



IMPROVING EFFICIENCY FOR AIR CONDITIONERS

THE ROLE OF THE MANAUS FREE TRADE ZONE

RECOMMENDATIONS

- The Basic Production Process (PPB) should be simple, clear, and well-defined.
- Industrial policy and energy policy should be aligned to foster the growth and development of the Brazilian AC sector. The requirements of the PPB should be aligned with Brazil's labeling policy and with minimum energy performance standards (MEPS) for air conditioning units.
- Current industrial policy should be modified to encompass the entire manufacturing process, refining the mechanisms that directly influence the efficiency of the sector and its products and promoting a competitive environment.

Compared to international standards, air conditioners produced in Brazil not only lag in energy efficiency, but they also failed to show any significant improvement in recent years. Average efficiency in Brazil increased by only 10.2% in eight years (2010-2018), while the average efficiency of air conditioners sold in India improved 29% in six years (2011-2017), and, in Vietnam, 30.8% in five years (2013-2018).¹ According to a 2018 estimate by the Energy Research Office (*Empresa de Pesquisa Energética* - EPE), substantially increasing the efficiency of Brazil's air conditioners would reduce emissions of CO₂ greenhouse gases by 6.3 metric tons by 2035, indicating an energy saving of 14.5 TWh or R\$ 8 billions reals.^{2,3}

This policy brief, carried out by researchers at Climate Policy Initiative / Pontifical Catholic University of Rio de Janeiro (CPI/PUC-Rio), analyzes the production line of air conditioning sector in Brazil with a focus on productive and energy efficiency. Researchers find that efficiency levels in the air conditioning (AC) sector declined between 2003 and 2015, in contrast to the Brazilian manufacturing industry, which had stable indicators over the same period.

The industrial policy affecting this sector is the Manaus Free Trade Zone (*Zona Franca de Manaus* - ZFM). For more than fifty years this policy has provided tax relief to firms located in a specific part of the state of Amazonas, the Manaus Industrial Park (*Polo Industrial de Manaus* - PIM). To take advantage of these benefits, a business must

1 Institute for Climate and Society. 2019. Assessment of Brazil's Labeling Program for Air Conditioners. Rio de Janeiro: iCS.

2 Energy Research Office (*Empresa de Pesquisa Energética*). 2018. *Uso de Ar Condicionado no Setor Residencial Brasileiro: Perspectivas e contribuições para o avanço em eficiência energética*. Rio de Janeiro: EPE.

3 Considering the 2016 average residential tariff of R\$ 0.54/kWh. Available at <https://bit.ly/2BXnKSq>.

perform a minimum set of operations during the manufacturing process of a product—the Basic Production Process (*Processo Produtivo Básico* - PPB). In the AC sector, the PPB requires practically all stages of manufacturing and assembly to be performed within the ZFM, and air conditioning units must contain components made of domestic materials.

Despite the large amount of tax exemptions, CPI/PUC-Rio analysts do not find any indication that this industrial policy has helped boost energy or productive efficiency in the AC sector. Rather, the policy appears to create distortions that result in a final product with low energy efficiency, and a production line with low levels of productive and energy efficiency. The policy also hinders the dynamism of the sector and inhibits competition throughout the manufacturing process.

While the current discussion on minimum energy performance standards (MEPS) in AC units is important, it will also be essential to modify current industrial policy to encompass the entire manufacturing process and to refine the mechanisms that directly influence the efficiency of the sector and its products.

THE ROLE OF THE ZFM IN THE AIR CONDITIONING SECTOR

In Brazil, 98% of the air conditioning sector is concentrated in eight foreign multinational companies. These large companies operate factories in the ZFM, in order to take advantage of the region's tax incentives.

Despite benefiting from ZFM incentives, these major firms continue to have high production costs and with low exportation. This could be due to structural and geographic challenges, such as the poor transportation network between Manaus and Brazil's ports. Furthermore, bureaucratic issues also impact production costs in the ZFM. For example, in order to receive tax incentives, a firm must perform certain stages of manufacturing locally, according to the PPB.

In the AC sector, the PPB requires nearly all stages of production and assembly to occur within the ZFM. The PPB also requires that a certain percentage of air conditioning units use compressors fabricated domestically: 30% for split AC units, and 50% for window units. The quality and technology of the compressors are essential to an AC unit's efficiency, since this component is responsible for adjusting a room's temperature and is therefore key to the energy consumption of the appliance.

Only one company in Brazil - in São Carlos, in the state of São Paulo - makes non-industrial compressors, so the air conditioning industry uses these compressors in its manufacturing process. However, the compressors made in Brazil employ outdated technology and are not inverter compressors. Inverter compressors allow an AC unit to operate at variable speeds, thereby avoiding the energy wasted when a system is constantly turning itself on and off.

On the one hand, AC companies in the ZFM must produce units that meet the new energy efficiency standards. On the other hand, they are also required to follow the PPB. In 2014, changes to the PPB temporarily allowed companies to import inverter compressors with the mandatory condition of investing in Research and Development (R&D). However, the change was only temporary, and varying interpretations of the new rule have led to legal uncertainty.

With the goal of characterizing the Brazilian AC sector, this study looks at 2015 plant-level data from the Annual Survey of Industry (*Pesquisa Industrial Anual* - PIA) collected annually by the

Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística - IBGE*). It is important to note that the term “AC sector” refers to firms that produce AC components as well as those that manufacture air conditioners. Each local unit represents a single plant that performs a firm’s production activities, ranging from indirect support, such as office functions, to direct support such as water treatment, quality control, etc.

Table 1 shows each state’s share of local units, employees, and gross value of industrial production. In addition, the table also presents the average of employees per unit and the wage average compared to the Brazilian AC sector average.

Table 1. Percentage (%) by state of local units, employees, gross value of industrial production, average of employees per local unit and wage average in the air conditioning sector, in 2015

States	Compared to Brazil			Compared to the Brazilian average	
	Local units	Employees	Gross value of industrial production	Average of employees per unit	Average wage per unit
São Paulo	39%	31%	23%	79%	110%
Amazonas	17%	48%	58%	280%	70%
Rio Grande do Sul	14%	11%	15%	77%	172%
Paraná	8%	8%	3%	101%	150%

Note: Data tabulated for local industrial units employing 30 or more people. Table created by CPI, disaggregating the National Classification of Economic Activities (CNAE), version 2.0, at four-digit level for sector 2824. It includes states with at least three local units and non-zero value of production.

Source: Climate Policy Initiative using special data from 2015 PIA.

The state of Amazonas is home to only 17% of the sector’s local units in Brazil, but employs 48% of its workers. It also employs more than triple the national average of workers in the sector. Thus, it is clear that the ZFM is home to large-scale AC firms, since despite a relatively low number of local units, nearly half of the people employed in this sector work within the ZFM. However, they earn the lowest average wage compared to workers in the other states and compared to the national average.⁴

As indicated in Table 1, the state of Amazonas also enjoys the highest share of the gross value of industrial production (58%).

Thus, on average, a company producing air conditioners in the ZFM has a specific profile: few local units, large-scale, large number of employees, salary below the national average, and a high share of the sector’s gross value of industrial production.

⁴ It is worth pointing out that the statistics quoted for the ZFM correspond to the state of Amazonas. Since this study analyzes Brazilian manufacturing industry, which is concentrated within the ZFM, the terms “Amazonas” and “ZFM” may be used interchangeably without a loss of representativeness.

Given the expressivity of industrial policy in the ZFM, it is worth knowing the amount of tax exemptions directed toward the region. To that end, the Brazilian Federal Revenue Office (*Receita Federal do Brasil* – RFB) has drafted a statement of tax expenditures that estimates the extent of tax exemptions throughout the country. However, its methodology does not make a distinction between industrial sectors.

To identify the extent of tax exemptions in the AC sector within the ZFM, CPI analysts carried out an exercise using Annual Social Information Report (*Relação Anual de Informações Sociais* - RAIS) and PIA' data. They estimate, in 2015, tax expenditures for the industrial ZFM totaled around R\$ 4.3 billion reals, of which 7% (R\$ 285 million reals) went to the AC sector.

ANALYSIS OF PRODUCTIVE AND ENERGY EFFICIENCY IN THE AC SECTOR

Since the AC sector's manufacturing is concentrated within the ZFM, it is worth understanding its levels of productive and energy efficiency in that zone. This allows for a comparison with the rest of Brazil, which then indicates whether the incentives granted in the region have an impact on efficiency.

To measure the evolution of these indicators, this study uses annual data on manufacturing firms between 2003 and 2015, from three sources: PIA, RAIS, and ANEEL.⁵ Merging these databases allows researchers to track the evolution of energy and productive efficiencies in the AC sector, for both Brazil and ZFM. A firms' energy efficiency indicator is defined using the added value divided by the amount of electricity, while productive efficiency corresponds to the firm's added value divided by the number of employees. Figure 1 shows such indicators for the period from 2003 to 2015.

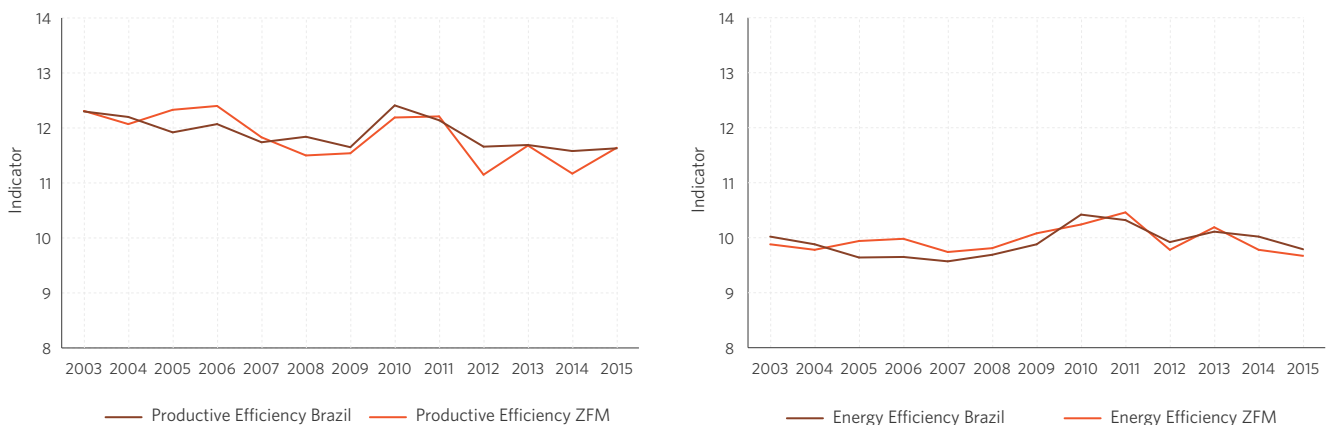
As illustrated in Figure 1, energy and productive efficiencies in the AC sector evolved at similar rates for Brazil and ZFM during this period, with both indicators showing a decline: 2% for energy efficiency and 5% for productive efficiency.

Despite the large number of tax incentives granted to ZFM firms, productive and energy efficiency in the region evolved at about the same rate as Brazilian manufacturing industry. Thus, the benefits received by the AC sector in the ZFM do not appear to have contributed to overall improvements productive or energy efficiency.

The report "*Challenges and Opportunities of Energy Efficiency: A Look at Brazilian Industry*" (Assunção, Schutze e Brolhato, 2018) show that, both indicators – productive and energy efficiency – in the Brazilian manufacturing industry remain stable during the period from 2003 and 2015. According to the present report, efficiency levels of firms in the AC sector declined between 2003 and 2015, in contrast to trends in the Brazilian manufacturing industry.

⁵ The Brazilian Electricity Regulatory Agency (*Agência Nacional de Energia Elétrica* – ANEEL) provides the average industrial tariffs for each distributor company .

Figure 1. Productive and Energy Efficiency in the Air Conditioning Sector, 2003-2015



Source: Climate Policy Initiative with data from PIA, RAIS, and ANEEL.

EFFECTS OF INCREASED AC SALES

Demand for AC units has grown considerably in Brazil over the past decade. PIA data tracks the number of air conditioning units the industry sells each year. Between 2005 and 2017, sales more than tripled. Despite the growth in AC sales, no mechanisms have been adopted to improve productive or energy efficiency, neither in the product itself nor in the AC sector.

The steady rise in AC unit sales is directly reflected in the country’s consumption of electricity. According to the EPE (2018), electricity consumption by residential air conditioners increased by 237% between 2005 and 2017.⁶ This was due to the increase in the number of AC units sold, and the fact that the energy efficiency of these units has not improved enough to compensate for the greater number of residential units.⁷

Therefore, it is clear that improvements must be made to energy efficiency indicators in air conditioning units so the sector can stop putting pressure on the infrastructure that generates, transmits, and distributes electricity, and instead contribute to a low-carbon economy.

⁶ Energy Research Office (*Empresa de Pesquisa Energética*). 2018. *Uso de Ar Condicionado no Setor Residencial Brasileiro: Perspectivas e contribuições para o avanço em eficiência energética*. Rio de Janeiro: EPE.

⁷ International Energy Initiative Brasil. 2019. *Estudo de Impacto Regulatório: Diretrizes Gerais e Estudo de Caso para Condicionadores de Ar Tipo Split System no Brasil*. Campinas: IEI Brasil.

CONCLUSION

The AC sector has failed to incorporate productive and energy efficiency and lags behind manufacturing trends in the rest of the country. The current approach of labeling policies and minimum energy performance standards for air conditioning units will not spur greater efficiency if PPB imposes measures that work against improving the efficiency of the units. Aligning industrial and energy policies will help this sector develop and grow.

The AC sector needs industrial policies that align with energy policy and prioritize productivity, energy efficiency, and competition. Brazil's current policy approach hinders competition and — despite tax exemptions — creates distortions that result in a low-efficiency final product from a low-efficiency production line.

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