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UMM AL-QURA UNIVERSITY

# BOOK OF PROCEEDINGS

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**14 - 17 MARCH 2022**

**UMM AL- QURA UNIVERSITY**
**MAKKAH - SAUDI ARABIA**

# 13th INTERNATIONAL EXERGY, ENERGY AND ENVIRONMENT SYMPOSIUM (IEEES-13)

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# PROCEEDINGS BOOK

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# ABOUT UMM AL-QURA UNIVERSITY

Umm Al-Qura University (UQU) is one of the global leading educational institutions that was found in the vicinity of the Holy Mosque in the Holy city of Makkah. It was founded by an order for King Abdulaziz as the College of Shari`ah in Makkah in 1949. This College was back then the first higher education institution in the Kingdom of Saudi Arabia. Thus, it was the nucleus for Umm Al-Qura University that was officially named a university in 1981 after the progressive expansion of the number of colleges, departments, and programs. Nevertheless, the university managed to maintain its status as one of the most distinguished universities due to its location and noble origin. Moreover, it has acquired a superior status as an academic institution that has a great reputation with regard to Shari`ah sciences, education, and Islamic studies, as well as modern scientific and applied specializations. Currently, UQU includes 5 campuses with about 5000 faculties, and 95,000 registered students.

The College of Engineering and Islamic Architecture was established on 1982 and currently includes four departments providing ABET accredited programs towards Bachelor's degrees. In addition, several Master programs are offered. According to the 2020 statistics, the College has over 22,000 enrolled students out of the University's 95,000 students.

# Chair's Welcoming Message

It is my pleasure to welcome you to the 13th edition of the International Energy, Exergy, and Environment Symposium (IEEES-13).

The journey of IEEES began over 17 years ago. It traveled the world, passing through many cities and countries. This edition is organized and virtually hosted in the College of Engineering and Islamic Architecture, at Umm Al-Qura University, in Makkah. The IEEES has built an outstanding and renewed reputation in the fields of energy, exergy, and environment, making it an annual forum for many researchers, scientists, professionals, and students as they join this event to exchange ideas, experiences, and enjoy the mutual learning process. It is a unique opportunity to envision solutions utilizing cutting-edge advances in science and technology.

The IEEES-13 brings outstanding keynote speakers coming from different backgrounds to address the evolving issues of energy, environment, and sustainable future. Furthermore, fellow researchers and scientists from over 30 countries will contribute to this symposium. This event, with participants from all over the world, represents the global commitment to resolving energy and environmental challenges such as global warming and climate change. It will also highlight scientific advances in many subjects, including Renewable Energy Technologies, Oil and Gas Technologies, Hydrogen production and Utilization, Smart Grid, and Green transportation.

Tackling these issues falls in close alignment with The Kingdom of Saudi Arabia Vision of 2030. The kingdom witnessed remarkable initiatives that have been taken to increase renewable energy contribution to the local power mix. Similar initiatives have been taken to utilize green hydrogen and reduce carbon emissions. All these efforts aim for sustainable energy and environment all across the globe, and IEEES-13, by all means, will be an excellent venue to serve this great objective.

The IEEES-13 organizing committee received more than 200 submissions, of which about 100 have already been accepted for presentation in this symposium. Some of these papers will be selected for publication in one of the prestigious journals: 1) International Journal of Energy Research, 2) International Jour-

nal of Hydrogen Energy, 3) Energy storage, 4) International Journal of Exergy, and 5) International Journal of Global Warming.

It is regrettable that this edition of the IEEES is being organized during these challenging times as the world is still recovering from the COVID-19 pandemic. Otherwise, we would love to welcome you in person at Umm Al-Qura University and in the holy city of Makkah. Nevertheless, the organizing committee of the IEEES-13 has determined to make your experience of this event exceptional and rewarding.

Last but not least, I would like to express my warmest thanks to His Excellency Minister of Education Dr. Hamad Al Ashikh, for his kind patronage of this conference. Special thanks are due to those who have contributed to the organization of the IEEES-13, including the various teams and committees who have been working hard to make this event a success.

I hope everyone will find IEEES-13 enjoyable, informative, and fruitful.

**Abdullah A. AlZahrani**
On Behalf of the Organizing Committee
Symposium Chair

# The challenge in damage claim in Brazilian energy sector – customers and service providers responsibilities

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**Abstract**

**The scenario:** Brazilian electric policies and regulations define customers' reimbursement by possible damages caused by the energy distribution services. Some kind of events could cause possible damages to users´ appliances connected to the grid, as unsafe and unprotected private energy network and/or energy grid disruption, non-compliance energy services, operational intervention, environmental or climate occurrences into a provider or home grids. Moreover, there are no standardized or audited regulated procedures in the country to guarantee better energy home installations and regular inspections to avoid obsolescence and detect co-responsibilities.

Considering the historical customer claims requiring reimbursement (judicialized or not), damage claims quantification and qualification indicators were defined, and money and controls dispended were analyzed as a big data processing. An analytical and AI tool was developed to support operational strategies to avoid or decrease the number of claims and customers' appliance damage.

**The solution:** analytical process dealt with around 11 million energy installations at an energy distribution company over 5 years of grid and relationship information (2 Terabytes of data). It provided support to appliances energy fragilities analysis and metrology evaluation by lab-specific studies, as well as grid simulations to understand the quality of energy service offered, possible interferences of distributed energy generation, and digitalization currently aggregated to the grid. This approach also concerned with grid events analysis; maintenance and investments strategies; improving business; human resources, and leadership competencies to deal with customers' claims; and workflow scope review, from attendance effectiveness from the multi-channel relationship to regulated/nonregulated process operationalization. The tool deals with the possible events' causes; climate correlations; and operational and organizational interferences from the regional and local grid.

Procedure's review and better practices in a dynamic way with the world market reinforce the necessary Brazilian regulatory updating to accommodate the grid digitalization, robustness, and service quality, rethinking and evolving services providing.

**Keywords: Energy policies, Damage claims, energy grid, customer relationship, customer co-responsibility**

## I. Introduction

**The scenario:** it is time of structuring technological changes, digitalization of the grids (that can became smarter), services and new appliances connected to the grids. The context also considers the legal and regulatory conditions, the current practices and standards in the damages claims payments and the possibilities of new approaches based on private grid infrastructure protection (co-responsibilities). Also, the regulated relationship customer-energy distribution utility, the offered services, and the energy contractual conditions were re-evaluated to a fairness litigation rights. The initial focuses of this work were understanding the strategic assessments of the operational and management process of customer damage claims, establishing new models and propositions to highlight operational conditions in the treatment done as well as forecasting reimbursement requests. It also sought to contribute to customers' communication and relationship, increasing attendance resources, team performance and efficiency in its activities, based on competencies improvement and better available systems information.

The evaluation of requests for reimbursements (judicial or not) considered customers' service journey (footprint as relationship and consumption). This journey indicates a sort of refinement/expansion for validation/rejection criteria of damage evaluation. New variables were incorporated to the current analysis and business rules to support regulated damage claim policies (ANEEL, 2010). These also reinforce the strategic commitment in the utility multi-areas/departmental responsibilities in the treatment of the conditions that could generate customer appliances damage throughout the revaluation of control systems, operational maintenance and energy quality. Emphasis should be placed on the (re) organization and association of indicators and targets to improve the utility company results (from the point of view of time/costs of service until the fair characterization of payments to be made), in an effective, agile and predictive manner.

Within the ethical responsiveness to the customer service conditions offered in the legal space, the work sought to compile defenses that support the conformity /non-conformity of events in the energy grid, presenting the possible causes linked with the electrical damage and historical customer´ requests. The energy distribution utility analyzed has 90% of the cases without any administrative requests prior to the judicial proceedings, that is, the costumers did not interact with the distribution utility before for possible reimbursement under the regulatory rite. Still, from a legal point of view, the work seeks to raise awareness in the Judiciary, which currently has an extremely expressive number of regressive actions filed by Insurance Companies, many of them without causal links with the distribution energy grid alleged but caused by the private home/business grid.

Another important point to be highlighted was the adherence to the development made within the utility's strategy preparing the new scenario of digitalization, committing its modernization with better/newer services to the customer (as well as appropriated systems coherent infrastructure) and with the quality of the energy associated.

Four problem situations challenged the quest for solutions in an innovative way, with economic-sustainable results for the energy company and that allowed to expand or readjust the relationship with the consumer:

- Reviewing the decision process, with a more systemic, adequate and predictive procedures, regarding the refunds and rejections of customers' requests for their appliances damage. A new system proposal was done with Data Science, Big Data and unstructured information analysis procedures. This proposal resulted in applying artificial intelligence over the relationship's fields of observation, customers' requests, grid disruption events, appliances electrical characteristics and information from management system of judicialized proceedings.
- Updating the technical analysis of possible damages suffered by current electronic appliances by the energy grids. Laboratories' tests were carried out to establish interferences limits or possible events / causes link with damages in residential environments and energy distribution grids. The work sought to characterize conditions that could generate damage to appliances (including the grid assessment, the climatic conditions, and lightning).
- Characterizing new possible regulatory and legal elements/conditions to represent the legal situations regarding consumption and the regulated business policies: according to the main grid conditions, current grid and damage knowledge and the demands for reimbursements with new characteristics carried out by insurance companies. There has been an increase in judicialization, with higher costs, due to the newer judicial defenses and allegations proceedings.
- Evaluating new interferences in the energy grids that could result in appliance connected damage caused by the new entries of distributed energy generation (as Eolic and Photovoltaic residential prosumers) and storage systems, sensing, smart grid equipment, and information availability. The work dealt with the evaluation of new possibilities in the systems regarding the analysis of energy quality and the expansion of events information by the grids and by its elements.

These strategic challenges characterization resulted in methodology, operational processes and software development for the damage claims evaluation as a result of grids' electrical events and financial end-user appliances compensation. These were done automating analyses improved with artificial intelligence procedures and data science approach, where applicable.

Processed data were organized from 5 years (60 months of data) of around 11.5 million customers' skill data records, 60 months consumption data for each customer, around 698 cities (around 25 million population), 480 million disrupting energy grid event records over 4,600 feeder lines information, 8.5 million attendance record/month within 32 communication media channels, 480,000 damage claims records, 40,000 judicial processes (from 1 to 40 customers associated in each one).

## II. Experimental Procedure/Methodology/System Description

Some major goals were treated into this work:

- Recognition of the analysis update of electronic appliances damages' origin and causality, observing newer appliances with less than 4 years of technology lifetime (2018 as the referenced year). These were done by:
  - Evaluation of current analysis criteria/procedures for origin and causality of electronic appliances damages. The real possibilities of appliances damages resulted from energy grids events occurred were analyzed and estimated, considering the supportability of traditional appliances and those ones with the most recent technologies, introduced and largely used by the customers in the last 3/4 years. The analyzes were based on studies over the distribution grid infrastructure conditions that could produce abnormal requests through computer simulations and based on supportability tests carried out in the laboratory.
  - The study, recognition, and application of equipment and systems that can minimize the interference occurrence by disturbances in low voltage distribution grids, allowing the evolution of norms and standards for the new technologies connections from electronic appliances over distribution grids. Among these studies, it is possible to mention the study of conditions to minimize the occurrences of disturbances that can cause appliances' damage in feeders and in consumers' installations.
- Recognition of new practices and sensoring, systems, and information databases to characterize the origin of electrical damage and that can support legal and regulatory contexts, looking for a better format of

customer service and conditions for the distribution utility business regulation (and the energy quality).

- Generation of methodology to avoid socio-economic losses and subsidize legal-administrative decisions in the most appropriate way with the client/consumer. The methodology (Shearer, 2000) made up use high-performance analytical algorithms to assess the origin of damage claims and their reimbursements, mainly recognizing unstructured information databases (descriptive fields, with observations made by customers to attendants or in their requests) and information from numerous systems and services orders representing the distribution grids' operational records.
- An assessment was made of the implications of applying the current damage claims analysis procedures correlated with the real possibilities of appliances' damage, their electrical supportability and the probability (possibility) of the occurrence of conditions in the feeder system that could cause damage.
- Characterization of reimbursement services' times, reinforcing the facilities offered to the client, available communication channels, the costs of each part of the human process and the existing systems. The main challenges in the operation were also listed, such as strategic analysis and proposals to investments in grids, in processes and in newer resources.
- An automated model was built to provide technical support to judicial defenses, making analysis and improving information over current results obtained.

## III. Analysis

In the context of aligning the current operational situation with the newer conditions, grid requirements, attendance services strategies and grid infrastructure evolution, systems, human resources skills, and energy services offered to the consumer, analyzes were performed as:

- Recommendations for improving systems and operational practices to speed up the process of analyzing and recovering damages, as well as characterizing costs and times for each phase of the damage claim' evaluation process.
- Investment recommendations in grids and maintenance conditions to avoid/reduce events in historically recognized situations, based on the operational and strategic characterization of claims recurrences, expenses, and detected weaknesses.
- Recommendations for technical improvements/normalization and standards to reduce electrical damage and protection to minimize socioeconomic impacts, both for the grid and the customers' relationship communication.
- Recognition and proposals to directions for greater efficiency and simplicity in customers' communicating, seeking to bring them some rules to co-responsibility at their private grid security and maintenance, as well as in the better appliance's connection to use the energy service.
- Characterization of disruption grid events, the responsibility of the utility grid and conditions to minimize their influence on the consumers' appliances connected, recognizing the weaknesses existing by newer electronic appliances and their telecommunications connections damage influence. Characterization of newer energy standards to minimize impacts of utility outbreaks at the customers' facilities.
- Support for information on conditionings and causal links, as well as a formal technical outfit for legal proceedings and customers' conflict relations. Treatment intelligence was developed, using artificial intelligence and machine learning techniques, to characterize the analysis conditions, allowing automated processes design for requested damage claims conditions evaluation.
- Recommendations for improvements at regulation and procedures grids' connections/changes already existing to minimize damage situations.
- Evaluation of new issues, such as voltage increase, resulting from newer grid technologies and connections as distributed generation.
- Analytical and structured characterization from the utility diverse systems databases, allowing the translation of terabytes of information into strategic indicator systems (based on (Parmenter, 2007) and (Alexancer,2006)), that represent customers' services, grid events, service requests from different media channels and judicial conditions.
- Recommendations for improvements in the structuring of systems data and standardization of information in order to allow more and more accurate strategic analyzes of the conditions and efforts of attendance, as well as claims, clarifying their costs and times, dispended to solve requests.
- Construction of relationship models via robots with artificial intelligence to answer frequently asked questions and maximize the efficiency of teams of specialists.
- Identification of the main competencies and skills necessary to various human resources involved in claims analysis to provide an effective, productive and healthy operational environment (Luthans, 2004).

## IV. Results and Discussions

The energy business parts, administrative-operational and legal ones, were exercised looking for opportunities and main strategies, focused on the customer's footprint and the offered energy service quality. Brazilian energy utility regulators received proposals at evolutionary points that could improve services provisioning optimization and updating requirements that the grid and customers' private networks must be attended.

As part of the strategy of reimbursement operation characterization, an analytical system was designed, developed and provisioned, named **DCAF** (Damage Claims Analytics Framework). DCAF system reflects the dynamic conditions of indicators presented in the methodological part of business representation. DCAF adds

possibilities of analysis prediction and strategies with different granularities from geographical and physical filters (reflecting the distribution grid) to regional historical studies analytics and to specific case studies. DCAF promotes the understanding of the reimbursement claims operationalization dynamics, the digitalization, and the investments occurring into the grid. It also brings the vision of the client's journey in their requests and energy consumption, relating reimbursements made, regional and local claims at the same time with a regional evaluation, characterizing volumes, money spent with grids disruptions, and offering automating analyzes for subsidizing the legal needs in judicialized processes, among other analytics possibilities.

Financial issues, which reflect the costs of service and reimbursements, media channels used to communicate, calls and recalls, were also presented in each situation. The customers' segmentation by consumption classes (as residential, commercial, rural, industrial), consumption range, and defaulters were possibilities available in the system, allowing special studies of business impacted by each segment at regional infrastructure.

Some facilities as a Chabot were implemented to support FAQ, simplifying attendance (IBM, 2019).

Some strategic evaluations were proposed considering many points of possible relationship reorganization, agility, efficacy, efficiency, costs, current and evolutionary grid infrastructure, climate and lightning influences (using The Weather, 2019), judicialized processes and clients' allegations.

The exploratory laboratory evaluation presented some co-responsibilities at newer appliances connected to the grid, based on private grid protection needs and smart sensors that could be aggregate to feeders' grids. Simulations were also made on the energy grid conditions under the distributed generation environment (Photovoltaic and Eolic) and the possible interference influences over the functionalities and grid quality of service at energy delivery to other non-prosumers customers.

## V. Conclusions

Many contributions were made for operation, according to the existing business strategy and their evolution, evaluating the conditions of legal and commercial attendance, competencies mapping for employees' development such as negotiation skills, and characterization of aggregated services and information to the systems, fraud assessments, customer communication reorganization, automation of processes with AI (Artificial Intelligence) and machine learning, chatbot, advanced analytical structures, predictions and range of indicators, among others.

It is perceived that the analysis reflected the strategic evaluation of Brazilian energy distribution utilities and prepare digitalization of the entire operating environments with newer smart equipment in the grid. They record the possibilities and challenges in the new model of digital services required by ANEEL (Brazilian Energy Regulatory Agency) and prepare the conditions to operate, in a strategic way, the grids with distributed generation, with increasingly sensitive customer appliances connected to the grid, indicating security and protection conditions that should be expanded (or standardized).

It is further proposed, based on the findings made, that the regulation must be improved in order to guarantee the new demand conditions for energy services, dimension the co-responsibility in the installations, safety and use of this energy, respecting and recognizing the weaknesses of appliances connected and grid infrastructure conditions. The grid fault and customers grid usage's influence resulted in processes that can be useful for the grid digital transition. These define strategies that do not depend on the country and can improve energy business.

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