243	1.462	0.795	0.039	6.4

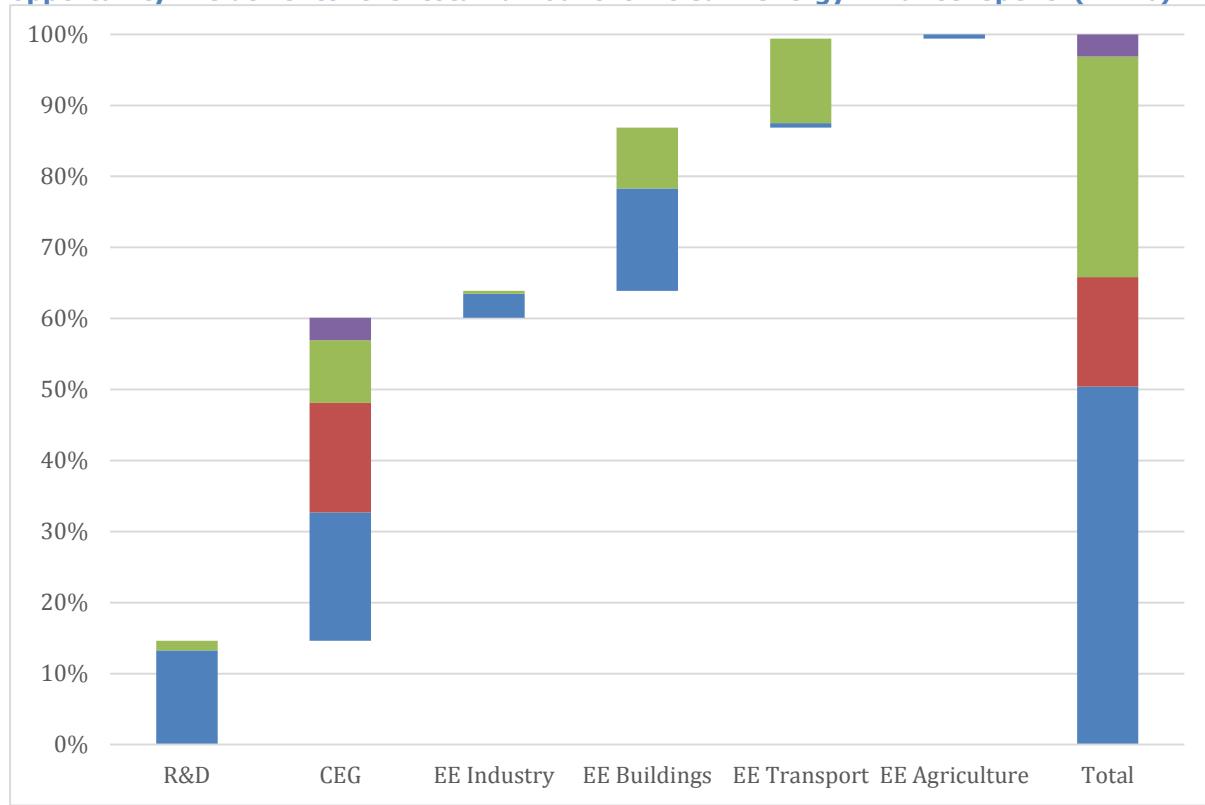
The following table shows the same results but then in relative terms. Interesting is that 'climate related services' (R&D) does count for about 15% of the total investments, which is considerable. We could assume similar or higher percentages for countries like France and especially Germany (given the high investments in some RES technologies).

Table 5-6 Total clean energy investments for Belgium, in relative terms (in %)

BELGIUM 2013	R&D	CEG	Energy efficiency				TOTAL
			Industry	Buildings	Trans.	Agri.	
Equity and own resources	13%	18%	3%	14%	1%	1%	50%
Market rates debt	0%	15%	0%	0%	0%	0%	15%
Public grants and subsidies	1%	9%	0%	9%	12%	0%	31%
Concessional Debt	0%	3%	0%	0%	0%	0%	3%
TOTAL	15%	45%	4%	23%	12%	1%	100%

The below figure shows the investments in relative terms with for each of the sources of finance in a different colour. Blue stands for 'Equity and own resources', orange for 'commercial debt', grey for 'grants and subsidies' and finally, yellow for 'concessional debt'. For Belgium, 50% was financed with own private or corporate resources which is very high. It also hints that it is rather difficult in Belgium to find enough financial resources in the market for many of these investments and, at the same time, that Belgium has one of the highest saving rates in the world.

Figure 5-3 Investment volumes by 'source of finance' and 'clean energy investment opportunity' relative to the total amount of clean energy finance spent (in %).



Similar to the cases of Germany and France, the Belgian case did not allow for a direct mapping of investments per type of project and financial sources, so that some assumptions had to be made based on general patterns of the data (see Annex C).

5.1.5 Explaining the differences

As stipulated above, the structure, level of detail and categorization of the three existing domestic landscape studies are different. The reasons are that these studies have been ordered by different clients (with a different focus), with different budgets and timeline (time for bottom up research or not) and thus also referring to different years.

The first study was the one for Germany, done by CPI in 2012, referring to data for 2010, followed by the one of France (data from 2013 and 2014) and the third and last available study at MS level is the Belgian study (2016, with data for 2013).

The below comparison table explains in a nutshell the characteristics of each of these three studies.

Table 5-7 Comparison of the three domestic landscape studies

		Landscape of Climate Finance in Germany		Landscape of Climate Finance in France		Landscape of Climate Finance in Belgium			
GENERAL	Authors of the study	CPI - Climate Policy Initiative		I4CE – Institute for Climate Economics		Trinomics and EY			
	Partners or sponsors			French Ministry for the Environment, ADEME, Climate-KIC, Caisse des Dépôts		FoD Environment, Climate Change Service			
	Year of publication	2012		Editions in 2014, 2015		2015 (officially Jan 2016)			
	Year(s) covered	2010		2011 to 2014		2013			
SCOPE	Climate scope	Mitigation		X	Mitigation	X	Mitigation	X	
		Adaptation		-	Adaptation	-	Adaptation	p	
		Climate Services		-	Climate Services	-	Climate Services	X	
	X indicates strong coverage p indicates weak or partial coverage - indicates no coverage	Buildings	New buildings	X	Buildings	New buildings	Buildings	New buildings	X
			Retrofitting	X		Retrofitting		Retrofitting	X
		Transport	Vehicles	X	Transport	Vehicles	Transport	Vehicles	X
			Infrastructures (1)	X		Infrastructures (1)		Infrastructures (1)	X
		Agriculture	Energy	X	Agriculture	Energy	Agriculture	Energy	X
			Other GHG (2)	X		Other GHG (2)		Other GHG (2)	p
		Industry		X	Industry		Industry		X
		Energy	Fossil	p	Energy	Fossil	Energy	Fossil	p
			Nuclear	-		Nuclear		Nuclear	-
			Renewables	X		Renewables		Renewables	X
			Networks (3)	X		Networks (3)		Networks (3)	p
	Capital scope	Tangible, material assets		X	Tangible, material assets		Tangible, material assets		X
		Intangible assets, R&D		p	Intangible assets, R&D		Intangible assets, R&D		p

[Source: adapted from EEA workshop on domestic climate finance of 25/10/2016]

The first difference is related to the 'climate scope'. The Belgian study took also climate services and (partially) adaptation activities into account. As the two other studies only looked at mitigation activities it is important to compare not the overall outcome of the different studies but only the mitigation results.

The second difference is related to the 'sectoral scope'. The biggest differences are found back in the energy sector. In the French study, also fossil fuel related energy production and the nuclear sector are taken into account. In the German and Belgian study, the nuclear sector is excluded and also fossil fuel related activities are mainly excluded (CHP is included in the Belgian study).

The third and maybe most important difference is related to the sources taken into account and the way the data have been gathered. All three studies have worked with mainly public available data. A difference is that for the Belgian study, quite some additional data have been retrieved (especially for EE) by interviewing people, especially in the corporate and banking sector (including obtaining not public available data). In the German study, also some interviews were done but mainly to verify public data. The French study didn't fall back on interviews. The limitation of data availability (and if not corrected for by assumptions backed up by extra interviews) caused a lower estimation of EE investments in the German study (this was acknowledged by the authors themselves). The German authors also indicate in their study that they 'only focused on the most significant financial flows'. A consequence is that several investment flows could not be split up between instruments or sectors and as such, assumptions were used (see Annex C).

Besides the above explained differences, which are all related to methodological choices of the authors of the studies, there are also differences in the results which are typical for the set-up of the financial system and other socio-cultural characteristics of the three countries.

In **Germany** for example, public banks (such as KfW, the agricultural Rentenbank, and state banks) played a key role by providing concessionary loans.

In **Belgium**, on the other hand, public banks are a negligible factor when referring to investments in low-carbon activities (with 3% of the total investments). It is a typical socio-cultural characteristic in Belgium to have high savings (especially the household sector) and when interested or stimulated to invest in green or low-carbon activities. These high savings can also serve banks to finance long term credits/projects against higher rates, in which low-carbon projects should play a larger role. This hints that finance for low-carbon activities could come more from banks (based on this high saving quote), if the household sector is not active enough in financing such activities directly themselves. Nonetheless, one should bear in mind that in Belgium changing the supporting policy of green certificates had a discouraging effect on investments in RES.

In **France**, as stated before, the historical choice for nuclear energy is weighing heavily on the low rate of clean energy (-financing).

5.2 Financial lessons learned from the three existing climate finance landscape studies

When comparing the structure of financing between these three countries, various lessons can be learned:

- Financing by market rate debt lies in Germany and Belgium at 15%, where in France this lies at 34%. This could imply that financing by market rate debt is less used in Germany and Belgium, and that market rate debt could be stimulated more in those countries.
- Financing by equity and own resources lies in Belgium at 50% (and can be related to the high savings quote and since high upfront investment is demanded these investments are more related to the higher incomes). This high investment rate can be linked to the advantageous subsidy-scheme (green certificates) that stimulated households to invest in renewable energies.
- Public grants and subsidies are at 28% and 31% in France and Belgium. In Germany, they seem extremely low (2%), but this is explained by the FiT premium on electricity bills which are not considered public funds.
- Concessional debt financing is very low in France and Belgium (resp. 10% and 3%), and is very high in Germany because of the important (historical) role KfW plays. French public banks don't seem to use this kind of financing often (although France has some public development banks). In Belgium, the high savings quote allows for low-carbon investments directly by the households, or indirectly for financing of low-carbon investments by banks (and as such, public developments banks don't play a role in the Belgian financial structure).
- In Germany, the public bank KfW plays a key role in concessional debt financing. When looking at the role of German Development Financial Institutions (DFIs), a report of Deutsche Bank¹⁷⁸ indicates that they play a policy role and governments provide them their strategic priorities. While they are financial market participants, they often have a special status in financial systems. The heterogeneity of institutions and different local market conditions make a comparison between the DFI's difficult. One similarity consists of the supervision and governance structure that reflect their hybrid role between the state and the market. KfW in Germany is owned for 80% by the Federal Republic of Germany and for 20% by the German states. BPI in France is owned for 50% by the French state (via EPIC-BPI Groupe) and for 50% by Caisse des dépôts et consignations (itself government-owned). Another similarity is that the DFI's play more or less the same promotional role in their national MS and that participation in EU programmes and making funds accessible is a major part of the business for many European DFIs – particularly in structurally weaker regions in the European Union. This is the case for renewable energy, energy efficiency, but also for supporting (export business for) SMEs.
- Data from Eurostat shows that in terms of nominal GDP (2015), Germany, France and Belgium are present in the top 10, whereas for the GDP per capita (2015), the 3 countries are at the bottom of the top 12.
- Comparing those countries with countries from the higher WACC-groups like Lithuania, Estonia and Croatia shows that the latter countries are among the last ranked 10 countries in the GDP-ranking (nominal and per capita). It may be assumed that the structurally 'weaker' regions can be characterized by a higher WACC (and therefore a higher required rate of return).

¹⁷⁸ Deutsche Bank Research. EU Monitor Financial Markets. Promoting investment and growth: The role of development banks in Europe (23/12/2015)

- Germany, France and Belgium are members of the first group of the Diacore-project¹⁷⁹, showing a WACC between 3,5% to 7% (for onshore wind projects)¹⁸⁰. The cost of equity for these three countries ranged between 9.3% and 10.8%, while the cost of debt ranged between 5,3% and 6,3%. However, the number (and size) of the investments in onshore wind projects are very different between these three countries and as such, we could state that there is no good correlation between these WACCs and the investments in onshore wind projects.

5.3 MS-level exercise

The aim of this exercise was to find out if, for some clean energy activities, financial information can be gathered for each of the Member States and in which way this information is comparable with the three climate finance landscape studies.

Given the different clean energy activities, we could find information on the RES-E capacities per Member State and average CAPEX figures for several RES technologies so we were able to calculate estimations for the current (2015) RES-E investments per Member State.

The investment levels were estimated on the basis of the additional added capacity and the capital expenditure costs for ten different renewable sources. The added capacity is the difference between the installed capacity of 2015 compared to 2014. These figures were taken from the 'EU energy in figures statistical pocketbook', matching the Eurostat statistics. Initially twelve renewable sources were explored, but for 'concentrated solar power' and 'liquid biomass' no capacity change was observed.

The 2015 CAPEX costs for each technology were taken from the IEA/OECD World Energy Outlook 2016 (thus not at MS level). Conversion to EUR'15 was done using the WorldBank 2015 exchange rate¹⁸¹ of 0.901659 EUR/USD. To calculate the solar photovoltaic investments, we assumed the CAPEX as given by IEA/OECD for 'large-scale' PV. For 'hydro <1 MW' and for 'hydro 1-10 MW' we used small scale hydropower prices. The large-scale hydropower CAPEX was used for the categories 'hydro 10+' and 'mixed and pumped storage'. At last for (solid) biomass we used the average CAPEX price of the two categories 'biomass power plant' and 'biomass CHP medium'. All prices are given in Table 5-8.

¹⁷⁹ Diacore - The impact of risks in renewable energy investments and the role of smart policies, Febr 2016

¹⁸⁰ Although, Germany, France and Belgium are in the first group, the WACC for onshore wind projects in Germany is 200bp lower than the one for France and Belgium

¹⁸¹ <https://data.oecd.org/conversion/exchange-rates.htm>

Table 5-8 Capital expenditure costs as of 2015 (in EUR per kW)

	EUR'15/kW
Geothermal	2,615
Hydropower - large-scale	2,389
Hydropower - small-scale	3,516
Solar photovoltaics - Large scale	1,190
Marine	6,267
Wind onshore	1,659
Wind offshore	4,148
Biomass	2,773

[Source: WEO 2016 OECD/IEA; converted from USD using the Worldbank exchange rate of 0.901659 EUR/USD]

The results, per technology and per Member State, are given in the table below, showing RES-E investments for 2015 in million Euros for each MS for ten different technologies. In total, an estimated 45.9 bn EUR'15 was invested to add RES-E capacity in the EU28.

When comparing the figures of Germany, France and Belgium in the below table with the figures of the landscape studies (although the base years are different), we can conclude that the RES-E figures in the below table are (much) lower. The RES figure for Belgium was 2671 million euro for 2013 compared to 628 million euro in the table below; for France, the RES figure for 2015 (from the landscape study) was 5.4 billion euro compared to 3.9 billion euro in the table below. The main difference is coming from the RES definition: for Belgium, the figure from the landscape study includes all RES projects, including CHP (and thus not only RES-E activities). Another difference is that a bottom-up approach is more accurate as the real investments figures of specific RES projects are taken into account whereas in the (top-down) approach (see table above), average CAPEX figures per technology type were used across all Member States.

Table 5-9 RES-E investments (mn EUR'15) in the EU28 Member States for 2015

MS	Hydro <1 MW	Hydro 1-10 MW	Hydro 10+ MW	Storage	Marine	Onshore wind	Offshore wind	Solar PV	Solid biofuels	Biogas	Geothermal	Total
Austria	141	-	-	-	-	539	-	179	424	32	-	1,315
Belgium	-	-	-	-	-	489	-	113	-	25	-	628
Bulgaria	9	-	-	-	-	-	-	7	-	-	-	16
Croatia	7	-	-	-	-	139	-	13	46	24	-	229
Cyprus	-	-	-	-	-	17	-	25	-	-	-	42
Czech	-	-	12	-	-	-	-	19	-	-	-	31
Denmark	-	-	-	-	-	292	-	218	-	-	-	510
Estonia	-	-	-	-	-	-	-	7	-	-	-	7
Finland	-	-	60	-	-	663	-	-	28	23	-	774
France	-	-	303	-	6	2,140	-	1,065	302	99	-	3,916
Germany	-	-	-	-	-	5,759	9,469	1,666	3	354	36	17,287
Greece	-	-	-	-	-	288	-	12	-	11	-	312
Hungary	-	-	-	-	-	-	-	22	-	-	-	22
Ireland	-	-	-	-	-	457	-	-	5	-	-	462
Italy	-	-	-	-	-	735	-	358	-	124	146	1,364
Latvia	-	-	-	-	-	-	-	2	-	-	-	2
Lithuania	-	-	-	-	-	226	-	2	75	9	-	312
Lux	-	-	-	-	-	0	-	12	-	-	-	12
Malta	-	-	-	-	-	-	-	6	-	-	-	6
NL	-	-	-	-	12	609	825	536	-	-	-	1,982
Poland	-	-	-	-	-	2,097	-	52	-	55	-	2,205
Portugal	-	-	72	-	-	370	-	46	-	2	-	490
Romania	-	-	-	-	-	-	-	10	70	-	-	80
Slovakia	-	-	-	-	-	-	-	-	-	-	-	-
Slovenia	-	-	-	-	-	-	-	20	3	2	-	25
Spain	49	293	1,450	614	-	55	-	54	- 75	5	-	2,445
Sweden	-	-	-	-	-	1,541	-	61	930	-	-	2,532
UK	-	70	-	-	-	974	2,559	4,211	993	132	-	8,939
EU28	206	364	1,897	614	18	16,902	12,854	8,716	2,804	898	182	45,944

5.4 Conclusions

The three climate finance landscape studies show us that it is important to have a good understanding about and to track climate finance flows for many reasons:

- The climate finance landscaping process helps many different stakeholders (and especially policy makers) to have a better understanding about the financial flows (i.e. the financial sources, the intermediaries, the instruments and the final destination of the financial flows – in which clean energy activity has been invested). As such, policy makers can improve the interactions between the different players in the financial value chain.
- It helps all the players in the financial value chain to understand the interactions between climate action plans, climate investment and climate finance.
- It helps policy makers to better understand what is needed to reach the energy and climate targets and where to put priorities, to identify strengths and weaknesses; it helps them see the bigger picture.
- Climate finance landscaping can also lead to a better regulatory framework that should support project developers to invest.

In conclusion, climate finance landscapes can become a useful policy tool, helping in taking stock of progress made towards mobilising public and private finance in support of the national climate policy objectives (if done on a regular basis).

At the same time, only three countries have done this type of in-depth analysis so far (and only one country is doing it on a regular basis) and even for these three countries, data availability and accuracy remains a big issue. As such, we can conclude that the current data gaps prevent a detailed understanding of the European climate finance landscape.

The analysis showed that for some specific estimations it is possible to fall back on EU-level statistics and accessible data; however, for many of the quantified financing streams across the European landscape it would be crucial to have a good understanding of the financing flows and interactions in each of the Member States.

Hence, there is a need to improve the data and information availability on both European and Member State level.¹⁸² Without the necessary data behind the boxes and arrows depicted in the European clean energy finance landscape diagram it will be impossible to tell the full story and have the full overview on clean energy finance for Europe. Such an overview would help keep track of progress as to whether Europe is managing to mobilise sufficient public and private sector finance to meet its ambitious climate and energy targets and objectives.

In the meantime, while such efforts need to be undertaken to close current data gaps, the integration of the qualitative information and logic behind the European clean energy finance landscape can be a first powerful step to already improve the forward-looking policy assessment tools in form of macro-economic modelling.

¹⁸² This urgent need for closing current data and knowledge gaps prior to being able to quantify a European landscape similar to those of BE, DE and FR is reviewed and highlighted in more depth in a forthcoming (2017) publication by the European Environment Agency entitled "Assessing the state-of-play of climate finance tracking in Europe".

6 Annex A: Literature review on influencing factors

This annex provides further background information relevant for Chapter 4 of this report. The annex summarises existing literature on influencing factors that has been reviewed and assessed in order to draft our own interpretation of the key influencing factor groupings.

This annex delivers an overall comparison of factors by investment sources and decarbonisation sectors. This section provides a full literature review, a type of synopsis of various reports, where analyses of categories of influencing factors are explained. As mentioned before, this review serves as additional background information of material that has been assessed prior to the writing of Chapter 4.4 of the main document. The general report provides a more synthetic categorisation of such influencing factors. Therefore, this literature review annex aims to provide the readers, in particular the modellers, with a broad overview of which factors are reasonable and to explain how we have drawn our own expert conclusion on a set of proposed influencing factor categories as presented in Chapter 4.4 of the main document.

It should also be noted that available literature mostly focuses on discussing investment decision and risk factors around RES and EE in buildings. Therefore, the largest part of the discussion presented in section 6.1 refers to RES and EE in buildings. To balance out this overview, section 6.2 presents a literature survey that particularly focuses on known influencing factors in EE for industry and transport sectors.

6.1 Existing literature: broad comparison of influencing factors

This section highlights discussions on influencing factors presented in various selected studies and reports.

Report: "Bridging the funding gap: The financing challenge for European cleantech and renewable energy".

This report from TaylorWessing (2016) is based on "a survey of over 200 senior executives active in the European cleantech and renewable energy industry". "It addresses the financing challenges confronting companies and project developers in the cleantech and renewable energy sector".

We start the broad literature overview with the PE/VC investment source. This source is particularly interesting to analyse in order to compare the seven groups of factors as it appears to be currently the weakest link in financing a decarbonised economy. Except for proven technologies such as solar, and to a lesser extent, wind onshore and energy efficiency, it is currently extremely difficult for technology developers to successfully complete initial rounds of finance. This difficult early stage is representative of other investment sources as it performs a particularly diligent analysis of investment opportunities at a project level.

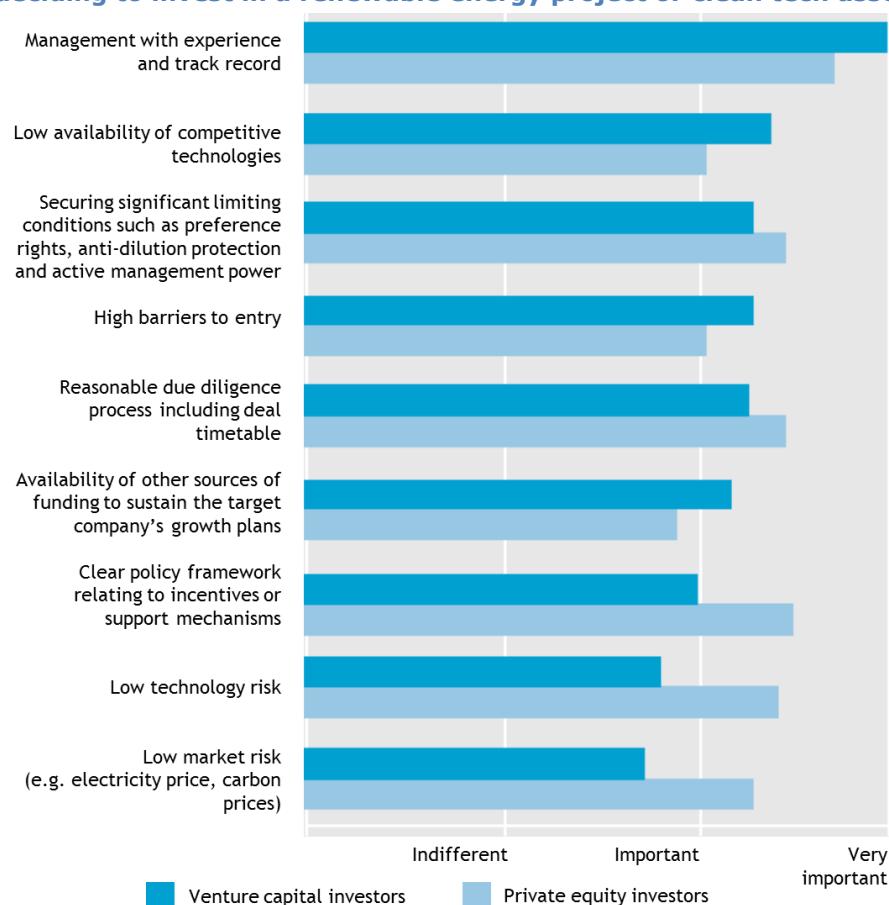
The 2016 TaylorWessing survey, based on interviews of senior executives in the cleantech sectors, states that the main issue of PE/VC from a project developer viewpoint

lies with "Uncertainties on policy framework relating to incentives or support mechanisms".¹⁸³ This refers to factor I of the seven influencing factor categories listed above. The two slightly less important factors relate to the difficulty of accessing satisfactory financing terms "Unsatisfactory terms (e.g. margin, debt service coverage, loan to value)" and "Uncertainties on the availability of other sources of funding to sustain the company's growth plans". These factors are very specific to early stage investments for PE/VC but they broadly fall under factor II. However, surprisingly of yet slightly lesser importance is the factor "Uncertainties on technology performance". This corresponds to the factor category III.

Other factors linked to size of debt requirements, due diligence requirements, management team, and relationship with lender (part of factor II) are considered to be much less important.

Technologies surveyed for the study include RES but also the wider clean tech space (including advanced materials and technologies, agriculture, energy efficiency, energy storage, environmental services and remediation, green transportation, recycling and waste and water and waste water treatment).

Figure 6-1 Key factors for interviewed venture capital and private equity investors in deciding to invest in a renewable energy project or clean tech asset



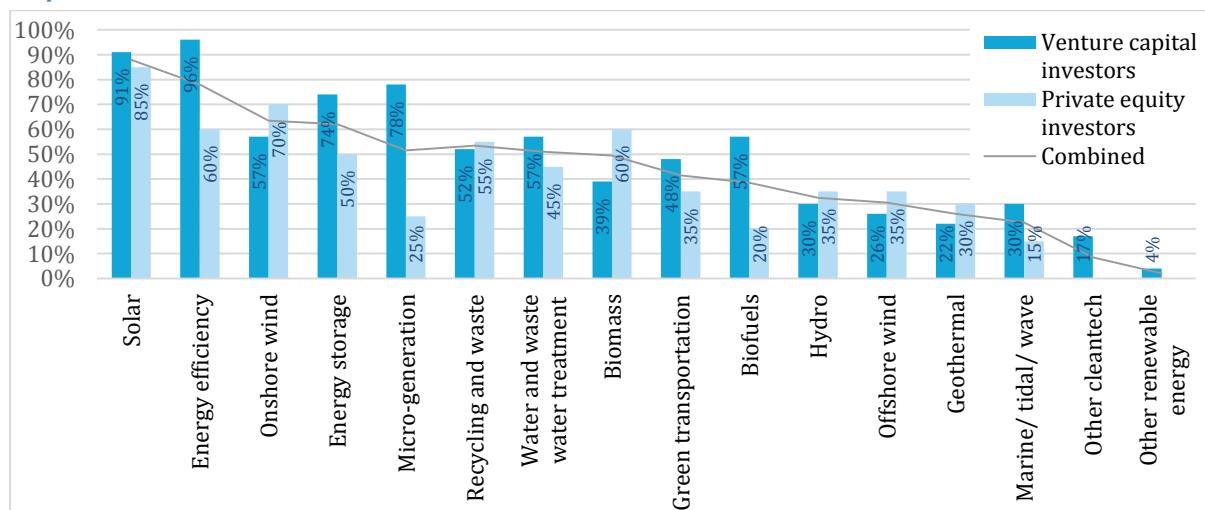
¹⁸³ TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

[Source: Own development based on TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy. P.14.]

Another issue the survey¹⁸⁴ pinpoints is the concentration of funds going into PE/VC for solar energy? (including subsectors, i.e. technologies or solutions that can increase the efficiency and competitiveness). It continues to attract over 85% of PE/VC, followed by onshore wind and energy storage businesses, due to the perceived smaller risk of such technologies. This kind of concentration means that less funding will be available for the other technologies.

Factors affecting more specifically VC/PE include primarily "Uncertainties on policy framework relating to incentives or support mechanisms".¹⁸⁵ However other factors are also important for specific projects, such as Terms of the arrangement for the investor, Quality within the company (management, organisation, due diligence result), Uncertainties on technology performance and to a lesser extend Electricity market risk and Environmental factors. That sort of investments vary by types of energies as shown in the figure below.

Figure 6-2 Targeted sub-sectors in the cleantech or renewable energy sectors by VC/PE investors



[Source: Own development based on TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy. P.16.]

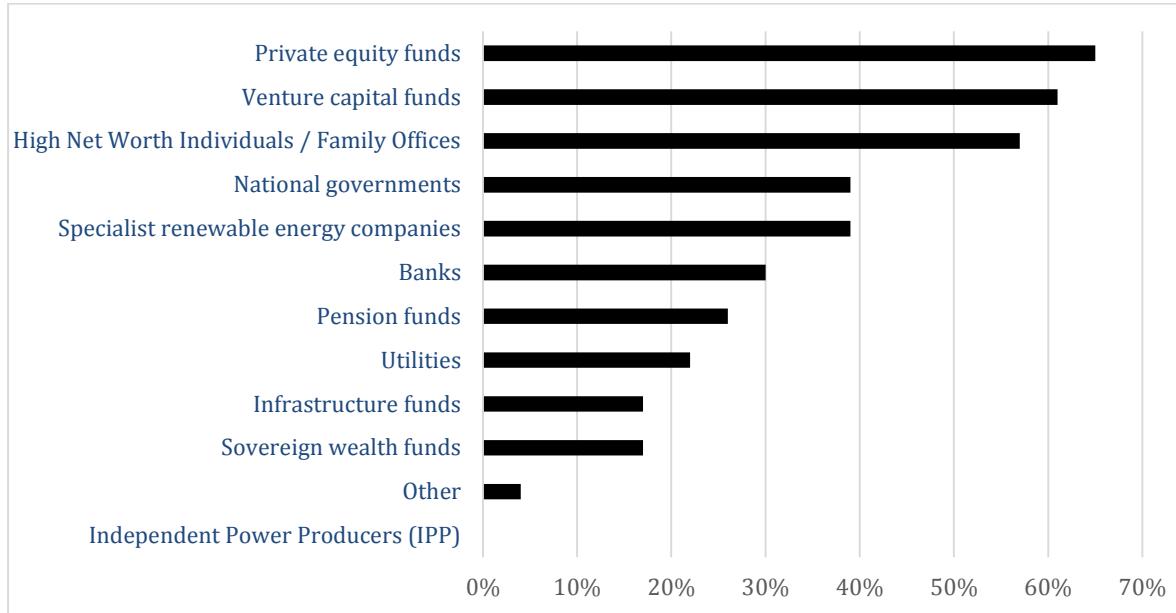
The same study¹⁸⁶ provides interesting information on the sources of finance at the early stage of investment, see figure below.

¹⁸⁴ TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

¹⁸⁵ TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

¹⁸⁶ TaylorWessing (2016). Bridging the funding gap: The financing challenge for European cleantech and renewable energy.

Figure 6-3 Respondents perception of most suitable potential investor types (sources of finance) for early stage project development (percentage of respondents who thought that a given investor type was a suitable one)



[Source: Own development based on Clean Energy pipeline]

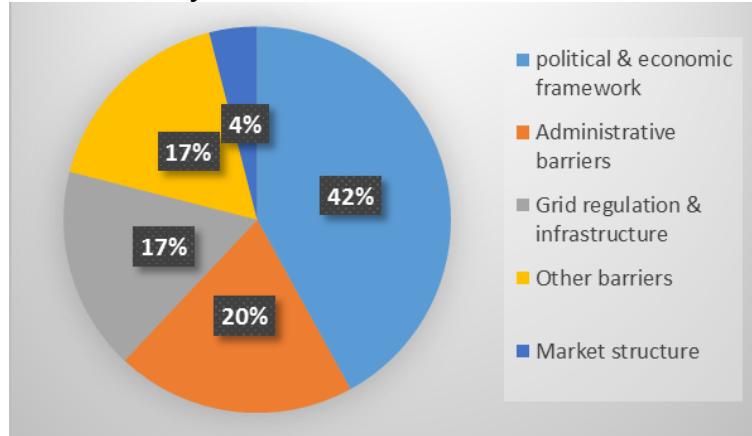
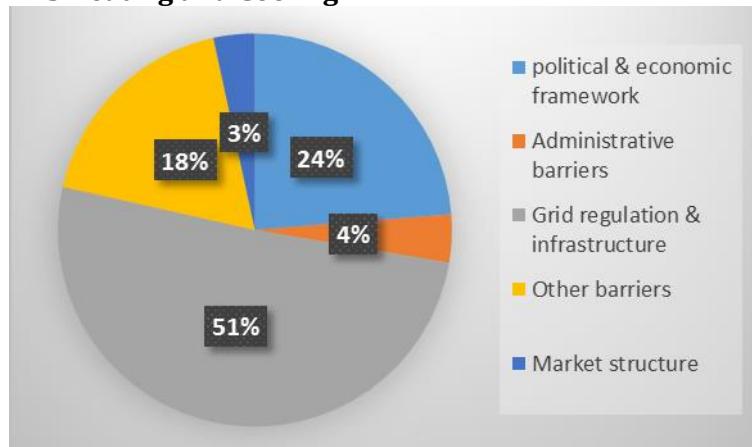
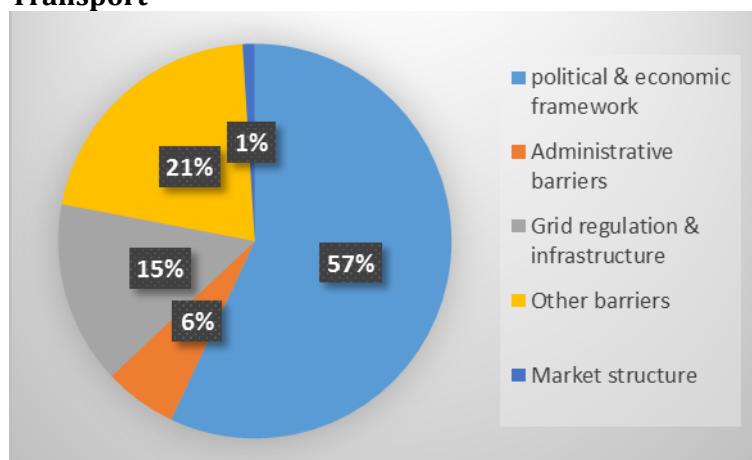
Report : the DiaCore initiative and report.

The DiaCore project aims at providing an estimation of the current cost of capital for wind onshore projects across the EU and assessing the impact of policy design changes on cost of capital. This is done on a Member State basis and comprises an extensive report and a website that provides analyses of a survey outcome.

Beyond this initial analysis of the specific early stages of VC/PE, the DiaCore initiative¹⁸⁷ compiles statistics which are obtained from industry responses to a website survey on perceived barriers to development and investment from players in the industry sectors of RES Electricity, RES Heating and Cooling and Transport.

Within each of the sector categories, the barriers' level of importance is ranked as follows:

¹⁸⁷ <http://www.diacore.eu/>

Figure 6-4 Investment barriers' level of importance. Ranking per sector**RES Electricity****RES Heating and Cooling****Transport**

[Source: own development based on DiaCore data]

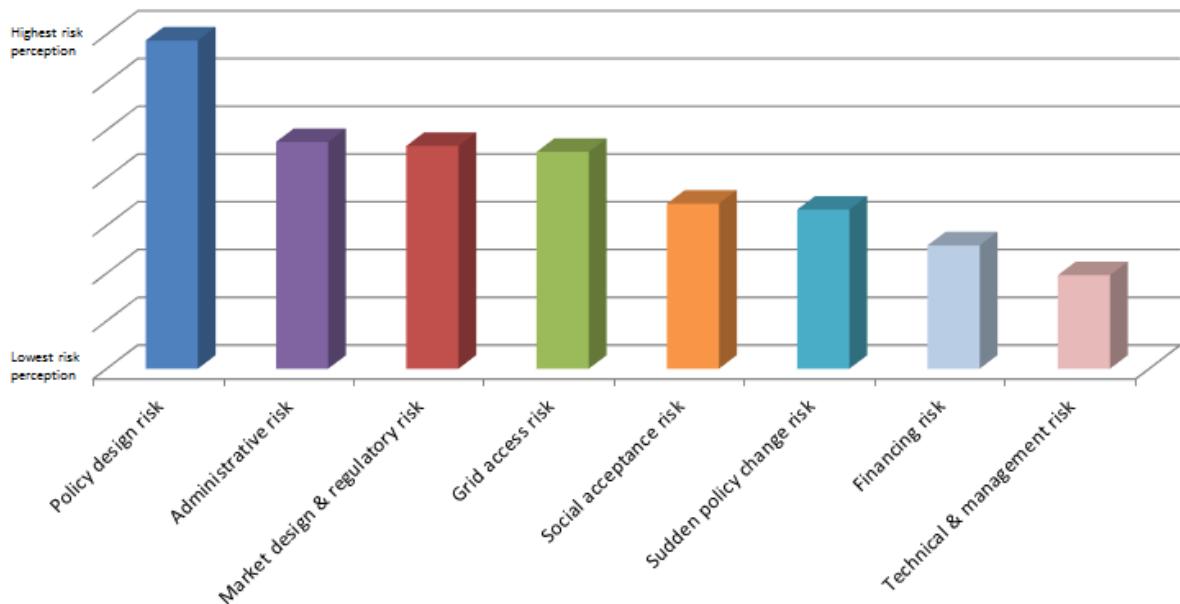
Parallel to this survey, DiaCore produced a report¹⁸⁸ which groups risks into eight risk categories for investors. The report's objective differs from the survey as it does not specify the category of investors. However, investments are considered at a project level. Such risk categories are interesting for our analysis. The eight DiaCore risk categories include:

- social acceptance risks (not in my backyard risk);
- administrative risks (refers mostly to the complexity and time required to obtain all necessary permits);
- financing risks (refers to the combination of the CAPEX/OPEX combine with public financial assistance (e.g. subsidies) and sources of capital scarcity (including from banking regulation Basel III));
- technical & management risks (refers to knowledge and to the maturity of used technologies as well as to resource availability and future potential);
- grid access risks (refers to procedures in granting grid access, connection, operation and curtailment);
- policy design risks (refers to Member State own support mechanism, combined with policies aimed to mitigate risks that are related to electricity price and demand);
- market design & regulatory risks (refers to the uncertainty regarding governmental energy strategy and power market deregulation and liberalisation);
- sudden policy change risks (refers to risks associated with drastic and sudden changes in the RES strategy and the support scheme itself).

Based on a survey of RES players, a ranking of the risk factors was compiled as follows:

¹⁸⁸ DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report.

Figure 6-5 Average ranking of risks across 24 EU MS (missing due to lack of data: HR, IE, LU, MT)



[Source: DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report. P. 31]

The report mentions that “the design of the support scheme is still one, if not the key, prerequisite for stable investment conditions.” And that several experts referred to the policy design as being “the rules of the game”. Changes made in the policy design will have an important impact on investors.

**Report: Allianz, German Watch, New Climate Institute (2016).
Allianz Climate and Energy Monitor: Assessing the needs and attractiveness of low-carbon investments in G20 countries.**

“The Allianz Climate and Energy Monitor ranks G20 Member States by their attractiveness as potential destinations for investments in low-carbon electricity infrastructure. It takes into account their current and future investment needs in line with a 2° C global warming trajectory”.

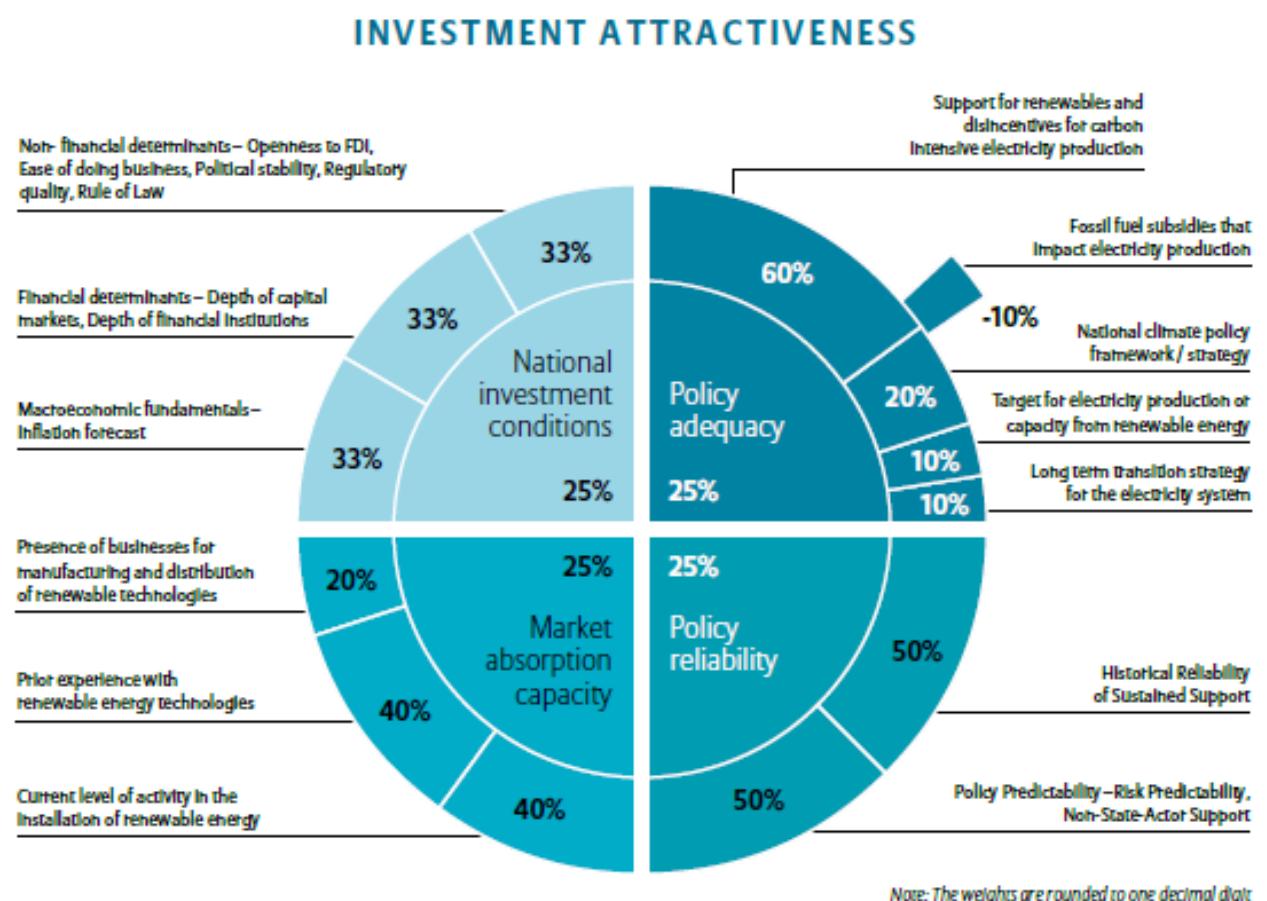
Another report, the Allianz Climate and Energy Monitor¹⁸⁹ provides a short classification of investment attractiveness for investors in general. This report aims to rank the G20 Member States by their relative attractiveness for investment in a low-carbon energy infrastructure, taking into account current and future investment needs in the sector in line with a 2° C global warming trajectory. This is based on “The Monitor” that has been jointly compiled by the New Climate Institute and German Watch in order to focus on the electricity infrastructure in 19 of the G20 members (the EU, as a supranational body, has been excluded). Investment attractiveness and needs of

¹⁸⁹ Allianz, German Watch, New Climate Institute (2016). Allianz Climate and Energy Monitor: Assessing the needs and attractiveness of low-carbon investments in G20 countries.

countries that have been examined are ranked as very low, low, medium, high or very high, with countries rated according to their performance in relation to one another.

The monitor equally ranked the four following factors, "Policy adequacy" and "Policy reliability" (i.e. translating to factor I 'Policy design, regulatory risk'), as well as "Market absorption capacity" and "National investment conditions" (i.e. translating to factor IV 'Country's enabling framework to support clean energy transition').

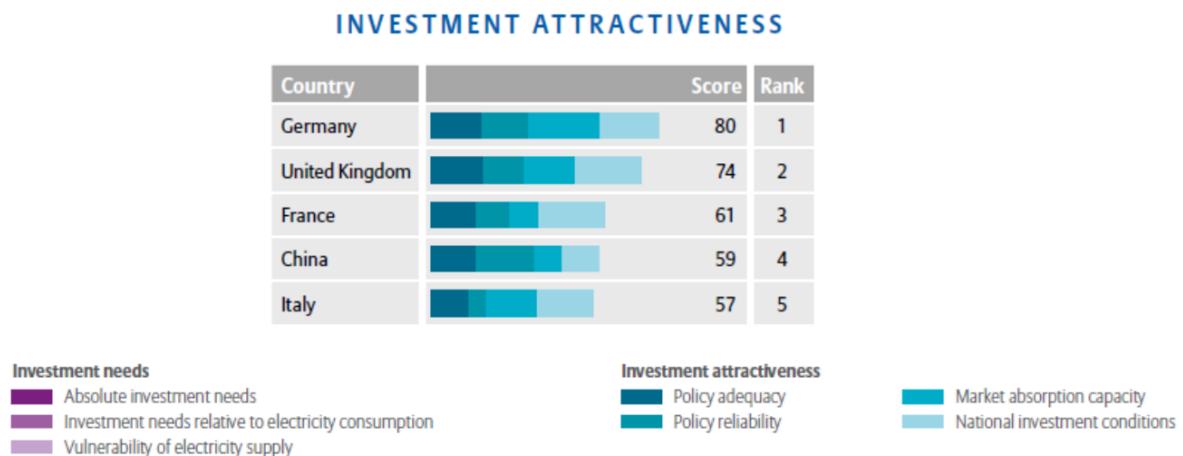
Figure 6-6 Perceived investment attractiveness in low-carbon activities in G20 Member States



[Source: Allianz, German Watch, New Climate Institute (2016). Allianz Climate and Energy Monitor: Assessing the needs and attractiveness of low-carbon investments in G20 countries. P. 14.]

As can be seen in the next figure below, four out of the five highest ranked G20 countries in terms of low-carbon investment attractiveness, are European Member States, namely Germany, the UK, France and Italy. The figure also summarises which broader investment conditions help explain and interpret this high position.

Figure 6-7 Top-5 ranking in terms of overall investment attractiveness for low-carbon investments (G20)



[Source: Adapted from Allianz, German Watch, New Climate Institute (2016). Allianz Climate and Energy Monitor: Assessing the needs and attractiveness of low-carbon investments in G20 countries. P. 16.]

Report: Accenture-Barclays (2011). Financing the low-carbon economy.

In this report, Barclays and Accenture have joined their in-depth expertise to analyse “the role of corporate and investment banks in accelerating the shift to a low-carbon economy”. It attempted to quantify “the capital required to fund the development of low-carbon technology (LCT) in the building, energy and transport sectors”.

The Accenture-Barclays report on “Carbon Capital – Financing the low-carbon economy”¹⁹⁰ also analyses barriers to investments. It states that the three main barriers to the deployment of capital for low-carbon technologies are:

- 1) Policy uncertainty, is seen for EU mostly via the issue of policy support for developed RES. The example of Spain’ retroactive cut-back is compared to France’s FITs system which intends to provide an 8% return over a period of 15 to 20 years. This corresponds to influencing factor category I of this report.
- 2) Restrictions on capital lending, is mostly considered in terms of regulation improving Tier 1 capital (Basel III) or limiting the investment in private equity. There is a dire shortage of money going to secondary market investments e.g. “asset backed securities or bonds, which allow investors to access secondary markets, make up less than three per cent of low-carbon technologies asset financing”. The often fragmented and unstructured nature of many small-scale projects made them inappropriate for funding, e.g. retrofitting of energy-efficient and

¹⁹⁰ Accenture-Barclays (2011). Financing the low-carbon economy. P. 49.

microgeneration equipment in buildings, which is covered in the influencing factor category VI of this report.

- 3) Technology uncertainty represents the difficulty in estimating the cash flow generation of projects concerning low-carbon technologies especially for RES and Energy Efficiency. This is discussed within influencing factor III of this report.

The report states that "The complexity and relative immaturity of low-carbon technologies increase the risk attached to investing in them." However the report does not make any attempt to rank the identified barriers.

Report: Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

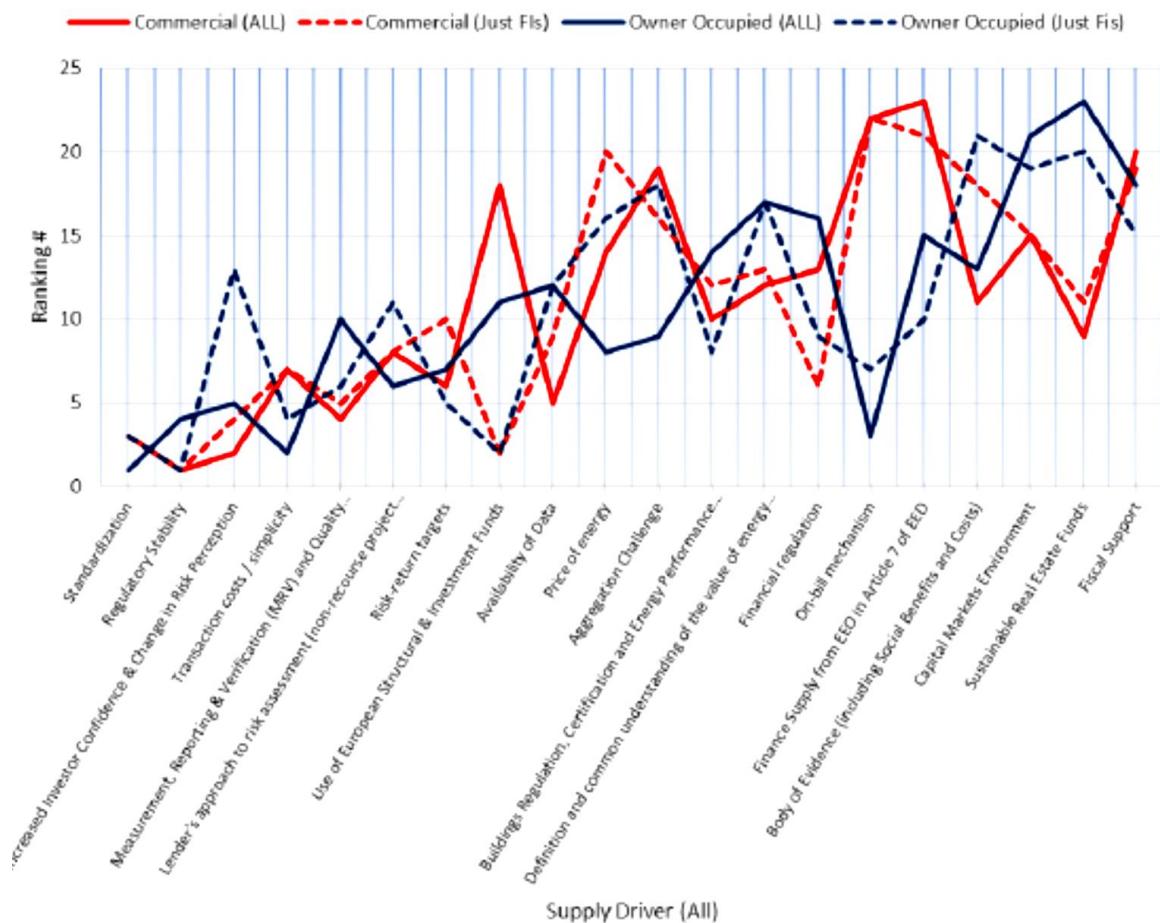
"EEFIG" is an energy specialist working group created by the EC and UNEP FI. The report is the joint effort of more than 120 active participants with a diverse range of professional experiences. It aims at analysing energy efficiency investments, their drivers and trends and challenges for buildings, industry and SMEs in the European Union (EU).

More specifically for the sector of energy efficiency, the Energy Efficiency Financial Institutions Group (EEFIG)¹⁹¹ reports on "How to drive new finance for energy efficiency investments"¹⁹² analyses. It also ranks the key drivers of investments in energy efficiency projects for housing and commercial properties. The results are based on a wide survey conducted by the EFIG. The figure below shows the differences in ranking (importance) of various drivers per different investor type.

¹⁹¹ The EFIG has been established by the European Commission and United Nations Environment Programme Finance Initiative. For more information, see: <http://www.eefig.eu/>

¹⁹² Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

Figure 6-8 Comparison of survey responses ranking key supply drivers of energy efficiency investments (for commercial and owner occupied buildings) from EEFIG members representing Financial Institutions versus entire EEFIG group



[Source: Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs. P. 19]

It is interesting to note that although the structure of the EE sector is considerably different from RES, key drivers have some strong similarities concerning public interventions (influencing factor I) and commercial necessities (influencing factor II). However, the highest ranked driver is with "standardisation" which clearly translates the issue that this sector not only has to deal with a large number of small projects, especially for housing, but also has to determine how to aggregate such projects in order to make them more palatable to investors. This important element is discussed in influencing factor VII.

This section has provided the reader with a broader idea of the existing literature and research as well as a reference to influencing factors. The goal was to improve the understanding of how such influencing factors may be interpreted and from which aspects they derive.

6.2 Factors with particular relevance for EE in industry and transport sectors

As mentioned before, the reports reviewed above tend to have a particular focus on RES and/or EE in the buildings sector. This subsection therefore pays particular attention to the specificities of decarbonisation (primarily EE) investments in the industry and transport sectors. The purpose of this section is to provide a background for the understanding of the industry and transport sectors prior to go further into details about the seven influencing factor categories.

Industrial sectors (including manufacturing industries, industrial processes and construction) represented roughly 50% of emission reductions achieved so far between 1990 and 2014 in Europe.¹⁹³ This is mostly the effect of the European ETS and other constraining regulations. Such emission reductions have also been influenced by an independent element, the economic crisis of 2008-2009, which de facto considerably slowed down all productions. Today the emission reduction in the industrial sector is largely born by large companies (ETS does not affect small industrial units) and has therefore been financed from their own balance sheet or via conventional debt such as loans and bonds. As mentioned in the EEFIG report¹⁹⁴, the visibility of corporate energy efficiency investments is decreased as nearly 60% of energy efficiency investments in industry are currently "self-financed"; with a Eurochambres survey confirming the higher figure of 76% of SMEs funding energy efficiency investments with their own funds. Nonetheless smaller businesses may emerge with "clever ideas" for new processes of a cleaner way to produce. In these cases, public incentives are much less clear than within the energy sector. Then, such "carbon clean" SMEs do not take more advantage in seeking finance than any other young SMEs. Often, their best option is to seek funding from large companies within the same industrial sector that could benefit from such innovations in due course of time.

The risk of public incentives being removed for small companies with bright ideas of emission reductions is, contrary to the energy sector, less of a risk factor, as fewer of that sort of direct specific emission reductions incentives exist.

Transport, on the other hand, is mostly the game of large automakers. Starting a new automaker from zero in the way Tesla did in the US, requires important initial capital and is a risky avenue. As a consequence, investments are, similarly to the industry sector, mostly using large companies' own balance sheet or conventional ways of raising debt (loans and bonds). Here also, smaller innovative businesses have less access to specific public incentives linked to the potential emission reductions that they may help to achieve.

Nonetheless, public incentives (influencing factor I) on vehicle retail prices such as tax reductions and exemptions in Austria or Germany and bonus payments and premiums in France and the UK have a direct impact on the sales of such vehicles. Innovations generally first enter markets in low volumes and at a significant cost premium and this needs to be offset by a positive policy framework. Electric mobility will make an important contribution towards ensuring sustainable mobility. As for renewable

¹⁹³ EEA (2016). Renewable Energy in Europe 2016: Recent growth and knock-on effects.

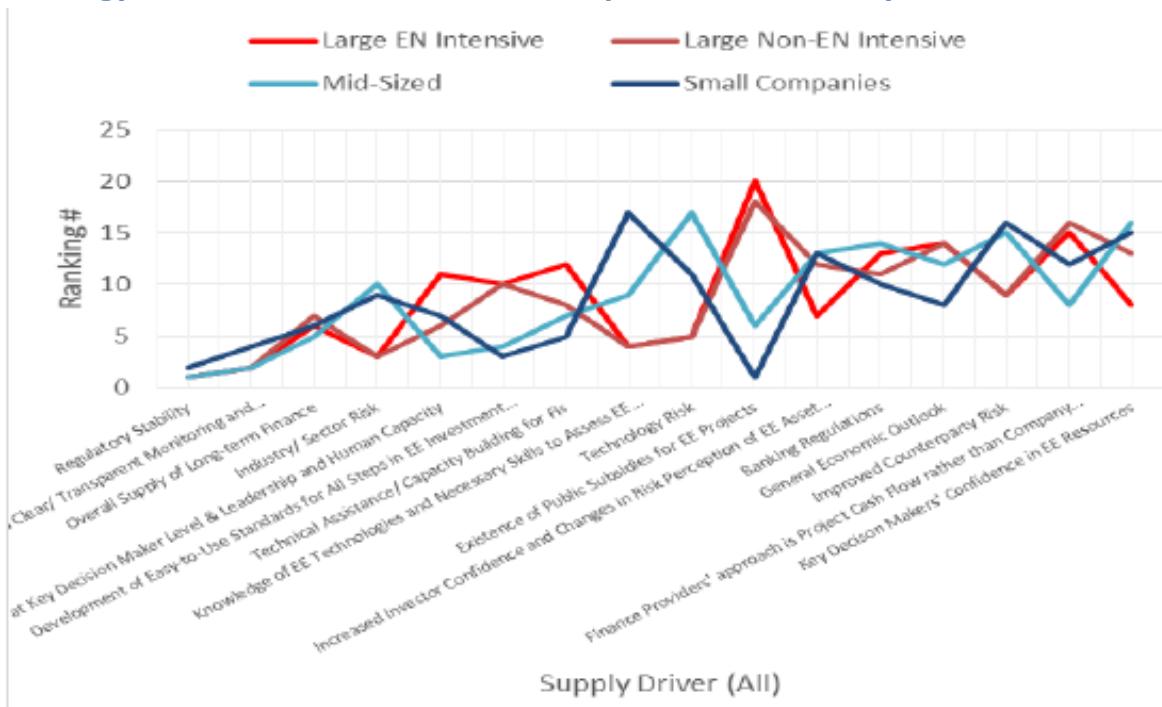
¹⁹⁴ Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

energy, once such an incentive system has been removed, sales of vehicle may plummet and greatly affect the investment in that sort of a business.

In the absence of an efficient carbon cap and trade or carbon tax system or any other specific carbon constraining or incentive systems for emission reductions of SMEs within the industry and transport sectors, the main factors impacting investments in such companies are linked to commercial necessities, as in influencing factor II, (ROI, securing markets and demands for products, risk of cost overrun, social acceptability of a project, etc.) and technologies, influencing factor III. Government subsidies are important when they are specific for decarbonisation purposes. As mentioned earlier, this is mostly the case for financial incentives for individuals regarding EV.

The same report¹⁹⁵ mentioned above about energy efficiency in buildings also analyses energy efficiency for industries. It also ranks the key drivers of investments in energy efficiency in the industry sector. This is based on a wide survey conducted by the EEFIG.

Figure 6-9 Investment drivers ranking for large versus SME sized companies, as well as energy-intensive versus non-intensive companies in the industry sector



[Source: Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs. P. 45]

As the report notes it, "Regulatory Stability is, again universally, the #1 driver of supply of energy efficiency investments across all corporate segments" (corresponding

¹⁹⁵ Energy Efficiency Financial Institutions Group (EEFIG) (2015). Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments. Final Report covering Buildings, Industry and SMEs.

to factor I). However, it is interesting to note different rankings appear depending on the size of the industrial corporate segments “Macro-economic factors” (corresponding to factor VI) and “commercial necessities” (corresponding to factor II) also have a high ranking. “Commercial necessities”, such as human capacity, are more important for small companies than for large ones.

One can conclude that company-specific elements such as “macro-economic factors” (e.g. fossil fuel prices) and the size of companies may equally impact investments in transport and industry sectors (see factor VI).

7 Annex B: Accounting for particularities between Member States

In this Annex, particularities between EU Member States are analysed for the purpose of modelling. This attempts to determine how factors may vary, depending on differentiated sources of finance by Member State.

7.1 Accounting for geographic differences of renewable energy investments

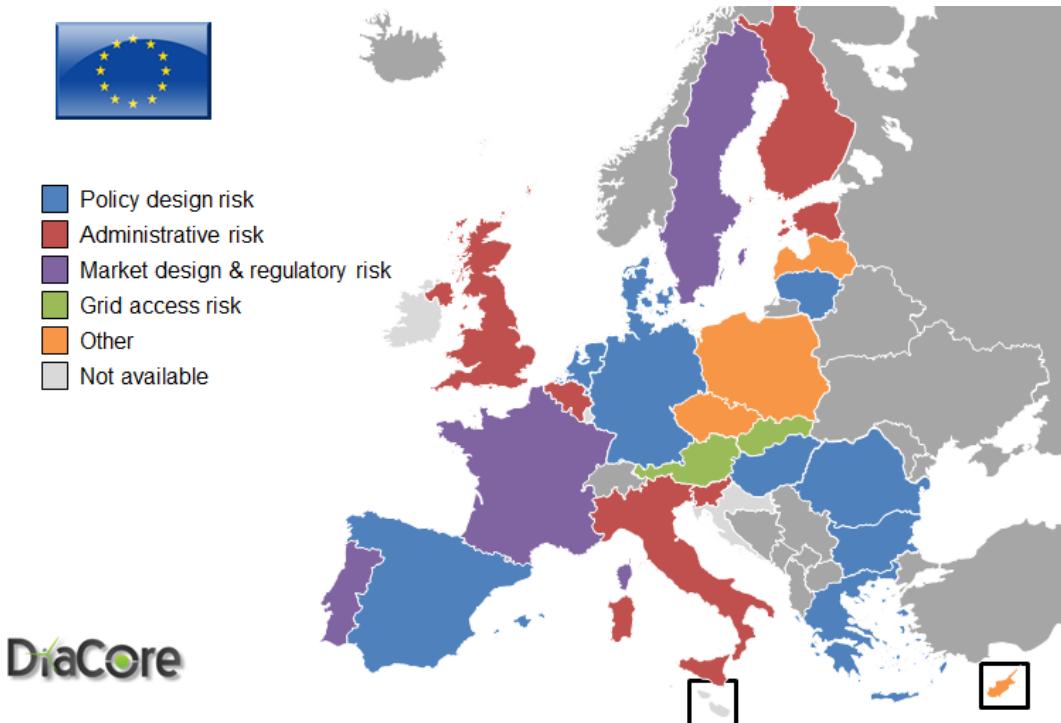
The final report of the DiaCore research project⁶ is most informative in this respect. It demonstrates that there is a wide disparity between EU countries in terms of cost of capital (Weighted Average Cost of Capital (WACC)). The WACC varies between 3.5% (Germany) and 12% (Greece, Cyprus, Croatia); cost of debt varies between 2% (Germany) to 10%-12% (Spain, Italy, Hungary, Romania, Greece), and cost of equity varies between 6%-7% (Germany and the UK) up to 18%-20% (Estonia, Poland). The report has been written for onshore wind, however other decarbonisation technologies would come to very similar disparity between the European countries. For the purpose of modelling, these elements of profitability are a consequence of the overall country environment in the decarbonisation space and leads us to suggest the following country groupings:

- Group 1: Germany, the UK, France, Belgium, the Netherlands, Luxembourg, Denmark, Austria, Finland, with a WACC of 3.5% to 7%;
- Group 2: Italy, Portugal, Sweden, Czech Republic, Slovakia, Poland, Ireland, Lithuania, Latvia, with a WACC of 7.5% to 9.5%; and
- Group 3: Spain, Estonia, Greece, Cyprus, Bulgaria, Romania, Hungary, Slovenia, Croatia with a WACC above 10%.

Such groupings among others take the policy design (including sudden policy changes) that countries have with respect to decarbonisation investments into account. A country such as Spain for instance, suddenly interrupted all policy support.

The map below extracted from the DiaCore Final Report⁶ helps us to understand the distortion that might exist between countries from a viewpoint of factors which can impact investments.

Figure 7-1 Top ranked risk categories across EU-28 (interview results for onshore wind)



[Source: DiaCore (2016). The impact of risks in renewable energy investments and the role of smart policies. Final report.]

Although in the DiaCore report - as in many other reports - the most important risk overall is the "Policy design risk", on an individual country level. Other risks, such as the "Market design & regulatory risk", "Administrative risk" and "Grid access risk", may come first as obstacles in the decarbonisation path, even in advanced countries such as the UK, France, Belgium and Austria (all listed in group 1 above).

7.2 Accounting for geographic differences of energy efficiency investments

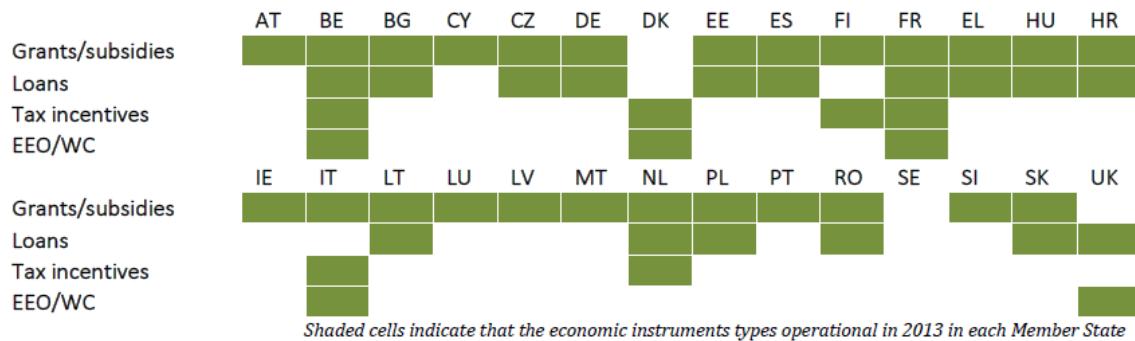
When looking at EE it is more difficult to find studies which deal with importance of factors or risks/challenges within European MS. We have summarised below elements of differentiation between MS which have been mentioned in the literature review. The table below summarises such differences within 4 categories of economic instruments.¹⁹⁶ As Economidou and Bertoldi (2014)¹⁹⁷ express it "It is not possible to derive a clear pattern as a fixed combination of instruments cannot be singled as the best solution across all Member States. For example, France had all types of instruments in place, while Germany has had a long successful tradition with grants and loans through its KfW scheme". Furthermore the table below does not give indications of the levels of such incentives. Many of the instruments examined herein were designed to work together with other economic instruments or to be part of a

¹⁹⁶ Economidou, Marina and Paolo Bertoldi (2014). Financing building energy renovations: Current experiences and ways forward. JRC Science and Policy Reports.

¹⁹⁷ Economidou, Marina and Paolo Bertoldi (2014). Financing building energy renovations: Current experiences and ways forward. JRC Science and Policy Reports.

policy package. This mildly informs us on the factors at play. We understand that there are little differences between MS for factor I "policy design, regulatory risk and public incentives uncertainties". Countries like Belgium, France, Italy, and the Netherlands seem to have a more extensive incentive system. Such analyses also lead us to think that the factor "country's enabling framework to support clean energy investments" might be more important in countries offering a larger panel of economic instruments. As for the other 5 factors nothing indicates at this stage that they may be different, depending on the country.

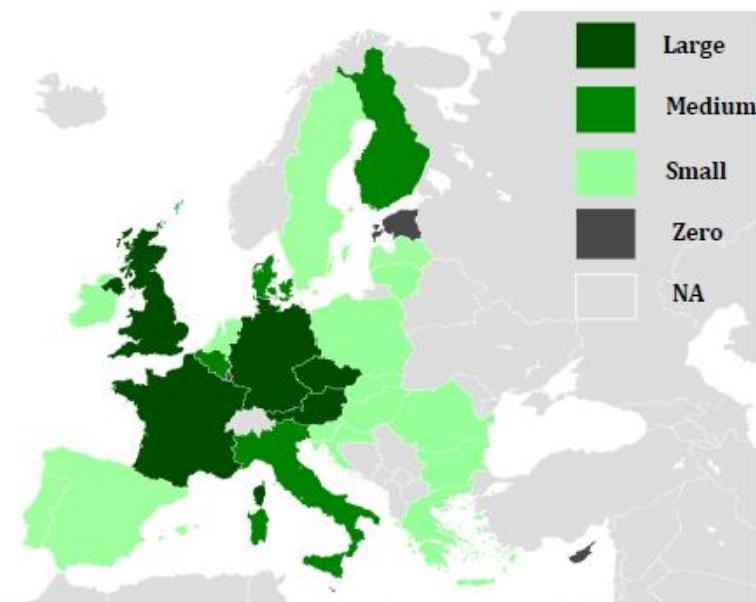
Figure 7-2 Main EU-28 economic instruments in 2013 targeting energy renovations



[Source: Economidou, Marina and Paolo Bertoldi (2014). Financing building energy renovations: Current experiences and ways forward. JRC Science and Policy Reports. P. 14.]

Also, to reach energy efficiency targets, countries increasingly encourage the creation of ESCO (Energy Services Companies) to implement energy efficiency projects. Under the Energy Performance Contracting (EPC) arrangement, an ESCO develops, installs, maintains and monitors an energy efficiency project and uses the energy cost savings to repay upfront investment costs. The map below illustrates the differences between EU countries.

Figure 7-3 Size of ESCO market across the EU



[Source: Bertoldi, Kiss, Panev and Labanca (2014)]

Although ESCOs are still growing in Europe, most of them have been founded either by large companies or as subsidiaries of large companies and under EPC arrangements they have provided financing themselves (mainly in France, Italy and Germany). Therefore utility investors may have modified factors for groups of countries.

Unlike for RES, and in light of the two elements above, it may be challenging to group countries in terms of Energy Efficiency. However, countries such as the UK, Germany, France, Italy, the Netherlands, Denmark and Sweden may be considered more advanced in terms of energy efficiency than the other European countries. These countries may be grouped together especially based on factors such as "policy design, regulatory risk and public incentives uncertainties" and "country's enabling framework to support clean energy investments".

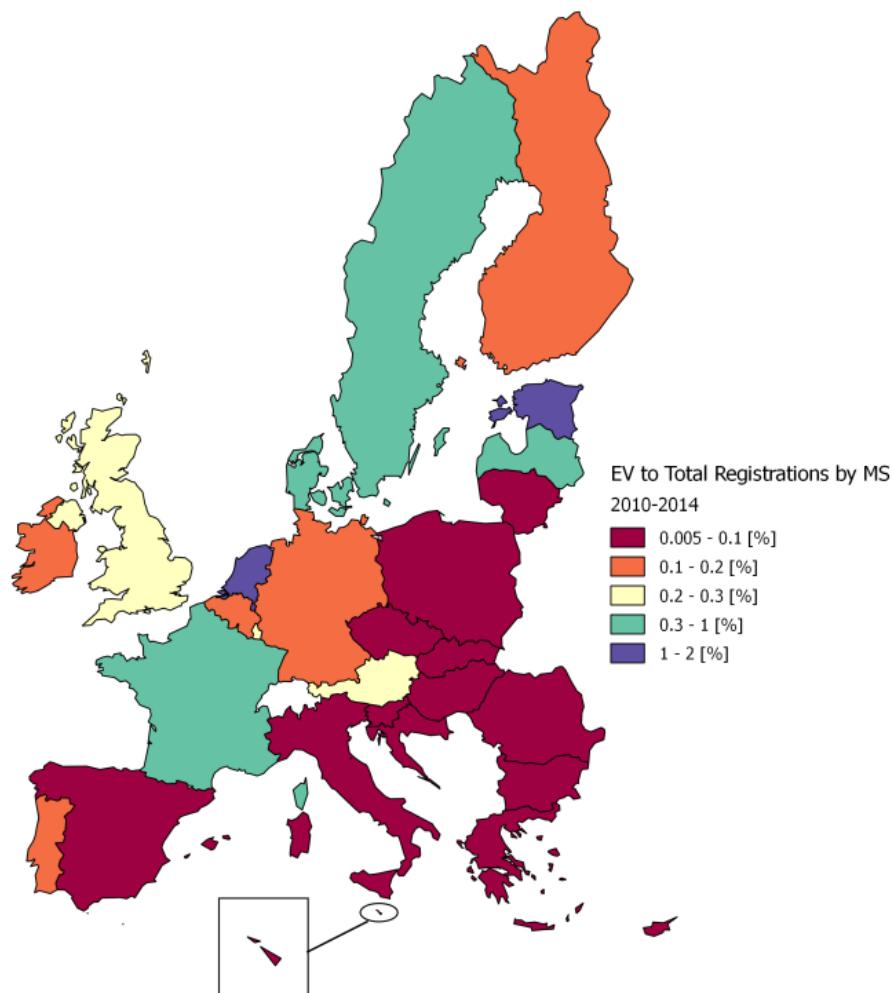
For obvious reasons, factors such as "country efficiency to support decarbonisation" and "macro-economic factors" may vary between countries.

As for Transportation, countries are inclined more and more to embrace the adoption of EV mostly depend on factor 1 "policy design, regulatory risk and public incentives uncertainties", factor IV "country's enabling framework to support clean energy investments" especially in terms infrastructure of charging stations. The adoption per country of EV is shown in the map below from a JRC Science and Policy Report.¹⁹⁸ The map indicates that 2010 to 2014 EV registrations as a share of total car registrations per MS. For this metric the ranking of MS is quite different from only looking at the total amount of new EV registrations per MS: The map puts into perspective the fact that in terms of the share in overall new vehicle registrations, the Netherlands leads in terms of the EV share (1.87%), followed by Estonia, Sweden, Latvia, France, Denmark, Luxemburg, Austria, and the United Kingdom. We may assume that these countries can be grouped under the two factors mentioned earlier. All other MS have shares lower than 0.2 %.

Also, factors such as "business elements", "macro-economic environment factors" may be considered to be higher in the more advanced European countries in the north-western part of the continent.

¹⁹⁸ Thiel, C. et al (2015). Electric vehicles in the EU from 2010 – 2014: is full-scale commercialisation near? JRC Science and Policy Report.

Figure 7-4 New electric vehicle (EV) registrations as share of total new vehicle registrations per MS



[Source: Thiel, C. et al (2015). Electric vehicles in the EU from 2010 – 2014: is full-scale commercialisation near? JRC Science and Policy Report. P. 17]

As for industry, industries are regulated at a European level, especially the large multinationals. Also, such carbon intensive industries today are mostly located in more developed western European countries (Germany, Benelux, the UK, France, and Northern Italy) although a number of Eastern European countries still have less carbon efficient industries coupled with emitting electricity generation. Therefore we do not envisage that at this stage there are noticeable discrepancies between EU countries for the purpose modelling.

8 Annex C: Assumptions applied in Chapter 5

This annex provides the underlying assumptions that had to be made when working with the three domestic climate finance landscapes in Chapter 5.

8.1 German domestic climate finance landscape: assumptions

The cases in which assumptions had to be made were the following:

- €0.1 billion in energy generation (infrastructure) attribute to public funds: the report cites €3.1 billion invested in infrastructure for energy generation, of which €3 billion would have come from private equity and own resources. The rest was assumed to have come from public funds.
- €5.084 billion in energy efficiency (buildings) attributed to concessional debt: it is clear that concessional debt played a role in these investments, but the report is unclear as to which extent exactly. However, the report mentions that 72% of all investment in energy efficiency was financed with concessional loans. Therefore, we applied the national average of 72% to the total investments in energy efficiency and chose the amount of concessional loans in buildings in order to preserve that proportion in overall investments in energy efficiency.
- €0.2 billion in energy efficiency (buildings) attributed to public funds: again, though the report suggests that there was public money directly invested in such projects, it is not clear to which extent. Since there was €0.4 billion of public funds in projects for buildings in general, we simply assumed that 50% were directed at energy generation and 50% at energy efficiency.
- €0.2 billion in energy generation (buildings) attributed to public funds: see above.
- €0.516 billion in energy efficiency (buildings) attributed to private equity: this is the difference between the total investment in energy efficiency in buildings and investment financed by public funds and concessional debt.
- €4 billion in energy generation (industry) attributed to concessional debt: the report refers to loans provided by KfW reports estimated between €3.7 billion and €4.2 billion. Total energy generation investments from concessional debt were set to be €11.3 billion, as mentioned in the report.
- €2.176 billion allocated to energy generation (buildings) attributed to equity: this is simply the difference between the investments with total equity (and own resources) and those allocated to energy efficiency projects. Total energy generation investments from equity and own resources summed up €12.9 billion.

8.2 French domestic climate finance landscape: assumptions

The cases in which assumptions had to be made were the following:

- €800 million out of €2.1 billion of grants and subsidies for buildings were assumed to be directed at renewable energy generation, whereas the rest was assumed to be for energy efficiency purposes (retrofitting).
- Similarly, €800 million out of €2.2 billion of concessional debt for buildings were assumed to be directed at energy generation, and the rest for retrofitting. The value of €2.2 billion of concessional debt was calculated by the difference of total investment in buildings and the values of other sources.
- All commercial debt (€5 billion) in buildings projects were assumed to be directed at energy efficiency projects.
- Approximately €1.6 billion of equity and own resources was invested in renewable energy generation: this was based on the text, particularly on one single project by EDF (€900 million) and approximately €700 million invested in PV installations in buildings.
- In several smaller amounts (such as agriculture and industrial projects for energy efficiency) it was assumed that the financial source was market rates debt, the reason being that all other sources of finance had been pinned down with more or less precision by information in the text. Thus, it was by “filling the gaps” that, to a certain extent, financial sources were attributed in some types of projects.

8.3 Belgian domestic climate finance landscape: assumptions

The cases in which assumptions had to be made were the following:

- €980 million for power generation from market rates debt: it was assumed here that all the investments with market rates debt were directed at power generation (RES). The reason is that the report mentions several projects with a high amount of debt (in fact, the report states that about 70% of private finance for power generation came from debt). However, if we apply 70% to the total amount of private finance in power generation, this amount is above €980 million, which is the total amount of market rates debt that was recorded in the report. Therefore, we decided to use set this total for power generation, and the rest of private finance for equity and own resources.
- Similarly, the amounts of equity and own resources for energy efficiency projects in buildings and industry were calculated by subtracting the total from the amounts of grants and subsidies (mentioned in the report). This assumes that no market rates debt was used in order to finance such projects.
- The €120 million in concessional debt refer to a specific mention in the report regarding a loan by the EIB. The project indeed highlights that

Belgium has made little use of this financial instrument, as opposed to Germany, for example.

- €40 million attributed to transport from equity and own funds: this is the difference between total investments in this type of project and the amount that was financed by public sources.
- €39 million to agriculture from equity and own funds: this was an assumption made due to lack of more precise information.