MPzero: Sustainable, Affordable and Clean Heating Available to Everyone

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An installed low-emission MPzero oven

Summary

Every winter, the air pollution caused by the combustion of biomass for residential heating is one of the biggest environmental problems suffered by the cities of South-Central Chile. Because the use of wood-burning stoves as

the most affordable heating method, the problem remains today despite its negative environmental implications and continues to be the used most by the population despite itcausing serious health problems in the community, mainly in children and elderly. MPzero is a device for reducing emissions of fine particulate material, developed in Chile, which captures up to 97 percent of the emissions produced by this heating equipment, helping to keep the air clean and heating costs low, especially for families who do not have access to less polluting heating methods.

The Problem

Although it is public knowledge how harmful the smoke produced by the combustion of biomass is for health, wood is still the most economical biofuel and is used for heating and cooking food in Chilean households. It is estimated that, in the residential sector, wood is present in 33.2 percent of households in the country (1.721.032 homes), a percentage that is increasing in the south, reaching 98.2 percent in the Aysén region.

In 2016, the World Health Organization (WHO) pointed to Coyhaique, the capital of the Aysén region, as the city most contaminated by particulate matter in Chile and Latin America, reaching contamination levels in the population equivalent to smoking 16 cigarettes a day. These facts have led to the authorities taking prohibitive measures such as limiting the performance of any outdoor activity, restricting the use of wood-burning heating or

cooking, prohibiting the sale of non-certified heating equipment and imposing fines for homes that use firewood for heating during environmental pre-emergency and emergency periods.

The strong socioeconomic and cultural link to firewood is a fundamental element for its continued use. "Its entire chain, including production and marketing, is impregnated with practices rooted for several generations[1]". That is why, along with the hard facts of the problem is that, to achieve a radical change in the situation, the solutions used must be crosscutting, taking into consideration several factors and on a large scale.

Solutions projected in the public and private sector have been ineffective due to the wide spectrum of the operating variables under which this type of heater works, which leads, for various reasons, to misuse by users.

The State has been in front of the problem in different ways, from subsidized plans of replacement of heaters, to replacement of old wood-burning stoves with certified wood-burning stoves that are more efficient and less polluting[2] or by other types of heaters (electric, pellet, gas, or paraffin) and periodically carrying out different plans and activities of environmental awareness in the population while trying to regulate and certify the sale of dry wood, among other measures.

On the part of the private sector, improvements have been

made in the design of heating equipment to make them more efficient and lower emissions; firewood sellers have begun to work with firewood management plans to be able to supply dry firewood in a sustainable manner, and equipment has been put on sale that helps reduce emissions from stoves, such as catalytic filters, permeability filters, and pills to improve combustion.

Unfortunately against these measures, no significant changes or improvements have been detected in the air quality of cities affected by the problem in recent years, in fact, according to the National Firewood Certification System, about 40 percent of those who have received replacement of heaters, have gone back to using firewood.

Looking for An Answer

Due to the problems mentioned above, in the national entrepreneurial ecosystem, a seedbed of ideas and projects have been generated by private innovators that seek to solve this problem. Some of the initiatives are catalytic equipment that works by means of a semi-permeable ceramic material installed on the exhaust of the stove, which allows it to burn at a lower temperature so that the soot that cannot be incinerated inside the combustion chamber. The problem with this system is that, although its cost is relatively low ($200 USD), its benefits are limited, it has a maximum capture efficiency of only 60 percent and restrictions of use under non-

optimal combustion conditions, such as low temperature or use of green or moist wood. Another product available on the market is a device called "living filter," which retains contaminant particles by permeability and, although it has a high capture efficiency close to 92 percent, its value is extremely high, (about $4,200 USD), more than 10 times the minimum wage in Chile.

Move Up to an Efficient Solution: From Industry to Housing

The control of polluting emissions in industries is a common problem for which there are different types of emission "abatement" systems, validated and used for decades to reduce the pollution produced by the processes that require combustion within industries.

One of these systems is the electrostatic precipitator, which, by means of an induced electric charge, polarizes polluting particles contained in the gases, so that they adhere to metal plates with an opposite charge. These plates are hit with a certain periodicity, causing the solid waste formed by the continuous accumulation of particles to "precipitate" in a discharge zone. This technology is widely used in coal-fired thermoelectric plants, achieving a capture efficiency of close to 99 percent.[3]

From the knowledge of this technology, a new edge appears to solve the problems of particulate matter pollution produced by burning wood: scaling this device

by installing installed in each firewood-burning stove and cooker residentially in the country.

MPzero, The Economic Heat of Firewood Can Be Clean and Sustainable:

From this technology, widely validated on an industrial scale, the challenge is to design a device that can use the principle of electrostatic precipitator to reduce the emissions produced by wood-burning stoves and cookers.

To carry out this challenge, an interdisciplinary team meets, composed of: Eduardo Burboa, an electrical engineer who holds a master's degree in renewable energies and clean technologies, Esteban Soto, an industrial engineer who holds a master's degree in industrial management, Gabriela Bustos, a journalist, and Ricardo Soto, an architect.

This group of young professionals, united by friendship and a common challenge, together embarked on the innovation path under the umbrella of "Potential Chile," an organization (company) created to be a hotbed of ideas and projects that, through technological development and innovation, seek effective solutions to problems of an energetic, social, and environmental nature, which are its three pillars of action.

Having the idea and the knowledge to carry out the

creation of this product, the team obtains the financing and support of the Government of Chile through competitions of entrepreneurship and innovation as *"Impacta Energía"* 2016 of the Government Laboratory and the Ministry of Energy and *"Capital Semilla"* 2017 from Corfo (Corporation for the Promotion of Production).

Having obtained the resources to develop the technology, the Potential Chile team focused on the development, testing and prototyping of the product through an accelerated incubation period of approximately eight months, in which different versions of the product were built, in order to fully understand its operation and thus reach the most effective design to solve the pollution problem.

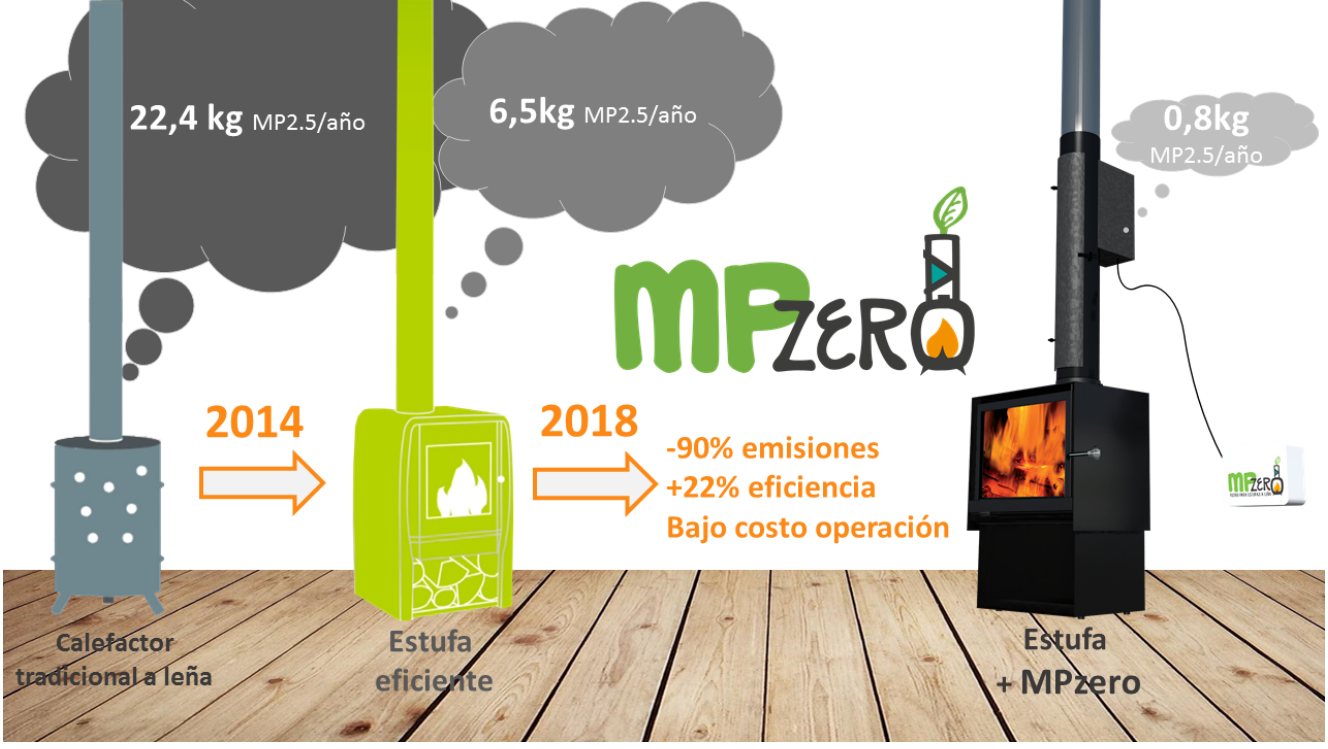
After this iteration process and technology assessment, it was possible to find the design of a prototype for piloting, which was tested by end users, during the months of August and September of 2017. The process consisted of replacing the first section of the stove tubes of stoves of the users by MPzero, to later turn it on and operate its heating equipment in a traditional way.

During the piloting, which was carried out in seven houses, surveys of satisfaction, operation, performance, thermographic measurements, and photographic records were conducted, in order to gather as much information as could be useful for the development of possible improvements to the final product design.

Pzero Technology in Simple Words

The developed product consists of a household-scale electrostatic precipitator, which captures the particulate material that passes through the stovepipe, generating an induced electric charge inside this tube, in order to polarize the polluting particles so that they are adhered to the inner walls of the tube, thus retaining the release of about 97 percent of the polluting particles produced by combustion.

To understand the technology in a practical way, we can remember the effect produced in the classic experiment to understand static electricity, in which small pieces of paper are cut or bitten to be attracted to an inflated balloon, which has previously been rubbed against the hair. What MPzero does is to repeat this electrical behavior, in which the pieces of paper would be the polluting particles, the balloon would be the internal walls of the stovepipe, and the induced load produced by rubbing the balloon with the head would be produced electronically by a high-voltage source and carried into the stovepipe by means of an electrode (metallic bar located in the center of the tube)



The results of piloting and laboratory tests validated the assumptions that initially led to the development of the technology, since capture measurements of up to 97 percent reduction in emissions were obtained, the reduction efficiency was certified in optimal combustion conditions by 66 percent and a savings of 22 percent in the use of firewood was obtained. Piloting provided important qualitative results, such as understanding the equipment operation and performance, validation of aesthetics, high sense of safety against technology and, most importantly, all participants would acquire the product once it was available in the market, which is estimated to have an approximate market value of $400 USD.

Today

After the technical and social validation of the technology, the application for the patent of the product was carried

out, which is currently under evaluation. We are working together with local governments to carry out massive plans of installation of the technology in heating equipment, as an effective measure to decontaminate the air of the cities. Work is already underway on the construction of the first commercial units and there is a waiting list of more than 200 people who wish to purchase the device.

Future

Because only significant social and environmental changes can be achieved through massive use of technology, Potential Chile is in search of private investment capital to scale up the production of technology and achieve greater scope in the territory, thus being able to help effectively improve the quality of life of people living in areas of environmental emergency.

It is expected that the use of this and other technologies, which actively reduce emissions produced by firewood-burning equipment, are part of public policies related to the use of heating equipment. Just as some years ago the catalytic converter was incorporated as a restrictive measure for the use of vehicles in environmental emergency zones, the same or similar could be carried out with the integration of these technologies to wood-burning cooking and heating equipment.

To conclude, the validation of the developed technology

and the implementation of its massive use could radically improve the quality of life of people living in communitiess that, due to the low levels of economic income and the precarious quality of the construction and insulation of their homes cannot resort to another heating method that is less polluting than the firewood combustion. To this day in Chile, it seems that poverty is synonymous with firewood and pollution, respiratory diseases and collapse of hospitals in winter, children who cannot go out to play at the break, and public and sports spaces that cannot be used because of pollution. This is why, as an organization, we firmly believe in the insertion of this type of technology as an effective response to the problem of current pollution, in the hope that in the future (we hope not very far) the quality of the houses and their insulation will improve; more efficient, clean, and sustainable heating methods are developed and finally, there is a real interest and motivation on the part of the population to take care of the environment, its surrounding environment and to be aware of the damage to health and quality of life that this entails.

Works Cited

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Author bio

Ricardo Soto Espinace, is the CEO and Project Manager of POTENTIAL SpA. Ricardo is a father, an architect from the Universidad de Concepción 2015 and holdsa diploma in strategic management of organizations with emphasis on innovation from the Pontificia Universidad Católica de Chile in 2018. He s currently pursuing a Master's Degree in Advanced Architecture Studies, with specialty in Technological Innovation in Architecture at the Polytechnic University of Catalonia. His work has been marked by the participation and development of innovation projects linked to the areas of architecture, technology, and environment. In 2016, due to his work in these areas, he was awarded the Revelation Architect Award given by the Concepción Architects Association. In his professional development, he has excelled in several competitions of innovation and entrepreneurship, such as the impact of the Energy Laboratory and the Ministry of Energy, Capital Semilla of Corfo, and Construye Solar, among others.