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White Paper

Frameworks for the Future of Electricity

Leading the Transformation through Multistakeholder Cooperation

In collaboration with Bain & Company

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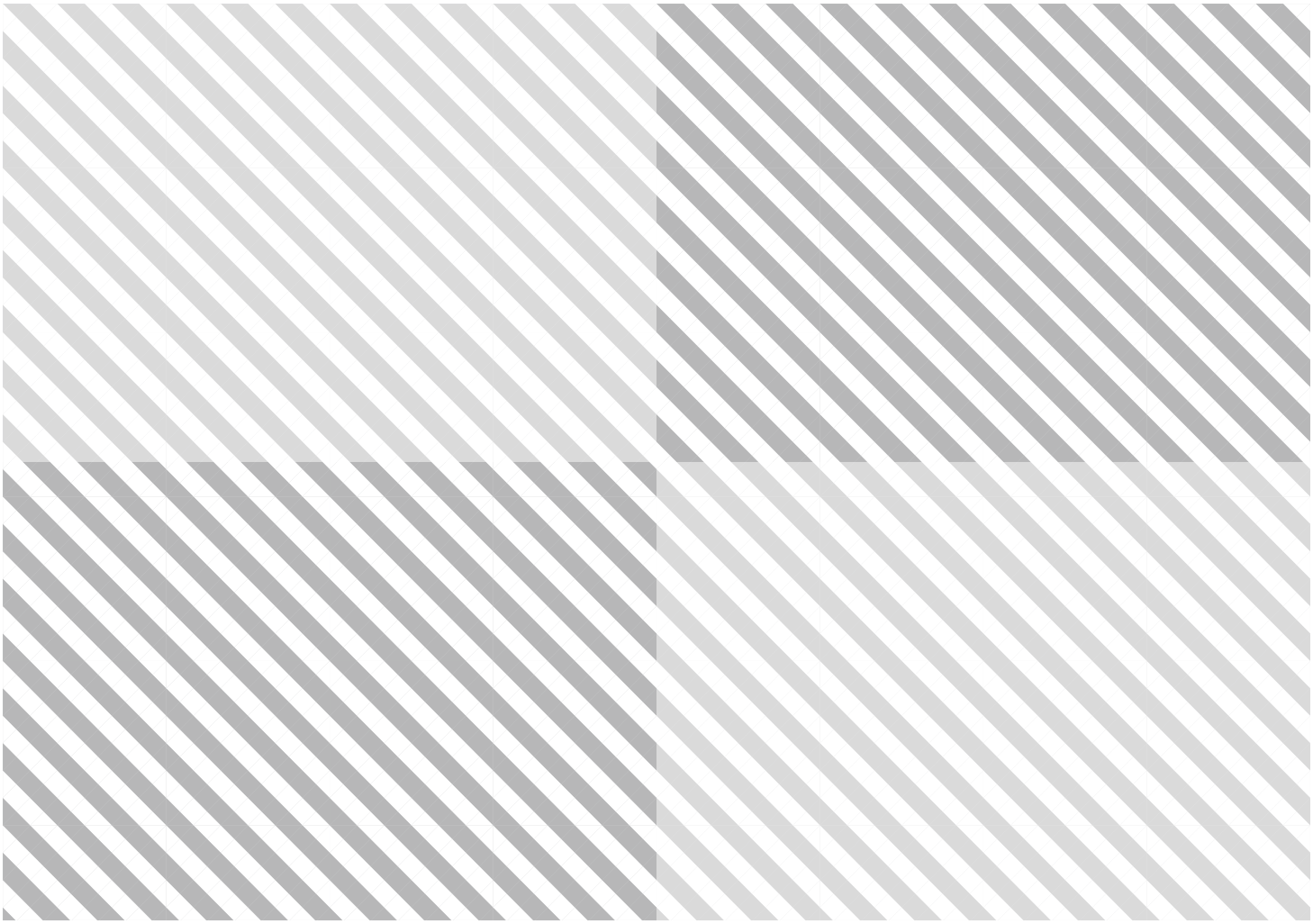

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Introduction

In 2016, the World Economic Forum examined three major trends transforming the energy system: decentralization, digitalization and electrification. Building on this work, in 2017 a general framework of guidelines was published, to design policy, business models and infrastructure development in the context of this transformation.

Subsequently, the Minister of Mines and Energy of Colombia, Germán Arce Zapata, launched an initiative to implement this framework in Colombia. Through public-private sector working groups, and in cooperation with the Forum, Colombia identified priorities for the modernization of its electricity system. As of 2018, progress has been made in establishing the mechanisms to implement smart metering systems, as well as demand response programmes and integration of decentralized energy resources.

In the next phase of the global initiative, the World Economic Forum plans to replicate the Colombia model in new markets around the world and scale this country-specific, multistakeholder approach to shaping policy, infrastructure and business models. Additionally, the initiative will integrate the new complementary framework, published by the World Economic Forum in 2018, providing recommendations to develop electrification of transport in cities, where energy, mobility and urban transformations converge.

This white paper presents the Colombia case study and a general model that can be replicated in other countries.

The future of electricity

The electricity system is a prime example of the impact of the Fourth Industrial Revolution as it undergoes transformation, becoming more complex, with rapidly evolving technologies, emerging innovative business models and shifting regulatory landscapes.

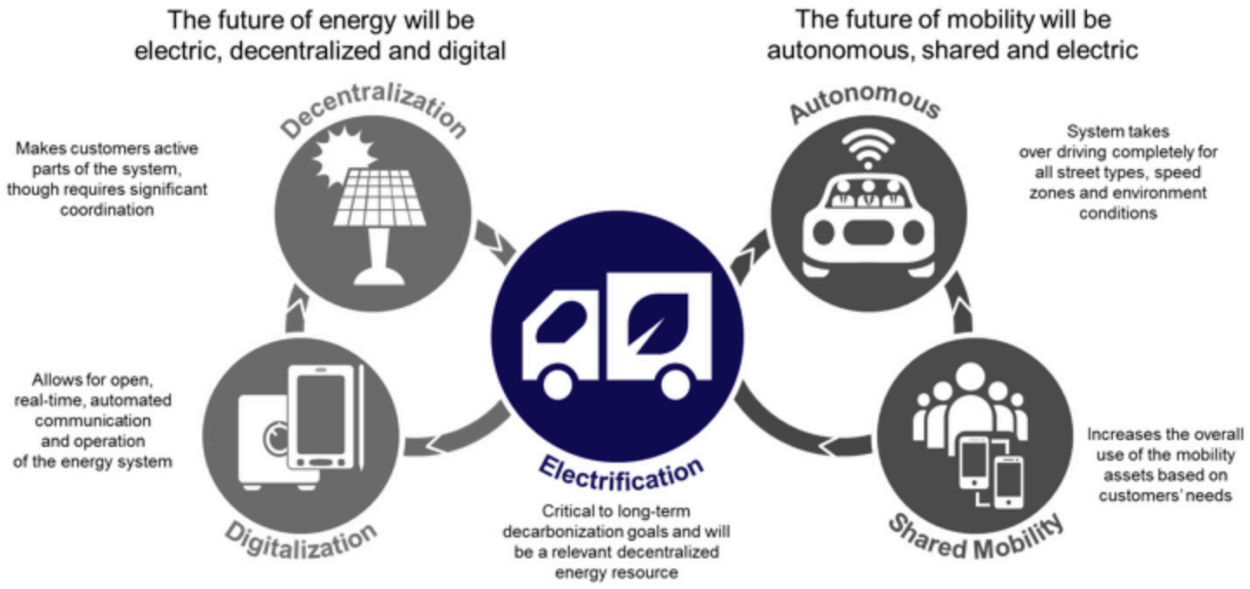
Three trends are converging and reshaping the electricity sector:

1. **Electrification** of new uses, especially light transportation such as electric vehicles (EVs). Given the convergence of energy, mobility and urban transformations, electrification will improve the ability of cities to meet climate goals, optimize grid infrastructure investment, enable innovation of services and infrastructure, and dramatically increase productivity and generate economic growth.
2. **Decentralization** of the system's active resources, with increasing penetration of decentralized energy resources (DERs), such as decentralized storage, generation and energy management systems.
3. **Digitalization** driven by the advent of the Internet of Things and power-consuming connected devices, smart metering and other digital electricity network technologies (e.g. automation, remote control, smart sensors).

These trends act in a virtuous cycle, enabling, amplifying and reinforcing developments beyond their individual contributions, and leading to the so-called grid edge transformation. They help to build a better, more resilient, secure, sustainable and efficient electricity system, creating new jobs and services for customers:

- With the system becoming fully digitalized, operations can be fully automated and capable of managing and exploiting the new flexible and mobile resources, such as renewable generation or EVs.
- Customers will be able to select the decentralized energy technologies of their choice, connect them to the central grid, and even transact electricity and related services with other appliances with real-time interactions.
- The role of the electricity network evolves beyond supplying electricity, becoming a platform that exploits and maximizes the value of DERs and the economic potential of retail services.

Figure 1. The convergence of energy and mobility futures



The value and potential of grid edge transformation

The World Economic Forum has identified that, by 2025, the transformation of the electricity system can create more than $2.4 trillion of value globally for the electricity industry and for society by reducing carbon emissions, increasing the efficiency of infrastructure, improving mobility systems, creating jobs and increasing options to customers.

The potential of grid edge technologies is fuelled by three elements:

1. Their cost is exponentially decreasing.
2. They enable innovative customer-centric business models.
3. They can significantly improve the electricity system utilization rate by reducing peak demand, shifting and flattening the load profile.

The public and private sectors can work together – using the example set by Colombia with a multistakeholder working group – to take the necessary actions to create value for industries and societiy.

Transformation framework

The World Economic Forum has developed, in cooperation with the private and public sectors, and building on global perspectives and best practices:

– A general **framework of guidelines** to design policy, business models and infrastructure development in the context of the grid edge transformation.
– A complementary **framework of recommendations** to push the electrification of transport in cities, in combination with grid edge technologies and new mobility patterns.

The general framework is a practical guide of recommendations for policy-makers and decision-makers, regulators and executives, in four areas:

1. **Policy**: Change the rules of the game by redesigning the regulatory paradigm, advancing and reforming regulation to enable new roles for electricity distribution network operators, innovation and full integration of DERs.
2. **Infrastructure**: Ensure timely deployment of the infrastructure to enable new business models and the future energy system.
3. **Customers**: Redefine the customer experience, incorporating the new reality of a digital, customer-empowered, interactive electricity system.
4. **Business models**: Embrace new business models to activate new revenue sources from innovative distribution and retail services.

The complementary framework focuses on driving electrification of transport in cities, in combination with grid edge technologies and new mobility patterns, and suggests that policy and infrastructure development follow three guiding principles:

1. **Take a multistakeholder and market-specific approach**: Industries of energy, mobility and infrastructure along with policy-makers, regulators and urban planners can collectively define a new paradigm for cities, exploiting the local energy, mobility and urban infrastructure characteristics. The paradigm would go beyond the industry divide of today and call for complementary municipal, regional and national policies.
2. **Prioritize high-use vehicles**: Focus on electrifying fleets, and completing electrification of public transportation system, while enabling the integration of autonomous vehicles.

3. **Deploy critical charging infrastructure while anticipating the transformation of mobility**: Focus on reducing range anxiety and fostering interoperability, prioritize charging hubs integrated with grid edge technologies and smart charging, and develop a digital end-to-end customer experience.

In 2017, Germán Arce Zapata, Minister of Mines and Energy of Colombia, launched an initiative to adapt and implement the general framework, with the cooperation of local public and private sector stakeholders. In 2018, the World Economic Forum aims to scale this model globally as an effective example of a country-specific multistakeholder approach which brings benefits to society and industry, especially in order to bring environmental and economic benefits.

Champions in the public and private sector will be identified, and a national multistakeholder working group will be formed with a mission to adapt the frameworks to the local conditions in countries and cities.

Colombia: Framework into Action

Context

Colombia has set a medium-term objective to move towards sustainable and low-carbon growth. For this reason, the country committed to the Paris Agreement, the Post-2015 Development Agenda of the United Nations and the Sustainable Development Goals. To meet these commitments, alongside other sectors, the Colombian electricity system needs to evolve to become more efficient and sustainable, by redesigning its services and products.

In this context, the Grid Edge Transformation Colombia Initiative was launched in December 2016 to accelerate and modernize the country's electricity system, as a cooperative effort of stakeholders from the public and private sectors.

Grid edge technologies are considered an opportunity to solve the current challenges (such as low load factor, obsolete, or non-sustainable electricity supply to non-interconnected zones, and low customer engagement) in a cost-saving and time-effective manner.

The adaption and implementation of the framework depend on having a well-established regulatory body, organized corporations that can act on the changes, and clear definitions of roles and responsibilities.

"In the current scenario of transformation, driven by such rapid technological innovation, these forms of cooperation between the public and private sector, such as the World Economic Forum initiative – Grid Edge Transformation Colombia, represent a unique opportunity to develop inclusive policies and create a flexible and resistant ecosystem able to continuously adapt and anticipate the future."

Germán Arce Zapata, Minister of Mines and Energy of Colombia

Colombia was well-positioned for the framework given the following:

– Colombia's energy system is ranked eighth out of 126 countries in the World Economic Forum Global Energy Architecture Performance Index 2017.
– Colombia has established independent entities for planning and regulation, including UPME (Unidad de Planeacion Minero Energetica) and CREG (Comisión de Regulación de Energía y Gas), as well as strong electricity corporations (both private and public-private) in charge of infrastructure and services.

Scope of the initiative

Under the leadership of the Ministry of Mines and Energy, the UPME and a collaborative network organization called Colombia Inteligente, the initiative engaged relevant public and private stakeholders. The group has to date defined a shared vision of the future of the Colombian electricity sector and identified the necessary actions required to implement the vision.

The focus was set on four pillars of the transformation of the electricity system in Colombia:

1. **New business models**: Enable the emergence of innovative business models and partnerships among industry players, supported by regulatory changes
2. **Technology deployment**: Ensure the massive roll-out of smart metering to drive active participation of customers
3. **Electric mobility**: Accelerate the speed of electrification of transport
4. **Micro-grids**: Develop micro-grids solutions in areas not connected to the grid

Outcomes

The group agreed that the future electricity system should be decentralized and digitalized; should guarantee flexible reliability, portable and mobile solutions for supply, and grant access to multi-product services. In this system, customers would be informed, aware, diverse and active in the decision-making process, and infrastructure will provide value-added services in a cost-efficient way.

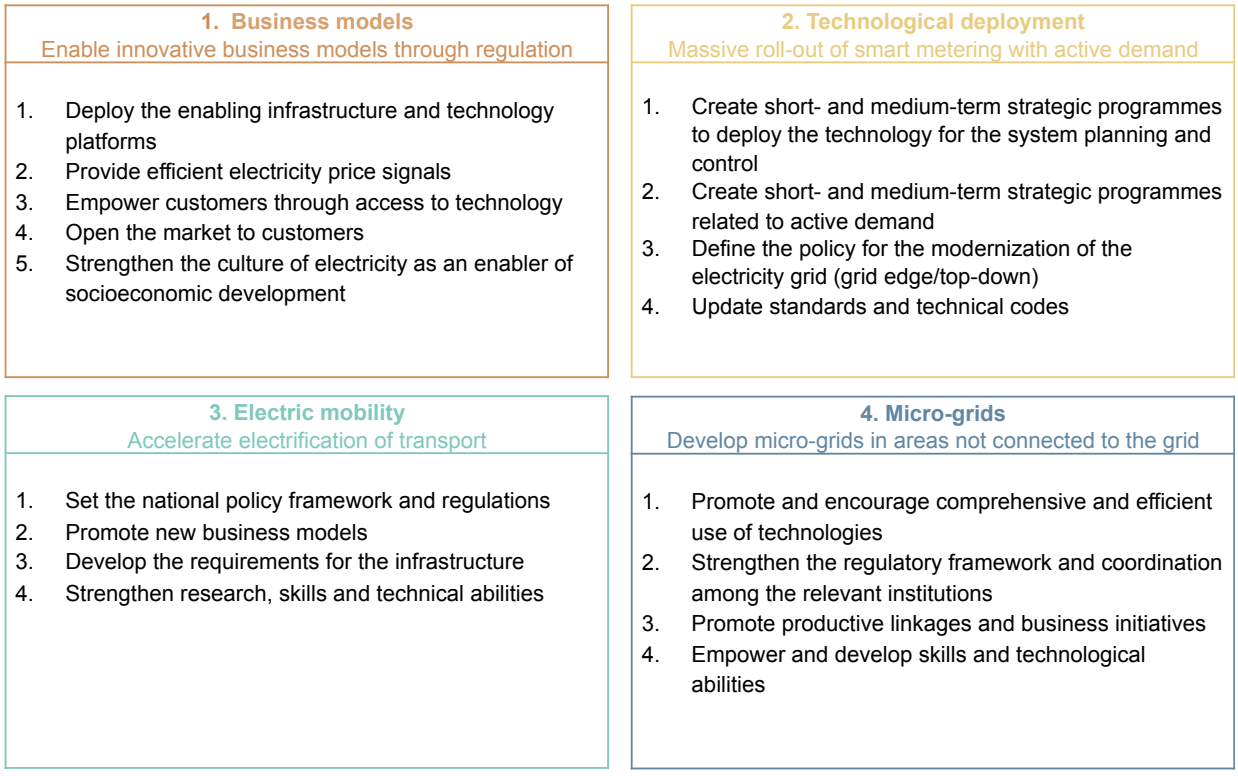
The priorities for each of the four pillars are:

1. **New business models**
– Infrastructure and technology platforms for the new services associated to the convergence of prosumers, electric mobility, energy storage and value-added services
– New revenue models to promote grid modernization, innovation and new roles of electricity system players

2. **Technology deployment**
– Smart metering systems to monitor and improve the quality of service, and efficiently manage assets like decentralized generation and storage
– Intraday pricing for demand response programmes

3. **Electric mobility**
– National policy to allow state entities to work with energy and mobility stakeholders in a coordinated and collaborative way
– Promotion of the electrification of vehicle fleets, and introduction of financing programmes for the recycling, renewal and replacement of cargo and passenger vehicles

Figure 2. Macro actions for the acceleration of the Grid Edge Transformation in Colombia



4. **Micro-grids**
– Focus on programmes to increase access to electricity, subsidies to adopt clean technology and processes to maintain and optimize micro-grids during their lifecycle

The way forward

As a next step, the above priorities are being translated into concrete energy policy. Already, the Ministry of Mines and Energy of Colombia has made progress in establishing the mechanisms to implement smart metering systems (Resolution 40072 issued on 29 January 2018), as well as demand response programmes and integration of DERs.

Lessons Learned

Based on lessons learned in Colombia, the country-led, multistakeholder approach to adopting the frameworks is described below.

Phase 1 – Scoping the initiative

– The World Economic Forum and the Ministry of Energy convene the relevant stakeholders in a workshop to discuss the local implications and opportunities of accelerating policy and business models pertaining to electrification, decentralization and digitalization.
– The stakeholders will include the relevant public sector agencies at national and city levels, the regulatory entity, the major electricity companies, experts and other relevant stakeholders; it is ideal to also include a civil society organization.
– Under the leadership of the Minister of Energy, a working group will be set up to work on the top 3-4 priorities identified at the workshop.
– The working group will split into teams dedicated to detail each of the priorities identified. Their mission will be to define what short- and medium-term actions will accelerate the transformation.
– A civil society organization with a similar mission may be ideal to act as the coordinator of the initiative.
– An extended coordination entity will include representatives of the Energy Minister, the relevant city and the World Economic Forum.

This phase should last up to three months. The outcome will be a workplan to be validated by the Ministry of Energy.

Phase 2 – Development of the national framework

– The teams will meet regularly for the next three months. They will identify short-term (up to maximum 12 months) and medium-term actions, the barriers addressed and the risks associated with not taking action.
– The extended coordination entity will convene every two weeks.
– At the end of period, the working group will convene the leaders of the companies and entities involved for the restitution of the results and arbitration.

This phase should last up to six months. The outcome will be a roadmap for implementation of the identified actions, as well as a case study to inspire future deployments.

Phase 3 – Implementation and handover

The relevant local entities will turn the recommendations into laws, pilots and implementation projects.

The World Economic Forum can play a role to ensure knowledge sharing and highlight best practices through the Forum's convening platform.

Acknowledgements

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Additional acknowledgements

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