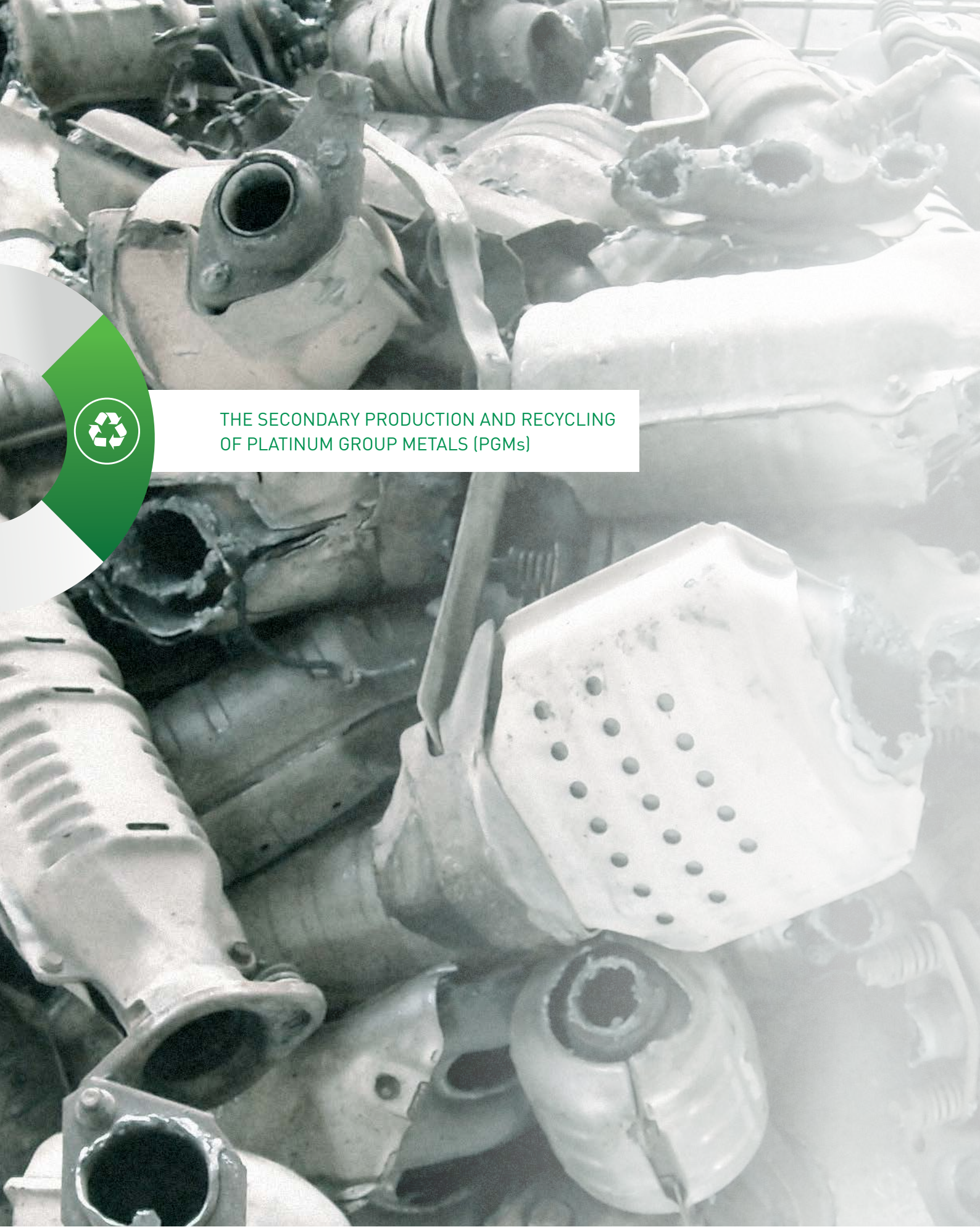
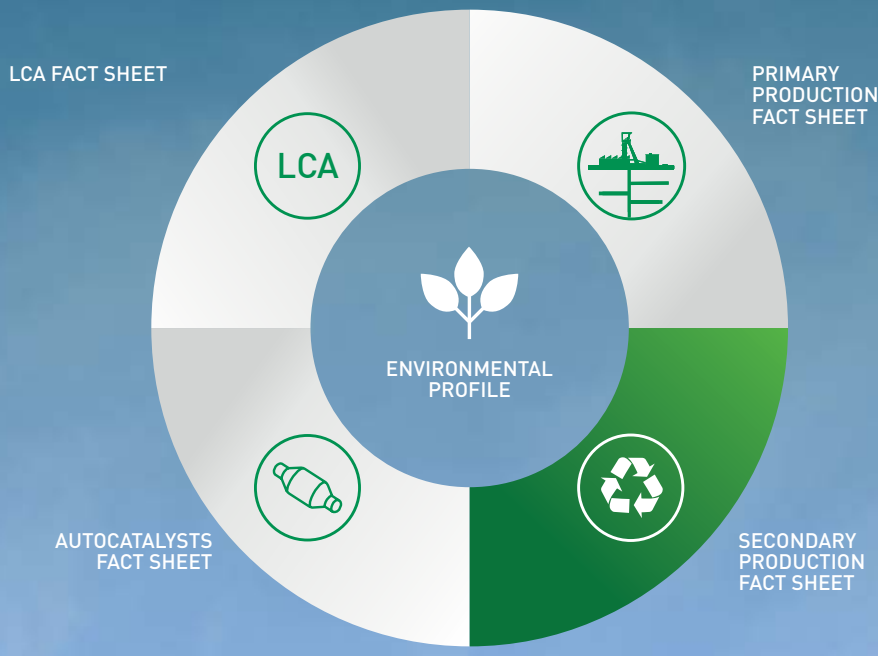


THE SECONDARY PRODUCTION AND RECYCLING OF PLATINUM GROUP METALS (PGMs)



IPA fact sheets come in a series. **Download them all at www.ipa-news.com**

IMAGE CREDIT

cover | ***Autocatalyst Scrap.*** Johnson Matthey.

THE SECONDARY PRODUCTION AND RECYCLING OF PLATINUM GROUP METALS (PGMs)

Primary and secondary production of PGMs are complementary and mutually-dependent; both are required to meet the growing global demand for this indispensable group of metals

The secondary production of PGMs includes the recycling of these metals from industrial applications and end-of-life products, as well as the recovery of metals from by-products and residues created in primary production, as seen in FIGURE 1. Secondary production contributes a significant part of the PGM supply, as shown in FIGURE 2 for autocatalysts where recovery of PGMs from end-of-life vehicles was equivalent to 28% of gross demand in 2010. Due to the high value of PGMs, the attractiveness to recover metals from end-of-life products is extremely high.

In reality, the secondary production of PGMs is achieved through a complex, global web of companies, processes and material flows arranged to maximize the efficiency of PGM recovery from a variety of sources. Typically, PGM-containing materials from industrial applications and by-products and residues are received directly by secondary producers, while consumer products must first be collected from consumers and pre-processed to separate the PGM-containing components from other materials (e.g. removal of autocatalyst from a vehicle).

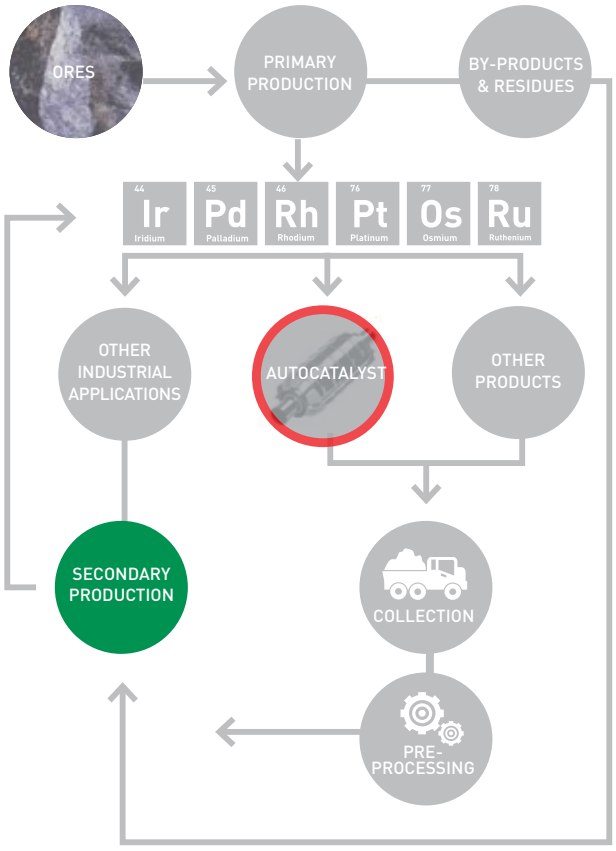


FIGURE 1 Secondary production in the PGM life cycle.

Secondary production itself, is typically composed of two processes. First, PGM-containing materials are either smelted to form a molten metal matte, or dissolved to bring the PGMs into a solution. Second, the PGM-enriched output from step one is then refined to recover the individual metals separately in a pure form identical to that from primary production.

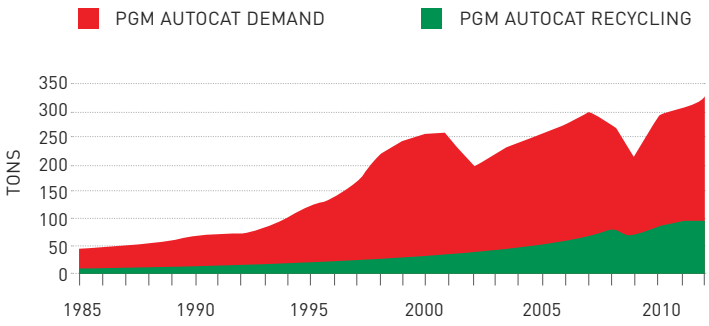


FIGURE 2 Demand of Pt, Pd and Rh for autocatalysts and amount recovered from end-of-life vehicles
SOURCE: Johnson Matthey.

Secondary production saves energy and minimizes the overall environmental impact of the PGM supply

An LCA study conducted by the IPA has quantified the environmental impact of secondary production of PGMs for the first time on an industry-wide level. The results indicate that secondary production has a lower impact than primary production. This is expected for various reasons, including the significant differences in concentration of their respective "ores", as shown in FIGURE 3.

Secondary production plays an important role in lowering the environmental footprint of global PGM production. With responsible stewardship, PGMs can be recycled over and over again resulting in a continual reduction of the environmental burden of each successive life cycle. In addition, the high value of PGMs drives the recycling of other metals present in PGM-containing products that might not otherwise be recovered.

PRIMARY ORE 2-6g/t PGMs

OXO-CATALYST ORE 100g/t PGMs
[SECONDARY ORE]

AUTOCATALYST ORE 2000g/t PGMs
[SECONDARY ORE][1]

FIGURE 3 **Concentration of PGMs in primary and secondary ores.**

Using state-of-the-art recycling technologies, 95% of the PGM content of spent automotive catalysts (and other PGM-containing materials) can be repeatedly recovered

Today's high-tech secondary production processes approach thermodynamic limits in achieving yields greater than 95%. FIGURE 4 shows how high-tech recycling can be used to reduce the average global warming potential of platinum over three life cycles when a 95% recycling rate is achieved. The first life cycle of a product which uses or contains platinum has an unavoidably high impact because it requires 100% mined production. The impacts of the second and third life cycles, which need only 5% of newly mined platinum, are significantly lower, and the average environmental burden over three cycles is greatly reduced.

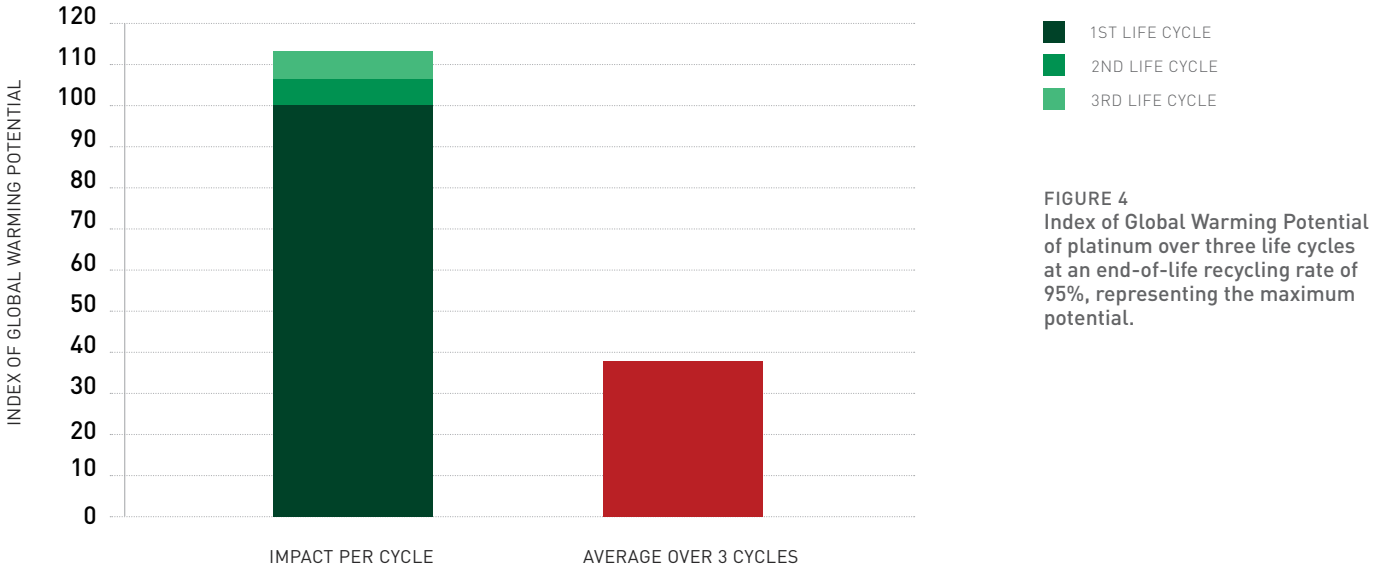


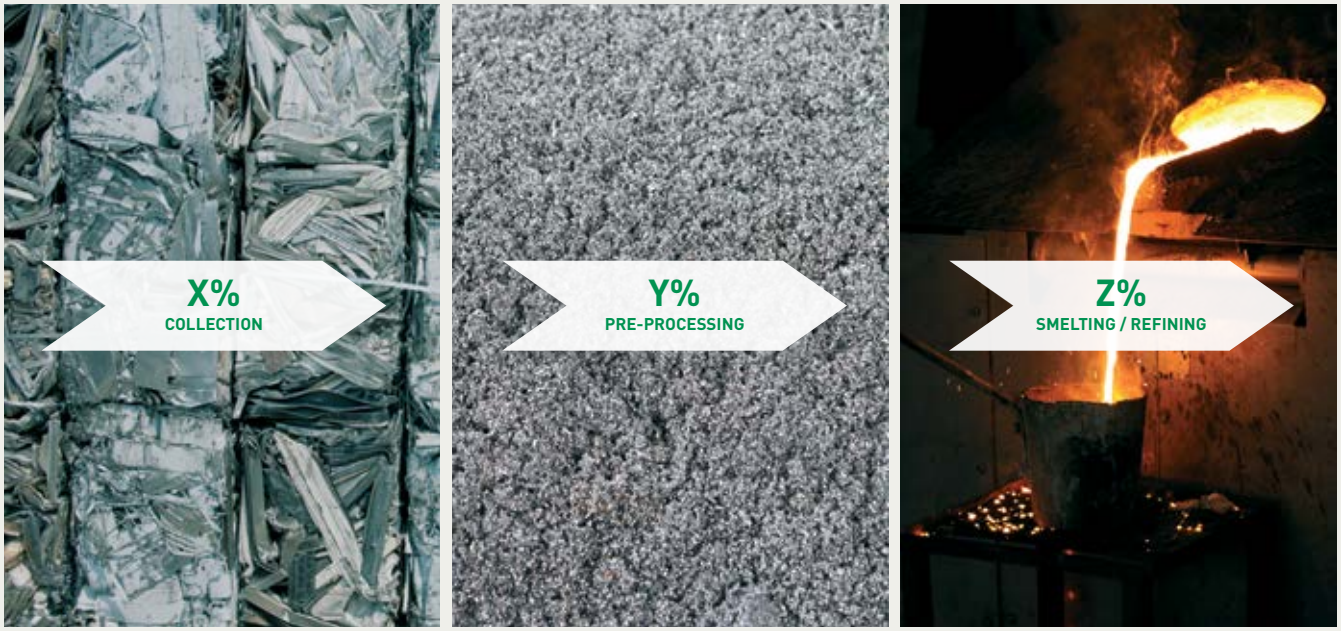
FIGURE 4
Index of Global Warming Potential of platinum over three life cycles at an end-of-life recycling rate of 95%, representing the maximum potential.

1 PGM concentration in the autocatalyst ceramic (decanned).
Image credit: (top to bottom) ***Platinum Ore***. Johnson Matthey. | ***Autocatalyst Scrap***. Johnson Matthey.

PGM materials that are collected at a very high rate or enter secondary production directly from industrial processes, such as industrial catalysts, are recycled at a rate near the 95% maximum potential. For PGMs in consumer products, however, end-of-life recycling rates are lower, as high recovery requires an efficient recycling chain from collection to refining. Unfortunately, a well-functioning chain that targets PGM recovery is not always in place when these products reach their ultimate end-of-life and are ready for recycling.

Thus, the end-of-life recycling rate for these PGMs is largely determined by the weakest link in the chain for the specific product. Targeting the weakest links in the chain provides the best opportunity for improving the recycling rate for PGMs, which in turn can help reduce the overall environmental impact of the PGM supply. In fact, opportunities for improving the recycling rate exist throughout the recycling chain:

End-of-life recycling rate = X*Y*Z%



1. Work with stakeholders to increase consumer awareness and rethink collection approaches.
2. Ensure collected materials end up in appropriate recycling chain.
3. More focus on low concentrated metals in automated processes.
4. Prevent materials from entering inefficient, low-tech processes.
5. Work with manufacturers to aid design for recycling and increase knowledge in the recycling chain about the presence and location of PGMs in products and best practices.

FIGURE 5 **Opportunities for improving the recycling chain for PGMs.**

PLATINUM GROUP METALS

THE POWER TO *IMPROVE LIVES*

ABOUT THE IPA

The IPA is a non-profit organisation representing 80% of the mining, production and fabrication companies in the global platinum group metals (PGM) industry, comprising platinum, palladium, iridium, rhodium, osmium and ruthenium.

CONTACT INFORMATION

International Platinum Group Metals Association

Schiess-Staett-Str. 30, 80339 Munich – Germany

Phone +49-89-5199-6770, Fax +49-89-5199-6719

info@ipa-news.com, www.ipa-news.com