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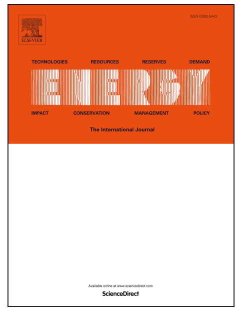


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# Modeling the long-term impact of Demand Response in energy planning: the Portuguese Electric System case study

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## ABSTRACT

With the urge to decrease carbon emissions, electricity systems need to evolve to promote the integration of renewable resources and end-use energy efficiency. Demand Response (DR) can be used as a strategy, one among many, to improve the balance between demand and supply of electricity, especially in systems that rely heavily on variable energy renewable resources. Thus, it is important to understand up to what extent a countrywide system would cope with DR implementation.

In this work, the impact of demand response in the long-term is assessed, using a model of the Portuguese electricity system in the modeling tool OSeMOSYS. The theoretical potential of DR is computed to understand better the impact on the overall system planning, by analyzing three scenarios – a business as usual scenario, a carbon-free system scenario in 2050, and a scenario without heavy carbon emission restrictions.

DR impact in all three scenarios results in a decrease in the overall costs, on the capacity installed and in an increase in the percentage of renewable capacity. Further, an economic analysis showed that DR would take 15 years, on average, to influence the average electricity cost and that the reduction in total costs is mainly due to the avoided capacity investments.

## Keywords

Demand response; Flexible electricity demands; Energy systems modeling; Renewable energy

## List of Acronyms

BaU – Business as usual
DR – Demand response
ENTSOE - European Network of Transmission System Operators for Electricity
NG – Natural gas
PRE – Production in special regime
PRO – Production in ordinary regime
ToU – Time-of-use

### 1. INTRODUCTION AND RELATED WORK

#### 1.1. Demand-response integration

Since the California energy crisis in 2004, the promotion of Demand Response (DR) has been considered in the US energy planning [1]. One year later, the European Network of Transmission System Operators for Electricity (ENTSOE), issued an explanatory document on demand side management and its definition of DR, stating that "*DR is a voluntary temporary adjustment of power demand taken by the end user as a response to a price signal (market price or tariffs) or taken by a counter-party based on an agreement with the end-user*" [2]. In Figure 1, the different strategies that DR can assume are explained graphically, using a comparison between two profiles – a standard profile with a load peak and an optimized profile with DR considering three different strategies. The valley filling strategy increases the consumption of the installed capacity that is free during most part of the day in order to keep the consumption fluctuation more balanced; the peak shaving strategy decreases the need for offline/backup capacity that is ready for dispatch, as a result of a decreased load peak; finally, load shifting uses a combination of the first two strategies [3].