Interacción de los Vehículos Eléctricos (VEs) con las redes eléctricas

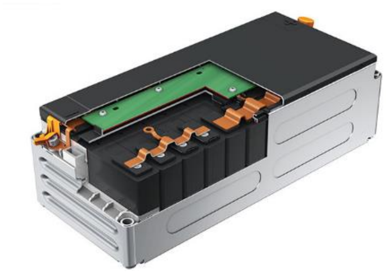
INTRODUCCIÓN

El desarrollo en la propulsión eléctrica de los vehículos ha servido como respuesta a la creciente contaminación generada por los vehículos impulsados por motores de combustión interna ICEs.

Obstáculos en el desarrollo de VEs:

- Uso del petróleo

- Baja autonomía de las baterías en VEs



A pesar de lo anterior, durante la crisis del petróleo en 1973, la atención volvió hacia la adquisición de VEs y a la mejora de las tecnologías de almacenamiento de energía.

Fuentes:
- http://www.pbs.org/now/shows/223/electric-car-timeline.html
- http://www.autonews.com/article/20131014/global/131019959/10-waysthe-1973-oil-embargo-changed-the-industry

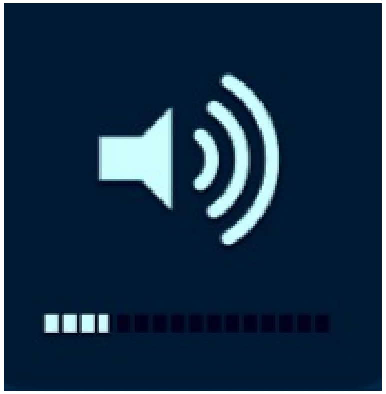
INTRODUCCIÓN

Ventajas del uso de VEs:

Cero dependencia de combustibles fósiles

Reducción de GEI

Poca generación de ruido



INTRODUCCIÓN

Autonomía
de las baterías

Condiciones
climáticas

Tráfico

Topología

ANSIEDAD DE
RANGO

INTRODUCCIÓN

Año 2050 según *Energy Technology Perspectives*

Reducción de dióxido de carbono: 50% comparado con 2005

Ventas de VEs: 50 millones de unidades al año

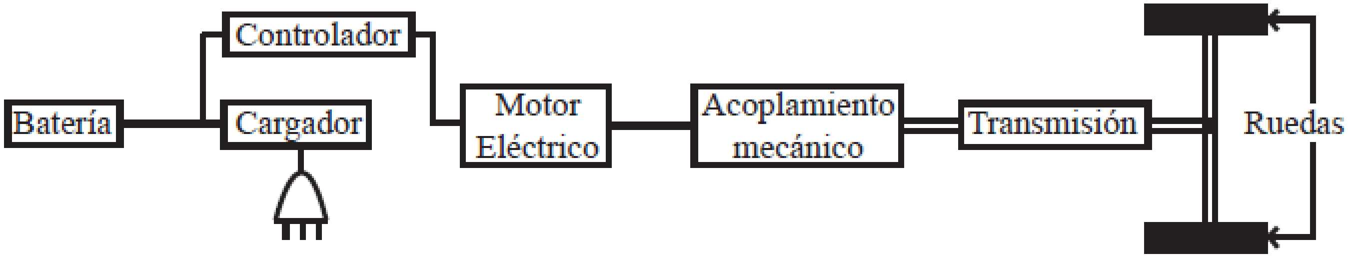
	2010	2015	2020	2025	2030	2035	2040	2045	2050
PHEV	0.0	0.7	4.9	13.1	24.6	35.6	47.7	56.3	59.7
EV	0.0	0.3	2.0	4.5	8.7	13.9	23.2	33.9	46.6
Total	**0.0**	**1.1**	**6.9**	**17.7**	**33.3**	**49.5**	**70.9**	**90.2**	**106.4**

Source: IEA 2010.

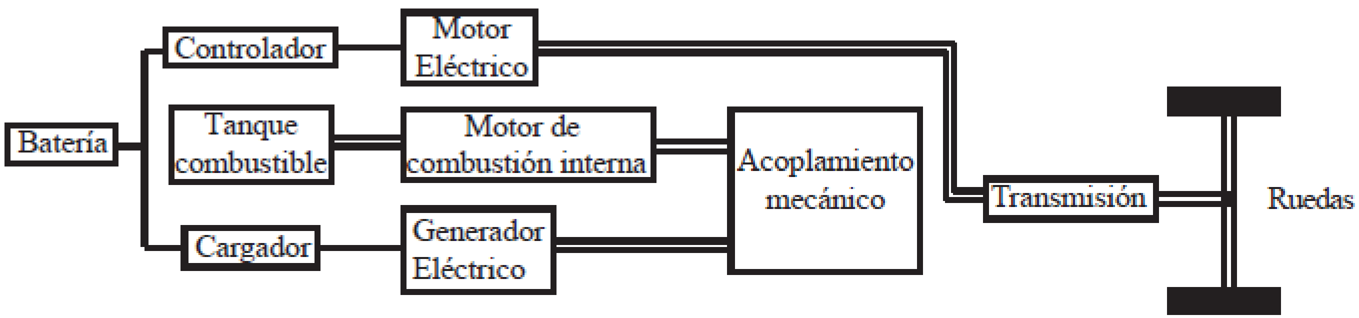
Notorio despliegue del VE, pero con dificultades en la autonomía

TIPOS DE VEs

- NEVs (Non plug-in Electric Vehicles)
- PEVs (Plug-in Electric Vehicles)

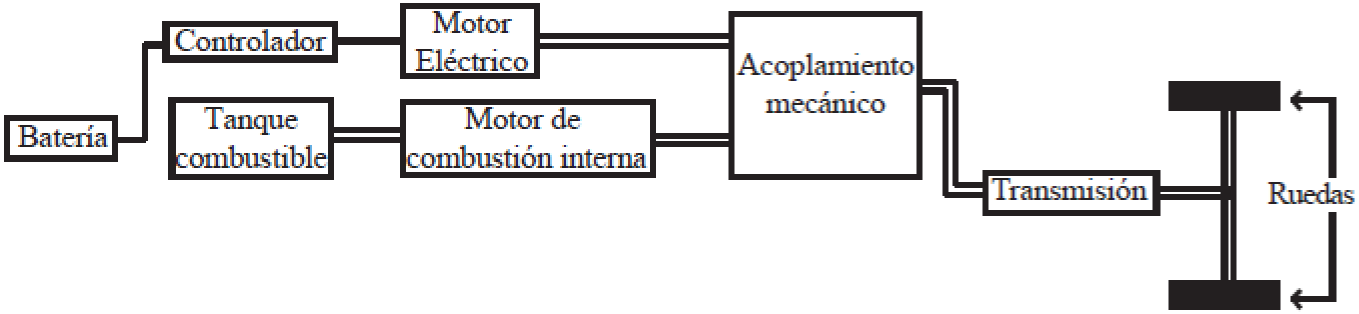


- HEVs (Hybrid Electric Vehicles) configuración serie



TIPOS DE VEs

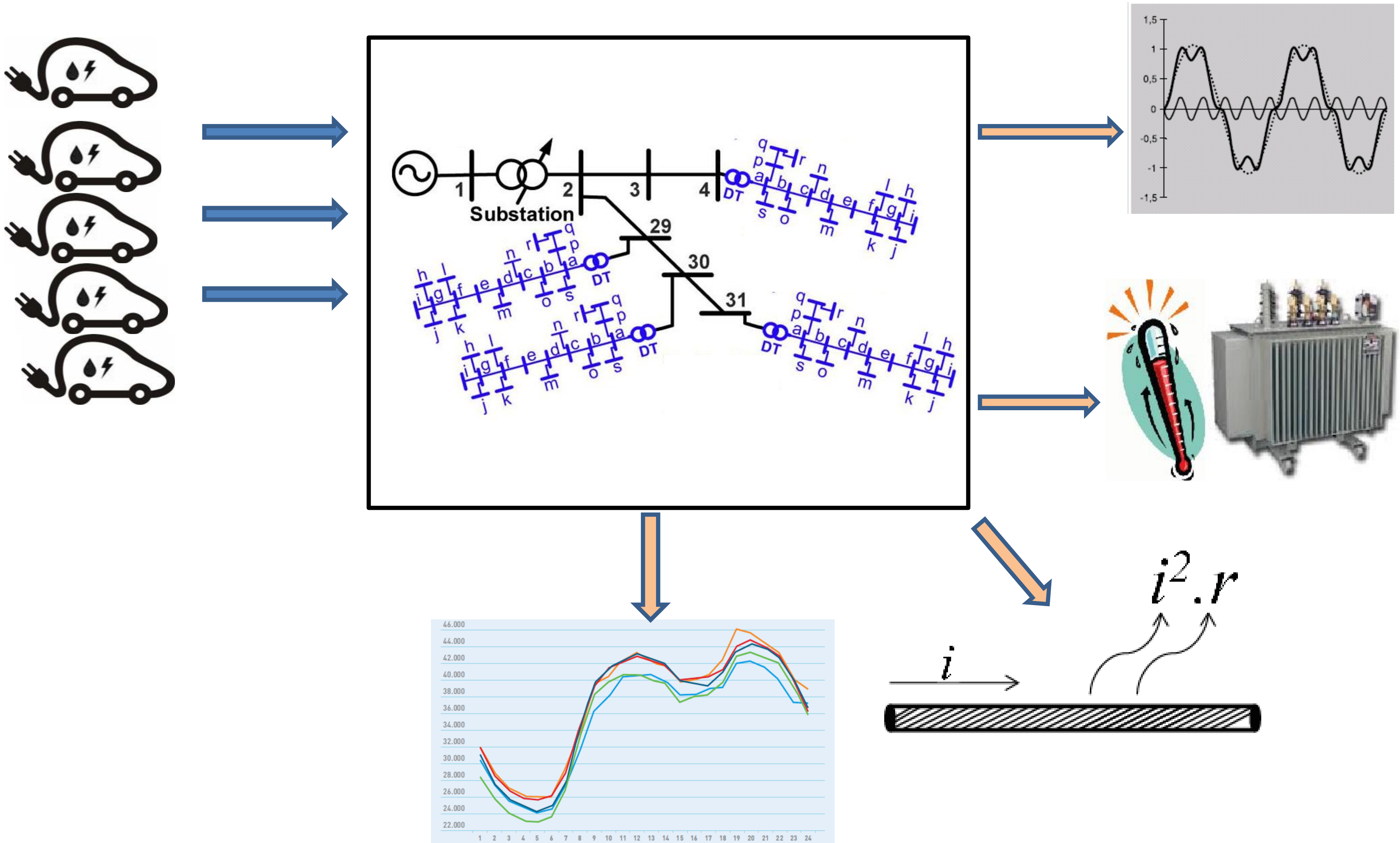
- HEVs (Hybrid Electric Vehicles) configuración paralelo



- PHEVs (Plug-in Hybrid Electric Vehicles)

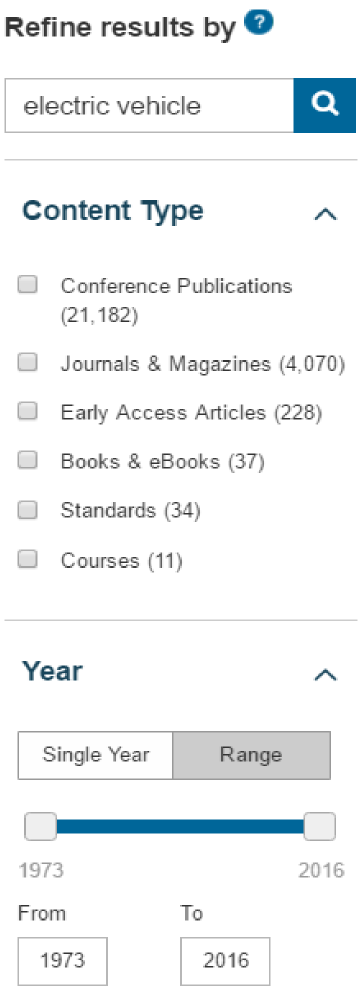
PROBLEMAS EN LA RED

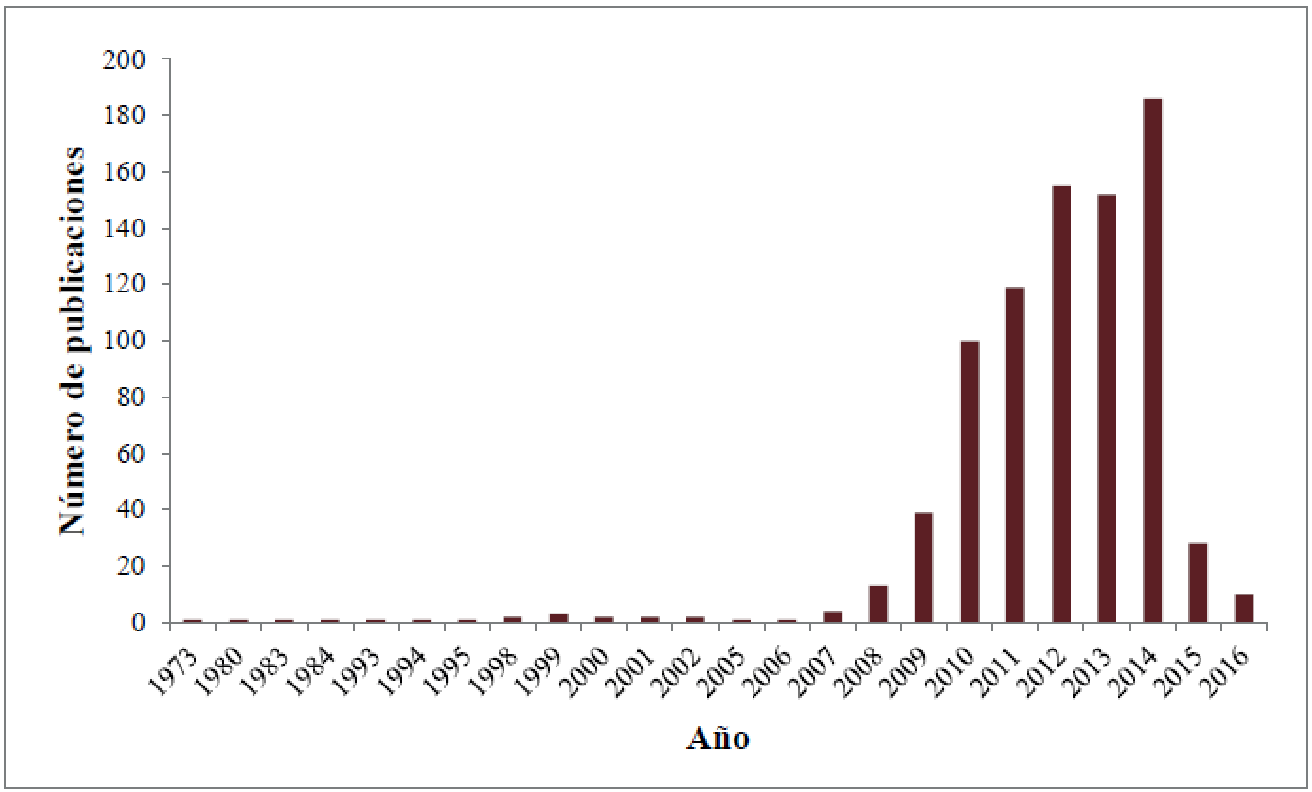
La carga y descarga de gran cantidad de VEs puede generar efectos adversos en el sistema de distribución de energía eléctrica.



TENDENCIAS DE ESTUDIO

En los próximos años estos problemas podrían representar una realidad, más aún con proyecciones que estiman un aumento de 50 millones de VEs por año al llegar el 2050. Por esta razón en las últimas décadas, se ha realizado un amplio trabajo alrededor de los efectos de los VEs en la red eléctrica.



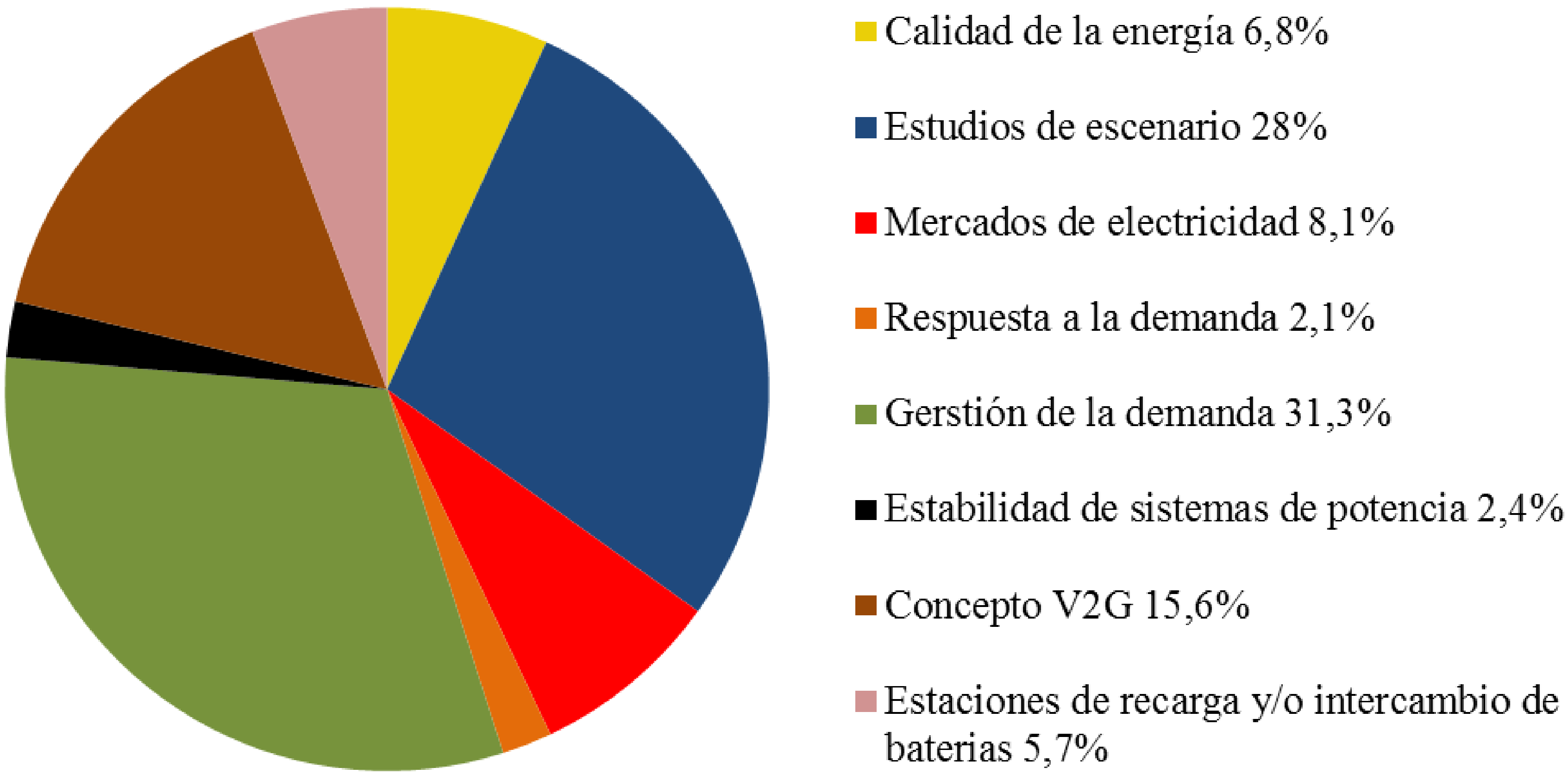


Fuentes: - http://ieeexplore.ieee.org/

- Garcia-Valle, Rodrigo, and João A. Peças Lopes. *Electric vehicle integration into modern power networks*. Vol. 2. Springer Science & Business Media, 2012.

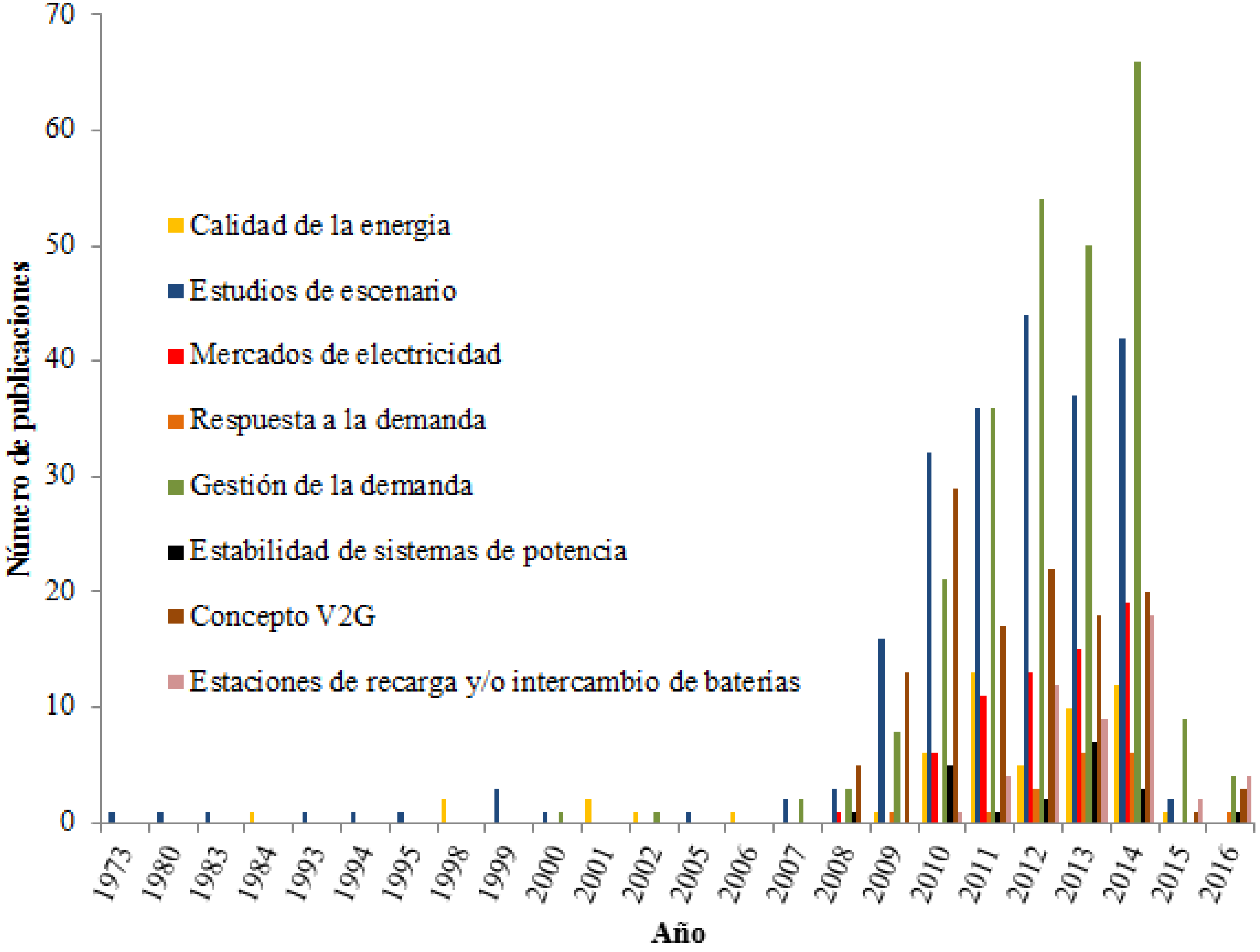
TENDENCIAS DE ESTUDIO

La interacción entre los EVs y los sistemas de distribución puede ser estudiada desde diferentes puntos de vista. El siguiente gráfico refleja una taxonomía de la temática.



TENDENCIAS DE ESTUDIO

A lo largo de los últimos cuarenta años, el abanico de posibilidades de estudio se ha incrementado, proporcionando herramientas robustas para manejar eficientemente el impacto de los EVs en las redes eléctricas.



TRABAJOS REALIZADOS

An IEEE Xplore database literature review regarding the interaction between electric vehicles and power grids

Andrés Arias L., Juan D. Sánchez A., Ricardo A. Hincapié, Mauricio Granada

***Abstract*—Lately, the development of the Electric Vehicle (EV) has become a strategy to soften the collateral damages of the environment pollution. However, the forecasts of a wide EVs deployment, establish a stress that has to be carefully analyzed in distribution systems. Whereby, the need arises of researching respect to the effects of EVs on electric grids since different perspectives. This paper presents a review of the last forty years around the interaction of EVs and distribution systems. Several works have been reported, considering diverse trends: the power quality, ancillary services and the participation of EVs in electricity markets, among others.**

***Index Terms*—Battery swap stations, demand management, Electric Vehicle (EV), power quality, recharge stations, Vehicle to Grid (V2G)**

I. Introduction

During the last decades, the reduction of fossil fuel reserves and the strengthening of environment policies in function of counteracting the ambient pollution, have motivated in the

These problems could come true in the next years, according to projections of IEA (International Energy Agency) which estimates by 2050, EVs sales at any of its configurations (EVs and PHEVs) will increase up to 100 millions of units per year around the world [4]. Under these circumstances, during the last forty years a massive work has been done in specialized literature around the topic related with impacts of EVs in the distribution networks, generating a primary focus of attention for network operators to establish demand management strategic plans, to confront a vertiginous growth of number of EVs interacting with the electric network. Hence, in this work a compendium of the efforts focused on effects either positive or negative carried out by the introduction of EVs and PHEVs in the electric system is developed. The review is framed in the majority by works published at IEEE Xplore database from 1973 to 2015, providing a chronologic focus and trends around this thematic.

TRABAJOS REALIZADOS

An efficient approach to solve the combination between Battery Swap Station Location and CVRP by using the MTZ formulation

Andrés Arias L., Juan D. Sánchez A., Ricardo A. Hincapié, Mauricio Granada

***Abstract*—In the last decade the merchandise transportation has considered the insertion of Electric Vehicles (EVs) in their fleets, in order to reduce the negative environment impact generated by the internal combustion engines (ICE). Whereby, this paper addresses the solution of two combined problems: determining the Battery Swap Station Location (BSSL) and solving the Capacitated Vehicle Routing Problem (CVRP). The model presents a slight variation in its formulation reported in the specialized literature, which provides a better computational performance in the analyzed problems. The mathematical model implemented using commercial software and the results were validated supported by different instances.**

***Index Terms*—Battery Swap Station, combinatorial optimization, Electric Vehicle, Vehicle routing.**

NOMENCLATURE

$P_{before}(v,k)$ remaining range of drive of the battery after the vehicle k arrives to the node v

$r(v)$ auxiliary variable that counts the delivered load in the visited nodes from the depot until node v

$u(v,k)$ remaining load in the vehicle k when its leaves the node v

$x(v,w,k)$ Binary variable of decision that takes the value of 1 if the vehicle k ride through the arc $v-w$

$y(w)$ Binary variable of decision that takes the value of 1 if the node w require a Battery Swap Station

I. Introduction

Nowadays, the growing concern due to the deterioration caused by the release of toxic gases to the environment, has obligated the creation and development of new and strict

TRABAJOS REALIZADOS

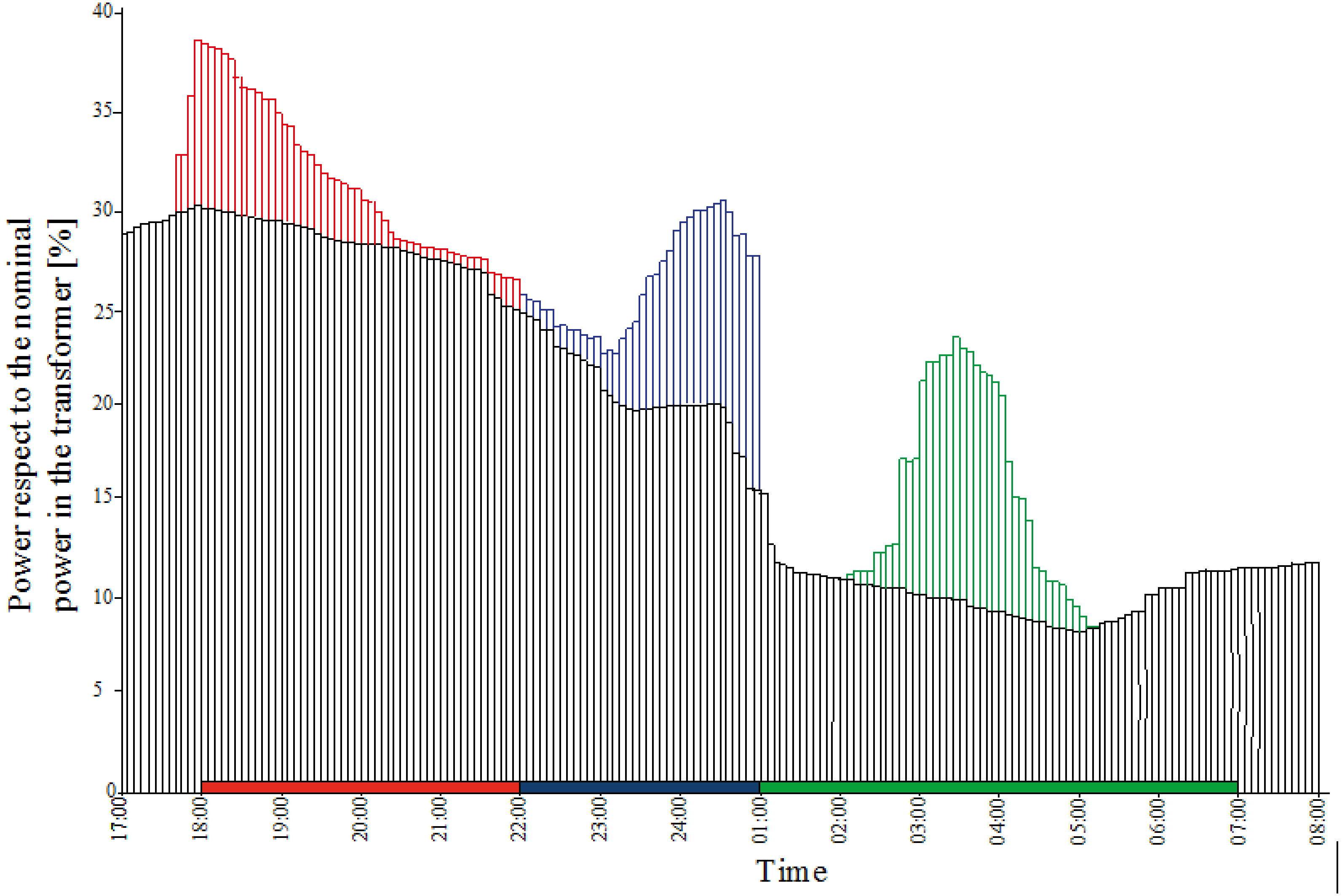
Optimal probabilistic charging of electric vehicles in distribution systems

Andrés Arias [1], Mauricio Granada [1], Carlos A. Castro [2]

[1] Program of Electrical Engineering, Technological University of Pereira, Pereira, Colombia
[2] School of Electrical and Computer Engineering, University of Campinas, Campinas, Brazil
E-mail: andresarias@utp.edu.co

Abstract: In this paper, a probabilistic approach for the optimal charging of Electric Vehicles (EVs) in distribution systems is proposed. The costs of both demand and energy losses in the system are minimized, subjected to a set of constraints that consider EVs smart charging characteristics as well as operative aspects of the electric network. The stochastic driving patterns of EVs' owners, battery capacity and active and reactive power demand at load nodes are considered. The optimal charging of EVs connected to the system benefits the system's operation, as it does a strategy to minimize the cost of energy losses and to evaluate the capability of the system to charge EVs' batteries fully under certain penetration scenarios. Additionally, its results may be useful for other types of studies, e.g. risk analysis for decision-making, improvement of performance and operation of distribution networks, among others. Monte Carlo Simulation (MCS) is used to assess the stochastic nature of the problem in a secondary (low voltage) distribution network.

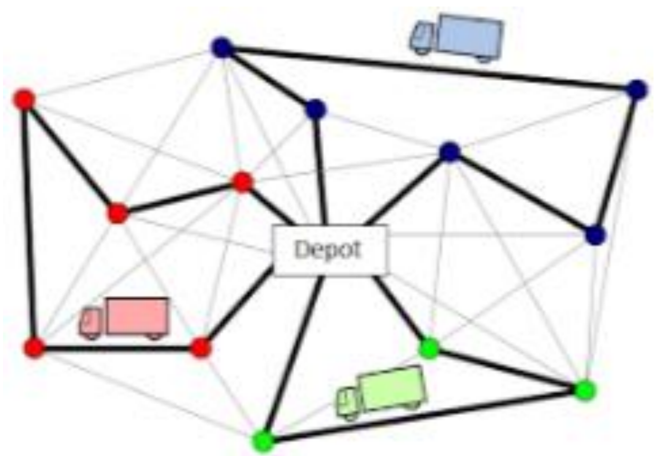
TRABAJOS REALIZADOS



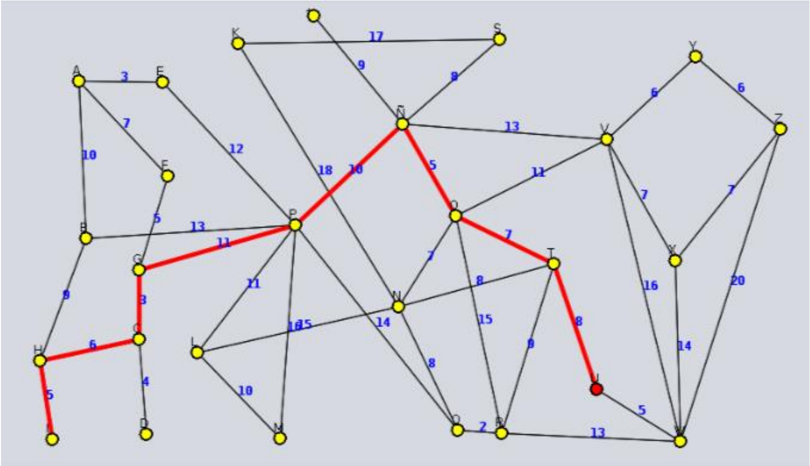
TRABAJOS EN EJECUCIÓN

Planeamiento de estaciones de recarga en sistemas de distribución y en la red de transporte

CVRP: Capacitated Vehicle Routing Problem



SP: Shortest Path



TRABAJOS EN EJECUCIÓN

Flujo de carga linealizado

A Linear Three-Phase Load Flow for Power Distribution Systems

Alejandro Garces, *Member, IEEE*

***Abstract*—This letter proposes a linear load flow for three-phase power distribution systems. Balanced and unbalanced operation are considered as well as the ZIP models of the loads. The methodology does not require any assumption related to the R/X ratio. Despite its simplicity, it is very accurate compared to the conventional back-forward sweep algorithm.**

***Index Terms*—DC power flow, load flow analysis, power distribution, unbalanced distribution systems.**

I. Introduction

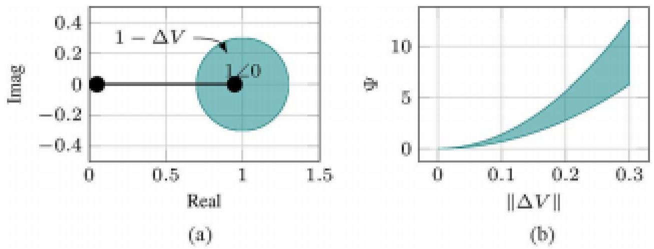


Fig. 1. Schematic representation of the proposed linearization. (a) Values of V in the complex plane. (b) Total error in percentage.

$$\begin{pmatrix} -A_r \\ -A_i \end{pmatrix} = \begin{pmatrix} B_r + C_r & B_i - C_i \\ B_i + C_i & -B_r + C_r \end{pmatrix} \cdot \begin{pmatrix} V_r \\ V_i \end{pmatrix}$$

TRABAJOS EN EJECUCIÓN

CVRP

SP

Flujo de carga linealizado

Planeamiento integrado de estaciones de recarga

GRACIAS