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POLICY BRIEF

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Investing in a Low-Carbon Power sector

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ABSTRACT

In this policy brief we present and discuss recent research that analyzes the financial requirements to decarbonize the power sector.

We find that climate policy will not induce higher investments in the power sector with respect to those needed in the Reference scenario, i.e. the one occurring in the absence of climate policy, mainly because higher average investment costs in electricity generation are offset by a contraction of electricity demand. Thus, according to our work, a low-carbon world seems not to require higher investments. It rather requires a shift of resources towards a totally new technological mix.

This does not mean that the transition will not be costly from a macroeconomic point of view. Rather, it indicates that the costs will come from the necessary re-adjustment of our economies and not from higher financial needs in the power sector.

We show that criticalities will possibly emerge when investments have to be diverted –in a relatively short time frame– towards intrinsically complex and risky technologies (e.g. carbon capture and sequestration). These financial requirements, although costly, appear to be manageable from a financial point of view.

We suggest that governments can play a great role to smooth the transition to a low-carbon power sector by reducing the risk associated to the new technologies. In particular, we propose that revenues from auctioning carbon emissions permits are used to finance a sort of insurance fund for the power sector.

Policy Challenge

In order to avoid dangerous climate change our economies need to start a deep transformation that will last several decades. The declared objective is to cut Greenhouse gases (GHGs) emissions at least by 80 per cent in 2050 (MEF, 2009). This poses huge challenges that will require a radical transformation of basically all economic sectors.

In particular, we need to rethink the way in which we generate, delivery and use energy. It has been shown by many studies that a necessary condition to achieve a low-carbon economy is to generate electricity with zero carbon emissions.

Guiding the power sector to this goal is a tremendous policy challenge for policy makers, regulators and industry all over the world. In particular, Europe will need to start the march towards a new mix of power plants and a new integrated grid as soon as possible if it wants to maintain the leadership of climate mitigation policies.

The study that we illustrate in this Policy Brief (Bastianin, Favero and Massetti 2010) suggests that the most cumbersome task will not be to secure the financial flows to fuel this transformation – as they appear totally manageable – but rather to govern a totally different power sector, with technologies that present higher risks or bigger uncertainties than those presently used.

With this Policy Brief we highlight the major challenges at stake and we propose a sensible strategy to overcome the major difficulties.

Introduction

While the literature on mitigation policy costs has grown considerably during the past fifteen years, the focus has always been on overall macroeconomic costs. Often overlooked are instead the implications of mitigation policies in terms of investments needed to support the required low-carbon transformations of the economies.

Despite being two sides of the same coin, costs and investments inform on two very different aspects of climate policy and they should not be confused.

Unfortunately, it is frequent to find studies that do not distinguish clearly between investments and costs. In particular, investments are often referred to as costs of the climate policy (see for instance: IEA, 2008, p. 487; Russ et al, 2009; European Commission, SEC(2009) 1172, p. 4, Table 2; a notable exception is UNFCCC, 2007).

Investments are expenditures to increase productive capital. They imply a financial transfer from one agent to another, from one sector of the economy to another sector, or from one generation to the next. If investments are re-distributed among capital assets that have the same productivity, there is a re-distribution of resources from one sector to another, but the level of macroeconomic activity is not affected.

Macroeconomic costs arise only when investments are redistributed from more productive uses to less productive uses. This loss of productivity generates a lower level of output, which is the true net cost for the economy as a whole.

There is now a wide agreement on the fact that, not counting environmental benefits, mitigation policy will divert resources from less expensive to more expensive ways of producing and using energy. Advocates of win-win solutions to climate change dispute this result and support the idea that, by reducing inefficiencies of the economy other than the environment, climate policy might actually have overall macroeconomic benefits. This will probably be true for some sectors and in some periods of time but very few studies show that this would hold at the aggregate level and over a long time horizon. Therefore, climate policy is almost commonly considered to be costly over the long-run.

However, until recently, implications of climate policy on investment patterns have not been widely explored. In our study we focus on the power sector because it will be completely reshaped by climate policy.

We assess investment trajectories on a time horizon that stretches up to 2050, a year now widely used to set intermediate stabilization targets, and we assess when criticalities will likely emerge along this time path. In order to draw policy insights, we compare the required financial efforts to previous large scale investment projects.

The transition to a zero-carbon power sector

The first question we answer is by how much will investments in the power sector increase when economies are forced to reduce emissions steadily from present levels to almost zero.

We draw our insights, by comparing the required financial efforts in two scenarios produced using the hybrid integrated model WITCH (See Bosetti, et al. (2006), Bosetti, Massetti and Tavoni (2007) and Bosetti et al. (2009) for a detailed description of the WITCH model).

In the Reference scenario, we assume that there is no policy to reduce global warming. Countries behave as if they were not concerned by the climate problem.

In the Policy scenario GHGs concentrations are forced instead to remain below 550 ppm CO_2-eq at the end of the century. The policy tool is a global cap-and-trade scheme in which allowances are distributed according to the contraction-and-convergence (CC) rule: in 2010 permits are first distributed in proportion to present emissions and then progressively converge to a full equal-per-capita allocation scheme in 2050. We name this policy scenario *Stabilization*.

It is often believed that mitigation policies will require a much higher level of investments in the power sector. In fact, zero or low-carbon generation technologies have investment costs per unit of installed capacity higher than the traditional coal or gas fired power plants that they are meant to replace.

If all the electricity demand required by fossil-fuels based economies was supplied by low-carbon technologies, the total amount of investments in the power sector would certainly increase. However, this is not necessarily true. In fact, one of the cheapest ways to reduce carbon emissions is to increase overall energy efficiency, reducing also electricity demand with respect to the Reference scenario.

There are thus two forces at play: more technologically advanced power plants will increase the investment cost per unit of installed capacity, but at the same time overall installed capacity will decline as a result of contraction in electricity demand. We find these two forces to be roughly equal at the global level. As a result, the financial requirements of the power sector do not change significantly when climate policy is implemented in our scenario (Figure 1).

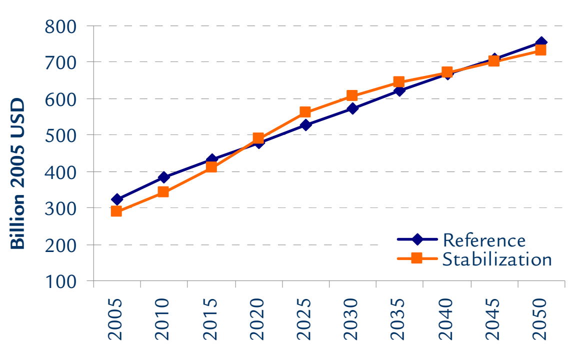
We do not include here investments in new power grids. Super-grids to dispatch electricity at long distances and smart-grids to connect a large number of diffused producers are key components of a future zero-carbon power sector and they deserve further analysis.

A second caveat applies to our results. We have not considered the possibility to have electric cars. The financial requirements of the power sector might therefore be revised up-ward.

Our results provide a clear-cut answer to the first policy question that we have addressed: climate policy will likely not require investments to finance the transformation of the power sector that are significantly different from those that would be planned without any concern for climate change. The pattern of investments will still be increasing over the century – to satisfy a growing demand of electricity from developing countries – but they will not differ substantially from those needed in a world in which climate change is not a concern.

The key message is that the higher cost of electricity will induce a contraction of demand. This fact tends to be overlooked but reminds us that when it comes to climate policy, the *ceteris paribus* hypothesis can be badly misleading.

Figure 1. World investment in the power sector, 2005-2050.



Geographical distribution and Technological challenges

The second question that we answer regards the geographic and the temporal distribution of investments in the power sector.

We find that although cumulative global investments in the power sector remain substantially the same, some important changes occur in the distribution across regions and across power generation technologies.

If we consider the time pattern of investments, our data suggest that the mitigation policy requires additional investments only for a quarter of a century, from 2020 until 2045. After 2045, the optimal level of investments in the Stabilization scenario converges to the one of the Reference scenario at the global level (see Figure 1). Of course the pattern of investments in low-emissions power plants will depend on the pattern of emissions reductions imposed by the policy. The contraction of GHGs emissions in 2050 is around 60 per cent with respect to the Reference scenario.

If we focus on the geographical dimension, investments in OECD countries will be higher in the Stabilization scenario from 2015 until 2050 (Figure 2), while Non-OECD regions will reduce investments from 2010 to 2025 and also from 2040 until 2050 (Figure 3). This difference is mainly explained by higher space for energy efficiency improvements in Non-OECD regions.

Figure 2. OECD investment in the power sector, 2005-2050.

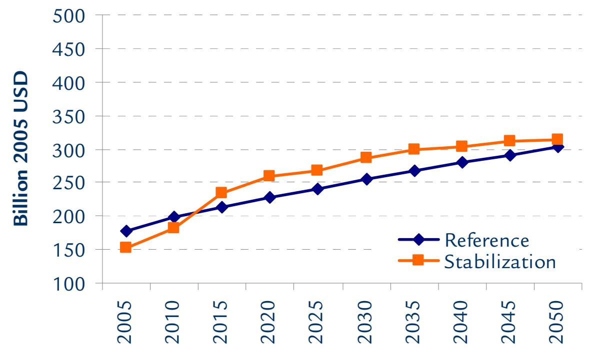
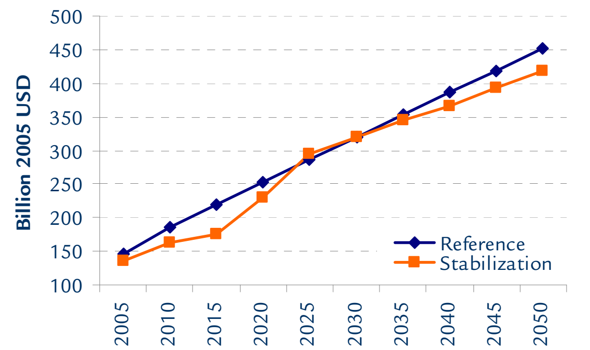


Figure 3. Non-OECD investment in the power sector, 2005-2050.



Total investments in the power sector do not increase in the Stabilization scenario with respect to the Reference scenario, but the decarbonisation of energy supply asks for a completely new energy mix and hence a radical re-organization of the power sector.

Conventional fossil fuels power plants are progressively substituted by nuclear, coal power plants with Carbon Capture and Storage (CCS) and renewables (Figures 4 and 5).

Figure 4. Total investment in the power sector 2005-2050, by production technology – Reference Scenario.

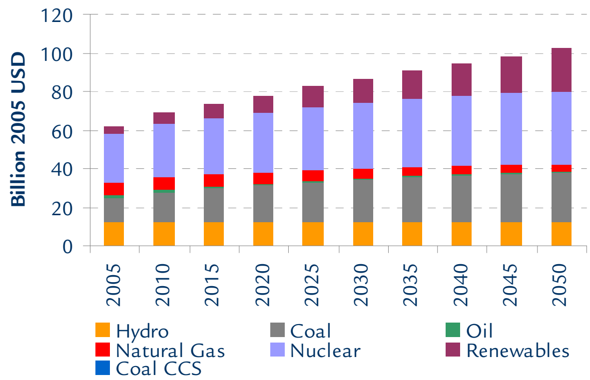
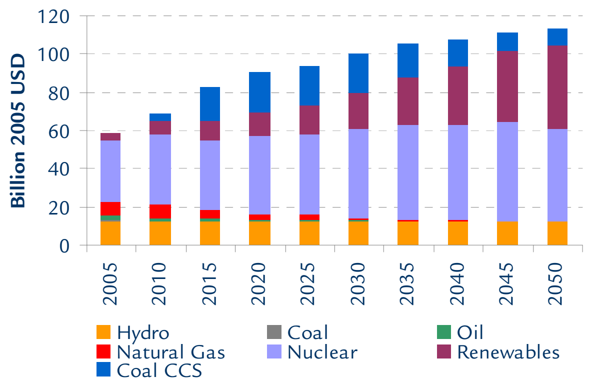


Figure 5. Total investment in the power sector 2005-2050, by production technology – Stabilization Scenario.



The Stabilization scenario requires a rapid reallocation of investments in power generation technologies.

By 2020 it is optimal to stop investing in traditional coal power plants: coal can be used only if power plants are equipped with CCS. Nuclear becomes attractive in a carbon-constrained world. After climate policy starts, the share of investments in these two technologies increases and becomes dominant from 2020 onward.

Natural gas remains competitive in the first years of climate policy, but then gradually disappears. Only oil-rich regions continue to invest in oil power plants, although less than in the Reference scenario.

Investments in renewable power generation – such as photovoltaic and wind – increase progressively and tend to replace investments in coal with CCS by 2050. Hydroelectric power capacity is assumed to be already fully exploited and follows an exogenous dynamic in the model.

The joint analysis of Figures 2-3 and Figures 3-4 suggests that this quick reallocation of investments can be described in different steps. First, fast-growing investments in nuclear power explain the first jump. This is immediately followed by two shocks: the first due to the deployment of CCS technologies in OECD countries and the second, with a lag of ten years, in Non-OECD countries.

Criticalities and solutions

From our analysis, investing in a low-carbon power sector seems not to pose any serious stress from a macroeconomic standpoint.

The main challenge will be instead to govern the reallocation of investment across different industries.

Also, criticalities will emerge when large investments must be diverted –in a relatively short time frame– from well-known technologies to ones that have associated higher technological risks.

If risks and distributional issues will be managed appropriately, the amount of resources to be mobilized will not be of an unprecedented size.

In the past, vast amounts of resources have already been successfully mobilized to finance ambitious projects in a short time.

For instance, according to our study, additional cumulative investments needed by the USA to transform the power sector would amount to USD 355.3 billions in 2050, with an average yearly expense of USD 7.9 billions from 2010 onward. This effort is comparable with the one USA faced to finance the Interstate Highway System, one of the biggest infrastructures in the country. The construction of the Highway System took 35 years (46,876 miles), and required an investment of USD 425 billions,[1] or an average annual investment of USD 12.1 billions.

Another example is offered by the Apollo Space Programme of the NASA which, in the 1960s, has required a massive investment that is comparable to what would be necessary to spend in Research and Development (R&D) to develop a backstop fuel in the United States. To send a man on the moon the NASA spent approximately 97.9 billion of USD, at 2008 prices, over 13 years, which reaches the 0.4 per cent of the average national GDP during the peak year of funding (Stine, 2009). In GDP terms, this is much more than what is required in to finance R&D in the USA according to our Stabilization scenario.

What should then be the role of governments to ease the transition to low-carbon power systems?

Our answer is that governments should keep their intervention in the system minimal in order to avoid crowding out of private resources, which are perfectly capable to finance new, costly, power plants.

Governments should act to reduce the risks and uncertainties – of technological, economic and social nature – associated with controversial technologies (nuclear), technologies with large uncertainties (carbon capture and sequestration or concentrated solar power) and complex systems based on diffused renewable generation.

A solution that we suggest here is to use part of the revenues from auctioning carbon allowances – or fiscal revenues from carbon taxes – to insure investors against the higher risks in the power sector. This could be a true insurance fund, or it could also serve to bridge the gap between interest rates paid by investors in carbon-free power plants and average interest rates charged in the industry. Public funds would then leverage and not crowd-out private investments.

The rising price of carbon, that will characterize any stringent climate policy, can quickly generate a flow of resources that is sufficient to finance a large public fund serving the power sector.

[1] Figure expressed in 2006 USD. Source: Al Neuharth (2006-06-23), "Traveling Interstates is our Sixth Freedom," USA TODAY.

Conclusions

We have shown that the overall amount of funding required by the power sector in a low-carbon economy should be equivalent to what required without any climate policy. However, criticalities will emerge to finance problematic and complex technologies, to manage the transition in relatively short time periods and to convince the public to accept nuclear and coal with CCS power plants in their backyard.

The real challenge that our societies face to create a zero GHGs emissions power sector is not financial but rather technological, political and social.

Governments should not step-in and crowd-out private investors, wasting important collective resources. We rather suggest to support private investments by means of a public fund that covers the higher risk of these new technologies. The fund should be financed by using revenues from emissions taxes or from auctioning emissions permits.

There are other noteworthy options for recycling carbon revenues – for example lump-sum transfers to low income households would reduce the regressive component of carbon pricing – but diverting part of the funds to increase the incentives to invest in a low-carbon power sector is crucial to combat global warming.

Finally, governments should spend most of their efforts to create credible and strong climate policy to drive investments in the right direction. A credible commitment emerges from well-functioning price signals but also from instilling a new mood in the business and public communities. In the past, when a "sense of mission" was attached to some public goals, large and risky investment projects have been managed successfully in short time periods.

With sufficient political will the same can happen for climate policy.

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