Socioeconomic impacts of developing smart grids

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Overview

It is known that developing smart grids can help reach the European Union "2020 energy targets" moving towards new horizons like 2030. In fact, smart grids will increase the use of renewable resources to generate electricity in urban areas and promote new electricity applications in mobility strategies and a more efficient domestic use of energy by means of smart metering.

The development of smart grids means to adapt the current transport and distribution grids and the metering and power conditioning equipment to new requirements, as the current electricity infrastructure was not designed to satisfy the needs of an electricity industry with a high proportion of generation from renewable energy sources or the incorporation of equipment that manages the energy demand.

It is common to find answers related to the technical considerations but some answers related to their economic aspects have to be answered before encouraging large investments, particularly in the current international context of recession. The most suitable energy plans with effective energy policies have to be developed as well if smart grids are considered a key factor within energy sustainability.

This paper introduces a methodology to evaluate the socio-economic impact of establishing smart grids on a domestic scale, in particular needs for investment, benefits due to energy efficiency (energy security, GHG emissions reduction, savings on electricity bill) and job creation, considering public and private points of view. The method was applied to Zaragoza, a medium-sized city in the region of Aragon (Spain), were some developments in the area of smart metering and electrical vehicle integration are being carried out. Only household and tertiary sector were considered.

Methods

It is currently difficult to estimate the impact the implementation of smart grids would entail for a territory. Different multidisciplinary analyses are needed that take into account the effects of this technological change on the investment, the production model, the habits of the citizens, the dimensions of the grids, etc.

In consequence in order to establish the effects of the adaptation of the current electricity grid, four groups of variables were considered:

- Those related with the grid size, i.e. length of distribution and transmission grids as well as number of substations and transforming stations required.
- Those related with adaptation costs, i.e., costs for transmission grid, costs for distribution grid and costs per user.
- Those related with the temporary implementation of the technology such as project execution time and rate of investment deployment.
- Those related with social behavior, the consumption profiles at home on one side and the social adaptability to different models for energy management on the other.

As a starting point, the results obtained from two research projects carried out by the authors as well as information from primary sources were analyzed in order to have a picture on the current situation of the electricity infrastructures and make projections for the implementation of a smart grid according a feasibility analysis of different renewable energy systems and the consideration of the priority lines of R&D&I in energy efficiency.

Due to the lack of data of specific costs at local level, reported data were used and correction factors were applied in order to take into account differences between town planning models and home occupation as they are the aspects that mainly affect the scales of these impacts. In addition a variability range of ±15% for estimated investment was taken account in anticipation to different initial state of the transmission and distribution grid.
While the roll-out phase for the adaptation projects of the transmission and distribution grids was fixed and allocated to the period 2012-2020, three scenarios of acceptance by the users of smart solutions thought the deployment period (2014-2030) were simulated.

Scenario 1 covers a progressive penetration of smart applications as a consequence of the whole adapted grid in 2020, the following years cause a high demand for applications and the later years (2028-2030) full demand from domestic smart applications by all users.

Scenario 2 covers a penetration that is initially very high as a consequence of widespread acceptance of this technology, as it offer great advantages for users. This scenario is also linked to an increase in the price of energy which causes the smart energy management systems, distributed generation, rates differentiated by time bands and electrical vehicles all develop quickly and in the later years (2024-2030) the remaining 20% of users adapt to the new applications.

Scenario 3 is symmetrical to 2 and shows a very low market penetration initially but in the years 2024-2030 there is a high acceptance of the applications and consequently it is in these years that 65% of users demand smart applications.

Regarding socioeconomic impacts two approaches were distinguished: the private one which is mainly focuses in a simple cost-benefit analysis (investment versus bill savings) and the public one for which energy security, GHG emissions reduction and job creation are its major motivations. These impacts were evaluated by means of different indicators and ratios and compared with required investments.

Results

As a consequence of the application of this method to the city of Zaragoza the rate of investment made both by customers and consumers and by the transmission and distribution grids and their annual evolution were evaluated. Total investments range from 950 to 1450 M€ depending on the minimum and maximum unitary cost and different acceptance by the users.

According some studies, it is estimated that a direct reduction of 6% in electricity consumption, with a range of 1% to 10%, can be achieved in the residential and small/medium commercial building sectors through implementation of smart grid technologies. Assuming the current level of electricity consumption and price of the electricity, this means pay-back ratios from 20 to 35 years for private users, well above those obtained by means of other efficiency implementations. This means that public incentive schemes are highly required for smart grid deployment if 2030 targets want to be carried out.

These incentives could be totally recovered if external costs such as CO_2 emission costs, job creation potential and energy security are considered. Only taking into account these three factors, private investments could be recovered in 15 to 20 years.

Conclusions

The development of the smart grids require significant investments to adapt and prepare the current systems for the new requirements. Thus investment in smart grids can constitute a new economic motor that may develop new equipment and services for society and will inherently stimulate the labour market demanding applications and specific services for them.

Smart grids will have more or less development depending on the social demand of the applications, but for there to be enough initial demand, policies and actions regulated by the government need to be created beforehand to boost the demand and favour the roll-out of this technology based on the improved energy sustainability they champion.

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