EUROPEAN

POLICYBRIEF

THE GREEN TRANSITION:

PUBLIC POLICY, FINANCE AND INNOVATION

F. Lamperti[1], M. Mazzucato[2], A. Roventini[3], G. Semieniuk[4]

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ISIGrowth is a 3-year EC Horizon 2020 funded project aimed at offering comprehensive diagnostics on the relationship between innovation, employment dynamics and growth in an increasingly globalised and financialised world economy. The project will provide a coherent policy toolkit to achieve the Europe 2020 objectives of smart, sustainable and inclusive growth. The theoretical foundation is based on the dynamic link between Schumpeterian economics of innovation and Keynesian demand policies. Analytical tools include agent-based modelling, non-parametric statistics, and detailed case studies of business and industry histories.

[1] Scuola Superiore Sant'Anna (Pisa, Italy) and Fondazione Eni Enrico Mattei (Milan, Italy)
[2] Institute for Innovation and Public Purpose, University College London (UK)
[3] Scuola Superiore Sant'Anna (Pisa, Italy) and OFCE, Sciences Po (Nice, France)
[4] Department of Economics, SOAS University of London (UK)

POLICY BRIEF SUMMARY

Europe can move towards a sustainable and innovation-friendly growth-path as long as it implements the right policy mix to sustain a green transition where economic growth is decoupled from greenhouse gasses emissions.

ISIGrowth researchers have analysed the conditions to move away from a fossil fuel-based economy, while spurring growth and employment. Two main results emerge from the analysis.

First, policy interventions should be timely and substantial. There is a limited window of opportunity to achieve the 2° target set by the COP21 conference and avoid the catastrophic consequences of climate change. At the same time, the technological opportunities offered by renewable energy and climate management are sizable and need to be harnessed by the European Union so the region becomes a world leader in these new sectors, reinforcing the transition to green growth. Monetary incentives – carbon taxes and green subsidies – may not be effective on their own unless accompanied by regulation and mission oriented investments. Indeed, ISIGrowth results show that climate impacts interact with concrete policy interventions: **a timid or wrong policy mix can lock the economy into fossil-fuel trajectories.**

Second, government-led investments constitute the most valuable and effective form of renewable energy financing. Public direct investments by a *green entrepreneurial state* combined with directed procurement policies are pivotal to the creation of a market for not yet competitive low-carbon technologies, also crowding in private finance and investment. As in past technological revolutions, ISIGrowth results suggest that an active public sector with a network of mission-oriented organizations active across the innovation landscape is likely to be necessary to achieve the green energy transition.

Third, a mission oriented approach—focussed on clean growth missions—can help stimulate innovation across multiple sectors. The opportunities for a shift towards a low carbon economy offered by the aftermath of the financial crisis should not be wasted. Conditional on the implementation of *timely* and *substantial* policies, Europe could pursue a win-win strategy of long-run sustained growth with low environmental impacts, reducing the threat of the possible catastrophic impact of climate change. A green entrepreneurial state can direct innovation and technological development to face one of the biggest societal challenges humankind has ever faced. The European Commission's new mission oriented approach to innovation policy can provide a useful framework for understanding how broad clean growth challenge can be transformed into a top down targeted mission (clear and targeted) while stimulating cross-sectoral investments/innovation and bottom up experimentation.

CONTEXT: EU AND THE OPPORTUNITY OF A GREEN TRANSITION

"Make no mistake: a new world order is emerging. The race for leadership has already begun. For the winners, the rewards are clear: Innovation and investment in clean energy technology will stimulate green growth; it will create jobs; it will bring greater energy independence and national security.", Josef Ackermann[5]

The 2008 economic crisis severely hit the European Union and the signs of recovery are still weak and uneven. Under business as usual practices, regional disparities in Europe are likely to increase and unemployment will not fall. However, the European Union can revitalize its economy by developing a credible vision for investment led growth where the direction of growth is just as important as the rate of growth. Fully embracing such a perspective, ISIGrowth considers the challenge of building a low-carbon economy both as an objective and as an opportunity to create "good" green jobs.

Climate change is one of the most significant challenges humankind has ever faced. Fostering growth while reducing emissions requires a transition towards low carbon energy technologies and, more extensively, it requires greening our economic system. A green economy is more easily characterized than defined and should not be limited to the creation of some niche sectors concerned with environmental protection. It is an economy with very low levels of carbon emissions in the atmosphere, and it protects biodiversity and environmental quality. It delivers high levels of human welfare (not only measured monetarily) for low throughput of energy and material resources. Fundamentally, it requires changes to production, distribution and consumption patterns, and innovation strategies that can eventually lower the material content of all sectors.

Moving towards such goals requires ambitious and timely policies on both the supply side and the demand side, creating the conditions for the transition to happen and, further, generating "good" growth and jobs. Beyond the selection of correct policy tools, a key question is how to finance the turn from fossil fuel based (brown) to renewable energy (green) technologies. The present Policy Brief tackles these two, related, issues.

FINANCING GREEN ENERGY TECHNOLOGIES: WHAT, WHO AND WHEN

One of the major challenges that the COP21 Paris agreement of December 2015 poses to our societies consists in finding effective measures to decouple global economic growth from fossil fuel technologies. As with any technological transformation, such a shift to renewable energy requires an appropriate investment landscape.

The question of how to finance a green transition is wide open. Too often, the debate focusses on the *quantity* of finance and not on its *quality*. The focus is on scaling up finance to invest into a low carbon energy transition, disregarding the fact that there are different types of finance with different impacts. While it is typically acknowledged that public sources of finance are important to finance the initial research stage, there is less attention to mid-stream development (except with Venture Capital (VC), but *who* invests in the VC funds is typically left unanswered) and downstream deployment finance in spite of recognition of a financing gap (or "death valley") that requires large investments prior to competitiveness, and is thus capital-intensive and high risk. With all finance treated the same, the policy debate loosely boils down to a discussion about policies to "de-risk" investments in general.

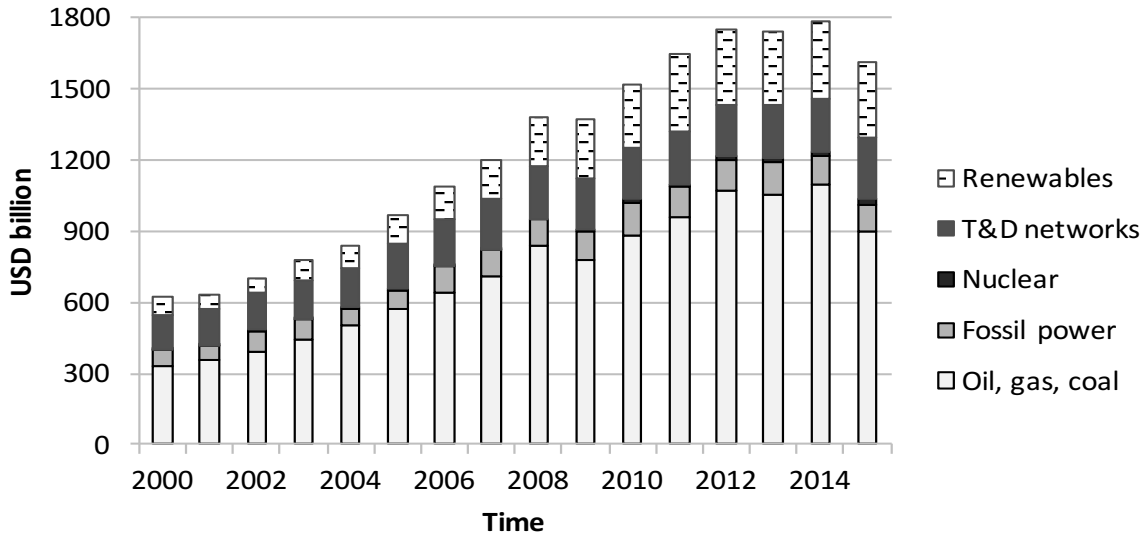
[5] Green Growth - the Role of Financial Institutions. Global Metro Summit: Delivering the next Economy, Chicago, 8 December 2010

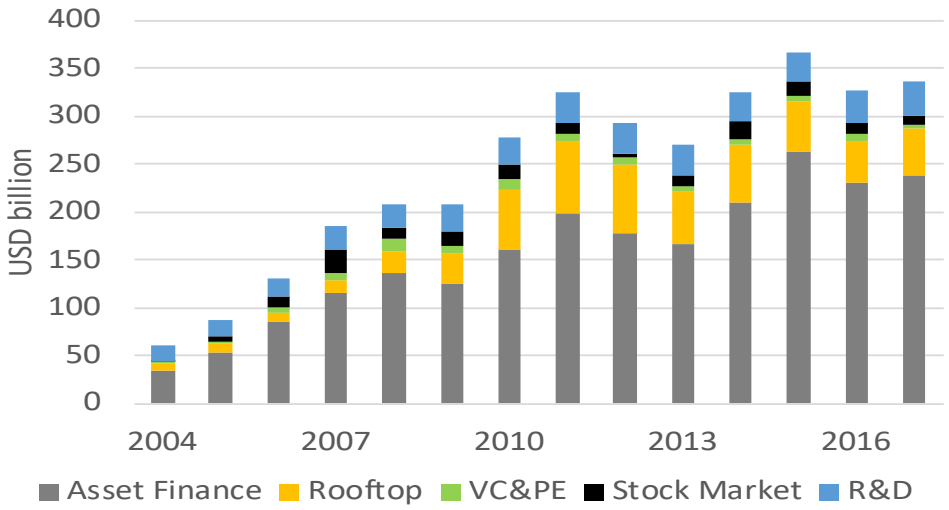
A different perspective comes from viewing investors as a heterogenous group, and in particular recognizing that historically, the state has played a preeminent role in providing the high-risk, long-run investments needed for transformational innovation. Such entrepreneurial states have taken on the lead role by staking out a vision for where to innovate, that is by setting a direction, and then acting as the investor of first resort to high-risk projects, but not only at research state but throughout the innovation landscape: deploying a demonstration power plant is also very risky, but it is far more capital intensive than basic research (Mazzuato and Semieniuk 2017). These activities are carried out by a variety of public innovation institutions, wedded to the mission of getting the innovation through, stimulating also the private sector to actively participate and invest in this innovation effort. This perspective suggests that rather than de-risking, the quality of direct finance deployed by public actors is crucial in transitioning to a green economy (Mazzucato 2015).

Using this green entrepreneurial state lens, Mazzucato and Semieniuk (2017; 2018), Semieniuk and Mazzucato (2018) and Mazzucato, Semieniuk and Watson (2015) closely inspect the quality of finance and its impact on investments in the renewable energy sector from a global perspective. In presence of rapid growth in renewable energy spending over the last 15 years (Figure 1, top panel), they find that different financial actors (e.g. commercial banks, state banks, energy companies, state-owned and private utilities) were active in different technological areas. Crucially, the presence of these types of investors was deeply intertwined with the relative riskiness of the technology to be financed. In particular, various state-owned enterprises and government agencies invested a much larger share of their funds in high risk sectors than any privately-owned actors. Such tendency is also visible in R&D funding, where the share of government R&D funding is higher in technologies farther away from commercialization, such as tidal and wave energy, while private sources predominantly fund R&D in more established technologies, such as wind energy (Semieniuk and Mazzucato, 2018).

Hence, the quality of available finance matters, and influences the quantity of funding devoted to high-risk, high-rewards projects in the renewable energy sector and ultimately the direction of innovation.

Figure 1 (a/b)- **Global investments in energy supply by destination (a top) and global investment in renewable energies by area of finance (b bottom).** Source: updated Mazzucato & Semieniuk (2018) with data from IEA (2017), Frankfurt School-UNEP & BNEF (2018)





Additionally, public finance has been found to be crucial not just in fueling research, but across the innovation landscape, where the various areas and amounts of total renewable energy finance destinations are shown in Figure 1 (b). Thus, public sources of finance played a crucial role in midstream product development financing via various "public Venture Capital" agencies, that often provided more money than private venture capital, combined with substantial grant funding (Mazzucato and Semieniuk 2017).

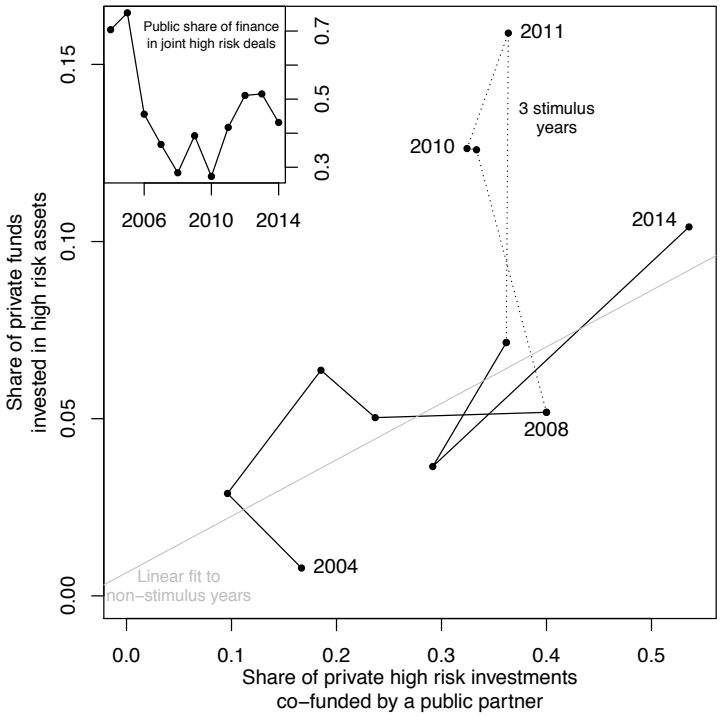
At the level of deployment and diffusion, public sources raised up to 40% of total financial sources for renewable energy asset finance in 2014. Further, the use of indirect instruments that still commit public funds, such as loan guarantees and export credit guarantees, were used to alter the quality of finance and increase projects' access rate to streams of private financing.[6] These results conflict with the idea of the private sector taking over low-cost and low-risk investments, and the idea that fighting climate change can be achieved while reducing public sector activity, but support the entrepreneurial state perspective (Mazzucato, 2013).

Finally, private actors were more likely to be active in high risk areas when public sector actors were already co-investing on the same project, supporting the idea of public finance sources dynamizing private ones. As can be seen in Figure 2, public actors provide a high share of risk finance with a strong reduction of the relative risk exposure borne by private investors. Public investments into specific projects exceeded 40% of total investment value (Mazzucato and Semieniuk 2017).[7] The public banks often engaged in large co-investments conversely took on high risk projects, while often getting lower returns due to the use of subordinated debt or concessional interest rates (Mazzucato, Semieniuk and Watson 2015).

[6] For example, as reported by Mendelsohn and Kreycik (2012), a surge in photo-voltaic panels installations in 2011 in the US was mainly driven by public grants and private loans underwritten by public loan guarantees, as the risk was too high for other types of financing schemes.

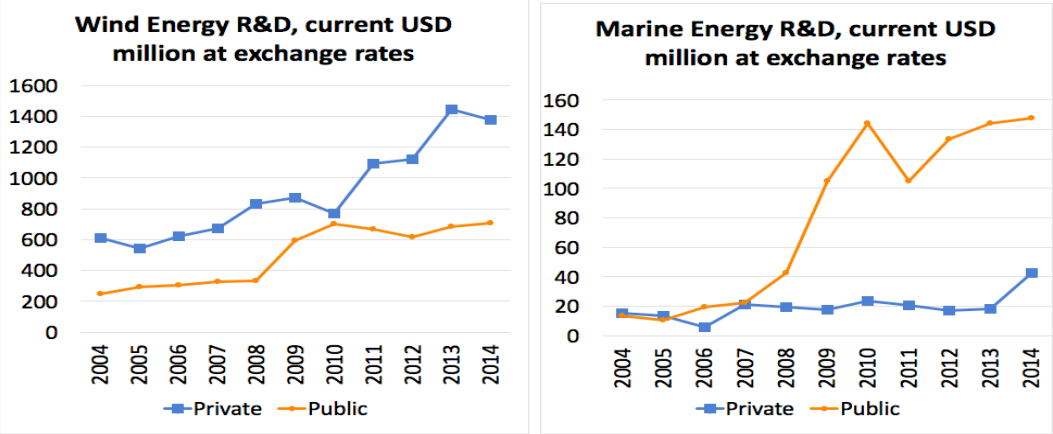
[7] Similarly, Nemet et al. (2018) document that among hundreds of demonstration projects in clean technologies in the last 75 years, public sources financed a median 64% of investments.

Figure 2 – **Scatter of the share of high-risk private renewable energy investments where a public source co-invested (x axis) vs the share of private investments into high-risk assets (y axis) for every year 2004-2014.** Source: Mazzucato and Semieniuk (2017)



And in Figure 3 we see a concrete example where public is leading in the new high risk areas (marine).

Figure 3: **Global R&D in renewables: wind and marine**. Source: Semieniuk and Mazzucato 2018, data from BNEF)



Direct public finance of course does not replace but interacts with procurement policies geared to creating a market for renewable energy (Mazzucato, Semieniuk and Watson 2015) as well as fiscal measures such as feed-in tariffs. Overall, the last two decades have seen an increasingly central role for publicly-owned actors in leading and fostering investments into renewable energy projects – across the whole innovation and financing chain - that will contribute to a green transition. Given both the size of such investments and their catalytic role (Mazzucato and Semieniuk 2017), the leadership of governments is central to moving away from fossil fuel technologies.

STRUCTURAL SHIFTS TO LOW CARBON ENERGIES: POLICY TOOLS

A Mission Oriented Approach: As shown in the previous section, public finance and procurements have a key role in supporting the transition to renewable energy. More generally, the challenge of sustaining a timely green transition needs EU governments cooperating and implementing an effective set of policies. As emphasized in Mazzucato (2018a), a mission oriented approach is useful to guide innovation. Missions are set from above, but inspire bottom up experimentation across a diversity of sectors (Mazzucato, 2018b). Successful missions should result in a clear target which rewards those organisations 'willing' to engage, whereby the priorities are translated into concrete policy instruments and actions to be carried out by all levels of the public institutions involved.

Given the current shares of low carbon energies in EU (see Figure 4), the low carbon transition remains some years away and gains might be sizable. By being at the forefront of technological development in the field, the EU can take advantage of the opportunities offered by renewable energies and climate change management.

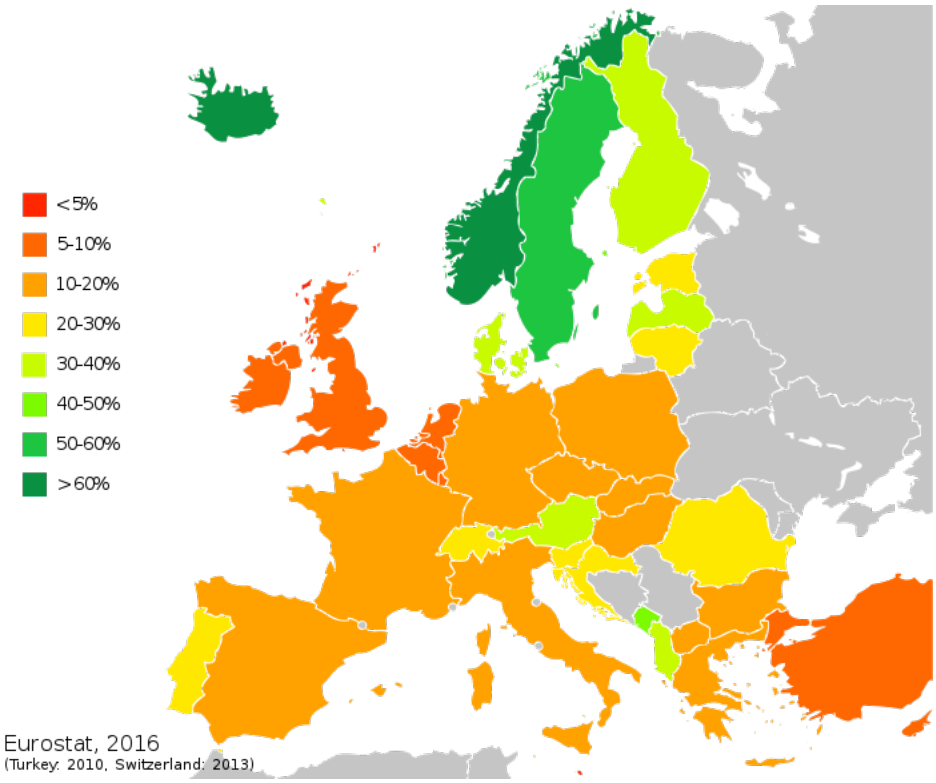
In this framework, ISIGrowth researchers have built a set of models to explore the impact of policy solutions aimed at fostering green R&D, diffusing low carbon energy technologies and, ultimately, promoting the transition to green and sustainable long-run development paths (see Balint et al. 2017 and Lamperti et al, 2018a,c).

Lamperti et al (2016) proposed a careful comparison of market based (taxes and monetary incentives) and command and control (regulation and enforcement) policies in fostering a green transition. They find that market-based policies are rarely successful in redirecting technical change from brown to green energies. Given the cumulativeness of technical change, a low carbon transition can be triggered only in a limited window of opportunity, when the productivity gap between the dirty and green technology is sufficiently small. The time for effective interventions gets shorter the more renewable energy can substitute fossil fuel energy, thereby posing attention on the increasing size of energy grids connecting large energy plants to the myriad of small green energy producers around the EU (see also Ciarli et al 2018). On the other side, command-and-control policies can always redirect technical change toward the green sector.

The presence of climate damages can both increase or reduce the likelihood of transitions. Which way it goes mainly depends on the effects of damages on energy demand. Climate damages that increase energy demand (Auffhammer and Mansour, 2014) reduce the likelihood of a transition and, ceteris paribus, make carbon taxes and green subsidies less effective. Also, the price of fossil fuels influences the likelihood of a shift non-linearly: small price variations have a low impact on inducing the transition, while for moderate/high values the likelihood increases substantially.

Such results support the idea that policy interventions aimed at modifying the relative profitability of green vs. brown technologies (e.g. increasing the cost of fossil fuels) must be substantial to significantly affect the odds of a transition. In turns, large government spending in promoting green R&D would be advisable but, possibly, it should be complemented by strict and ambitious environmental regulations.

Figure 4 - **Share of renewable energies in gross final energy consumption in 2016 by country in the European Economic Area, Switzerland and Turkey.** Source: Eurostat.



CONCLUSIONS

According to ISIGrowth research, monetary incentives and private initiatives are not enough to save our societies from the threats of climate change. Large policy interventions are then needed, but how should they be framed? Mission-oriented policies performed by a *Green Entrepreneurial State* (Mazzucato 2015) are probably the best tool to sustain the transition to sustainable growth. This implies that government and its various bodies, agencies and companies act as leaders, rather than facilitators of the green transition: setting directions through regulatory measures and directing financing, helping create and shape markets in these directions through sustained activity across the business cycle, and pursuing a portfolio of pathways towards green, that mobilizes all other stakeholders across society in its various tasks and aims. In other words, the ambition to achieve sustainable economic growth requires government direction and a mission-oriented approach.

The green transition possesses all the desirable features a mission may require (Mazzucato, 2018a/b). It engages the public and aims at achieving a more adequate balance between the environment and the economic activity, thereby generating widely spread gains for EU citizens' well-being. It is clearly defined in terms of quantities (CO_2 concentrations, temperature levels, share of renewable energies in the final energy mix) and time (objectives for 2020 has been assigned and COP21 explicitly pushes signing countries to determine their emission targets up to 2030). Further, the mission of a rapid green transition is ambitious and looks at technological change as its major driver; it is cross-sectoral and involves a wide array of stakeholders that must cooperate in a well-focused network. European policy makers could learn from national policies aimed at reducing the economy's footprint on the environment and the climate, such as Germany's *Energiewende*. ISIGrowth findings would advise European governments to follow such examples and boost their coordination both upstream - with the EU institutional bodies - and downstream – with local public authorities.

POLICY INSIGHTS AND RECOMMENDATIONS

1) In fostering a transition to low carbon energies, market-based policies (carbon taxes and subsidies towards clean sectors) may not be enough and suffer from bounded windows of opportunity: delays in their implementation make them ineffective both in redirecting technical change, i.e. triggering a transition towards clean energy, and in avoiding environmental catastrophes.

2) Command-and-control interventions can guarantee the shifts to green energy technologies irrespectively of the timing of their introduction. As command-and-control policies are always able to direct technical change toward "green" technologies and to prevent climate disasters, they should be seen as a valuable alternative to market-based interventions.

3) The presence of climate damages can potentially reduce the likelihood of transitions, mainly by increasing the final demand of energy. In such a framework carbon taxes and green subsidies are less effective than command-and control interventions.

4) The quality of finance differs between actors and is not neutral: different actors invest in different portfolios and therefore set directions in innovation, that can be locked in via path dependencies.

5) The quality of finance also matters for the rate of investment because private sources may need public counterparts to be mobilized to invest in high risk areas. Accordingly, institutional investors, often seen as the solution to the supply of finance problem, may not be enough to vastly increase renewable energy investments to the scale consistent with mitigation scenarios. Direct public co-investment is needed.

6) In order sustain the green transition, public investors must be patient, welcome risk, and have the necessary capacity to sustain temporary losses. At the same time, they should gain a fraction of returns from successful projects.

7) Public direct investments combined with directed procurement policies are more effective for creating a market for not yet competitive low carbon technologies

8) The renewable energy research evidence as well as those of past technological revolutions suggests that an active public sector, willing and able to set clear missions, along with a network of mission-oriented organizations active across the innovation landscape is likely to be necessary to achieve the green transition..

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PROJECT IDENTITY

PROJECT NAME	Innovation-fuelled, Sustainable, Inclusive Growth (ISIGrowth)
COORDINATOR	Giovanni Dosi Institute of Economics, Scuola Superiore Sant'Anna, Pisa, Italy. Email: giovanni.dosi@santannapisa.it
CONSORTIUM	Columbia University – IPD – New York City, U.S.A. OFCE Sciences Po – SPO – Nice, France Scuola Superiore Sant'Anna – SSSA – Pisa, Italy Universität Bielefeld – UNIBI – Bielefeld, Germany Universität Zürich – UNIZH Zürich, Switzerland University College London – UCL – London, UK University of Sussex – UOS, Brighton, UK Univerza Ljubljani – UL – Ljubljana, Slovenia
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WEBSITE	http://www.isigrowth.eu
FOR MORE INFORMATION	Contacts: Giovanni Dosi, giovanni.dosi@santannapisa.it Andrea Roventini, andrea.roventini@santannapisa.it
FURTHER READING	