DEFERRING T&D (TRANSMISSION & DISTRIBUTION) INFRASTRUCTURE INVESTMENTS THROUGH LOCAL END-USE EFFICIENCY MEASURES

Country/region	**United States: California**
Type of E1st approach	D –Behind / Investment 1 – Allowing E1st
Energy carrier(s) targeted	Electricity
Sector(s) / energy system(s) or end-uses targeted	Residential / Tertiary sectors Transmission / distribution
Implementing bodies	Pacific Gas and Electric (PG&E)
Decision makers involved	Utility, end consumers
Main objective(s)	Defer T&D infrastructure upgrades though geographically-targeted end-use efficiency measures.
Implementation period	1991-1993, 2013 - ongoing

Transmission and distribution system operators are subject to ongoing investment needs into their capital assets. In the U.S., several electricity and natural gas utilities have made successful use of locally targeted energy efficiency programmes to defer some of these investments in specific areas for a period of time (Neme and Grevatt, 2015). These projects highlight how the trade-off between demand-side resources and energy infrastructure can be practically solved, with benefits accruing to both the utility and its customers. This example discusses such activities of the Californian utility Pacific Gas and Electric (PG&E). Similar activities are or have been pursued in the states of New York, Vermont and Oregon.

1. Background

Pacific Gas and Electric is a regulated electric and natural gas utility serving Northern and Central California and currently supplying approximately 16 million customers in its service area (PG&E, 2020). Beginning in the early 1990s, fast-growing power demand in the suburban Delta area outside the city of San Francisco was causing a number of the company's transmission and distribution infrastructures to rapidly approach their peak capacity.[1] Facing capital expenditures of $112.3 million for the construction of a new substation and auxiliary equipment, the company began to evaluate if locally-targeted, cost-effective and reliable energy

[1] More specifically, in 1990, peak demand in the Delta area was approximately 90 MW, while the existing distribution system could serve 120 MW. PG&E anticipated about 1,200 new homes and 200 new firms added to the service area per year, corresponding to an annual load increase of 7.7 MW (Orans et al., 1994).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 839509. The sole responsibility for the content of this website lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

efficiency measures can reduce the need for these infrastructures and minimise the total cost of serving the Delta area (Orans et al., 1994). Based on these considerations, in July 1991, PG&E launched the Model Energy Communities programme (MEC) – also referred to as the Delta Project – which today is one of the most widely publicised early projects for active deferral of T&D investments (Neme and Sedano, 2012).

2. How has the E1st principle (or similar concept) been implemented?

One of the first steps taken by PG&E to implement the Delta Project was to involve the local community. A local citizen advisory committee was established for the project, made up of 6-12 community leaders. The purpose of the committee was to act as a sounding board for the initial programme design and possible revisions. Subsequently, potential customers for the implementation of energy efficiency measures were contacted, including details on economic and technical benefits for the customers (IEEC, 2009).

In terms of actual project implementation, PG&E designed several energy efficiency programmes for different customer groups. Given the fact that peak demand was driven primarily by residential customers who turned on their air conditioners when they arrived home after work, the largest portion of the project's savings was projected to come from residential homes. Measures included the following (IEEC, 2009; Kinert and Engel, 1992; Neme and Sedano, 2012):

- During an initial site visit, participating homes would receive free installation of low-cost efficiency measures (e.g., CFLs, low flow showerheads, water heater blankets).
- Homes could then be scheduled for follow-up work with major measures (e.g., duct sealing, air sealing, insulation, sun screening).
- Other minor programme components included commercial retrofits (e.g., retrofits for lighting, HVAC, and motors), and residential/commercial new construction (e.g., reduce cooling requirements).

Overall, 3,648 customers participated in the low-cost efficiency measures, and 2,297 customers received major measures. In addition, a total of 363 commercial retrofits were performed, and there were 318 participants in the new construction component. On average, PG&E paid 80% of direct installation project costs for the commercial programmes; in the residential sector, a complex matrix was used to calculate customer incentives (IEEC, 2009; Neme and Sedano, 2012).

Upon completing work for each participating customer, data was entered into a comprehensive database run by engineering consultants, followed by data reviews and random inspections in order to track achievable and actual programme savings. Overall, the Delta Project was completed in March 1993. In contrast to similar energy efficiency programmes during that time, it was unique in the way that it 1) considered the peak capacity constraints of a specific distribution planning area and the associated proposed substation construction; 2) expanded the energy efficiency measures to include all major market segments in the planning area (including residential and commercial retrofits as well as new construction); and 3) closely evaluated the programme process and impact relative to the local area peak demand (IEEC, 2009).

3. Effects / impacts

Locally targeted energy efficiency measures are of particular relevance to transmission and distribution systems that are likely to reach their peak capacity. Since T&D systems can experience peak demand at different times, the extent to which an energy efficiency programme can help defer investments in T&D infrastructures essentially depends on the hour and season of peak and the hourly and seasonal profile of the programme's savings (Neme and Grevatt, 2015).[2] Accordingly, well-designed, location-specific energy efficiency programmes can be used to significantly reduce the costs associated with upgrades in T&D infrastructures, saving money for both energy companies and customers participating in the programme (Bayer, 2015).

With regard to the Delta Project, the measures implemented are estimated to have reduced investment in local T&D infrastructures from $112.3 million to $74.4 million over a 30-year period, i.e., a 32% decrease. From a total resource cost perspective, the programme resulted in $35 million in savings (Kinert and Engel, 1992). In terms of T&D capacities, the project produced 2.3 MW of peak demand savings while also reducing annual energy consumption by 4,322 MWh (IEEC, 2009; Neme and Sedano, 2012). The savings achieved succeeded in deferring the need for the new substation and other auxiliary equipment for at least two years (Neme and Grevatt, 2015).

Overall, the cost-effectiveness of locally-targeted end-use efficiency programmes and other non-wires resources will unquestionably be project-specific. However, the experience from PG&E and similar projects implemented in the states of Vermont, New York and Oregon highlight that efficiency resources can be a valuable replacement or complement to traditional "poles and wires" alternatives in T&D system planning (Neme and Grevatt, 2015).

4. Changes over time, if any

Despite having been a successful pioneer of T&D infrastructure deferral in the early 1990s, PG&E did not carry out any other projects similar to the Delta Project until recently. In 2013, the company started evaluating specific capacity expansion projects at distribution substation level that required attention due to load growth and that could potentially be deferred. Starting from a list of 150 distribution capacity expansion projects within the PG&E service area that would need to be addressed in the next five years absent any action to defer them, the company ultimately selected four projects for which to deploy non-wires alternatives for the years 2014-2015. Similar to the initial Delta Project, measures were targeted for residential customers, this time focusing on HVAC equipment, pool pumps and demand response programmes for air conditioners (Grueneich, 2015; Neme and Grevatt, 2015).

[2] Note that, besides peak loads, T&D system investments are driven by more factors, including the replacement of aging infrastructure and the need to connect new generation – particularly in the context of ongoing deployment of remotely located renewable generators. Energy efficiency programmes can hardly defer any investments related to these two factors (Neme and Grevatt, 2015).

5. Barriers and success factors

The Delta Project case certainly highlights the effectiveness of using geographically-targeted DSM measures to defer T&D system upgrades. However, throughout its implementation, PG&E was facing a very narrow timeframe. Planned and launched within six months, difficulties arose with regard to implementing management control mechanisms, quality assurance and budget tracking. Based on this, PG&E recommends selecting a targeted T&D area where the window of opportunity (i.e., capital investment point) is approximately three to four years out in time. Similarly, it is important to focus programme design on measures that are well-developed, commercially viable, readily available in terms of timing and quantity, and priced reasonably to enable straightforward implementation (IEEC, 2009).

In terms of success factors, two elements can be highlighted. First, the company later enhanced its management structure through the formation of an interdisciplinary working group covering all relevant functional areas (e.g., energy efficiency and demand management, distribution engineering, substation planning, electric operations). The company's experience indicates that such cross-disciplinary communication is critical to develop confidence necessary for energy efficiency programme implementers and T&D system engineers to work together effectively. Second, PG&E makes increasing use of data-driven tools, including geographically-specific potential models to assess the economics of energy efficiency for cost-effective deferral or capital expenditures required to meet growing customer demand. This has been shown to enable more sophisticated strategies for geographically-targeted efficiency programmes (Neme and Grevatt, 2015).

6. Replicability and scalability potential

An important issue is the applicability of the approach beyond electrical transmission and distribution systems. In principle, the experiences from the electricity sector in using demand-side resources to defer T&D upgrades are just as applicable to natural gas T&D infrastructure investments, with both sectors exhibiting similar characteristics (Bayer, 2015; Neme and Grevatt, 2015). However, according to Neme and Grevatt (2015), the practice of *active* deferral – i.e., intentionally designed and geographically-targeted energy programmes to defer specific T&D projects – has either not been widely studied or not been widely publicised with regard to the natural gas sector.

An example worth noting is Vermont Gas Systems, a natural gas utility with about 50,000 residential and commercial customers in the U.S. state of Vermont. The company routinely includes the impacts of its efficiency programmes in its integrated resource planning. As noted in its 2017 integrated resource plan (Vermont Gas Systems, 2017), energy efficiency programmes are projected to not only reduce gas purchases, but also contribute to delayed transmission investment and produce enough peak day savings to delay implementation of at least one transmission system looping project by one year (Neme and Grevatt, 2015; Vermont Gas Systems, 2017).[3]

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[3] An important point to note is that, while there is limited experience with the targeted use of demand-side resources to defer natural gas T&D investment, there is significant experience with ratepayer-funded programmes to deliver effective natural gas savings. U.S. and Canadian ratepayer-funded energy efficiency programmes report savings of over 566

In the EU context, the Internal Gas Market Directive (2009/73/EC) provides opportunities for the introduction of targeted demand side measures in T&D systems planning. For instance, the Directive already includes the possibility for MS to introduce a public service obligation on natural gas undertakings relating to, among other things, energy efficiency. A public service obligation could come in the form of a least-cost investment requirement that requires the consideration of supply- and demand-side resources anytime an expansion of existing infrastructure is considered (Bayer, 2015). Overall, this would be consistent with the stated goals of natural gas TSOs and DSOs, with the Directive stating that they shall "operate, maintain and develop under economic conditions secure, reliable and efficient transmission, storage and/or LNG facilities to secure an open market, with due regard to the environment" (Directive 2009/73/EC, Art.13a).

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million therms (10.7 TWh) of gas in 2017, representing an increase of approximately 16% compared to 2013 levels (Bayer, 2015; CEE, 2019).

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ABOUT ENEFIRST

ENEFIRST is a 3-year project funded under the Horizon2020 programme, which gathers a consortium of partners from across sectors and regions: IEECP, BPIE, Fraunhofer ISI, CEU, RAP, IREES, TU Wien.

From definition to implementation, ENEFIRST aims at making the “Efficiency First” (E1st) principle more concrete and operational, better understand its relevance for decision processes related to energy demand and supply, its broader impacts across sectors and markets, focusing on the building sector and related energy systems in EU Member States.

> ***E1st gives priority to demand-side resources whenever they are more cost-effective from a societal perspective than investments in energy infrastructure in meeting policy objectives. It is a decision principle that is applied systematically at any level to energy-related investment planning and enabled by an “equal opportunity” policy design.***

ENEFIRST combines policy analysis and quantitative assessments of E1st impacts to develop policy guidelines and recommendations, following a process with continuous exchanges with stakeholders.

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