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Technical and economic analysis of Domestic High Consumption Tariff niche market for photovoltaic systems in the Mexican household sector

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ABSTRACT

This study shows that grid-connected photovoltaic systems (SFVI) are profitable for electricity users falling within the so called Domestic High Consumption Tariff (DAC). These users do not receive any subsidy and make a SFVI feasibly due to the following double mechanism: on the one hand, the reduced amount of electricity that is drawn from the grid, and on the other, a re-classification which makes them pass from the DAC to a lower consumption tariff which benefits from State subsidies. It is also shown that the utilisation of SFVI would lead to economic benefits for the electric power sector which in consequence accounts for a social benefit. It is estimated that Tariff 1 DAC users account for a potential SFVI capacity of slightly above 400 MW. This capacity may deploy a first significant SFVI market in Mexico which so far barely exists and would also represent a reduction in electricity drawn from the grid of nearly 614 GWh per year and reduced CO_{2eq} emissions of 841 thousand tonnes per year. Finally, some recommendations are inferred in order to improve the social benefit of this first deployment of SFVI in the Mexican Household sector. The analysis presented for Mexico can be replicated for other countries with subsidised residential tariffs and similar structures such as those countries identified in this paper.

Contents

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Nomenclature

CB	cost–benefit [USD]
CFE	Mexican Federal Electricity Commission
CS	cost-savings [USD]
DAC	domestic high consumption tariff
GEI	greenhouse gases
kWp	kilowatt peak
MUSD	million of U.S. dollars
O&M	Operation & Maintenance
PR	payback period [Years]
SB	social benefit [USD]
SFVI	grid-connected photovoltaic systems
SIN	National Interconnected System
tCO_{2eq}	tonnes of carbon dioxide equivalent

1. Introduction

Commercial use of grid-connected photovoltaic systems (SFVI) has an important potential in the Mexican household sector due to the abundance of the solar resource [1,2], the existence of a regulatory framework which makes it feasible [3] and the drop in technology prices that has been observed in recent years [4,5]. However, the use of SFVI is still marginal in Mexico [4] and at present there is no on-going public policy intended to boost its utilisation in spite of several factors such as the need for an energy diversification, a precipitous decline of 23% in oil production in the 2004–2011 period [6] and its corresponding reduction to 10.6 years in production to proven reserves ratio [6,7]. Furthermore, Mexico has set voluntary targets for reducing 30% greenhouse gas emissions (GEI) by 2020 and 50% below year 2000 baseline by 2050 [8,9].

Available international experiences such as those of Germany [10–13], Italy [14,15] and the American State of California [16] show that large-scale SFVI household applications come into a reality when adequate support mechanisms of public policy are implemented. For instance, Germany has successfully increased its SFVI capacity from 100 MW to 17,320 MW in the 2000–2010 period out of which 17% (4229 MW) corresponded to the household sector [4,17,18]. Likewise, installed capacity in Italy has been increased from 1.1 MW to 4209 MW in the same period (15% in the household sector) [4,15,19], while in California installed capacity passed from 9 MW to 1243 MW between 2000 and 2011 (35% in the household sector) [16,20].

Previous studies have identified the existence of niche markets for SFVI in Mexico [21,22]. However, the scope of such studies has been limited to an analysis from a user perspective, but it does not evaluate the optimal capacity at which the social benefit is maximised as in this article. Indeed, this study analyses and shows that SFVI are economically feasible in Mexico for household users falling within the so called Domestic High Consumption Tariff (DAC) which does not benefit from State subsidies. It also shows the size of the SFVI at which this feasibility takes places. This implementation may also lead to significant social benefits at sectorial level as well important reductions in electricity used from the grid and CO_{2eq} emissions. Finally, some recommendations are made in order to improve the social benefit of implementing SFVI in the Mexican household sector.

The analysis presented in this paper can be replicated for other countries, mainly in Latin America, including Bolivia, Brazil, Ecuador, Guatemala, Honduras, Panama, Paraguay, Peru and Venezuela [23]. All these countries, besides Egypt [24], Lebanon [25], Libya [26] and Saudi Arabia [27], have subsidised tariffs which are best known in the region as social tariffs [23] and they are characterised by setting an upper limit for electricity consumption. A consumption below this limit is eligible for subsidies while an electricity consumption exceeding this limit will cause subsidies to be either significantly reduced or even completely eliminated.

Similar to the Mexican case, subsidised tariffs in these countries have different levels of subsidy within the upper limit. However, in some countries such as in Egypt [24], Lebanon [25], Libya [26] and Saudi Arabia [27] such a limit for subsidies does not exist, but anyway, going from less to more subsidised tariffs may lead the use of SFVI feasible. On the other hand, in other countries such as Brazil, Ecuador and Venezuela [23], the upper limit and level of subsidies depend on the distribution region, season of the year or even the consumption pattern of residential users making more difficult the identification of niche markets for SFVI. However, the methodology and mechanism that make a SFVI feasible would be the same as in the Mexican case.

In this context, and knowing that all these countries have a significant peak electricity demand that is generally supplied by diesel generators, the cost–benefit analysis of SFVI utilisation from a sectorial perspective, presented in this paper, is also well suited for these countries. For this reason, the analysis presented in this article can be replicated in nearly all countries with subsidised tariffs.

This paper contributes to show that the viability of a technology depends not only on its technical and economical characteristics, but also on the institutional framework in which the technology is implemented. This is the case presented in this paper where subsidies granted via household electricity tariffs make the photovoltaic technology economically feasible in the DAC niche market. Similar situations in which the institutional framework had an effect on the viability of a technology can be found worldwide, for example, in Germany, photovoltaic systems are also feasible due to the feed-in tariffs granted to this technology.

2. Mexican tariff system for household users

2.1. Domestic electricity tariffs

Historically, electricity used from the grid in the Mexican household sector has been vastly subsidised. In the last 10 years, this subsidy has accounted for 60% of the cost of electricity supply in this sector on average [28]. However, it is differentiated in accordance with different tariffs and consumption limits that have been set in Mexico. As of year 2011, subsidies granted to this sector totalled 6434 million dollars[1] (MUSD) and accounted for 85% of total subsidies for electricity used from the grid at national level [28].

All household electricity tariffs are subsidised except Domestic High Consumption tariff (named DAC tariffs for its acronyms in Spanish) and are classified in seven categories: 1, 1A, 1B, 1C, 1D, 1E and 1F. These subsidise tariffs are at the same time related to different regional climatic conditions of the country, and vary over the year depending on the season, month and the amount of electricity consumed by the user [29].

More precisely, each of these tariffs is subdivided into ranges of monthly electricity used from the grid, and except tariff 1, the remaining tariffs (from 1A to 1F) vary depending on two seasonal

[1] All economic calculations shown in this study were carried out in real terms and expressed in 2007 U.S. dollars (USD2007).