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# Not sustainable: the sad business of Portuguese new dams

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## 1. Introduction

The world is at a crossroads regarding energy policy and paradigms. We know our present course is unsustainable, but so far have been unable to curb the trend towards a high impact energy system. Modern strategic environmental assessment (SEA) and environmental impact assessment (EIA) must be concerned with both the cost-effectiveness of investments and their sustainability, especially in the energy sector.

Hydropower has long been hailed as a major source of renewable energy. It has also long been a focus of controversy, due to its significant social and environmental impacts. This paper examines the Portuguese large dam program to understand to what extent hydropower is a solution for an energy transition, and whether SEA and EIA have promoted better sustainability in the new dams and the energy system as a whole.

This paper comprehends the following steps: (i) identify key energy policy elements and indicators, (ii) examine the dam program targets and compare them with actual performance, (iii) examine the SEA and EIA processes applied to the program.

## 2. Energy indicators and policy

For three decades, the central focus of energy policy in Portugal has been the promotion of new energy sources to satisfy growing demand. Little attention has been paid to energy efficiency or demand management. One result of this policy has been a continually high dependency on energy imports, a steady increase in energy consumption and degradation in energy intensity — contrary to the trend of most countries in Europe and the World. By 2009 energy intensity in Portugal was 13% worse than EU-27 average, having improved only 2% since 1990, despite an excellent climate and decreasing industrial production (Table 1). In the same period, the EU-27 improved energy intensity by 27%, the USA by 25%, Russia by 26%, China by 52%, India by 35% and Canada by 19% (EC 2010b).

**Table 1 — Compared energy indicators in Portugal and Europe**

| **Indicator** (source: EC 2011) | **Portugal** | **EU-27** |
|---|---|---|
| Energy import dependency in 2009 | 81% | 54% |
| Energy intensity in 2009 (toe/M€ [2000]) | 186 | 165 |
| Energy intensity variation 1990-2009 | -2% | -27% |
| $CO_2$ emission variation 1990-2009 | +26% | -17% |

Following European directives, in 2004 the Portuguese Government approved the first climate change program, amended in 2006, known as PNAC 2006 (PCM 2006); in 2008 the national energy efficiency plan, known as the PNAEE (PCM 2008) and in 2010 the

national energy strategy 2010-2020, known as ENE2020 (PCM 2010). Those plans were centered on new sources (hydro, wind, biomass, photovoltaic, natural gas), with an emphasis on large projects such as new power plants and electric cars. Little attention and few financial means were dedicated to demand management or energy efficiency.

Electricity consumption in Portugal increased by 4% per year in the 2000-2010 period, more than twice the growth of GDP. During 2010, well into the economic crisis, electricity consumption still grew by 5% (DGEG 2011) — sure signs that the energy-efficiency measures were not enough or not reaching the electricity sector.

## 3. Hydropower in Portugal

Portugal is a mountainous country with water availability above the European average, although with large geographic, seasonal and inter-annual variations. Over decades, the country has invested heavily in dams and hydropower.

By 2007 Portugal had 170 large dams, 60 of which were equipped with power plants. Installed capacity in hydropower was 5 052 MW, of which 1 029 MW allowing pumping. On average, hydropower accounts for about 20% of electricity production in the country, although it is highly variable depending on rainfall: roughly between 10% (in a dry year) and 30% (in a rainy year) of electricity production. Hydropower is and will continue to be an important part of the national power generation system.

In the last decade no more large dams were constructed, due to a combination of poor cost-effectiveness and high impacts. Foz Coa dam was halted in 1995 to save unique Paleolithic rock engravings. The last large dam to be built was Alqueva, in operation since 2002. Two new large dams — Baixo Sabor and Ribeiradio Ermida — were approved before 2007, in the midst of a raging controversy, especially the Baixo Sabor, because it destroys a Natura 2000 site and unique landscape. Those works are currently under way, although litigation in the courts continues. The Baixo Sabor dam is already being considered a case study in poor decision-making and conflict between biodiversity conservation and renewable energy policies (Melo *et al*. 2010, Jackson 2011).

## 4. The dam program

In 2007 the Portuguese Government launched the "national program for dams with high hydropower potential", known as PNBEPH (INAG *et al*. 2007). It follows the PNAC 2006, which recommended an increase in hydropower capacity up to 7 000 MW. Neither program gave any justification for this target. The alleged goals of the PNBEPH were to reduce greenhouse gas emissions, to improve energy import dependency, and to improve the share of renewables. Strangely, no targets were set for these goals. No evaluation of impact on electricity cost or burden on the consumers and taxpayers was performed. No alternatives other than new dams were examined.

Given the previously approved dams at Baixo Sabor and Ribeiradio Ermida (250 MW) plus reinforcement of existing dams (600 MW), 1 100 MW remained to be covered by new dams. The PNBEPH also set a target of 2 000 MW for pumping capacity, based on wind power predictions. The whole program was supposed to cost about 1 200 M€ (INAG *et al*. 2007). In 2008 the Portuguese Government issued a call for proposals to concessions at the ten selected dam sites, supposedly adding up to 1 100 MW. Strangely, the proposals indicated twice the originally defined installed power, with almost three times the cost (cf. Table 2). This discrepancy was never officially explained. Seven out of the ten dams in the program were eventually approved.

**Table 2 — Comparison of indicators: PNBEPH vs. concession proposals**

| New proposed dam site | Power capacity (MW) | | Production (GWh/year) | | Investment (M€ 2008) | | Concession holder |
|---|---|---|---|---|---|---|---|
| | PNBEPH | Proposal | PNBEPH | Proposal | PNBEPH | Proposal | |
| Foz Tua | 234 | 324 | 340 | 350 | 177 | 340 | EDP |
| Gouvães | 112 | 660 | 153 | 52 | 103 | 1700 | Iberdrola |
| Padroselos | 113 | 230 | 102 | 110 | 101 | | (reproved) |
| Vidago/A.Tâmega | 90 | 127 | 114 | 142 | 106 | | Iberdrola |
| Daivões | 109 | 118 | 148 | 161 | 144 | | Iberdrola |
| Fridão | 163 | 256 | 199 | 327 | 134 | 242 | EDP |
| Alvito | 48 | 136 | 62 | 66 | 67 | 268 | EDP |
| Pinhosão | 77 | - | 106 | - | 109 | - | (no prop.) |
| Girabolhos | 72 | 355 | 99 | 104 | 102 | 360 | Endesa |
| Almourol | 78 | - | 209 | - | 96 | - | (no prop.) |
| **Total PNBEPH** | **1096** | **2206** | **1532** | **1312** | **1139** | **2910** | |
| Baixo Sabor | 170 | | 230 | | 257 | 481 | EDP |
| Ribeiradio Ermida | 77 | 82 | 134 | | 150 | 150 | EDP |
| **Total new dams** | **1343** | **2458** | **1896** | **1676** | **1546** | **3541** | |

Sources: INAG 2012, EDP 2012 and DGTF 2010.

In the meantime, a number of power reinforcements were approved for existing dams; those works are either finished, under construction or advanced project (Table 3).

**Table 3 — Indicators of power reinforcements in existing dams**

| Dam and power plant | Commission year | New power capacity (MW) | New pumping power (MW) | Production (GWh/year) | Investment (M€) |
|---|---|---|---|---|---|
| Picote II | 2011 | 246 | - | 244 | 140 |
| Bemposta II | 2011 | 191 | - | 134 | 132 |
| Alqueva II | 2012 | 260 | 220 | 470 | 160 |
| Venda Nova III | 2015 | 746 | 736 | 1038 | 300 |
| Salamonde II | 2015 | 207 | 207 | 274 | 200 |
| Paradela II | 2016 | 318 | 318 | 616 | 270 |
| **Total reinforcements** | | **1968** | **1481** | **2776** | **1202** |

Source: EDP 2012

The Portuguese Government and electric companies hailed the PNBEPH as the cornerstone of energy policy regarding climate change. To the untutored eye, the program appears to be a major improvement in renewables, increasing hydropower capacity by nearly 50%. But when we look at the economic indicators (Table 4), the new dams show an appalling performance: cost of electricity per kWh is twice the cost of the existing system; actual production amounts to only 3.5% of electricity, 0.7% of energy imports and 0.7% of $CO_2$ emissions saved, despite the fact that those were the alleged goals of the PNBEPH.

We can also see that, together with pre-existing capacity, power reinforcements already surpass the targets defined in the PNBEPH: 7 020 MW for total hydropower and 2 510 MW for pumping. This is an important point: none of the new dams are needed to reach the targets defined by the program itself.

The poor performance of the new dams is related to the low effective use of nominal power, 8%. The excess capacity seems to have been motivated by a promised State subsidy for "power availability", to the amount of 20 000 €/MW/year, as set out in "Portaria nº 765/2010" (SEEI 2010). That subsidy may now be withdrawn, by demand

of the International Monetary Fund, the European Central Bank and the European Commission (EC), due to the economic crisis and the recognition that subsidies to the electric companies are already excessive. This has prompted the electric companies to announce that most of the new dams may not be viable after all.

**Table 4 — Performance indicators for new dams, existing dams and energy saving**

| Subsystem / Indicator | Pre-2007 hydropower (a) | Reinforcing power in existing dams (b) | Total in existing dams (a)+(b) | New dams | Energy-saving measures | |
|---|---|---|---|---|---|---|
| | | | | | 1.7 TWh/y | 13 TWh/y |
| Installed power (MW) | 5 052 | 1 968 | 7 020 | 2 458 | n.a. | n.a. |
| Pumping power (MW) | 1 029 | 1 481 | 2 510 | 1 875 | - | - |
| Production (TWh/year) | 10 | 2.8 | 12.8 | 1.7 | 1.7 | 13 |
| Effective use (% of time) | 23% | 16% | 21% | 8% | n.a. | n.a. |
| Investment (M€) | - | 1 202 | 1 202 | 3 541 | 290 | 6 200 |
| Production cost (€/MWh) | 55 | 22 | 50 | 110 | 9 | 30 |
| % of hydropower in 2007 | 100% | 39% | 139% | 49% | n.a. | n.a. |
| % of electricity production | 21% | 5.9% | 27% | 3.5% | 3.5% | 27% |
| % of primary energy | 3.2% | 0.9% | 4.1% | 0.5% | 0.5% | 4.2% |
| % of energy imports | 3.9% | 1.1% | 5.0% | 0.7% | 0.7% | 5.1% |
| % of $CO_2$ emissions saved | n.a. | 1.1% | n.a. | 0.7% | 0.7% | 5.1% |

Adapted from EC 2010 and GEOTA et al. 2011 (n.a. = information not available)

## 5. SEA and EIA for the new dams

The PNBEPH was subject to a strategic environmental study (COBA/PROCESL 2007). This study examined 25 locations for new dams and identified probable impacts in each of them. Final selection of ten dams was based on a single target and a single environmental factor: power capacity must amount to 1 100 MW, and no major Natura 2000 sites should be destroyed.

Unfortunately, this study ignored or overlooked four major objectives of a true strategic assessment, required by Directive 2001/42/EC and referred to by many authors (e.g. Wood 1992, Melo and Andrade 1999, IAIA 1999, Brown and Thérivel 2000, OECD 2006):

a) The study failed to recognize that the alleged program goals were not fulfilled and the mandated targets were redundant;

b) No strategic alternatives were studied. The two most obvious were (i) reinforcing power in existing dams, that was tripled after the issue of the program, and may be expanded further, and (ii) promotion of energy-saving measures, according to EU doctrine, stated in the Energy Strategy of 2010 but already known by 2007. Both show better cost-effectiveness than new dams (cf. Table 4);

c) No cumulative impacts were studied. Cumulative impacts are critical regarding biodiversity, river habitat destruction, sediment transport and water quality, especially because six of the proposed dams were in the Douro basin;

d) Transparency was lacking throughout the process. Decisions were taken based on incomplete information and false arguments. Faults pointed out by stakeholders during public consultation were blithely ignored.

The dams included in the PNBEPH were later subject to EIA (e.g. Ecossistema 2003 for Baixo Sabor, Profico Ambiente 2008 for Foz Tua). Together with other national and international studies (Arcadis/Atecma 2009, IDP 2009, Melo *et al*. 2010, ICOMOS/IFLA 2011, Simão and Melo 2011) we have a clear picture of the impacts caused by these

dams: (i) obliteration of rare river and riverbank ecosystems, including the extinction of migratory fish and other species that depend on natural rivers; (ii) disruption of ecological corridors essential for the connectivity of larger ecosystems, affecting other habitats and species, e.g. the wolf among many others; (iii) cumulative degradation of river habitats resulting from several dams in the same basin, especially in the Tagus and Douro basins and the Tâmega sub-basin; (iv) water quality degradation, by creating conditions for eutrophication; (v) added risk of coastal erosion by retention of sediments; (vi) destruction of good agricultural land that, in mountain areas, is largely confined to the riverbanks of major valleys; (vii) elimination of the last few large wild rivers in Portugal, with a unique landscape; (viii) elimination of conditions for sustainable tourism and local development, e.g. by the destruction of the Tua valley and hundred-year-old railway; (ix) possible withdrawal of the UNESCO World Heritage classification of the Alto Douro Wine Region.

The water to run hydropower may be renewable, but the land, habitats and human communities destroyed by reservoirs most certainly are not. These dams, particularly Baixo Sabor (under construction) and Foz Tua (now beginning construction) are true paradigms of unsustainability. Still, they were approved by the Portuguese Government and so far tolerated by the EC. In both cases, most of the damage has yet to happen, so those impacts could be averted if the construction works were stopped.

The main reason why the European Commission is not moving against the Portuguese State on the dam program seems to be they are reluctant to tackle before the EU Court of Justice the delicate issue of "national public interest" — never demonstrated but assiduously invoked by the Portuguese Government to try and dismiss EU directives.

## 6. Conclusion

The Portuguese new dam program is a paradigmatic example of the limitations of SEA and EIA processes: the program was found adequate though the analysis was very incomplete; and the identification of significant, long term, unavoidable impacts did not stop unsustainable and environmentally destructive projects. It should be noted that the way SEA and EIA were used is to blame, rather than the instruments themselves.

The dam program shows very poor cost-effectiveness: program goals are not fulfilled; program targets have already been met with power expansion in existing dams; and the cost per kWh in the new dams would be more than ten times higher than the best alternative, energy efficiency. Negative environmental impacts are of high significance, but have been overlooked so far by Portuguese and EU authorities. However, the values threatened could still be saved by a strong public opinion and decisive action.

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