# A SYSTEMATIC MAPPING AND EVALUATION OF BARRIERS AND BENEFITS OF THE DEMAND SIDE RESOURCE PARTICIPATION IN ELECTRICITY MARKETS

Joonas Päivärinta, RWTH Aachen University, +49 241 80 49832, JPaivarinta@eonerc.rwth-aachen.de
Reinhard Madlener, RWTH Aachen University, +49 241 80 49820, RMadlener@eonerc.rwth-aachen.de

## Overview

The demand side in its versatility has climbed to the top of the energy policy debate. The importance of involving the demand side in the electricity markets for providing flexibility or for reducing $CO_2$ emissions has been widely recognized. In the EU energy policy sphere demand side management (DSM) contributes to all 20-20-20 targets.

A reduction in energy consumption directly results in reduced $CO_2$ emissions, while peak shaving decreases the average carbon intensity of generation. The flexibility attributes of the demand side resources facilitate the integration of renewable energy sources to the power system. Moreover, end-use efficiency, being a part of demand side management, directly contributes to the energy efficiency of the EU economy. Finally, the DSM is a key ingredient in delivering market efficiency and thereby an important enabler of the EU single energy market.

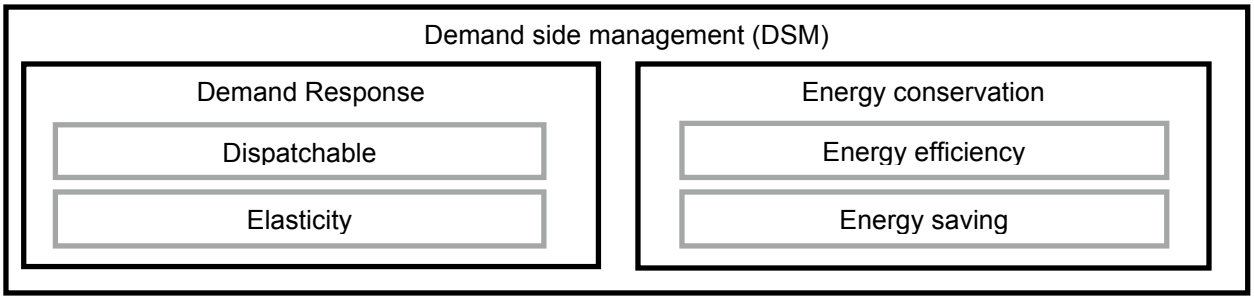



**Figure 1.** The typology of demand side management.

Despite the numerous benefits attributed to DSM, the literature identifies a vast variety of reasons for a rather slow uptake (e.g. Strbac 2008), calling for an investigation of the "DSM gap". Our research considers the full spectrum of DSM, covering different qualities of demand response, and distinguishing between welfare-neutral energy efficiency and saving energy, as depicted in figure 1.

## Methods

This paper proposes a novel approach for mapping DSM activities. The mapping is based on a systematic top-down clustering of the barriers and on the welfare-motivated clustering of potential benefits. Our approach structures the benefits according to the channel through which the benefit contributes to welfare, and the barriers according to the underlying market reasons for the short-coming.

Even in the liberalized power markets it is generally accepted to tolerate a certain degree of intervention due to the very limiting nature of the necessary conditions for reaching an Pareto-efficient market outcome, and due to the public good nature of service reliability as a result of a set of physical attributes of the electricity system, (see Roques, 2008, for a discussion of the notion of an efficient energy market equilibrium, and Joskow & Tirole (2007) for a discussion of system reliability considerations.). The theoretical market equilibrium is hence hardly achievable (or worth to strive for, for that matter).

Stepping down from the ideal Pareto-efficient market equilibrium as the policy goal to the second-best world constitute the rationale for the set of barriers, namely, acceptable market imperfections, such as:

1. Locational real-time spot prices are not feasible;
2. There is no explicit demand for service reliability; and
3. The retail tariffs are partially rigid.


**Figure 2.** Framework for structuring the barriers to DSM activity

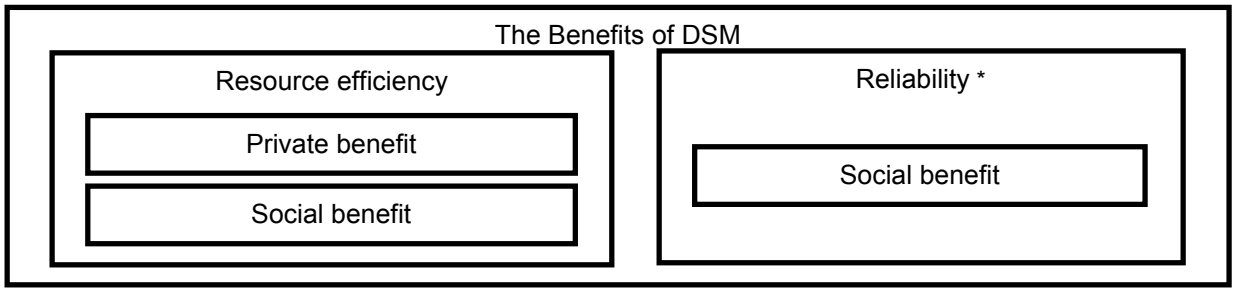
The total welfare in the second-best world is inferior to the welfare in the Pareto-efficient equilibrium world. These so-called "acceptable imperfections" constitute barriers to DSM activity. Lack of real-time or spatially precise prices means that the marginal value of flexibility is not transparent to the actors. Centrally defined reliability standards leave space for positive externalities by DSM. Thirdly, technological constraints and poorly understood consumer preferences aggravate the public good attribute of the reliability, and enable (unintentional) cross subsidization across consumers, leading to sub-optimal DSM efforts. These acceptable imperfections account for a reduced DSM activity, eventually constituting the gap between the ideal world and the second best world, namely "welfare gap", as illustrated in figure 2.

Additionally, a set of "avoidable imperfections" can be identified. The price level or the price variation is suppressed by inappropriate market involvement of the system operator, and by explicit or implicit price caps. Socially financed instruments for congestion management further distort locational price signals. Finally, DSM involvement can be limited by technical or regulatory barriers, inflating unnecessarily the role of the system operator. The avoidable imperfections constitute the second distinct set of barriers to DSM activity, constituting the "involvement gap" in figure 2.

## Results

In our research we find that the effectiveness of the policies addressing the DSM is increased if the policy measures are designed in line with the proposed mapping of the barriers to DSM. We further find that in the second-best world, all the potential either increase the resource efficiency, or enhance system reliability. The DSM benefits are channelled to welfare either as private or social benefit. These findings are summarized in figure 3 below.

Grouping the potential benefits under either resource efficiency or reliability enhancement is a step forward from the clustered grouping of benefits found in the literature. Our proposition is justified by the welfare implications of each of the benefits has, and by the structured mapping of the barriers to DSM suggested above.




*In a theoretical, efficient market equilibrium, reliability becomes a component of resource efficiency.

**Figure 3.** Grouping of the potential benefits of DSM according to the welfare gain channels.

## Conclusions

We systematically demonstrate how the barriers to DSM activity constitute – what we call – "the welfare gap", and "the involvement gap". By explicitly acknowledging, along the lines developed in this research, the nature of any observable DSM shortcoming facilitates the selection of appropriate policies or corrective measures: The DSM shortfall grounded on the "acceptable imperfections" should be approached differently to those grounded on avoidable imperfection.

While our method for mapping barriers to DSM facilitates policy analysis, our consistent approach to understanding benefits of DSM strictly by the welfare implications contributes to existing literature by introducing a coherent framework for bringing the whole spectrum of identified DSM benefits under one umbrella.

## References

Joskow, P., & Tirole, J. (2007). Reliability and Competitive Electricity Markets. *Rand Journal of Economics*, 38(1).

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