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Cleaning up heat: The changing economics for heat pumps in Poland

Duncan Gibb and Monika Morawiecka

Status of heat pumps in Poland

The 2022 energy crisis created mainly by Russia's invasion of Ukraine has fundamentally reshaped the economics of clean heating. Across Europe, prices of fossil fuels used for heating rose sharply. Electricity prices have increased in turn, due to fossil gas often being the price-setter in the electricity market, although not to the same extent as fossil heating fuels.

Poland is notably vulnerable to these volatile price increases due to its heavy reliance on fossil fuels for heating, especially coal. Around 85% of the EU's coal for home heating is burnt in Poland, and just under 50% of Polish homes use this fuel for heating.[1] This has resulted in high levels of greenhouse gas emissions and significant health impacts due to air pollution.[2]

In 2018, Poland introduced a programme funded with EUR 23 billion over 10 years to replace coal heating systems with cleaner alternatives, notably heat pumps. These subsidies also are now adjusted according to income, ensuring low-income households receive adequate support. Also, the government has introduced coal quality standards[3] as well as efficiency standards for coal stoves. Finally, many of Poland's regions have implemented emissions standards that aim to gradually phase out coal-fired stoves.

[1] Rosenow, J., & Morawiecka, M. (2022, 14 April). From laggard to leader: How Poland became Europe's fastest-growing heat pump market. *Foresight*. https://foresightdk.com/from-laggard-to-leader-how-poland-became-europes-fastest-growing-heat-pump-market

[2] Ortiz, A. G., Gsella, A., Guerreiro, C., Soares, J., & Horálek, J. (2021). *Health risk assessments of air pollution*. European Environment Agency. https://www.eionet.europa.eu/etcs/etc-atni/products/etc-atni-reports/etc-atni-report-10-2021-health-risk-assessments-of-air-pollution-estimations-of-the-2019-hra-benefit-analysis-of-reaching-specific-air-quality-standards-and-more

[3] These have been temporarily suspended by the government for the 2022/2023 heating season in view of supply shortages.

Backed by these policies, heat pumps sales have grown rapidly in Poland. The country had the fastest growing heat pump market in Europe in 2021, albeit starting from a small base, ranking 8th in the European Union. Heat pump sales grew 67% compared to 2020, reaching more than 93,000 units sold.[4] Heat pumps continued their upward trend in 2022, as the first half recorded 86% market growth. Heat pumps now constitute more than 60% of all subsidised heating systems in the Clean Air Programme, up from less than 30% at the beginning of 2022.[5]

The remarkable growth in Poland's heat pump market has been achieved despite the slightly unfavourable economics compared to fossil heating technologies. The upfront cost of a heat pump in Poland is still high, and far above estimates for coal stoves and gas boilers. In addition, heat pump running costs are increased because CO_2 costs are placed only on electricity and not on fossil fuels used for individual heating purposes.[6]

This paper shows that an investment in a heat pump makes sense for Polish households from an economic, environmental, climate and energy security standpoint. Notably, a heat pump is economically competitive during times of high fossil fuel prices, indicated by both current high retail prices and potentially even higher prices once price caps are removed. What's more, the upfront cost of a heat pump is likely to fall as new supply chain investments[7] are realised and, with appropriate policy decisions, the operating expenses will likewise begin to rival those of coal and gas boilers in Poland. Air quality issues will further stimulate demand for heat pumps and announced new investments in new heat pump manufacturing facilities will ensure the overall socio-economic benefits are even greater.

Economics of heat in Poland

Impact of volatile fossil fuel markets

Prior to the energy price surge in 2022, the total cost of ownership (TCO) for a heat pump was much higher than for a coal stove or a gas boiler in Poland. Much of this difference lies in the capital cost. The upfront cost of an air-to-water heat pump in Poland was estimated at EUR 8,000, far above the EUR 1,500 for a coal stove or EUR 3,000 for a gas boiler.

In terms of operating costs, heat pumps were almost on par with fossil technologies. According to 2021 prices, operating a heat pump cost around EUR 12,500 over its lifetime compared to a coal stove at EUR 11,700 and a gas boiler at EUR 11,500.

As the year 2022 has shown, fuel prices can be highly volatile and often subject to extreme swings. The price of residential coal in Poland rose from around

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[4] PORT PC. (2022, 17 August). Ponad dwukrotny wzrost sprzedaży powietrznych pomp ciepła w I poł. 2022 roku! [More than a twofold increase in sales of air source heat pumps in the first half of 2022!]. https://portpc.pl/ponad-dwukrotny-wzrost-sprzedazy-powietrznych-pomp-ciepla-w-i-pol-2022-roku/

[5] Ministerstwo Klimatu i Środowiska. Program Czyste Powietrze [Clean Air Program]. https://czystepowietrze.gov.pl/, accessed 20 October 2022.

[6] Rosenow, J., Thomas, S., Gibb, D., Baetens, R., De Brouwer, A., & Cornillie, J. (2022). *Levelling the playing field: Aligning heating energy taxes and levies in Europe with climate goals*. Regulatory Assistance Project and 3E. https://www.raponline.org/knowledge-center/aligning-heating-energy-taxes-levies-europe-climate-goals/

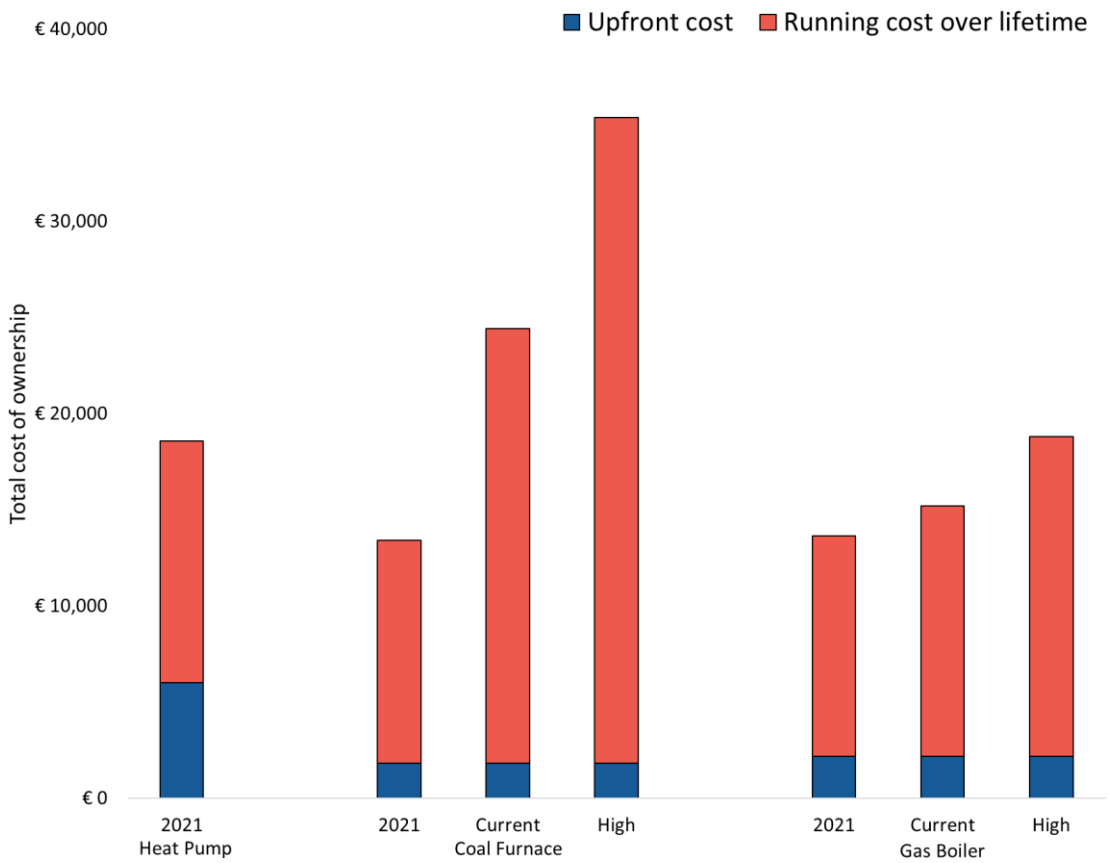
[7] Gordon, O. (2022). Viessmann to open €200m heat pumps facility in Poland. *Energy Monitor*. https://www.energymonitor.ai/sectors/heating-cooling/viessmann-to-open-e200m-heat-pump-facility-in-poland; Daikin Europe. (2022). *Daikin Europe invests €300 million in new Polish heat pump heating factory*. https://www.daikin.eu/en_us/press-releases/daikin-europe-invests-300-million-in-new-polish-heat-pump-heatin.html

800-1,000 PLN/tonne in 2021 to a peak of 3,000-4,000 PLN/tonne during 2022.[8] Gas prices similarly rose to record levels on the wholesale market, with the government introducing a partial price freeze for retail customers. Electricity prices saw a more moderate increase of roughly 15%.

Figure 1 shows the impact of different fossil-fuel price scenarios: previously low prices from 2021, current retail prices and even higher prices simulating the removal of government price caps and further volatility. Consumers using coal and gas are subject to extreme levels of price risk. A doubling and tripling of the price of residential coal (currently under a government price cap) leads to a TCO increase of 82% and 164%, respectively. Increasing household gas prices from 2021 to 2022 levels raises the TCO by 12%, while a 50% increase in the gas price corresponds to a 38% increase in TCO.

The operating expenses of a heat pump are competitive when electricity prices remain constant. Even in the low fuel-price scenarios, heat pumps require around EUR 700/year compared to EUR 645/year and EUR 637/year for coal and gas, respectively. In higher price scenarios, the cost to run a coal stove and gas boiler jump dramatically, giving heat pumps the lowest operating costs among all heating systems.

Figure 1. Total cost of ownership for a heat pump, coal stove and gas boiler under 2021, current, and high heating-fuel price scenarios



Note: Electricity prices are set at 125 EUR/MWh. Coal price scenarios are set at 1,000, 2,000 and 3,000 PLN/tonne (213, 426, 640 EUR/t), respectively. Gas price scenarios are set at 37.6, 43.3 and 56.4 EUR/MWh. See Annex.

[8] muratorplus. (2022, 20 October). *Ceny węgla w październiku 2022. Ile aktualnie płaci się za tonę węgla?* [Coal prices in October 2022. How much are you currently paying per ton of coal?]. https://www.muratorplus.pl/biznes/wiesci-z-rynku/ceny-wegla-w-pazdzierniku-2022-w-polsce-skladach-cena-tony-wegla-w-pgg-aa-2Wgb-NFp1-kFbJ.html

Impact of a Polish block tariff on electricity

Poland has also introduced a block tariff for households that freezes prices for electricity consumption up to 2,000 kWh[9] at 2022 levels and charges a higher rate for usage above this limit. The average Polish household demand for non-heating uses is roughly 2,000 kWh. Thus, all electricity used by heat pumps would be subject to higher retail prices, although still capped below their market value.

Figure 2 evaluates the impact of such a proposal by comparing the TCO of a heat pump versus a coal stove and a gas boiler across two scenarios: 1) under the introduced block tariff up to 2,000 kWh, and 2) if the block tariff were extended to 5,000 kWh for heat pump owners, exempting 80% of a heat pump's electricity use from high retail rates. The scenarios use current coal prices at 2,000 PLN/t (462 EUR/t) and high gas prices at 56.4 EUR/MWh.

In scenario 1, with heat pumps fully exposed to high electricity retail prices of 185 EUR/MWh, a heat pump is still more competitive than a coal furnace based on TCO. Compared to the TCO for a gas boiler, a heat pump trails by EUR 3,800.

Scenario 2 evaluates a block tariff with a limit of 5,000 kWh. Based on the average Polish electricity demand of 2,000 kWh, this would cover 3,000 kWh of electrified heat, or 80% of the electricity for heat — the average Polish household with fully electric heat from a heat pump uses 3,800 kWh. Our analysis thus uses a blended tariff calculated with 80% based on 2022 prices and 20% based on high retail prices. In this scenario, the TCO of the heat pump is more competitive than a coal furnace by EUR 4,700. With respect to a gas boiler, the gap is reduced to a EUR 870 difference.

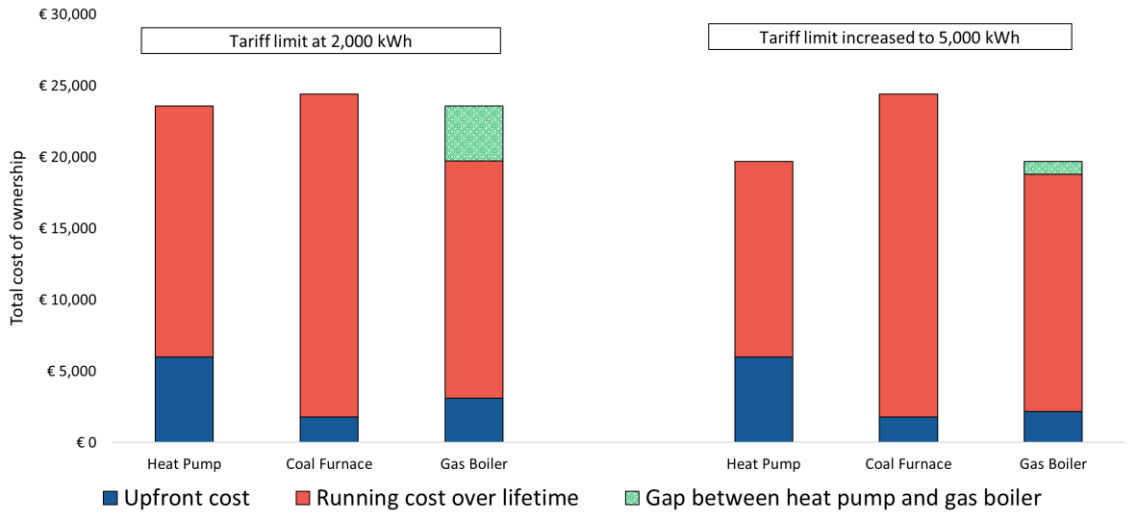
This analysis assumes a medium and high range of coal and gas prices because, as shown above, the risk of their being higher outweighs any possible benefit stemming from lower upfront cost, especially for the coal boilers.

Going forward, the key questions around the economics of heat pumps will be the relative volatility of fossil fuels versus electricity prices and government policies incentivising clean heating solutions. The risk profile is lower for heat pumps since they use less energy to produce equivalent amounts of heat, meaning that the overall cost of heating is less sensitive to electricity price rises. This is especially true when combined with additional investment into rooftop PV and coupled with flexible operation[10] and dynamic tariff structures in the future.

[9] For an average household. Higher thresholds are implemented for households with disabilities (2,600 kWh) and households with more than three children or for farmers (3,000 kWh). This analysis considers the standard 2,000 kWh threshold.

[10] This refers to the ability for a heating system to respond to price signals or market incentives, e.g., by producing heat when electricity prices are low. See Yule-Bennett, S., & Sunderland, L. (2022). *The joy of flex: Embracing household demand-side flexibility as a power system resource for Europe*. https://www.raponline.org/knowledge-center/joy-flex-embracing-household-demand-side-flexibility-power-system-resource-europe/

Figure 2. Effect of a tariff limit on the total cost of owning a heat pump in Poland



Note: From left to right, electricity prices are assumed at 185 EUR/MWh and 139 EUR/MWh. Coal prices are assumed at 2,000 PLN/t (426 EUR/t) and gas prices at 56.4 EUR/MWh. See Annex for explanation.

The way forward in Poland

Our analysis shows the strong economic case for owning and operating a heat pump in Poland, even considering the large upfront expense. Heat pumps also limit price exposure to highly volatile fossil fuel markets, shielding consumers through milder electricity price increases that, considering the heat pump's efficiency, translate into much lower overall cost increases.

The analysis also shows the impact of limiting the exposure of electricity used by heat pumps to high retail prices. We recommend increasing the limit of the block tariff to 5,000 kWh for heat pump owners to bolster the economic case even further.

In view of the long-term Polish economic, social and climate policy, it is imperative that any policies to advance transformation of the residential heating sector consider long-term objectives for decarbonisation, environmental, air quality and social impacts. We recommend that sustainable policies outside of the crisis mode therefore be based on the following actions:

- **Align economic, social and environmental considerations**. Properly price externalities into fossil fuels and make sure protective instruments introduced during the current energy crisis are clearly marked as temporary measures and are only accessible to the most vulnerable.
- **Strengthen and fully enforce clean air legislation**. Reinstate coal quality standards as soon as the immediate danger to security of supply has been overcome. Introduce amendments to the Energy Policy of Poland until 2040 that advance the date of full phaseout of coal use for individual heating.[11]
- **Effectively regulate to decarbonise heating**. Phase out fossil-fuel subsidies in line with EU legislation, and sooner for the most polluting fuels. Present a clear

[11] Energy Policy of Poland until 2040 refers to the policy document from the Ministry of Climate and Environment. Current wording calls for "abandonment of coal use in households in cities by 2030, in rural areas by 2040."

pathway for reducing gas use for individual heating. Given the high efficiency of heat pumps, prioritise gas use in sectors where it is harder to replace.

Moreover, to promote the most efficient use of resources, it is critical to strengthen all policies and instruments directed at energy efficiency (especially building insulation), and to legislate additional policies around the flexible operation of clean heat assets. Introducing dynamic tariffs and other measures that incentivise household demand-side flexibility is key, as well as encouraging 'smart' operation of heat pumps through well designed support schemes. We propose limiting support only to 'smart -ready' heat pumps that can automatically respond to price signals.

Another important point is unblocking onshore wind developments through the removal of the 10H rule alongside further permitting reform.[12] Onshore wind generation – highest in autumn and winter – correlates very well with heat demand. Aligning expansion of these two technologies, coupled with household flexibility measures, will allow for reduced stress on the electricity system, a flattening of winter peak demand for electricity and potentially a value stream for heat pump owners who provide flexibility services to the grid.

[12] Poland's 10H rule prohibits the construction of wind turbines in areas where buildings are within 10-times the tip height of the turbine.

Annex – Assumptions and data sources

Energy demand

Residential space and water heating demand in 2020 was taken from the Eurostat database *Household final energy consumption disaggregated*.[13] The average space heating demand in Poland was then divided by the number of households to reach an average space and water heating demand per household.[14]

Device characteristics

The conversion efficiencies for each device are from Appendix X in the European Commission's Energy Efficiency Directive guidance note for heat pumps (seasonal coefficient of performance of 3.1, minimum standard) and condensing gas boilers (efficiency of 95% for energy-efficient option).[15] Conversion efficiencies for coal stoves (75%) are from from Cambridge Econometrics.[16] For anthracite coal, a calorific value of 24 MJ/kg was used.[17]

Device lifetimes for each type of heating appliance can range from 18 to 25 years.[18] For simplicity of comparison, these values were set at 18 years.

Upfront cost

The upfront cost (equipment and installation) for heating devices can range greatly between European countries, sources of data and whether the heating system is a replacement or a new build. In this study, the upfront cost of a coal furnace in Poland was taken from recent average device prices and the upfront cost of a typical air-to-water heat pump (EUR 8,000) was provided by PORT PC. The upfront cost of a condensing gas boiler (EUR 3,000) was based on Table A.1.1 in a Cambridge Econometrics study for new builds. Air-to-water heat pumps and condensing gas boilers are assumed to be 10 kW to determine both investment and maintenance costs.

Subsidies

The levels of policy support in this study are based on existing subsidies in Poland. A subsidy of PLN 9,000 (EUR 2,000) was applied to heat pumps, as it is the maximum for an air-to-water heat pump for moderate-income households under the Clean Air Programme.[19] Larger subsidies are available for lower- and lowest-income households

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[13] Eurostat. (updated 2022, 14 June). Disaggregated final energy consumption in households. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_d_hhq

[14] Eurostat. (updated 2022, 27 September). Number of households by household composition, number of children and age of youngest child. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfst_hhnhtych

[15] European Commission. (2019). Annex to Commission Recommendation on transposing the energy savings obligations under the Energy Efficiency Directive. https://eur-lex.europa.eu/eli/reco/2019/1658

[16] Cambridge Econometrics. (2022). *Modelling the socioeconomic impacts of zero carbon housing in Europe*. European Climate Foundation. https://europeanclimate.org/wp-content/uploads/2022/03/modelling-the-socioeconomic-impact-of-zero-carbon-housing-in-europe-final-technical-report-march2022.pdf

[17] Eurostat. (2015). *Coal – Annual Questionnaire*. https://ec.europa.eu/eurostat/documents/38154/6935814/AQ2014-COAL-instructions.pdf/fb6e6d89-aa7d-4a5a-ba2a-846851b87135

[18] Eurostat, 2015.

[19] Ministerstwo Klimatu i Środowiska. Program Czyste Powietrze [Clean Air Program]. https://czystepowietrze.gov.pl/, accessed 20 October 2022; Braungardt, S., Bürger, V., & Stein, V. (2022). *Impact of a ban of fossil heating technologies on NECPs and national energy dependency*. https://www.coolproducts.eu/wp-content/uploads/2022/07/Coolproducts-gas-boiler-ban-2022-_11-July-22.pdf

(up to PLN 27,000 (EUR 2,700)). Similarly, a subsidy of PLN 4,500 (EUR 1,000) was applied to the gas boiler. The analysis does not account for one-time direct fuel subsidies introduced during the energy crisis, as we consider them temporary and they are not part of a long-term policy objective. These include subsidies for coal, biomass, liquified petroleum gas, heating oil use and for heat pump use.[20] The analysis also uses a VAT rate of 23%, rather than a temporary lower VAT rate of 5% for electricity and 0% for gas.

Energy prices

Different energy prices are used per scenario. These are listed in the tables below.

Figure 1	2021	Current	High
Electricity	125.90 EUR/MWh	N/A	N/A
Coal	1,000 PLN/tonne (213 EUR/tonne)	2,000 PLN/tonne (426 EUR/tonne)	3,000 PLN/tonne (640 EUR/tonne)
Gas	37.60 EUR/MWh	43.30 EUR/MWh	56.40 EUR/MWh

Figure 2	Tariff limit at 2,000 kWh	Tariff limit at 5,000 kWh
Electricity	185.00 EUR/MWh	139.00 EUR/MWh[21]
Coal	2,000 PLN/tonne (426 EUR/tonne)	2,000 PLN/tonne (426 EUR/tonne)
Gas	56.40 EUR/MWh	56.40 EUR/MWh

Electricity and gas prices in 2021 are from Eurostat. Gas prices in 2022 are taken from PGNiG.[22] Electricity price below the limit in 2022 was assumed at 2021 level. Electricity price above the limit is estimated based on the law[23] introducing block tariffs and average distribution charge from POBE[24].

The blended electricity rate (tariff limit at 5,000 kWh) is calculated with 80% based on 2022 prices and 20% based on high retail prices. The ratio between the prices was based on the additional electricity demand covered by the heat pump and the assumption that no previous heat demand was covered by electricity. Non-heat

[20] For example, a one-time subsidy of 3,000 PLN for heating costs for coal stoves and 1,000–1,500 PLN for heat pumps.

[21] The blended rate is a mix of 80% 2021 rate (125.9 EUR/MWh) and 20% of the high rate (185 EUR/MWh).

[22] PGNiG. (n.d.). *Taryfa* [Tariffs]. https://pgnig.pl/dla-domu/taryfa-gazu accessed 25 October 2022.

[23] Ustawa z dnia 27 października 2022 r. o o środkach nadzwyczajnych mających na celu ograniczenie wysokości cen energii elektrycznej oraz wsparciu niektórych odbiorców w 2023 roku [Law from 27 October 2022 on extraordinary measures to limit electricity prices and protect consumers in 2023] https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20220002243/O/D20222243.pdf

[24] POBE. 2022. Koszty ogrzewania w typowych budynkach. [Heating costs in new buildings] https://pobe.pl/kalkulator-pobe-koszty-ogrzewania-w-typowych-budynkach/ Accessed 15 November 2022

electricity demand is 2,100 kWh/year and heating demand per household is roughly 12,000 kWh/year. With a heat pump coefficient of performance of 3.1, this corresponds to 3,800 kWh of electricity demand for heating. That means that, with a 5,000 kWh tariff limit, 2,100 kWh for non-heat electricity and 2,900 kWh for heating will be subject to the capped rate, leaving another 900 kWh exposed to higher prices.

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Rue de la Science 23
B – 1040 Brussels
Belgium

+32 2-789-3012
info@raponline.org
raponline.org

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