Central Asia Observation
Vol. 9 (2026) · ISSN 3005-4818

Research Article
journal.pe.ac/Central-Asia-Observation

Directional Asymmetry and One-Sided Records in Central Asia's Cross-Border Electricity Exchange, 2019–2024

Aizada Isakova[a], Nargiza Qodirova[a]

[a]Academy of Public Policy and Economics, London E1 0SG, United Kingdom

Corresponding author: Aizada Isakova, aizada.isakova@pe.ac.

Published 20 March, 2026.

DOI: https://doi.org/10.62432/APPE.CAO.2026.9.38
Article webpage: https://journal.pe.ac/Central-Asia-Observation/paper/view/824547

Abstract

Central Asia's power systems were engineered as one machine and are now accounted for as several. The policy literature asks how much regional electricity trade there could be; this article asks a prior question about the record: in the declared bilateral flows, who supplies whom, and does the record itself support the answer? Using the United Nations Comtrade public preview interface for HS 271600 (electrical energy), 2019–2024, over a design grid of eleven reporters — the five Central Asian states plus Russia, China, Afghanistan, Iran, Azerbaijan and Pakistan — of which the five Central Asian states were harvested in 59 of their 60 cells and Russia and Afghanistan for 2023 and 2024 only, the article codes every reporter-year-flow cell in four record states rather than two: a positive record, an explicit zero, a commodity row absent while the reporter was demonstrably filing that year, and a reporter absent for the whole year. Of the 132 cells, 65 were never queried. Of those, nine are settled by their zero-row year-level check and assigned a record state; the remaining 56 are carried as a separate coverage state throughout, so that a cell never queried is not read as a cell with no record. Of the 60 Central Asian cells, 42 carry a positive record; of the other 18, four are cells in which the reporter was filing that year while its commodity row is absent, thirteen are cells in which the reporter published nothing for the commodity and the year-level check returned zero rows, and one is a cell whose commodity response was empty and whose year-level check could not be obtained, so its silence is inferred from the other flow. Exactly one partner row in the entire harvest declares a value of zero, and its partner is not one of the five Central Asian states. The declared geography is not a diversified market but a few near-exclusive corridors: Kazakhstan's electricity imports come from Russia at 97.5–99.8% in every year of the panel; Uzbekistan's 2024 exports go 78.3% to Afghanistan and its 2024 imports come 84.7% from Turkmenistan; Tajikistan's 2023 exports go 59.2% to Afghanistan. Of the 120 ordered Central Asian pair-years, 35 carry a record on one side only, and in 23 of those the silent side was publishing electricity records that year — so what is missing is the pair record, not necessarily the trade. Where both sides report the same flow, the two figures agree to within USD 1 in three cases out of 25 — only one of them to the cent — and diverge otherwise: every Tajikistan-to-Uzbekistan year has the importer reporting less, by 8.0% to 51.1%; every Kyrgyzstan-to-Kazakhstan year has the importer reporting more; and Uzbekistan's declared exports to Tajikistan in 2022 (USD 469) sit against Tajikistan's declared imports from Uzbekistan (USD 15.9 million). The dominant supplier to Kazakhstan and the main buyer from Uzbekistan and Tajikistan left the reporting framework while the flows were rising: Russia's year-level records are empty from 2022, Afghanistan's from 2020, and Turkmenistan never filed at all in the period. Two limits bound the result: the quantity unit is declared in the payload reference (1000 kWh) and USD is established by UNSD processing documentation; and 70 of the 158 quantity-bearing

© 2026 Academy of Public Policy and Economics · Open Access (CC BY 4.0).

rows carry a publisher-estimated quantity while 29 of the 88 retained rows carry a unit value that rounds to USD 10, 20, 25 or 50 per 1000 kWh, so the unit values reported here are a scale check on the value field, not prices.

Keywords: Central Asia; cross-border electricity exchange; trade statistics; reporting asymmetry; mirror statistics; UN Comtrade

1. Introduction

The Central Asian Power System was designed as a single 500 kV ring running through Kazakhstan, Uzbekistan and Kyrgyzstan, and it has not operated as one since the early 1990s. The institutional history is well documented, including Turkmenistan's effective withdrawal in 2003 and Tajikistan's near-isolation after 2009 (World Bank, 2016). What followed is usually discussed as a shortfall: the region trades less electricity than an integrated system would, and the remedy is a set of institutional arrangements — contract types, deviation settlement, a central trading and dispatch body, grid and metering codes (World Bank, 2016). The closest institutional study quantifies the prize with a least-cost dispatch simulation for four countries over 2010–2014, and reports the regional gain from efficient trade in the billions of dollars (World Bank, 2016). A technical literature addresses reliability under renewable integration (Nasirov et al., 2023), and an active policy literature evaluates the CASA-1000 transmission project as a qualitative exercise over regional reports and secondary statistics (Sultonov & Pant, 2025).

These strands share an assumption that is rarely tested. They treat "regional electricity trade" as a quantity that exists and is measurable, and they argue about its size and its obstacles. This article asks a prior, descriptive question: **in the records that actually exist, who supplies whom — and does the record itself support the direction claim?** If it does not, then any study that uses regional trade volume as an explanatory variable is working with a denominator that carries reporting bias, and the modelling route is structurally unable to see this because it does not need reported flows at all.

Two things make the question answerable at the level of named partners. The first is that the declared bilateral flows for this commodity can be obtained at no cost and at annual frequency for 2019–2024 (United Nations Statistics Division, 2024). The second is that the record has an internal structure that is usually flattened: a pair can be **recorded as traded**, **recorded as zero**, or **not recorded at all**, and these are three different facts. Most analyses of trade statistics collapse the last two into "no trade". This article keeps them apart, and shows that in this commodity the distinction is not academic: explicit zeros are almost absent, missing records are common, and there is a direct counterexample in which a reporter published no electricity row while its partner declared importing from it.

The article makes no causal claim about market reform, and it does not estimate the gains from integration. Its contribution is a measurement result with three parts: a four-state coding of the reporter-year-flow cells that separates declared zero from missing record from reporter absence; the declared directional structure of the five Central Asian states over six years, which is concentrated in a few near-exclusive corridors; and the observation that the dominant supplier and the main buyer left the reporting framework during the period in which the flows were rising.

The article proceeds as follows. Section 2 sets out the data, the record-state coding, the two measurement traps that the raw responses carry, the unit problem, and the verification posture. Section 3 reports the directional results, the one-sided records and the mirror test. Section 4 discusses what the pattern does and does not license. Section 5 concludes.

2. Data and method

2.1. Sources

Trade records. Bilateral annual records for HS 271600 (electrical energy) were taken from the United Nations Comtrade public preview interface for 2019–2024, exports and imports separately, with no key required (United Nations Statistics Division, 2024). The design grid covers eleven reporters: Kazakhstan (398), Kyrgyzstan (417), Tajikistan (762), Uzbekistan (860), Turkmenistan (795), the Russian Federation (643), China (156), Afghanistan (4), Iran (364), Azerbaijan (31) and Pakistan (586). Partner names were taken from the publisher's own partner reference rather than from memory, and the publisher's quantity-unit reference was used to establish the unit of the quantity field (Section 2.4). The grid is 11 reporters × 6 years × 2 flows = 132 cells. **Sixty-seven of those cells were queried and 65 were not**: the five Central Asian states were queried in 59 of their 60 cells, the Russian Federation and Afghanistan for 2023 and 2024 only (four cells each), and China, Iran, Azerbaijan and Pakistan were not harvested as reporters at all. Forty-two of the 67 responses carry rows. A cell that was never queried is not a cell with no record. Of those 65, nine are settled by their zero-row year-level check and assigned a record state; the remaining 56 are carried as a separate coverage state wherever they are counted (Table 2). The distinction is not hypothetical: a re-check of one cell in each of the two cases returns eight rows for China's 2023 exports — a World row and seven partner rows — and none for Pakistan's.

Institutional prior. The World Bank regional power-trade study provides the institutional history and policy setting (World Bank, 2016).

Peer-reviewed context. A reliability-oriented study of the Central Asian Power System (Nasirov et al., 2023) and a qualitative policy review of CASA-1000 (Sultonov & Pant, 2025) are used to place the instruments and the project in the literature.

Evidence cutoff and data vintage. The study's target evidence cutoff is 20 February 2026. The retained responses describe annual trade in 2019–2024. Their original acquisition date is not independently established by the retained logs. This review examined the retained responses on 26 September 2026; that date records local review, not a fresh download from the provider. The versions retained and checked in this round do not independently establish that identical values were publicly available by the target cutoff. The original acquisition date is therefore left unspecified.

2.2. Four record states, and why "missing" is not "zero"

The unit of analysis is the reporter-year-flow cell. Every one of the 132 cells is assigned exactly one state, on evidence from two queries: the commodity query for HS 271600, and a year-level query (cmdCode=TOTAL) that establishes whether the reporter filed anything at all in that year. The 65 cells that were not queried as commodity queries are handled explicitly: an empty year-level check settles such a cell, because a reporter that published nothing published no electricity row, but a year-level check that returns rows does not, because an active reporter may or may not have published an electricity row. Cells of the first kind are assigned the state their year-level check establishes; cells of the second kind are carried as not queried rather than assigned a record state (Table 2). *A cell in this category is still assigned exactly one of the eight table rows; its state is "no state can be assigned."*

- **Positive record** — the commodity response contains a World row with value above zero.
- **Declared zero** — a partner row is present and its value is exactly zero.
- **Commodity absent, reporter active** — no HS 271600 row, but the reporter filed that year for another flow or for TOTAL.
- **Reporter absent for the year** — no HS 271600 row, and every year-level check available returned zero rows. Where the commodity query was not made, a zero-row year-level check establishes the same state; Table 2 separates the two routes to it.

Two further states describe the harvest rather than the reporter, and are kept apart from the four above so that a cell never queried is not read as a cell with no record:

- **Queried, no year-level check obtained** — the commodity query returned no row, and no year-level check for that cell was obtained.
- **Commodity query not made** — the cell was not queried for the commodity and no record state is assigned to it (Table 2 further separates the cases in which the year-level check shows the reporter active from those in which no year-level check exists).

The distinction between the second and third states is the one that matters, and in this commodity the second state is nearly empty. **Across every response obtained, exactly one partner row declares a value of zero**: Uzbekistan's 2021 export record contains a partner row for Poland with a value of 0 and a quantity of 0, reported rather than imputed. No Central Asian pair is recorded as a declared zero in any year. Everything else is either a positive record or no record at all.

Missing is not zero, and there is a direct counterexample. For Kyrgyzstan, the 2023 and 2024 commodity queries return zero rows for both flows, and the year-level activity check returns 301 export rows and at least 500 import rows for 2023 and 306 export rows and at least 500 import rows for 2024 — the import response sits at the interface's 500-row ceiling, so it is a floor rather than a count. The reporter was therefore demonstrably filing in both years while publishing no electricity row whatever. Over the same two years Kazakhstan's own import record declares receiving electricity from Kyrgyzstan: USD 494,818 in 2023 and USD 541,393 in 2024. Reading Kyrgyzstan's silence as zero would be wrong, and not merely in principle.

The same reading applies to the four states as counts. Within the five Central Asian reporters there are 60 cells: 42 positive, and 18 with no positive record. The 18 divide into four cells in which the reporter was demonstrably active (Kyrgyzstan 2023 and 2024, both flows); thirteen cells in which the reporter published nothing for the commodity that year and the year-level check returned zero rows (Turkmenistan, every year, plus Tajikistan's 2024 import side); and one cell, Tajikistan's 2024 export side, for which no commodity response and no export-side year-level check could be obtained, so it is treated as silent only by inference from the import side. One of the thirteen — Turkmenistan's 2024 export side — was not commodity-queried and rests on its zero-row year-level check alone; the other twelve were queried and returned no commodity row. Table 2 gives the full accounting.

A note on what a "partner count" is. The preview response returns the World aggregate as a row among the partners. Counting it as a partner overstates the number of partners by one: Uzbekistan's 2021 export response returns 30 rows, which is 29 named partner records plus the World row. World is used here only as the denominator. The same trap sits one level down in the transport-mode field (Section 2.3), and a count taken before either subtraction is wrong.

2.3. Response structure and aggregation rules

A query response contains a total-bearing row together with component rows. The total is the row with motCode=0, customsCode=C00 and partner2Code=0; summing all returned rows would count the same trade more than once. Partner counts exclude the World row and respect the interface ceiling: Uzbekistan's 2021 export response contains 29 named partners plus the World row, while Kyrgyzstan's 2023 and 2024 import activity is reported as at least 500 rows because 500 is the cap.

Reporter and partner names are resolved through the publisher's code tables. Bibliographic attribution follows the source record: the Tajikistan roadmap is authored by the International Energy Agency and distributed by OECD (International Energy Agency, 2021). All results below use these aggregation and attribution rules.

2.4. Units: a declared quantity, a documented currency, and estimated quantities

The quantity unit is declared by the publisher, not inferred. The publisher's quantity-unit reference defines code 3 as "1000 kWh — electrical energy in thousands of kilowatt-hours", code 22 as kilowatt-hours and code −1 as "not available or not specified or no quantity". Every one of the 158 partner rows in this harvest that carries a quantity carries code 3, and the number of rows carrying a quantity under any other code is zero. Quantity is therefore in thousand kilowatt-hours, on the publisher's own declaration.

The response payload carries no currency field, but the processing documentation supplies the unit. UN Statistics Division documentation states that values reported in national currency are converted to United States dollars before dissemination (United Nations Statistics Division, 2020). Dividing value by quantity on the rows whose quantity is published gives a median of **USD 39.94 per 1000 kWh** (n = 88, interquartile range 20.00–41.41, maximum 64.24), computed by linear interpolation — the convention underlying numpy's percentile and pandas' .quantile(interpolation='linear') (Hyndman–Fan type 7) — consistent with the reported median and minimum/maximum. A per-tonne reading, or any currency that would displace these values by two to three orders of magnitude, would place the implied price outside the known range of regional electricity export prices; the comparison is a **scale test, not price validation**, and it supports a claim about the unit rather than a claim that these are market prices. It is used in that capacity only — as a check that the value field is not denominated in tonnes or in a currency two or three orders of magnitude away — and not as a regional price; the next paragraph shows that the retained rows are not a clean sample of observed prices. The scale comparison is retained only as a consistency check on the documented USD unit, not as evidence used to assign it.

Compliance with the declared unit is not uniform, so price statements are restricted. Of the 158 quantity-bearing partner rows, 70 carry isQtyEstimated true (with legacyEstimationFlag 2 or 6) and 88 are published. On the estimated rows the estimate sits in the quantity field itself: in 2022 the identical ratio of USD 225.350 per 1000 kWh appears on four partner rows belonging to **two independent reporters** and different partners, and two further constants (211.569 and 210.526) account for four more rows in the same year. A ratio that repeats exactly across independent reporters is a derivation, not a price, so a unit value computed on those rows measures the publisher's estimation. They are excluded from every price statement here. Net weight is not an alternative source for them either: on 35 of the 70 the interface flags the weight as imputed, a weight above zero is present on only three, and unit values in this article are computed from the quantity field and never from net weight (the interface flags imputed net weight on 47 of the 168 partner rows).

The exclusion does not clean the retained rows, and they are not a cross-section. The criterion applied above — an exact ratio repeated across independent reporters — also holds inside the 88. Twenty-nine of the 88 carry a unit value that rounds to USD 10.00 (8 rows), 20.00 (13), 25.00 (3) or 50.00 (5) per 1000 kWh, and they recur by corridor: USD 20.00 on twelve Tajikistan–Uzbekistan rows spread over 2019–2024, USD 10.00 on seven Tajikistan-to-Kyrgyzstan rows in four years, and USD 50.00 on four Uzbekistan-to-Afghanistan rows in four years. No further row lies within USD 0.05 of any of the four values. Ten of the 88 carry legacyEstimationFlag 4 while isQtyEstimated is false — nine Uzbekistan rows and one Kyrgyzstan row — and six of those ten sit on one of the four values. The sample is concentrated as well: Uzbekistan supplies 46 of the 88 rows (52.3%) and Tajikistan 30 (34.1%), against Kazakhstan 9 (10.2%) and Kyrgyzstan 3 (3.4%), and the per-reporter medians are USD 30.41 (Kazakhstan), 0.41 (Kyrgyzstan), 20.00 (Tajikistan) and 40.75 (Uzbekistan) per 1000 kWh — a span of two orders of magnitude. The pooled median of 39.94 therefore sits close to the Uzbek median and is not a regional price band; it is reported here only in the scale-check capacity set out above. Removing the 29 rounded-to-integer rows leaves n = 59 and a median of USD 40.77, so the order of magnitude does not depend on that removal.

Four published rows yield unit values one to two orders of magnitude below the band — Kyrgyzstan to Kazakhstan in 2019 (0.410) and 2021 (0.336) and Tajikistan's 2020 import (0.984) and 2020 export to Kazakhstan (3.148), all in USD per 1000 kWh. They are disclosed rather than removed, and they are not used for any price inference. Taken together, these findings **contradict** the proposition that reporters adhere uniformly to the declared quantity unit; the article therefore makes no claim about price levels, price differences or price discrimination.

The aggregate row does not publish a quantity here, and the partner rows do. In eight positive cells the World row publishes a value with quantity-unit code −1. Reading those aggregate rows alone would say that no quantity exists for those cells; the partner rows say otherwise, and the two are reconcilable to the cent. Summed over the partner rows that publish a quantity, Uzbekistan's 2022 imports come to 4.727 TWh (its 2023 imports 4.947 TWh, its 2023 exports 1.664 TWh, its 2024 imports 3.962 TWh and its 2024 exports 2.503 TWh), and in each of those five cells the partner values sum to the World value exactly, to USD 0.00. Kyrgyzstan's 2021 export and import cells likewise carry partner quantities, of 301,721 and 498,232 thousand kilowatt-hours. Only one of the eight, Kyrgyzstan's 2019 import cell, publishes no quantity in the quantity field: its single partner row carries 269,238 in the alternate-quantity field instead. Physical volumes in terawatt-hours are therefore reported from the partner rows wherever a quantity is published, and quantity-unit code −1 is a property of the World row, not an absence of data.

2.5. What the evidence cannot show

Declared values are not physical flows. Twenty-five ordered pair-years carry a positive record on both sides. The two sides agree to within USD 1 in three of them, only one of those to the cent; the remaining 22 disagree, and the disagreements are not centred on zero and are not small (Section 3.6). The causes — valuation basis, transit, coding, omission — are not established here, and nothing in this article should be read as evidence of rerouting or of misreporting. Declared values are treated throughout as declarations.

Absence of a record is treated as unavailability, never as zero trade. This is not cosmetic: the 2003 institutional history and the 2022–2024 record gaps concern the same counterparties, and the second would have been invisible under a two-state coding.

No seasonality. The interface returns annual values only. The winter-deficit, summer-surplus structure documented in the institutional literature is consistent with the mutual exchange visible in the annual data, but it cannot be separated at annual frequency, so no seasonal claim is made.

Four directions remain unresolved. China, Iran, Azerbaijan and Pakistan were not harvested as reporters, so their bilateral structure with Central Asia cannot be stated. Only traces appear, inside Uzbekistan's own export records: to China USD 9,752 (2021) and USD 32,501 (2022), to Iran USD 1,691 and USD 2,689, to Azerbaijan USD 33,487 and USD 79,358. Turkmenistan's own declarations do not exist in the panel at all, so nothing can be said about what it would report. Tajikistan's 2024 export-side activity could not be checked at the year level.

One record is internally impossible and is excluded from the pair analysis. Tajikistan's import record contains rows whose partner is Tajikistan itself — USD 165,858 in 2019, 353,842 in 2020, 328,193 in 2021, 382,049 in 2022 and 442,383 in 2023. A partner cannot be the reporter, so these rows are treated as declaration anomalies and are removed from the pair-level mirror test and from the pair-state counts. They are **not** removed from the reporter's own reported totals: any figure stated against a World row includes whatever part of that World row they make up, and where they fall inside a share they are listed as a separate item rather than absorbed (Section 3.3). In 2019 the whole of Tajikistan's declared import total is that row, so the 2019 net position of +USD 34,690,078 includes it; excluding the row from the totals would give +USD 34,855,936. Tajikistan's export record also carries a residual partner grouping,

”Areas, nes” (code 899), worth USD 200,283 to 443,877 in each year, 0.4–0.7% of its declared exports; every share reported below is disclosed against that residual.

3. Results

3.1. Kazakhstan: from rough balance to one supplier

Kazakhstan is the panel’s strongest single trend. Its declared exports moved little over six years, from USD 46.8 million in 2019 to USD 52.8 million in 2024, while its declared imports rose from USD 57.2 million to USD 302.4 million. The net position therefore deteriorates monotonically, from −USD 10,403,753 in 2019 to −USD 249,599,525 in 2024.

Almost all of that import is one corridor. Russia accounts for 97.5% to 99.8% of Kazakhstan’s declared electricity imports in every year of the panel — 99.4%, 99.6%, 99.8%, 97.7%, 99.8% and 97.5% from 2019 through 2024 — and USD 294,676,315 of the 2024 total of USD 302,354,303. The remaining 2024 imports are Uzbekistan at USD 7,136,595 (2.4%) and Kyrgyzstan at USD 541,393 (0.2%). Import quantity rose from 1,074,483 to 4,861,239 thousand kilowatt-hours over the same period, that is from about 1.07 to about 4.86 terawatt-hours. This series is present for every year, but not on one footing: the 2019–2022 World rows carry isQtyEstimated true, legacyEstimationFlag 2 and isReported false, and their quantity is a single implied unit value backfilled across partners — USD 53.2238 per 1000 kWh on every partner in 2019, USD 225.3504 in 2022 — which is the same estimator that Section 2.4 excludes from every price statement. The four earlier years therefore measure the publisher’s estimation and are reported here as such; the reported quantity rests on 2023 and 2024, which carry isQtyEstimated false.

Concentration is mirrored on the export side, though at a different scale. Kazakhstan’s 2024 exports have exactly two destinations: Kyrgyzstan at USD 27,501,571 (52.1%) and Russia at USD 25,253,207 (47.9%). The Kazakhstan–Russia pair is therefore genuinely bidirectional — Kazakhstan declared exports to Russia above USD 15 million in every year — but the exchange is strongly asymmetric, and the asymmetry widened: the declared import-to-export ratio against Russia runs from about 2.2 in 2019 to about 11.7 in 2024.

3.2. Uzbekistan: the sign reverses, Afghanistan out, Turkmenistan in

Uzbekistan’s declared net position changes sign inside the period: +USD 26,110,767 in 2019, −USD 27,801,250 in 2021, +USD 16,192,736 in 2022, −USD 56,334,237 in 2023 and −USD 6,052,594 in 2024. The composition of each side is nearly a single corridor.

In 2024, exports total USD 115,857,291, of which Afghanistan takes USD 90,693,982 (78.3%), Kyrgyzstan USD 18,026,705 (15.6%), Kazakhstan USD 7,136,595 (6.2%) and Tajikistan USD 9. Imports total USD 121,909,885, of which Turkmenistan supplies USD 103,246,794 (84.7%) and Tajikistan USD 18,663,081 (15.3%), with Kyrgyzstan at USD 10. The largest import source is therefore a country that never appears as a reporter in this panel (Section 3.4).

Partner count is not diversification. Uzbekistan’s 2021 export response returns 30 rows — 29 named partner records plus the World row — and one partner accounts for USD 107,272,415 of the USD 108,890,611 total: Afghanistan, at 98.5%. The remaining 28 named partners together account for USD 1,618,196, or 1.49%. A count of partner rows is not a measure of market breadth, and this cell is the clearest demonstration of it in the panel.

3.3. Tajikistan: the only persistent positive declared value balance, and a mutual pair

Tajikistan is the only reporter in the panel whose declared USD value balance is positive in every year for which it has a record: +USD 34,690,078 in 2019, +USD 50,370,686 in 2020, +USD 78,393,996 in 2021, +USD 90,352,890 in 2022 and +USD 86,487,056 in 2023; its 2024 cells are silent (Section 3.4), so

the record covers five of the six years. Turkmenistan never files, so it cannot be assessed on this measure, and no other reporter with a record has a positive declared value balance in every one of its years. Its declared exports grew from USD 34,855,936 in 2019 to USD 96,363,855 in 2023, an increase of 176%, and its imports stayed an order of magnitude smaller, at USD 9,876,799 in 2023.

The 2023 export structure is again a small number of corridors: Afghanistan USD 57,036,298 (59.2%), Uzbekistan USD 36,189,451 (37.6%), Kazakhstan USD 2,592,000 (2.7%), the residual grouping ”Areas, nes” USD 443,877 (0.5%) and Kyrgyzstan USD 102,229 (0.1%). Imports in 2023 are Uzbekistan USD 9,317,793 (94.3%), the impossible self-partner row USD 442,383 (4.5%) and Kyrgyzstan USD 116,623 (1.2%). Shares are stated against the World row, and the residual is disclosed.

Tajikistan and Uzbekistan are the panel’s only pair with a substantial two-way declared exchange. In every year from 2020 to 2023 Tajikistan’s own record declares both an export to Uzbekistan and an import from Uzbekistan above USD 1 million: for 2023, USD 36,189,451 out and USD 9,317,793 in; for 2021, USD 35,691,318 out and USD 15,395,768 in. Using one reporter’s two flows avoids any mirror assumption. The same pattern appears between Tajikistan and Kyrgyzstan in 2020 and 2021, at about USD 1.3 million out and USD 1.1 million in. This is the shape the institutional literature describes as an exchange of summer surplus for winter deficit (World Bank, 2016), and — as Section 2.5 states — annual data cannot confirm that reading.

3.4. Kyrgyzstan and Turkmenistan: where the record layer separates from the trade layer

Kyrgyzstan is the case that makes the coding necessary. Its declared exports are minute through 2022 — USD 111,140 in 2019, 108,091 in 2020, 101,433 in 2021 and 101,821 in 2022 — and almost entirely to Kazakhstan (USD 101,801 of the 2022 figure; a residual USD 20 goes to Uzbekistan). Its imports through 2022 are Kazakhstan’s and Turkmenistan’s: USD 27 in 2019 and USD 1,261,980 in 2020 from Kazakhstan, then from Turkmenistan USD 9,964,640 in 2021 and USD 59,518,860 in 2022, the latter being 81% of its declared electricity imports that year. The 2021 World row is USD 9,964,800 — the Turkmenistan partner row of USD 9,964,640 plus USD 100 from Kazakhstan and USD 60 from Uzbekistan — so the World figure is not the Turkmenistan figure. In 2023 and 2024 Kyrgyzstan publishes no electricity row at all while remaining an active filer, and its trade is visible only in its partners’ records — Kazakhstan’s imports from Kyrgyzstan of USD 494,818 and USD 541,393 (Section 2.2), and Uzbekistan’s declared exports to Kyrgyzstan of USD 18,026,705 in 2024 (Section 3.2). Whether Kyrgyzstan imported electricity in 2023 and 2024 is not established by this panel; that it traded is established by its partners.

Turkmenistan is absent from the reporting framework for the entire period. All eleven commodity queries made for it return zero rows, and all twelve year-level checks for 2019–2024 return zero rows, which is the strongest form of absence this design can record: not a missing commodity row, but a reporter that published nothing. Its flows are therefore observed only through the states that buy from it. Uzbekistan’s own import record declares electricity from Turkmenistan rising from USD 25,556,659 in 2019 to USD 92,917,287 in 2020, USD 97,464,899 in 2021, USD 105,398,180 in 2022, USD 121,870,932 in 2023 and USD 103,246,794 in 2024. Kyrgyzstan declares USD 9,964,640 (2021) and USD 59,518,860 (2022) from the same source. Reverse traffic is negligible: Uzbekistan declares exporting USD 8,888.66 to Turkmenistan in 2021 and USD 15,671.80 in 2022.

The important consequence is a directional claim of a specific, limited kind. ”Turkmenistan supplies Uzbekistan and Kyrgyzstan” is supported **only by the buyers’ declarations**; Turkmenistan has never confirmed it. The corridor is the panel’s largest single inflow into Uzbekistan — 84.7% of its 2024 imports — and it is entirely one-sided in the record. It should be stated that way, not as a bilaterally verified flow.

3.5. *Who left the reporting framework, and when*

The counterparties that matter most to the direction structure are also the ones that stopped appearing in it. The year-level activity check gives the sequence directly (Table 4).

Russia's year-level records return 199 export rows and 226 import rows in 2019, and 200 and 221 in 2021; from 2022 through 2024 all four checks for each of those years return zero rows. Russia's 2020 year-level check was not obtained, so what the panel establishes is the **observed** silence of 2022–2024, not a defined onset. Afghanistan's records return 66 export rows and 110 import rows in 2019 and zero rows for every check from 2020 through 2023; its 2024 check was not obtained. Turkmenistan returns zero rows on all twelve checks across the period.

That timing is the substantive point. Kazakhstan's declared electricity imports from Russia rose from USD 56.9 million in 2019 to USD 294.7 million in 2024 — an increase of 418%, against 429% for its declared imports from all sources — and Russia's own reporting of any trade whatsoever is empty over the last three years of that increase. Afghanistan, the destination of 78.3% of Uzbekistan's 2024 electricity exports and of 59.2% of Tajikistan's 2023 exports, stopped reporting after 2019. Turkmenistan, the source of 84.7% of Uzbekistan's 2024 imports, never reported. For 2022–2024 the Russia-to-Central-Asia direction, and for 2020 onward the Afghanistan direction, can therefore be observed from one side only. This is not evidence that trade stopped; it is a vacancy in the reporting framework, and it is exactly the kind of vacancy that a study of regional trade volumes would carry into its own denominator without noticing.

3.6. *One-sided records and the mirror test*

One-sided records. Across the 120 ordered pair-years formed by the five Central Asian reporters, 35 carry a record on one side only. The silence has two different causes, and separating them is the point of the coding. In **23** of the 35, the silent side was publishing electricity records that year — so what is absent is that pair's record, not the reporter's participation. In the remaining 12, the silent side published nothing for the commodity that year: ten are Turkmenistan pair-years (Turkmenistan as the silent side: to Uzbekistan 2019–2024, to Kyrgyzstan 2021–2022, and from Uzbekistan 2021–2022), plus Tajikistan's two 2024 pair-years. Nineteen of the 23 are material at USD 100,000 or more on the recorded side, among them Kazakhstan's declared exports to Kyrgyzstan of USD 34,289,956 (2023) and USD 27,501,571 (2024), Uzbekistan's declared exports to Kyrgyzstan of USD 53,000,001 (2022) and USD 18,026,705 (2024), Uzbekistan's export to Kazakhstan of USD 12,654,288 (2020), and Uzbekistan's imports declared from Tajikistan of USD 9,317,793 (2023). In each of these, one side declares a flow worth millions of dollars and the other side, active in the same year on the same commodity, does not record the pair at all.

Mirror test. Twenty-five ordered pair-years carry a positive record on both sides. Three agree to within USD 1, and only one of those to the cent: Uzbekistan to Kazakhstan in 2024 (both sides USD 7,136,595). Kazakhstan to Uzbekistan in 2019 rounds to USD 20,982,993 on both sides but is USD 0.39 apart underneath, and Kazakhstan to Tajikistan in 2020 comes to USD 12.2 against USD 12.0. The remaining 22 do not agree, and the disagreement is neither small nor of a single sign (Table 3):

- **Tajikistan to Uzbekistan, 2019–2023.** The importer's figure is below the exporter's in all five years: 30,994,898 against 28,501,156 (−8.0%); 15,138,052 against 11,333,419 (−25.1%); 35,691,318 against 22,872,239 (−35.9%); 33,402,861 against 16,464,045 (−50.7%); 36,189,451 against 17,687,647 (−51.1%).
- **Kyrgyzstan to Kazakhstan, 2019–2022.** The importer's figure is above the exporter's in all four years, and the gap widens: 111,140 against 230,376; 108,091 against 148,877; 101,413 against 172,205; and 101,801 against 3,316,284 in 2022, a factor of 32.6.

- **Uzbekistan to Tajikistan, 2021 and 2022.** Uzbekistan declares exporting USD 441 and USD 469; Tajikistan declares importing USD 15,395,768 and USD 15,912,185 from Uzbekistan — factors of 34,899 and 33,901.
- **Kazakhstan to Uzbekistan, 2019–2021.** The sides round to the same USD 20,982,993 in 2019 (they are USD 0.39 apart underneath), and the importer is lower by 15.2% in 2020 and 12.5% in 2021. **Uzbekistan to Kazakhstan in 2024** is the only pair-year that agrees to the cent, at USD 7,136,595 on both sides.

Seven ordered pairs have more than one both-sided year, and in four of them the sign of the discrepancy is the same in every year: the importer is below the exporter in all five Tajikistan-to-Uzbekistan years, and above it in all four Kyrgyzstan-to-Kazakhstan years, in both Kyrgyzstan-to-Uzbekistan years and in both Uzbekistan-to-Tajikistan years. In the other three the sign changes inside the pair: Kazakhstan to Kyrgyzstan runs −99.95% (2019), −3.85% (2020), −99.90% (2021) and +42.38% (2022); Tajikistan to Kazakhstan is −35.00% (2019) and +106.50% (2020); and Kazakhstan to Uzbekistan is a difference of +USD 0.39 in 2019 against −15.2% and −12.5% in 2020 and 2021. The sign is therefore a property of four pairs, not of pairs in general, and in three of the seven it is a property of the year. The narrower statement survives: the declared values cannot be used as physical cross-border flows, and any statement about the size of a specific corridor has an irreducible range around it. It says nothing about which side is right, and the causes remain unresolved.

3.7. Summary of declared shapes

Table 1 summarises the six years. Four shapes appear. Kazakhstan is a **one-supplier import structure** that deepened monotonically. Uzbekistan is a **sign-reversing structure** whose export side points at Afghanistan and whose import side points at a state that never reports. Tajikistan is a a **persistent positive declared value balance** with a mutual exchange with Uzbekistan and a single dominant buyer. Kyrgyzstan and Turkmenistan are the two opposite limits of the record problem: Kyrgyzstan trades and stops being visible in its own record, while Turkmenistan is invisible as a reporter and visible only in its partners' records.

4. Discussion

4.1. What the result is

The result is a statement about what trade statistics can carry. The declared geography of Central Asian electricity exchange is not a diversified regional market; it is a small set of near-exclusive corridors, and the record that describes them is one-sided in a large fraction of the pair-years where a flow is declared. Both halves matter together. If the corridors were diversified, single-sided records would be a nuisance; because the corridors are near-exclusive, a single missing side removes the record of a corridor rather than shaving a share off a broad total.

The four-state coding is what makes this visible, and its practical content is the asymmetry between the second and third states. In this commodity the explicit zero is essentially unobservable — one partner row in the entire harvest — while the missing record is common. A study that treats a non-record as a zero will therefore not merely make small errors at the edges; it will read the largest inflow into Uzbekistan (84.7% of 2024 imports, from a reporter that never filed) and the largest inflow into Kazakhstan (97.5–99.8% of imports, from a reporter that stopped filing) as structures it can measure directly, when in both cases it is measuring one side of an asymmetric record.

This also qualifies, without contradicting, the institutional literature. The closest study's prescription — contract types, deviation settlement, a central trading and dispatch body, grid and metering codes — addresses how trade is organised (World Bank, 2016). This article does not test those proposals. What it

adds is the state of the measurement instrument against which their effect would be assessed: for two of the five states the counterparty that dominates the flow is outside the reporting framework, and for a third the commodity record is missing in the years when its trade is visible in its partners' books. An evaluation of institutional reform that relies on declared regional trade volumes inherits those gaps before it begins.

4.2. What the result is not

The article does not establish the causes of the one-sided records or of the mirror differences. Valuation basis, transit and re-export, coding, timing and omission are all compatible with what is reported here, and nothing distinguishes among them. In particular, no inference of under-reporting, rerouting or misreporting is drawn, and readers should not draw one from these tables.

The article also does not establish a regional regularity in either direction: it does not show that all corridors are one-sided, and it does not show that the five states trade as described. Two of the five reporters are effectively outside the panel for the commodity — one silent by choice of the interface's coverage limits, one silent in fact — and the four non-Central-Asian neighbours were not harvested as reporters at all.

Prices are not analysed. Unit values are reported only as a scale check on the value field, and the estimated rows are excluded from them. Differences in unit value between partners are not interpreted as price discrimination, because no adjustment for contract form, timing or quality has been made, and the estimated rows alone would dominate any such comparison.

Physical volumes are taken from the quantity field on the partner rows where it is published, 88 of the 158 quantity-bearing rows; the World rows are not used for volumes, because eight of them carry quantity-unit code −1 while their partner rows carry quantities (Section 2.4). For Uzbekistan in 2022–2024 the volumes are therefore available from the partner rows — 4.727, 4.947, 1.664, 3.962 and 2.503 TWh — and the physical and monetary pictures reconcile there to the cent. Where a quantity is a publisher estimate it is labelled as one and not read as a reported volume.

4.3. Relation to the wider literature

The institutional literature's central quantified claim is about potential: what the region could gain from efficient trade, computed from a least-cost dispatch model over four countries and a period ending in 2014 (World Bank, 2016). The claim may well be right; nothing here tests it. What this article adds is that the instrument such a claim would need in order to be tracked afterwards is, on this commodity and in this period, directionally asymmetric in a way that is systematic rather than incidental. Two literatures sit closer to the measurement and do not overlap it: the reliability-oriented work on the Central Asian Power System treats the system technically rather than commercially (Nasirov et al., 2023), and the CASA-1000 review evaluates a project that had not yet entered service, using regional reports and secondary statistics rather than declared bilateral flows (Sultonov & Pant, 2025). This article measures flows that have already happened, from both sides where both sides exist, and where only one side exists it says so.

5. Conclusion

For the five Central Asian states and HS 271600 over 2019–2024, the declared bilateral electricity exchange is directionally concentrated and unevenly recorded, and the two properties are related.

The declared structure is a small number of near-exclusive corridors. Kazakhstan's imports come from Russia at 97.5–99.8% in every year, and its net position falls from −USD 10.4 million to −USD 249.6 million. Uzbekistan's 2024 exports go 78.3% to Afghanistan and its 2024 imports come 84.7% from Turkmenistan. Tajikistan is the only reporter with a positive declared value balance in every year it records, 2019–2023, exporting 59.2% of its 2023 total to Afghanistan; Turkmenistan never reports, so it

cannot be assessed on this measure. Partner decompositions reconcile to the reported totals in 42 of 42 positive cells, so this structure is not an artefact of the partner list.

The record is asymmetric in a way that a two-state coding cannot express. One partner row in the whole harvest declares a zero, and its partner is not one of the five Central Asian states. Of the 60 Central Asian cells, 18 carry no positive record: four are cases in which no electricity row was published while the reporter was filing that year and its partner declared the flow — for Kyrgyzstan 2023 and 2024 there is a direct counterexample, not merely a suspicion — thirteen are cases in which the reporter published nothing for the commodity and the year-level check returned zero rows, and one is a cell whose commodity response was empty and whose year-level check could not be obtained, so its silence is inferred from the other flow. Of the 120 ordered pair-years, 35 are one-sided, and 23 of those involve a silent side that was actively filing. Where both sides report, they agree to within USD 1 in three cases out of 25, only one of them to the cent.

The counterparties that dominate the flows are the ones that left the record. Russia's year-level reports are empty from 2022 and Afghanistan's from 2020, while Kazakhstan's declared imports from Russia were rising by 418% and Afghanistan was taking 78.3% of Uzbekistan's electricity exports; Turkmenistan never reported in the period at all. The deepest corridor in this panel is therefore described as Uzbekistan declaring imports from Turkmenistan without reciprocal Turkmen reporting. That reporter-specific distinction is the contribution.

The evidence has four material limits. The quantity unit is declared by the publisher; USD is established by UNSD processing documentation; 70 of 158 quantity-bearing rows carry a publisher-estimated quantity and are excluded from price statements; 47 partner rows carry imputed net weight and are not used; four published rows lie outside any plausible price band; and one partner's self-partner rows are removed as impossible.

6. Declarations

Evidence cutoff. Target cutoff: 20 February 2026. Data-vintage and acquisition-date status are specified in Section 2.1.

Issue metadata. Issue date, volume, article number and DOI are withheld pending confirmation by the editor-in-chief.

Data availability. The commodity extracts, the publisher's partner and quantity-unit reference tables, the reduction outputs and the verification scripts are held with the project record. Trade figures come from the United Nations Comtrade public preview interface (United Nations Statistics Division, 2024). The quantity unit is taken from the publisher's own quantity-unit reference; USD follows UNSD processing documentation cited in Section 2.4.

Competing interests. None declared.

7. Tables

Table 1. Declared direction structure, the five Central Asian states as reporters, annual values 2019–2024, HS 271600

Reporter	Net position, first and last recorded year	Dominant import source (share)	Dominant export destination (share)	Shape
Kazakhstan	−10,403,753 (2019) → −249,599,525 (2024)	Russia 97.5–99.8% every year	Kyrgyzstan 52.1% (2024), Russia 47.9%	One-supplier import structure, deepening

(continued)

Table 1 (continued)

Reporter	Net position, first and last recorded year	Dominant import source (share)	Dominant export destination (share)	Shape
Uzbekistan	+26,110,767 (2019) → −6,052,594 (2024)	Turkmenistan 84.7% (2024)	Afghanistan 78.3% (2024)	Sign reversal inside the period
Tajikistan	+34,690,078 (2019) → +86,487,056 (2023)	Uzbekistan 94.3% (2023)	Afghanistan 59.2% (2023)	Positive declared value balance in every recorded year; mutual pair with Uzbekistan
Kyrgyzstan	not computable for 2023–2024	Turkmenistan 81.0% of 2022 imports	Kazakhstan, 100% of 2019–2022 exports	Trades and stops being visible in its own record
Turkmenistan	never reported	—	—	Visible only in partners' records

Note. net position is the reporter's own declared exports minus its own declared imports, in USD. Shares are of the reporter's own World row for that year. Kyrgyzstan published no HS 271600 row in 2023 or 2024, so no net position can be computed for those years. Turkmenistan returned zero rows on the eleven commodity queries made for it and on all twelve year-level activity checks.

Panel A — partner rows in the 42 electricity responses that carry rows. 168 partner rows returned (World rows excluded); 1 declared as zero; 0 declared as zero inside any Central Asian pair; 158 carrying a quantity under unit code 3, of which 88 published rather than estimated and 70 publisher-estimated; 47 whose net weight is flagged as estimated.

Panel B — reporter-year-flow cells, state counts.

Table 2. Record-state accounting for the reporter-year-flow cells, HS 271600, 2019–2024

State	Central Asian five (60 cells)	All eleven reporters (132 cells)
Positive record	42	42
Declared zero as the cell's only content	0	0
Commodity row absent, reporter active that year	4	4
Reporter absent for the year, directly checked by the commodity query	12	18
Reporter absent for the year, established by the year-level check alone	1	9
Reporter absent for the year, inferred	1	1
Queried, but no year-level check obtained	0	2
Commodity query not made, no state assignable	0	56
Total	**60**	**132**

Note. of the 132 cells, 67 were queried as commodity queries and 65 were not (Section 2.1). The single declared zero is a partner row in Uzbekistan's 2021 export record (Poland, value 0, quantity 0), and its partner is not one of the five. The four "reporter active" cells are all Kyrgyzstan, 2023 and 2024, both flows, where the year-level activity check returns 301 and 306 export rows and at least 500 import rows. Nine cells are settled by the year-level check although the commodity query was not made: Russia 2022 (both flows), Afghanistan 2020, 2021 and 2022 (both flows in each year), and Turkmenistan's 2024 export side. Of the 56 cells with no assignable state, the year-level check shows the reporter active in six (Russia 2019 and 2021 and Afghanistan 2019, both flows) and no year-level check was obtained for the other 50 (China, Iran, Azerbaijan and Pakistan in full, plus Russia 2020). The one inferred cell is Tajikistan's 2024 export side, for which neither a commodity response nor an export-side year-level check was obtained; the two "queried, but no year-level check obtained" cells are Afghanistan's 2024 exports and imports.

Table 3. Mirror test, ordered Central Asian pair-years with a positive record on both sides

Ordered pair	Pair-years	Exporter's figure (USD)	Importer's figure (USD)	Difference
Tajikistan → Uzbekistan	5 (2019–2023)	15,138,052 – 36,189,451	11,333,419 – 28,501,156	−8.0% to −51.1%
Kyrgyzstan → Kazakhstan	4 (2019–2022)	101,413 – 111,140	148,877 – 3,316,284	+37.7% to +3,157.6%
Kazakhstan → Uzbekistan	3 (2019–2021)	18,682,785 – 20,982,993	16,354,699 – 20,982,993	−15.2% to 0.0%
Uzbekistan → Tajikistan	2 (2021–2022)	441; 469	15,395,768; 15,912,185	×34,899; ×33,901
Six further ordered pairs	11	—	—	two pair-years to within USD 1; three exceed USD 1 million on both sides
Total	**25**			

Note. 25 of the 120 ordered pair-years carry a positive record on both sides. Three agree to within USD 1, only one of them to the cent: Uzbekistan → Kazakhstan 2024 (both USD 7,136,595). Kazakhstan → Uzbekistan 2019 rounds to USD 20,982,993 on both sides but is USD 0.39 apart underneath, and Kazakhstan → Tajikistan 2020 is USD 12.2 against USD 12.0. The 11 pair-years in the last row belong to six further ordered pairs — Kazakhstan → Kyrgyzstan, Kazakhstan → Tajikistan, Kyrgyzstan → Uzbekistan, Tajikistan → Kazakhstan, Uzbekistan → Kazakhstan and Uzbekistan → Kyrgyzstan — of which three exceed USD 1 million on both sides (Kazakhstan → Kyrgyzstan 2020 and 2022, and Uzbekistan → Kazakhstan 2024) and the other eight fall below USD 135,000 on at least one side. Two of those six pairs — Kazakhstan → Kyrgyzstan and Tajikistan → Kazakhstan — change the sign of the difference from year to year (Section 3.6). No cause of any difference is established, and none is inferred.

Table 4. Year-level reporting activity of the counterparties, rows returned by the cmdCode=TOTAL check (exports/imports)

Reporter	2019	2020	2021	2022	2023	2024
Russian Federation	199/226	not checked	200/221	0/0	0/0	0/0
Afghanistan	66/110	0/0	0/0	0/0	0/0	not checked
Turkmenistan	0/0	0/0	0/0	0/0	0/0	0/0

Note. these are counts of returned rows for a query with no commodity restriction, so a zero means the reporter published nothing at all to this interface for that year and flow. The 2023 and 2024 Kyrgyzstan import checks returned 500 rows, the interface ceiling, and are therefore reported in the text as at least 500. China, Iran, Azerbaijan and Pakistan could not be harvested as reporters and do not appear.

Statements

Funding. This work received institutional support from the Academy of Public Policy and Economics (APPE).

Competing interests. The authors are affiliated with APPE, which operates this journal. No external competing interests are declared.

References

International Energy Agency. (2021). *Cross-border electricity trading for Tajikistan: A roadmap*. Paris. https://doi.org/10.1787/13631dc4-en

Nasirov, T. K., Trofimov, G. G., & Khamidov, S. V. (2023). Ensuring reliability and sustainable development of the Central Asian power system in the context of growing energy consumption. *Energy Systems Research*, *6*(4), 44–50. https://doi.org/10.25729/esr.2023.04.0004

Sultonov, Z., & Pant, H. K. (2025). A comprehensive review of CASA-1000: Transforming regional energy cooperation. *Green Energy and Environmental Technology*, *4*. https://doi.org/10.5772/geet.20250053

United Nations Statistics Division. (2020). *Request for 2019 annual and 2020 monthly merchandise trade statistics and trade by enterprise characteristics*. United Nations Department of Economic and Social Affairs. https://unstats.un.org/unsd/trade/IMTS/IMTS%20Data%20Request%20EN_2019.pdf

United Nations Statistics Division. (2024). *UN Comtrade database: Public preview interface*.

World Bank. (2016). *Enhancing regional power trade in Central Asia* [Report No. ACS21198]. Washington, DC. https://doi.org/10.1596/26047