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The “cost of not doing” energy planning: The Spanish energy bubble

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ABSTRACT

The Spanish power generation sector is facing dire problems: generation overcapacity, various tariff hikes over recent years, uncertainty over the financial viability of many power plants and a regulatory framework that lacks stability. This situation is the consequence of both poor energy policies and the economic crisis in the late 2000s and early 2010s. In this paper we analyze the following three points from an energy planning perspective: how the country has arrived at this situation; whether other alternatives would have been possible through adequate planning; and the quantitative benefits that would have been accrued from such planning. We do so by developing a LEAP model, and building three scenarios that allow to segregate the costs of the economic crisis from the costs of the lack of planning.

We find that appropriate energy planning could have reduced investments in the Spanish power sector by 2010€28.6 billion without compromising on performance in terms of sustainability or energy security, while improving affordability.

The main causes of these surplus investments were two supply bubbles: those of gas combined cycles and of solar technologies. The results of this work highlight the value of rigorous, quantitative energy planning, and the high costs of not doing it.

1. Introduction

The Spanish power generation sector has, in the past decade, undergone phenomenal change. In 2000, 90% of the generated electricity was from only four sources: coal (36%), nuclear (28%), hydro (15%) and oil (10%). By 2012, their joint contribution had been reduced to 52.0%. The introduction of gas combined cycles and renewable technologies (mainly wind and solar PV) substantially changed (see Fig. 1) a mix that had remained almost unaltered since the 90s.

From 2000 to 2012, 20 500 MW of onshore wind power, 4500 MW of solar PV, 2000 MW of CSP, around 700 MW of biomass production and nearly 26 900 MW of gas combined cycles were installed totaling 54 600 MW [1]. These increases doubled the generation available in 2000, which was 57 400 MW [2].

This new capacity has had some positive impacts. The power generation mix is now modernized, the specific CO_2 emissions of the power sector have decreased from 0.45 kg/kWh in 2000–0.32 kg/kWh in 2012 [3], and the renewable share in power generation nearly doubled, from 16.1% in year 2002–30.7% in year 2012 [3].

However, these changes have also provoked severe problems: overcapacity in the power generation system; high increases in the electricity tariffs; a lack of regulatory stability for the power generation sector; and the so-called “tariff deficit”. The latter is the difference between the income levied from government-set tariffs and the government-acknowledged generating costs. It has resulted in a large accumulated debt to the sector, currently amounting to approximately the total electricity generation costs over a whole year.

Although total installed power has doubled between 2000 and 2012, gross electricity generation increased by only 30% (from 226 TWh to 297 TWh, [4]). Thus, the average load factor has decreased from 44% in 2000–31% in 2012. For some technologies, the load factor was even lower: it was 17.8% in 2012 for gas combined cycle plants [5]. This low load factor has severely compromised their economic feasibility; so much that the

Abbreviations: 2010€, Euros at 2010 values; CNE, National Energy Commission; CSP, Concentrating Solar Power; EU15, EU-15 Member States; GDP, Gross Domestic Product; GFN, Numerical Fluid Dynamics Groups (University of Zaragoza); GW, Gigawatt; IDEA, Institute for Energy Diversification and Savings; IEA, International Energy Agency; IEA-PVPS, International Energy Agency-Photovoltaic Power Systems Programme; kWh, Kilowatt-hour; LEAP, Long-range Energy Alternatives Planning system; LEC, Levelized Electricity Cost; MW, Megawatt; PV, Photovoltaic(s); R&D, Research and Development; STSO, Spanish Transmission System Operator.

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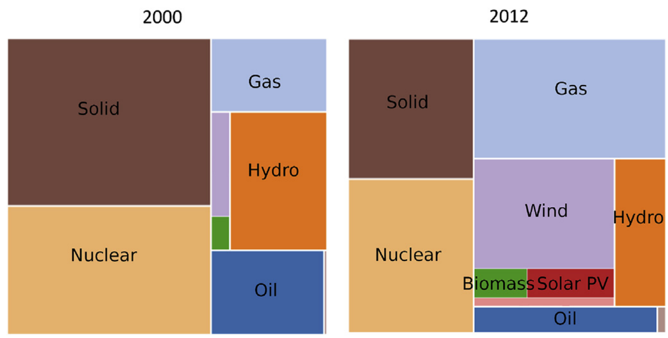

Fig. 1. Electricity generation by fuel in 2000 and 2012 in Spain. Authors' preparation using Eurostat data.

decommissioning or hibernation of gas combined cycles are now under consideration.

The average household price of electricity has increased from €0.109/kWh in 2000 to €0.223/kWh in 2012 [1] (both tax-inclusive figures). In 2012, Spain was the European country with the third highest residential sector electricity tariffs (excluding taxes), while in 2000 it ranked 10*th*, as shown in Fig. 2. Increased electricity tariffs conflated with the decrease in household income due to the economic slowdown to cause the emergence of energy poverty in Spain. According to [6], 10% of Spanish households were in fuel poverty in 2010.

Further, the economic sustainability of the power sector has been seriously threatened. The Spanish power sector was liberalized in the early 2000s, and generation was unbundled from transmission and distribution. While generation and supply prices are market driven, transmission and distribution are controlled (regulated) by the government. (This is the same scheme implemented by most European Union countries [7].) The electricity tariff is therefore composed of the wholesale electricity price (set by the market) and the remuneration of the regulated activities (set by the government). In Spain, the cost of the regulated activities includes not only transmission and distribution costs, but also other external items such as the financing of certain policies (promotion of renewables, energy efficiency), the back-end nuclear fuel cycle, a compensation for the additional electricity cost in the non-mainland systems, and electricity subsidies for low-income households.

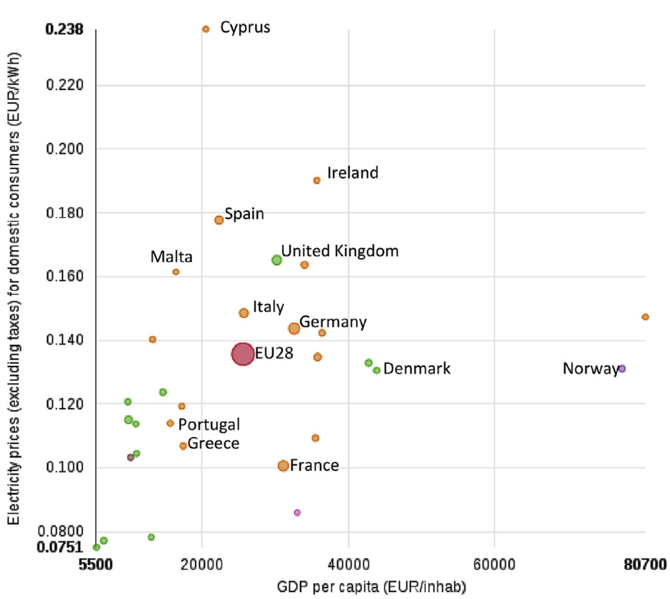

Fig. 2. Household electricity prices (excluding taxes) in European countries in 2012. Authors' preparation using Eurostat data.

However, since 2002 the government-set tariffs for the remuneration of the regulated activities have been systematically insufficient to cover their costs. The shortfall was largely intentional, to avoid even larger tariff increases and their corresponding effects on inflation, on the energy affordability for households, and on the competitiveness of industrial sectors with a high electricity consumption. Indeed, the government even passed a law (Royal Decree 1432/2002) to cap the annual increase in the average or reference electricity tariff to 2%, regardless of internal or external factors, such as inflation or the cost of fossil fuels. The cap was short-lived and was retracted in 2006 (Royal Decree 1634/2006).

The annual difference between the income levied from government-set tariffs and government-acknowledged generation costs was accredited as a debt to the utilities, underwritten by the government. Both this annual deficit and the accumulated debt are generally referred to as the "tariff deficit". It was in theory slated to be paid in subsequent years through progressive tariff increases or from the national budget. However, this prevision was never met: the deficit was rolled over year after year, with never-failing annual increases that have led to an accumulated debt of almost €26 billion [8]. This amount is roughly equivalent to the total cost of generating power in Spain over a single year. In 2012 alone, the annual deficit was €5.6 billion [9].

The government reacted, ex post, by suppressing incentives (feed-in tariffs) for future solar plants and even curtailing them for existing ones (Royal Decrees 1578/2008 and 14/2010). Subsequently, and in the midst of a national fiscal emergency, additional legislation was passed with the aim of reducing the tariff deficit by increasing taxes for utilities and consumer tariffs, and by decreasing the incentives for other renewable and cogeneration facilities (Royal Decrees 1/2012, 15/2012, 2/2013, 9/2013). Insofar as these measures apply to existing facilities, the move has created a great deal of controversy and regulatory uncertainty, and its hypothetical retroactivity has been challenged in court (especially by solar PV investors). In this uncertain context, the power sector is delaying or ditching new investment projects.

What led to this very unsatisfactory situation? Why were the wrong decisions taken? And how misguided were they? In other words, to what extent could this energy crisis have been averted had proper energy planning been in place? What benefits (in terms of sustainability, energy security and costs) would have been obtained? The aim of this paper is to answer these questions. It also aims to generalize the answers, so as to learn lessons on the value of quantitative energy planning as a pre-requisite for policy making in general.

The problems provoked over the last decade in the Spanish power sector have been researched in various works [10–12]. However, these focus on certain economic aspects (such as public subventions and feed-in tariffs) relating to the deployment of renewable energy sources, especially those of the 2008 solar-PV boom. In this paper, however, the scope is wider: we investigate the evolution of the whole power sector, and consider both conventional and renewable technologies; and we assess not only the economic aspects, but also sustainability and energy security indicators.

The paper is structured as follows. First, the main factors contributing to the current state of affairs are summarized in the following section. We have built energy scenarios under the framework of the LEAP (Long-range Energy Alternatives Planning System) software to quantify the benefits of proper planning. The strategy used is outlined in Section 3 and a brief description of the