TC Document

I. Basic Information for TC

▪ Country/Region:	URUGUAY
▪ TC Name:	Evaluation of smart meters and dynamic tariff structures in electricity
▪ TC Number:	UR-T1334
▪ Team Leader/Members:	Balza Angulo, Lenin Humberto (INE/ENE) Team Leader; Correa Poseiro, Cecilia (INE/ENE) Alternate Team Leader; Hoffmann, Bridget Lynn (RES/RES); Bagnoli Lisa Serena (INE/INE); Matias Garcia Edilberto David (INE/ENE); Eguiguren Cosmelli Jose Manuel (INE/ENE); Irigoyen, Jose Luis (INE/ENE); Casalino Franciskovic, Juan Manuel (LEG/SGO); Pineros Cely Ana Maria (INE/ENE); Belmar Ahonzo Jose Manuel (INE/INE); Diaz Gill Virginia Maria (LEG/SGO) Team Leader; Correa Poseiro, Cecilia (INE/ENE) Alternate Team Leader; Bagnoli Lisa Serena (INE/INE); Matias Garcia Edilberto David (INE/ENE); Eguiguren Cosmelli Jose Manuel (INE/ENE); Casalino Franciskovic, Juan Manuel (LEG/SGO); Pineros Cely Ana Maria (INE/ENE); Belmar Ahonzo Jose Manuel (INE/INE) Team Leader; Correa Poseiro, Cecilia (INE/ENE) Alternate Team Leader; Bagnoli Lisa Serena (INE/INE); Matias Garcia Edilberto David (INE/ENE); Eguiguren Cosmelli Jose Manuel (INE/ENE); Casalino Franciskovic, Juan Manuel (LEG/SGO); Pineros Cely Ana Maria (INE/ENE)
▪ Taxonomy:	Research and Dissemination
▪ Operation Supported by the TC:	N/A
▪ Date of TC Abstract authorization:	13 Sep 2024.
▪ Beneficiary:	Uruguay
▪ Executing Agency and contact name:	Inter-American Development Bank
▪ Donors providing funding:	OC SDP Window 2 - Infrastructure(W2B)
▪ IDB Funding Requested:	US$150,000.00
▪ Local counterpart funding, if any:	US$0
▪ Disbursement period (which includes Execution period):	36 months
▪ Required start date:	December 2024
▪ Types of consultants:	Individual consultants
▪ Prepared by Unit:	INE/ENE-Energy
▪ Unit of Disbursement Responsibility:	INE/ENE-Energy
▪ TC included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	No
▪ Alignment to the Institutional Strategy 2024-2030:	Productivity and innovation

II. Objectives and Justification

2.1 **Objective.** This Technical Cooperation (TC) will support the evaluation of a policy initiative implemented by the National Administration of Electric Power Plants and Transmissions (UTE) in Uruguay, which includes two key elements: (i) the massive deployment of smart meters for electricity consumption; and (ii) the establishment of dynamic tariff structures that adjust residential electricity prices based on the timing of consumption. To this end, the goal of this TC is to evaluate the effect of these two different interventions on outcomes such as electricity consumption patterns, household electricity expenditure, operational costs, and utility electricity losses.

2.2 **Justification.** The integration of smart meters and dynamic tariff structures presents a promising solution within the context of the energy transition. Indeed, smart meters and dynamic tariff structures could contribute to enhance the system's flexibility by making it possible to manage demand and enabling better use of renewable energy. Enabling better demand-side management facilitates electricity use when the cost of its provision is cheaper (e.g. when there is plenty of renewable-based electricity available or when capacity constraints are less restrictive), which would consequently encourage the electrification of energy consumption. Therefore, the deployment of smart meters, providing households with granular (e.g., hourly) consumption information, and the implementation of dynamic tariff structures could be crucial for a successful energy transition.[1] However, smart meter penetration in Latin America and the Caribbean (LAC) countries is still low, with a coverage of less than 5% of households.[2]

2.3 **Beneficiary.** Uruguay is the primary beneficiary of this TC, as UTE's nationwide installation of smart meters is in its final stages and is expected to achieve 100% coverage by the end of 2024. Alongside the deployment of smart meters, Uruguay has introduced new dynamic tariff structures offering residential consumers unprecedented flexibility, a tariff scheme still unusual in the region. An evaluation of this policy would not only help to assess the program's results but also generate valuable insights for other countries in the region, supporting their efforts to implement smart meters and adopt more dynamic tariff schemes.

2.4 **Question, Methodology and Data.** Based on non-experimental policy evaluation methods, we will exploit temporal and spatial variation in deploying smart meters and dynamic pricing structures to recover the effect of both policy components outcomes such as electricity consumption patterns, household electricity expenditure, operational costs, and utility electricity losses.

2.5 To explain the theory of change that connects the intervention with the expected results, it is essential to understand the two components of the initiative. An electricity consumption smart meter measures electricity consumption and communicates the information to the consumer and electricity suppliers hourly (it could be near real-time). From a client perspective, having a smart meter means having access to more information about its consumption patterns. For example, the client could potentially detect if one artifact at home consumes too much electricity or identify the hours at which the electricity consumption goes up, and therefore have a more active attitude toward energy efficiency during those hours. Thus, having a smart meter can potentially affect the client's consumption pattern and total electricity expenditure. From a utility perspective, smart meters allow utilities to monitor the service quality in almost real-time, detect power outages and losses, and automate the way electricity consumption is measured. All of this could affect variables such as electricity losses, the duration and frequency of service outages, and utility operational costs.

2.6 The second component of the initiative is the establishment of a dynamic tariff structure that adjusts residential electricity tariffs based on the timing of consumption. This means that the tariff per kWh is much lower when the cost of providing the service is cheaper (i.e., when there is plenty of renewable-based electricity available), and higher when providing the service is more expensive (i.e., peak demand hours). In

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1 Ma et al (2018); Golden (2019); Pereyra-Zamora et al (2019); and Rasheed et al (2020).

2 Álvarez Alonso et al (2023).

other words, a dynamic tariff reflects the resource's short-term scarcity. The theory of change is related to the incentives given to final users to move their electricity consumption towards hours when service provision is cheaper, and therefore affect their consumption patterns, and the expenditure in electricity. If there are changes in consumption patterns, in the medium term there should have to be an effect in the utility investment decision related to topic such as investment in transmission or distribution lines, or the extent to which they incorporate variable renewable energy into the system.

2.7 A noteworthy aspect of the Uruguayan policy is that while smart meters have been widely deployed, not all households have already adopted dynamic tariff structures. Also, both components of the policy were implemented gradually. This variation allows for an evaluation that can disentangle these two policy components' effects: (i) having a smart meter, and (ii) having a dynamic tariff. For measuring the effect of both of them on our outcomes variables, there are a couple of alternative approaches that can be useful: (a) a difference-in-difference estimator (we have both treated and non-treated households before and after the intervention), (b) an event study for different window sizes around the treatment date, (c) given the granularity of the data and the households socio-demographic characteristics we can either implement matching techniques to recover the main parameters of interest or take advantage of the data granularity for refining the approaches mentioned in (a) and (b) for specific subgroups. All the mentioned approaches have different identification assumptions. However, the criteria that UTE used to scale up the policy offer possibilities to justify them.

2.8 Most of the data will be provided by UTE. The data includes detailed information about their clients, including their location, tariff structure (fixed charge and price per kWh, and whether the structure is dynamic), type of meter (conventional or smart), and for those with smart meters: the date it was installed. Importantly, information about the electricity consumption includes, for all clients, monthly consumption between 2018 and 2024, and for those with smart meters, hourly consumption since the date of installation. Additionally, there could be a possibility of matching this information with household characteristics from census or household surveys. If this is possible, it will allow us to have a more refined analysis of the determinants and general patterns of consumption.

2.9 **Strategic Alignment.** This project is aligned with the IDB Group's Institutional Strategy: Transforming for Scale and Impact (CA-631) and with its following objectives of (i) address climate change by incorporating renewable sources of electricity and electrifying energy consumption through the deployment of smart meters, and the implementation of dynamic tariff structures; (ii) promote sustainable growth through essential dynamic tariffs for developing new markets, such as the massive adoption of electric vehicles, or the adoption at the household level of storage technologies; and (iii) reduce poverty, by addressing the effect of the initiative on household electricity expenditure. It is also aligned with the following operational focus areas: (i) Biodiversity, Natural Capital and Climate Action; (ii) Sustainable, Resilient and Inclusive Infrastructure; and (iii) Productive Development and Innovation through the Private Sector. In addition, this TC is aligned with the Ordinary Capital Strategic Development Program (OC SDP) Window 2 - Infrastructure (W2B) GN-2819-14 by strengthening the technical capacity of the public sector and promoting knowledge.

2.10 The project is also aligned with two sector frameworks. First, the Energy Sector Framework Document (GN-2830-8) and in particular with lines of action such as: promote universal, reliable, and affordable access to energy services; promotion of efficient and sustainable power generation; analysis of technical and economic viability of substituting conventional generation with renewable sources; promotion of the “prosumers” models; analysis of the impacts of electric transportation on the grids; and assist countries in establishing regulations that give clarity to potential investors. Second, the Climate Change Sector Framework Document (GN-2835-13) and second line of action: decarbonize rapidly, with points such as: implement already available decarbonization solutions; and ensure a just transition to net-zero emissions. Finally, it is aligned with the IDB Group Strategy with Uruguay 2021-2025 (GN-3056) in the following area: sustainable productive development, with the specific objectives of bolstering innovation, continue supporting energy decarbonization, and higher energy efficiency.

III. Description of components and budget

3.1 **Component 1. Primary data collection (US$50,000).** This component aims to harmonize data provided by UTE, in addition to collect complementary data to enrich the analysis. There is information available for all clients in the country (around 1,600,000), with monthly consumption information for six years and hourly consumption for all homes in which smart meters were installed. To have an idea of the amount of information, notice that for a household with a smart meter, 8760 consumption data are observed per year (24 hours x 365 days). In addition to the data provided by UTE, it will be necessary to systematize and incorporate into the database information related to the electricity sector in Uruguay, such as information on the wholesale market or regulatory changes, as well as the timing and scope of the policies under analysis. Finally, all these data will be potentially matched with household characteristics from census or household surveys, from which we will create a new dataset.

3.2 **Component 2. Applied Research in Electricity Market Design, particularly in Tariff/Pricing (US$70,000).** This component will support the development of new and innovative applied knowledge products (i.e. working papers). Research is expected to cover, among others, the following topics: (i) Has implementing higher electricity rates in hours where the provision cost of electricity is higher impacted consumption during those hours? If so, what is its value in monetary terms, including the value for lower emissions? If there is no significant shift in consumption towards hours with lower rates, what explains the lack of effects? (ii) Which strategies have been implemented to encourage the adoption of smart meters and dynamic rates programs, and how effective have they been in increasing participation in the programs? (iii) How has the smart meter and dynamic tariff policy affected the system load curve and total electricity consumption? What is the price elasticity of demand? (iv) Are there differences in the changes according to socioeconomic level, location, etc. (v) What have been the effects on the quality of the service delivered, specifically in the duration and frequency of service outages, with the installation of smart meters? (vi) Given the expected benefits of the policy (fewer emissions, less need to invest in infrastructure, better quality of provision), what would be the recovery period for an investment of this magnitude? (vii) Has there been a differentiated response to smart meter installations among different consumer groups (large customers, medium consumers, residential customers)? In residential consumption, do the responses vary by household income level? How have rate dynamics influenced these responses?

3.3 **Component 3. Knowledge Management and Dissemination (US$30,000).** This component supports project coordination, promotion, synergies, exchange, and dissemination of generated knowledge necessary for the project’s success. Relevant knowledge products generated by this TC will be integrated into the IDB research & policy discussion paper series. More specifically, a specific workshop will be organized to disseminate the knowledge products generated under components 1, and 2. The cost of publication is included in this component. Any knowledge products generated within the framework of this technical cooperation will be the property of the Bank and may be made available to the public under a creative commons license. However, upon request of the beneficiary, the intellectual property of said products may also be licensed and/or transferred to the beneficiary through specific agreements.

3.4 The total project cost amounts to US$150,000 and is financed entirely by the Ordinary Capital Strategic Development Program (OC SDP) Window 2 - Infrastructure (W2B). The disbursement and execution period of this TC will be 36 months and there will be no counterpart funding.

Table 1. Indicative Budget

Component	IDB/Fund Funding (US$)	Total Funding (US$)
Component 1. Primary data collection	50,000	50,000
Component 2. Applied Research in Electricity Market Design, particularly in Triff/Pricing Regulation	70,000	70,000
Component 3. Knowledge Management and Dissemination	30,000	30,000
Total	**150,000**	**150,000**

IV. Executing agency and execution structure

4.1 The Bank, through the Energy Division (INE/ENE), will be responsible for the execution and supervision of activities, in accordance with the guidelines and requirements established in the Technical Cooperation Policy (GN-2470-2) and the Procedures for the Processing of Technical Cooperation Operations (OP-619-4). The Bank is ideally positioned, given its vast presence in the region, its capacity to engage the most relevant stakeholders, and its knowledge across all infrastructure sectors, to undertake the data collection and studies necessary to complete the project, and to disseminate the results among relevant actors in the region. The Bank is expected to serve as a catalyzer of knowledge, innovation, and impact policy on multiple scales within the region, making the regional coordination of the IDB a necessary condition of this TC. ENE is best equipped to manage this operation and to assure the coordination needed. Active engagement with and awareness of the work of other organizations operating in the field will also help avoid any potential overlaps with on-going efforts. Prior to the initiation of specific in-country activities in the beneficiary countries, the Bank will obtain the letter of non-objection from the corresponding liaison office.

4.2 All procurement to be executed under this Technical Cooperation have been included in the Procurement Plan (Annex IV) and will be hired in compliance with the applicable Bank policies and regulations as follows: (a) Hiring of individual consultants, as established in the regulation on Complementary Workforce (AM-650) and (b) in case Contracting of services provided by consulting firms in accordance with the Corporate procurement Policy (GN-2303-33) and its Guidelines.

V. Major issues

5.1 The risk assessment carried out has identified one implementation risks and defined mitigation risks for it: scarcity and quality of reliable data and information. In this regard, the team will leverage IDB's relationship with UTE and stakeholders in Uruguay to facilitate access to information.

VI. Exceptions to Bank policy

6.1 This TC is not expected to request exceptions to any Bank policy.

VII. Environmental and Social Aspects

7.1 This TC will not finance feasibility or pre-feasibility studies of investment projects associated with environmental and social studies; therefore, it falls outside the scope of the Bank's Environmental and Social Policy Framework (ESPF).

Required Annexes:

Results Matrix_75791.pdf

Terms of Reference_51221.pdf

Procurement Plan_92524.pdf