Second-generation smart meter roll-out in Italy: A cost-benefit analysis

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1 Introduction

Italy pioneered a large-scale roll-out of smart meters in the early 2000s. The country deployed some 36.7 million meters between 2001 and 2011. The largest DSO, Enel Distribuzione (now called e-distribuzione), that accounts for about 86% of the points of delivery, started the roll-out of its own accord, covering almost all its network in 2001-2006. Other DSOs followed as the regulator adopted a mandatory plan. The relevant regulatory framework allowed the DSOs to recover their costs through the metering tariff. Regulation did not anticipate investments but was enacted after a large share of the total investment had been made, so no official cost-benefit analysis was performed at the time. Smart meters allow for a more efficient management of energy demand, enhance the consumers' engagement in the market, and improve the effectiveness of metering and billing, resulting in reduced interruptions and more frequent and precise readings. After a detailed consultation, the EU Commission itself identified a set of common minimum functional requirements for electricity smart metering systems (EC, 2012). Italy's smart meters – that were installed prior to the EC Communication – are compliant with all the requirements but one: they are not capable of providing an updated reading at least every 15 minutes. Acknowledging the impending obsolescence of the existing meters, as well as the need to improve their functionalities,[1] the regulator designed a framework for the roll-out of second-generation smart meters (2GSMs). As the oldest smart meters are connected to the distribution grid of e-distribuzione, this latter company started the deployment of the new meters in 2017. In fact, the technical

[1]As legislated in the Decreto Legislativo 4 luglio 2014, no.102, updated by the Decreto Legislativo 18 luglio 2016, no.141.

and regulatory lifetime of a meter is around 15 years. Differently from most EU member states, the regulator decided once again not to perform a cost-benefit analysis (CBA) of the new roll-out program. This decision was predicated upon the risk that an official CBA might delay the roll-out process and the fact that the cost of installing 2GSMs is not significantly different from that of merely replacing the existing meters with the same technology (AEEGSI, 2016). In this paper we perform a simplified CBA of the roll-out program of e-distribuzione. Other DSOs are developing their plans but no information is available yet.

2 Data and methodology

The analysis relies on publicly available data, that do not allow a thorough exercise. For example, data are not available with regard to operational costs on the cost side, or the expected improvement in credit management, in-site visits and energy thefts on the benefit side. Our estimate of the costs is based upon the information from e distribuzione (2017) and the regulator AEEGSI (2017). Benefits can be grouped in two categories: those related to the meter itself, and those unlocked by its use by consumers, suppliers, and network operators. We have ignored the former, because we assume that there is no significant difference between first generation and second-generation smart meters when it comes, for example, to the maintenance cost or the energy consumption of the meter itself. This is a conservative estimate. The consequences of smart meters on the behavior of the stakeholders are presumably much larger. Our assumptions – that will be detailed in the next paragraphs – are based on the benchmarking report from the EU Commission (EC, 2014) and the CBA performed by the UK Government (UK-DBEIS, 2016) as well as the literature cited thereby. The scope of the analysis is limited to residential users and small businesses (with a maximum power of 10 kW for the purpose of this article) with a single-phase meter. The main reasons for this are: i) small customers are those with the greater potential of behavioral changes and ii) the looming deregulation of Italian retail prices is likely to lead to greater customer engagement, whose consequences would be magnified by 2GSMs (Amenta et al., 2018; Benedettini and Stagnaro, 2015). The roll-out plan of e-distribuzione ranges from 2017 to 2031. Hence, the time span of interest goes from 2017 to 2046 (i.e. the 15th year after the last smart meter has been installed). Since 2033, the benefits cease from the meters installed in 2017, and so on. Our estimate for energy demand in 2017-2026 builds upon the baseline scenario of Italy's TSO (Terna, 2017). We focus on the forecast for residential demand, that we extrapolate linearly for the period 2027-2046. We assume the demand from small businesses (with a maximum power of 10 kW) to be around one third of the residential demand, based on data for 2016-2017 (ARERA, 2018). Based on the same source, we assume that the share of demand from users connected to the network of e-distribuzione is about 86%. The analysis develops three scenarios: a central scenario (that we regard as a conservative one) that reflects the most common assumptions regarding the behavioral consequences of smart meters, and an optimistic and a pessimist scenario – called "engagement" and "disengagement", respectively – that assume a high and low degree of reaction of energy users to the information and opportunities from the 2GSMs. The underlying assumptions are detailed in the Appendix. In performing the analysis, we adopt a discount rate of 3%.

3 CBA Analysis

Costs - We assume operational costs of 2GSMs not to significantly differ from those of first-generation smart meters. Therefore, we focus on capital expenditure. AEEGSI (2017) provides us with the cost for the Data Concentrator and the Data Management System. By including these we overestimate the cost to be incurred by residential customers and SMEs, because they will be partly borne by large users who are out of our scope of work. That moves us again towards the conservative side of the estimate. AEEGSI (2017) shows that the unit cost of installing 2GSMs grows over time as mass deployment ends. The expected Capex each year in the roll-out period is equal to the unit cost (as estimated by the regulator) times the number of 2GSMs that are installed (according to the plan released by e-distribuzione). We adjust the resulting cost for optimism bias, with a factor of 5-10%. The net present value of the cost stream is estimated at 3,638-3,742 million euro, with a central value of 3,555 million euro.

Benefits - The main sources of benefits are: energy demand reduction; increased competition and switching activity; peak-load shifting; and reduced carbon dioxide emissions. In order to estimate the benefits from 2GSMs, we assume the price of electricity to remain flat at 60 euro / MWh (nominal) for the entire period. This seems to us a reasonable assumption given the current trend and shift towards a generating fleet dominated by fixed costs. Increased feedbacks on actual consumption, and the possibility to compare alternative offers based on real consumption data, are strongly associated with greater energy efficiency. We assume a reduction of energy demand by those equipped with a 2GSM in the range 3-7%. This is a very conservative estimate if compared with data available from the literature. The net present value is 1,665-3,886 million euro, with a central estimate of 2,776 million euro. Easier price comparability and greater awareness of one's total consumption and consumption structure also result in increased competition and switching activity, which – in turn – is associated with more efficient energy use and lower prices. We assume this effect to be worth 1-3 euro per meter per year, resulting in a net present value of 404-1,212 million euro and a central value of 808 million euro. If consumers are on real-time pricing schemes, they may adjust their behavior by moving consumption from peak to off-peak time, in order to save money and protect the environment. Thanks to digital technologies, smart appliances and domotics the choice of when to run certain devices may be automatized. Based on data from 2018 and early 2019 (GME, 2019), we estimate the peak-off peak difference between 10-20%. We assume the share of those with a 2GSM and a real-time pricing tariff to be between 10-30%, and the share of their consumption that is shifted to be 5-10%. The benefit can be estimated as:

$PLS = T * C * D$

Where PLS = benefit from peak load shifting; T = those under real-time pricing (number of meters); C = the amount of consumption that is shifted (MWh); and D = peak/off-peak price differential (euro/MWh). The net present value is 28-334 million euro with a central value of 125 million euro. This is most likely an underestimate, as it ignores further benefits from reduced generating plant demand margin request and network capacity investments. Reduced consumption and peak-load shifting further decrease the environmental impact from electricity generation. To account for this, we make the following assumptions: i) the average CO2 factor of the Italian thermal plants of 489 gCO2/kWh (ISPRA, 2017), declines by 1-3% per year over time as a result of better technologies and the gradual shift leftwards of the merit order curve; ii) the share of renewable production grows from 34.1% in 2017 to 55.4% in 2030 as requested by the Draft National Climate and Climate Energy (Mise 2018), and keeps growing linearly ever since; iii) the marginal social cost of CO2 grows linearly from 25 euro / tonCO2 in 2017 to 50 euro / tonCO2 in 2046 (Molocchi, 2017; Parry et al., 2014). The net present value is 160-462 million euro with a central value of 297 million euro. Again, this is conservative because it ignores the environmental benefits from the reduction of pollutants other than carbon dioxide. Summing up, the net present value of all benefits from 2GSMs ranges between 2,258-5,893 million euro, with a central value of 4,005 million euro.

4 Results and policy implications

Combining our estimated costs and benefits, we find that the net present value of the 2GSMs roll-out program is positive by about 450 million euro, with a lower bound of -1,380 million euro in the disengagement scenario and an upper bound of 2,420 million euro in the engagement scenario. We have made a number of conservative assumptions so we are confident in our estimate, despite the lack of public data to perform a more precise exercise. Figure 1 illustrates the time distribution of costs and benefits in the central scenario.

Our CBA suggests that 2GSMs are likely to entail more benefits than costs, but it also shows that, while costs are relatively certain and immediate, benefits are much less so. The two most important variables affecting the CBA results are the discount rate and the degree of customer engagement. If a discount rate of 1% is chosen, then the benefits exceed the costs by 1,100 million euro in the central scenario; if it is set at 5% costs and benefits offset each other. If a 1% discount rate is applied to environmental benefits alone, investments in 2GSMs deliver a social benefit of 526 million euro. This raises an issue of how to properly account for social preferences when long-term, environmental threats are at stake (Barro, 2013; Weitzman, 2012). Benefits are dominated by the users' behavioral response: the more they adjust their consumption choices, the higher the benefits. In fact, energy demand reduction (the single most

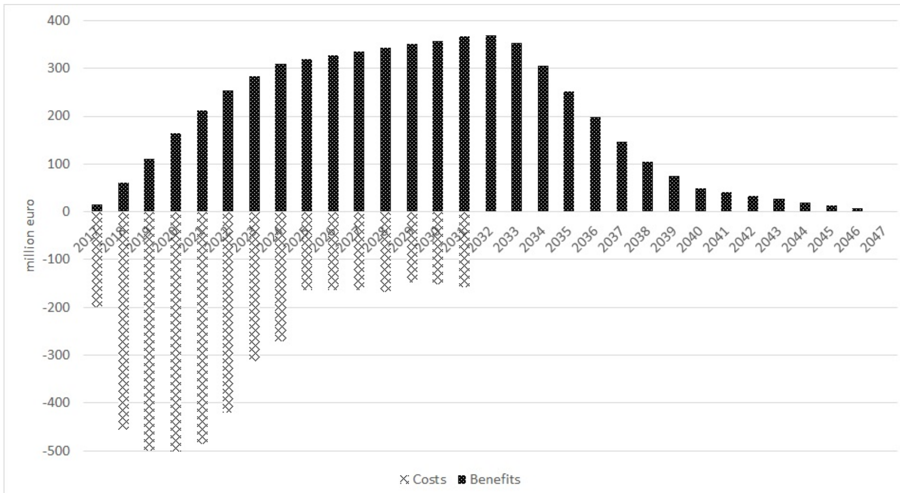

Figure 1: Costs and benefits of the 2GSMs roll-out program in Italy. Central scenario.

important item on the benefit side) and peak-load shifting are the direct effect of the consumer's choices; increased competition and reduced environmental impact are indirect consequences thereof. The main policy implication of our analysis is that smart meters generate a potentially valuable resource (i.e. real-time consumption data) but customer engagement and technological evolution are needed to turn that resource into actual value. A crucial take-away is that the customer is the elephant in the room of the energy transition: smart meters can help it to move its trunk, not move it by its tail.

5 Appendix

	Engagement	Central	Disengagement
COSTS			
Optimism bias	5%	7.5%	10%
BENEFITS			
Energy demand reduction	7%	5%	3%
Savings from switching	3 euro	2 euro	1 euro
Peak-off peak price differential	20%	15%	10%
CO2 factor reduction	1% per year	2% per year	3% per year

Table 1: Assumptions underlying the CBA

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