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OPINION ARTICLES

LOW PERMEABILITY RESERVOIRS: IT IS MORE THAN DRILLING WELLS THE MSEEL EXPERIENCE BROUGHT TO BRAZIL

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ABOUT FGV ENERGIA

FGV Energia is the Center for Energy Studies from Getúlio Vargas Foundation, created to place FGV as the protagonist of research and discussion of energy policies in Brazil. The Center develops researches, studies and analyses in the energy sector, and establishes partnerships to help companies and public entities evaluate investments and applications of energy resources sustainably.

OPINION

LOW PERMEABILITY RESERVOIRS: IT IS MORE THAN DRILLING WELLS THE MSEEL EXPERIENCE BROUGHT TO BRAZIL

Fernanda Delgado and Tatiana Bruce da Silva, FGV Energia

According to the International Energy Agency (IEA, 2017), energy security is the uninterrupted use of physically available energy sources at affordable prices. The concept is mistaken, however, with that of energy independence, where energy is sought within the country in order to reduce the weight of imports in energy demand.

In that regard, much has been discussed about the importance of revitalizing onshore exploration in Brazil, a topic that got traction recently with the launch of the REATE program. This discussion opens the door to an almost entirely new market in the country: exploration of low permeability resources.

Therefore, FGV Energia, in partnership with the Ministry of Mines and Energy (MME), the Energy Research Company (EPE), and the National Petroleum Agency (ANP), held the seminar "Discussions on the exploration of low permeability resources in Brazil: the Transparent Well project", which aimed

at demystifying the exploration of low permeability resources by hydraulic fracturing in order to promote its development. Revitalization of onshore exploration rekindles the need to discuss, in an open and transparent manner, the exploration of low permeability resources in Brazil, as happened with the shale gas industry in the United States, which became a hydrocarbon exporter in a short space of time.

Several experts from the oil and gas sector participated in the event, among them: José Mauro Coelho, director of the Energy Research Company (EPE); João Vicente, secretary of the Ministry of Mines and Energy; and Felipe Kury, director of ANP. In addition, Frederico Miranda, from ENEVA, Alfredo Renault and Silvio Jablonski, from ANP, and Fernanda Delgado from FGV Energia, along with representatives from Universidade de Brasília (UNB), the Ministry of the Environment (MMA), the National Confederation of Industry (CNI) and the Public Prosecutor's Office (MP), contributed to the discussion.

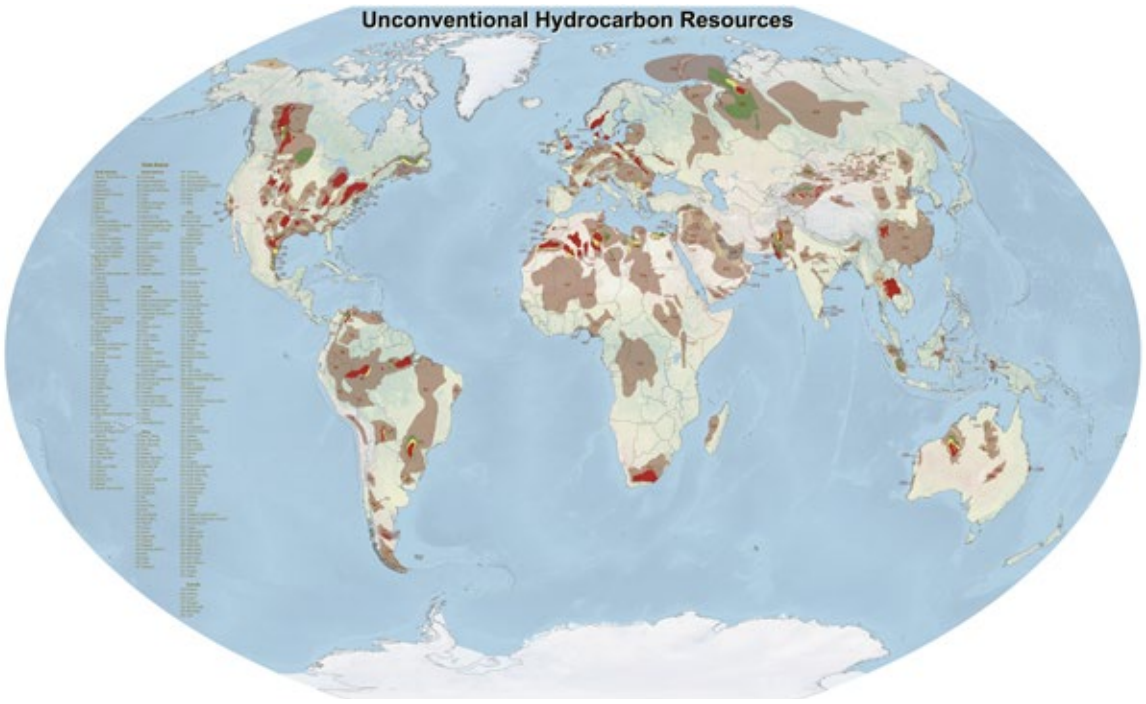
Also participated in the event Dr. Timothy Carr, from the Marcellus Shale Energy and Environment Laboratory (MSEEL), at West Virginia University, brought to Brazil by the American Consulate. Dr. Carr is a geologist seeking to develop the energy resources that will be demanded over the coming years, while protecting the environment. His current research focuses on unconventional fossil fuel resources and CO_2 storage and utilization in North America, Europe, Middle East and Asia.

The goal of the event was to feature international specialists with expertise in pilot projects that have risk monitoring systems, such as the Marcellus Shale Energy and Environment Laboratory (MSEEL) project, as well as onshore operating companies and state government agencies. The event also aimed at benefitting from Dr. Carr's experience in a moment when the discussion on unconventional fossil fuel exploration is in its early stages in Brazil.

UNCONVENTIONAL HYDROCARBON RESOURCES IN THE WORLD AND IN THE UNITED STATES

According to Dr. Carr, shale is the most abundant sedimentary rock in the world (Figure 1). Yet, the U.S. produces 90% of the world's shale gas and, specifically, the Marcellus basin produces 30% of these 90%. Uttica basin, also located in the U.S., in a decade or two will overcome Marcellus. In the United States, about 1% of the fossil fuel wells produce over 90% of the gas and 80% of gas liquids. There is room for 80,000 more wells in the country. These wells produce around two orders of magnitude more than traditional wells, with 15 million cubic feet a day each. In the basins map shown in Figure 2, two areas do not allow hydraulic fracturing for policy reasons: the state of New York and the city of Pittsburgh, but the latter is changing their view on that.

Figure 1: Unconventional Hydrocarbon Resources



Source: http://www.unconventionalenergyresources.com/

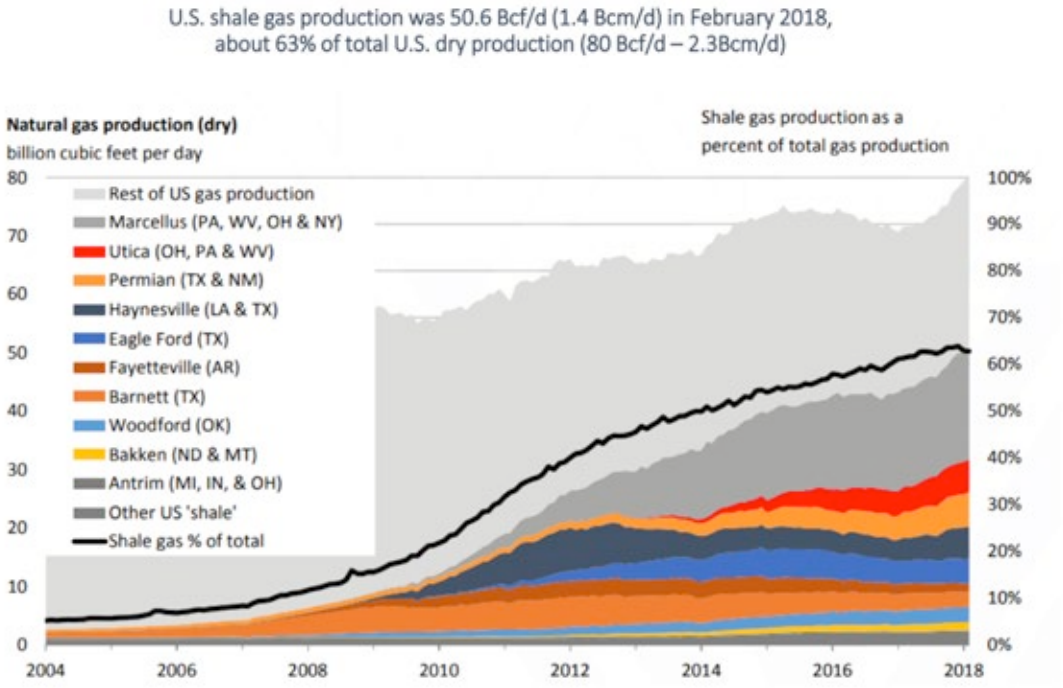
Figure 2: North American basins

Source: http://www.unconventionalenergyresources.com/

"FOR EVERY GAS WELL, ITS FIRST DAY IS ITS BEST DAY OF PRODUCTION."

Gas production in the United States is about 2.5 MM cubic meters a day and is increasing rapidly. Figure 3 shows how U.S. shale gas production has increased in the past years. The price of this gas is about 0.75 cents MMBtu to a producer and about 1 dollar or 1.5 dollars for a commercial operation. It used to be around 15 dollars (which is the regular price in Brazil today). Producers now are looking at increasing their productivity because prices are expected to increase. This way, greater efficiency will contribute to better competitiveness and lower environmental impacts.

Figure 3: US Shale production



Source: EIA Natural Gas Monthly, 2018
Note: 1 billion cubic feet Bcf = ~2.8 million cubic meters
1 thousand cubic feet (Mcf) = ~ 28.3 cubic meters

THE MSEEL PROJECT

The MSEEL project started in 2014 and is located about three kilometers from Morgantown, West Virginia. The objective of MSEEL is to provide a long-term collaborative field site to develop and validate new knowledge and technology in order to improve recovery efficiency and minimize environmental implications of unconventional resource development. Operators and technology centers, who have autonomy to make investment decisions because of the project's large capital expenditure requirements, sponsored the project. 11 million dollars were invested in it: the Department of Energy funded 4 million and 7 million came from private companies. From these values, one can see that the project received a large sum in private funds.

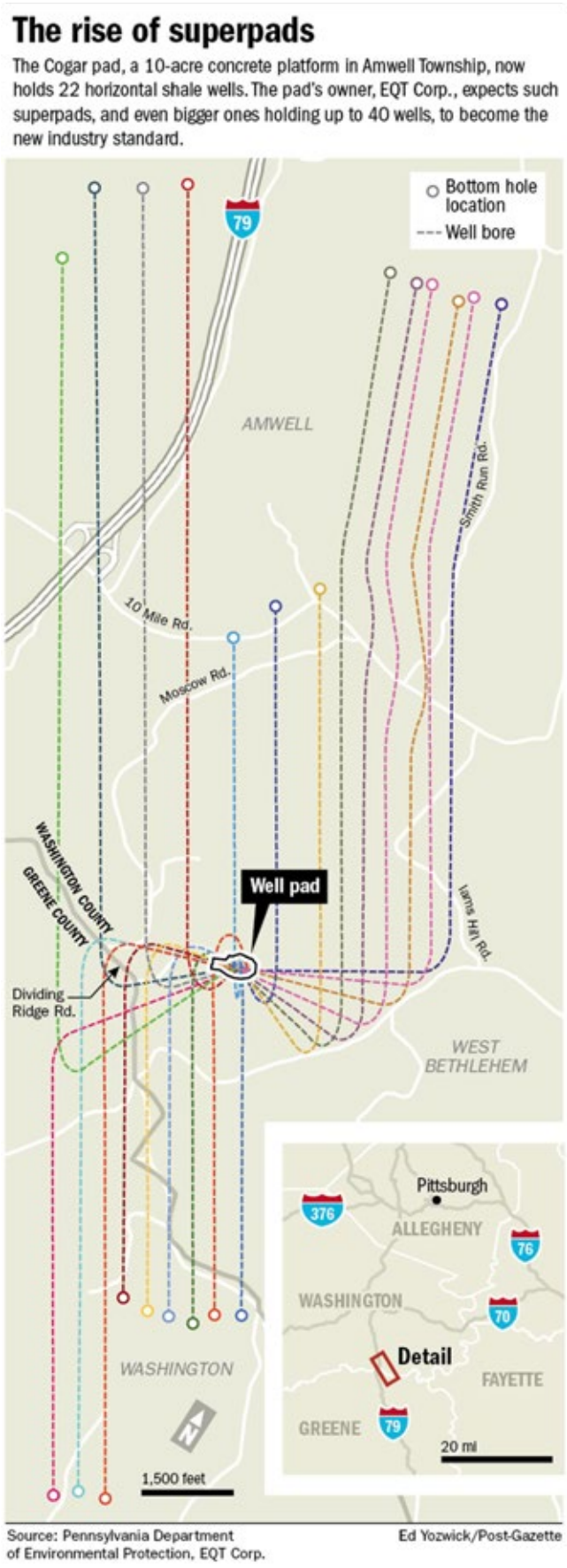
MSEEL consists of a multidisciplinary and multi-institutional team undertaking integrated geoscience and engineering research in cooperation with the oil and gas operator Northeast Natural Energy, LLC., numerous industrial partners, and the Department of Energy. The project operates two legacy horizontal production wells drilled in 2011, two new logged and instrumented horizontal wells drilled and completed in 2015, a cored and logged vertical pilot bore-hole, and a microseismic observation well. Production from the new horizontal wells began in December 2015 and is available online (http://www.mseel.org). Production is limited by pipeline distribution and consumption in the City of Morgantown, but the project wells are capable of producing multiple millions of cubic feet per day. MSEEL has integrated geophysical observations (microseismic and surface), fiber-optic monitoring for distributed acoustic sensing (DAS) and distributed temperature sensing (DTS), advanced well logs, core data and production monitoring, to better characterize subsurface rock properties, and propagation pattern of induced fractures in the stimulated reservoir volume.

One feature that really stands out in this process is the business-friendly regulatory landscape that allowed production and competition in a market-oriented environment. MSEEL had two wells that were able to attend the entire city. The first well faced many challenges due to protests from environmentalists. This way, in order to better inform the local population, in 2015 they decided to drill two more wells up in the north of the city in a transparent well model, with real time monitoring. Dr. Carr explains that drilling these wells is not an easy task because a 1-meter target must be hit in a 3000-meter radius area. Moreover, if that spot is not hit, it may create a geologic failure and is not possible to extract energy from that field.

"YOU WANT TO FIND THE BEST; YOU ALSO WANT TO FIND SOMETHING YOU CAN BREAK."

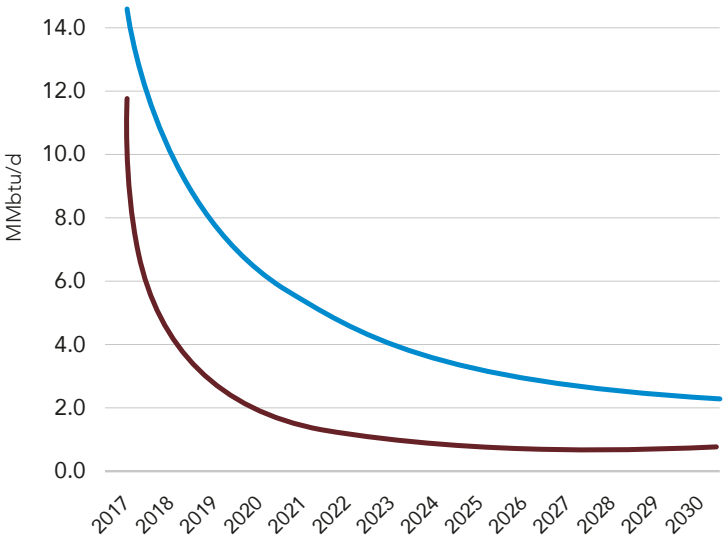
In addition, development of superpads allowed them to drill longer wells (Figure 4). The first wells are at about 1000 meters lateral, while the next two wells went up to 2500 meters lateral. Nowadays in the industry, 7000-meter lateral wells are not atypical. Although these wells do not produce for too long (Figure 5), their production lives grew and time of drilling fell to about a quarter because of their increased productivity. Meanwhile, costs were reduced from 5-7 million dollars per well to 3-4 million dollars. Another possibility is to reduce surface disturbance because now it is possible to use the same hole for wells that are 6000 meters separated.

Figure 4: Superpads



Source: West Virginia Energy Institute, 2018

Figure 5: Production decline per well



Source: EIA Natural Gas Monthly, 2018

Because of geological characteristics, Oklahoma and Kansas are located over abundant water drive reservoirs. As a result, in order to produce 100 barrels of oil a day in these states, 98 barrels of dirty water are also produced. If wells are drilled horizontally, the amount of barrels can increase to up 1000/day, creating a water disposal problem. Texas, in turn, is able to recycle water from its oil production, which is improper for drinking, to drill the next well, thus maximizing their water returns. Regarding West Virginia, it is not located in a water drive reservoir, so they produce less residual water from drilling. They use 20 million litters to frack, and get back around 10% of that.

Because of environmental concerns, opposition to fossil fuel exploration and consumption is increasingly growing nowadays. It is important to remember, however, that any type of energy creates residues, either in their production or in their consumption. In addition, our society still needs to consume a large amount of energy, especially in locations that still lack access to it.

Having these concerns in mind, MSEEL monitors all aspects related to the transparent well project. As far as for environmental impacts, they monitor air quality (CO_2, dust, and methane emissions), tail-pipe emissions from vehicles used in the project, water quality and drilling waste (cuttings and mud). Moreover, they assure that all national standards for radioactivity and non-hazardous waste are met. In addition, from their monitoring, they can affirm that methane found in water in the region is not from fracking development, and has existed in that location for a long time. In order to reduce environmental impacts, they also substituted diesel for natural gas in their trucks. Social impacts are also monitored, in order to guarantee that there are minimal effects from fracking activity.

As mentioned before, no form of energy is 100% sustainable; each affects the environment in its own way. The solution is to mitigate the problem as best as you can, through diversification of energy sources. Dr. Carr reassures that "natural gas is the best thing in the world for renewables," because of its lower costs and CO_2 emissions compared to coal, and quick turnaround time. He mentions Germany, who did not want to frack or rely on Russian natural gas, has been increasingly using coal to integrate renewables and, as a result, the country's emissions have gone up significantly. California´s energy demand is always higher in the months their production is lower; in his opinion, there would be no way for that turnaround without natural gas. Regarding solar power, it can generate an X amount of energy, but this source is not available at night, so its ability to generate energy decreases by half.

The MSEEL project is still under way. The goal today is to improve the wells' recovery factor. Therefore, the project is mostly in the development phase. Dr. Carr is pleased to say the project has stopped employing open pits and now uses completely closed loop systems, where cuttings and drilling fluids are all contained. They have also improved efficiency; while it used to take thirty days to drill wells in the past, newer wells are drilled in seven, which, at a cost of 30 thousand dollars/day, saves a significant amount of money.

"WE DO IT FASTER, BETTER AND CHEAPER AND THAT'S WHAT WE ARE FOCUSED AT".

SHALE AND FRACKING IN BRAZIL

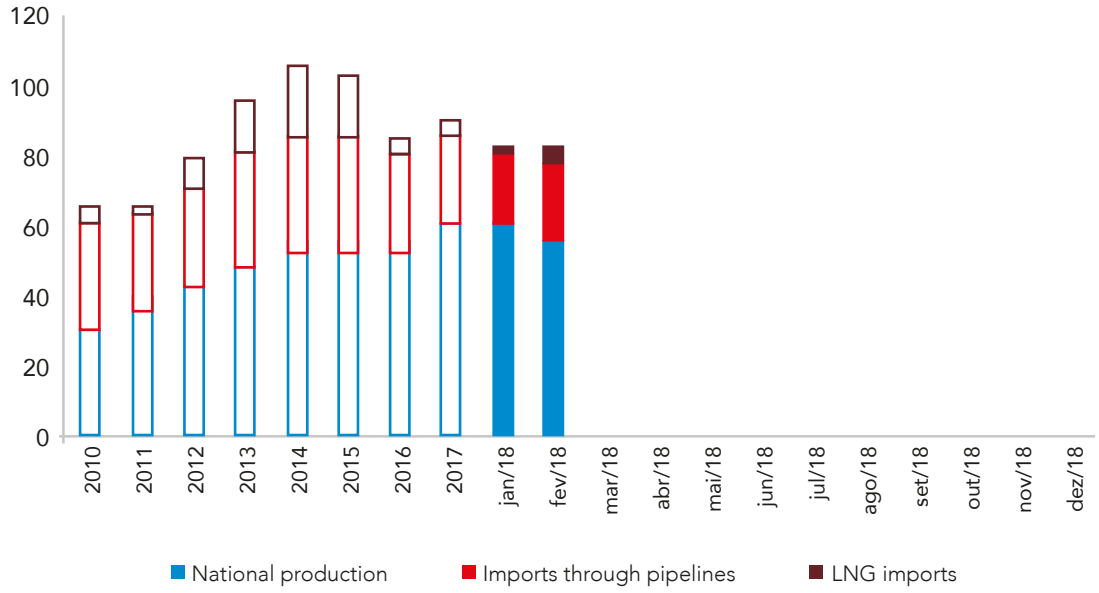
Nowadays, it is not possible to explore unconventional resources in Brazil due to legal matters that have imposed a suspension on fracking. Exploring this resource, however, should be discussed in the country for several reasons.

First, because of Brazil´s droughts and unreliable winds, fracking could be part of a solution to increase natural gas supply and address the issues faced by the power sector today. Dr. Carr mentioned that most of the United States' gas used to come from the Gulf of Mexico, but every time there was a hurri-

cane, production could get affected. Diversification of energy sources was key to solve this problem.

Secondly, energy diversity is important anywhere. Exploring new fuel sources brings energy independence to a location, contributing to lower reliance on energy imports. Figure 6 shows that Brazil imports large amounts of natural gas.

Figure 6: Natural Gas supply in Brazil (MMm³/day)[1]



Moreover, exploring this new shale gas resource will contribute to supply diversification and price reduction, also increasing competition in natural gas distribution in Brazil. As mentioned before, natural gas prices in Brazil are extremely high, especially when compared to the U.S. market. Natural gas is an important input for the country's power and industrial sector, and, consequently, is essential for the country's development. Shale can contribute to a more balanced natural gas market in Brazil.

Still according to Dr. Carr, however, here in Brazil, among other things, there are two great issues regarding shale gas development: if we decide to proceed with shale exploration, we are competing with the U.S., so we have to be able to produce at a lower cost. In addition, regulatory issues and society concerns, such as environmental ones, may hinder Brazilian shale development. Also in his opinion, it will take time until we succeed in a project like this. For instance, the U.S. started developing its shale industry in the 1990s and committed many mistakes in the process. He thinks, however, that the U.S. shale industry will last for another 50 or 100 years, so there is still time to invest and produce shale in the country.

1 Source: Resende, Larissa. Gás Natural. Boletim de Conjuntura Energética FGV Energia, May 2018.

Even so, Brazil must start a public debate in order to demystify shale development, such as those concerns related to its environmental impacts. Moreover, communities in the Brazilian countryside may benefit from this resource development. From the United States experience, it is possible to discern that small producers are key for this industry's expansion and that communities where it has happened have profited from it. It is important for the Brazilian society to consider the trade-off between economic benefits and potential environmental impacts.

Hence the importance of the transparent well project. Its implementation will bring visibility to low permeability resources and assess how to better develop this energy source in Brazil. This pilot project will be helpful to test assumptions before producing shale gas in a larger scale. Moreover, results from this pilot will be useful to standardize concepts and disseminate knowledge and information about shale resources and fracking in the country.

Overall, the main message about shale in Brazil is: inaction is not the answer. We must try first, understand how shale can be developed, and, from there, adjust what is necessary so that the country can benefit from it.

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