

The Geoeconomics of Renewable Energy Development in South and Central Asia Using PPPs: Scope for Inter-Regional Energy Cooperation

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Background and Rationale for Regional Renewable Energy Cooperation in South Asia and Central Asia

Core Hypothesis:

Leveraging complementary energy profiles between Central Asia (resource-abundant) and South Asia (demand-driven), cross-regional renewable energy (RE) sharing and Public-Private Partnership (PPP) frameworks present a critical opportunity for sustainable energy security and decarbonization in both regions.

Context: The Need for This Paper

- Asymmetric Energy Landscapes:
 - South Asia: Rapid economic growth and demographic expansion are driving up electricity demand.
 - Central Asia: Significant endowment of fossil fuels and renewables, but demand lags behind supply.
- Mutual Opportunity:
 - Cross-border RE trade and integration could address supply-demand mismatches, enhance energy security, lower costs, and support regional decarbonization (World Bank, 2024).

Key Regional Challenge:

- Aligning investment, policy, and cross-border infrastructure for scalable renewable energy integration—making use of both regions' comparative advantages while advancing climate-resilient development goals (World Bank, 2024; ADB, 2025).

Regional Electricity Production and Consumption

- South Asia's energy demand is projected to more than double by 2050, while Central Asia maintains significant surplus capacity for exports (ERIA, 2023; World Bank, 2022b).
- The regions are a natural fit: surplus energy in Central Asia aligns with South Asia's growing deficit, enabling mutually beneficial power trade and security benefits (CARECP, 2025; EDB, 2022).
- Academic and multilateral analyses (ERIA 2023, CAREC, UNECE 2024) confirm market integration would lower costs, optimize resource use, and support large-scale renewables deployment.

South Asia (2021)	Production	Exports	Imports	Consumption	Energy Surplus
Afghanistan	1,298	0	5,315	3,890	-2,592
Bangladesh	72,320	0	8,103	71,488	832
Bhutan	10,822	8,074	25	2,711	8,111
India	1,484,463	9,249	7,974	1,316,765	167,698
Maldives	596	0	N/A	355	241
Nepal	6,045	44	2,806	7,313	-1,268
Pakistan	143,704	0	498	116,816	26,888
Sri Lanka	16,716	0	N/A	15,214	1,502

Central Asia (2021)	Production	Exports	Imports	Consumption	Energy Surplus
Kazakhstan	115,079	2,663	2,120	114,536	543
Kyrgyz Republic	15,138	548	1,683	13,535	1,603
Tajikistan	20,624	3,303	883	13,800	6,824
Turkmenistan	22,500	3,200	0	14,700	7,800
Uzbekistan	71,363	2,644	6,232	74,952	-3,589

Source: ADB Key Indicators 2024

South Asia Background

- Demand-Side Pressures:
 - Population and industrial growth fueling electricity demand (ADB, 2023)
 - Increasing electricity prices and risks associated with fossil fuel imports
- Energy Transition Trends:
 - Major push to re-evaluate energy policy due to:
 - Falling cost of renewables
 - Volatility in global fossil fuel markets
 - Sustainability and climate targets (ICDR, 2024)
 - PPPs are increasingly used in hydropower, now followed by solar and hybrid RE projects
- Current Challenges:
 - Limited public sector coordination
 - Need to deepen green finance mechanisms
 - Making RE prices fully competitive against subsidized fossil fuels (Farooq & Arora, 2024)

Central Asia Background

- Supply-Side Dynamics:
 - Aims to create affordable, reliable electricity markets across highly diverse economies
 - RE adoption remains slow compared to resource wealth (CAREC, 2024)
- Policy and Market Environment:
 - Legal and regulatory frameworks at varying levels of maturity across countries
 - Transition fuel: Abundant natural gas supports reliability during RE ramp-up
 - Price interventions: Fossil fuel subsidies continue to influence energy sector economics
- Investment and Financing Challenges:
 - Limited public funding; private capital mobilization remains insufficient
 - Gradual improvements in regulatory environments, but more reforms needed to attract PPPs and green finance (ADB, 2025)

South and Central Asia RE study methods

- RE projects have particular challenges and public finance is crucial
 - RE require a high up-front investment, private sector capital, technology, and innovation
 - So PPPs can be used to crowd-in private finance with limited public funds
- As many of these countries are developing or middle-income
 - They have a lower infrastructure base with their citizens' limited ability to pay for their services
 - So the government cannot raise the needed funds through taxation
- provide policymakers with an integrated review of PPPs
 - Associated public policy interventions in these two regions that have been heavily reliant on coal and other carbon-intensive energy source to RE through PPPs
 - Data from World Bank Group's Private Participation in Infrastructure (PPI database 2003 - 2023)

South Asia: Economic and Energy Profile

- Resource Distribution & Demand:
 - Regional energy demand growth is sustained by large population and rapid economic growth (South Asia population: ~1.68 billion, GDP/capita (PPP): \$10,176, World Bank, 2025).
 - India, Pakistan, and Bangladesh hold most of the region's coal and natural gas reserves and are heavily reliant on these sources
 - Bhutan and Nepal possess substantial hydropower resources, while the Maldives remains almost entirely dependent on imported oil.
- Electricity Generation & Imports:
 - India is the largest power consumer, still highly reliant on coal (75.6% fossil in 2021), but robustly scaling solar and wind investments—targeting >50% renewables in electricity mix by 2030.
 - Pakistan's generation combines coal, gas, and significant hydropower, but imports remain critical to balancing demand.
 - Bangladesh and Afghanistan depend on gas and hydro (majority imported).
 - Bhutan and Nepal generate most of their power from large hydropower, exporting surplus to India; Maldives is dominated by imported oil.
- Market/Policy Trends:
 - Electricity access now reaches 99% region-wide, but generation is still 76% fossil and only 8.5% renewables (excluding hydro).
 - Political support for renewables is growing, but transition lags due to subsidies, finance challenges, and variable private sector engagement.
 - China continues to play a major investor role in Pakistani RE.
 - Import reliance for coal, LNG, oil/petroleum is expected to remain high as regional demand rises,

South Asia Profile of Economy, Electrification and Energy Source

Country	Population (million) 2024	GDP per capita, PPP (current international \$) 2023	Electric Power Consumption (kWh/capita) 2022	Electrification Rate (% of population) 2023	Fossil Fuel (% of total) 2021	Hydro (% of total) 2021	Renewables (% of total) 2021
Afghanistan	42.6	2,201.7		85	21.8	71.7	6.6
Bangladesh	173.6	9,147.8	603	100	98.6	0.7	0.8
Bhutan	0.8	16,254.0		100	0.0	100.0	0.0
India	1,450.9	10,323.5	1075	100	75.6	9.9	9.2
Maldives	21.9	14,455.7	684	100	51.1	41.5	7.8
Nepal	0.5	24,735.1		100	94.2	0.0	5.8
Pakistan	29.7	5,395.2	321	94	0.0	99.1	-15.3
Sri Lanka	251.3	6,036.6	606	96	63.6	20.5	7.8
South Asia	1,677.4	10,176.4	1007	99	75.7	10.8	8.5

Source: World Bank 2025

Renewable Energy Challenges for South Asia

- **Underutilization of Natural Resources:**
 - While the region is well-endowed with coal, natural gas, hydropower, and renewables, most countries have not fully developed these resources, leading to persistent fuel security risks (World Bank, 2025).
 - Gas reserves in Pakistan and Bangladesh are declining, raising vulnerability to supply shocks.
- **Lack of Fuel Diversification:**
 - India remains heavily coal-dependent; Bangladesh and Pakistan rely mainly on gas and increasingly on imported LNG; Bhutan and Nepal's generation mix is predominantly large hydro, with minimal fuel basket diversity (ADB, 2023).
- **Limited Renewable Energy Penetration:**
 - Despite strong solar, wind, and hydro potential, RE's share in the primary energy mix (and adoption rate) remains low across most countries except for hydropower in Bhutan and Nepal; and there is a significant push in India to accelerating solar and wind capacity
- **Dependence on Imports and Infrastructure Constraints:**
 - Heavy reliance on energy imports—especially oil and petroleum—is a consistent feature for most South Asian states.
 - Afghanistan, despite crude oil reserves, satisfies nearly all domestic demand through imports due to lack of processing infrastructure and political challenges
 - Refinery capacity is inadequate outside India; Bhutan, Nepal, and Maldives rely almost entirely on imports, amplifying vulnerabilities.
- **Private Sector and Policy Gaps:**
 - Private capital mobilization for renewables is rising in India, but incentives and regulatory clarity remain inconsistent across the region.
 - Grid integration and enabling policy frameworks lag, particularly for cross-border renewable energy trade and PPPs in smaller countries (ADB, 2023; World Bank, 2025).

Central Asia: Economic and Energy Profile

- Resource Concentration:
 - Kazakhstan, Turkmenistan, and Uzbekistan are endowed with major oil, gas, and coal reserves, driving their continued reliance on fossil fuels (fossil fuel share: 75%).
 - Kyrgyz Republic and Tajikistan remain hydro-dominated, with >85% of generation from hydropower; both import oil and gas in winter months to manage seasonal shortages.
- Sectoral Constraints:
 - Legacy Soviet-era infrastructure constrains system efficiency and reliability across all countries.
 - Power consumption and electrification rates are high (region average: 99.9%), but supply quality and diversity remain issues.
- Renewables and PPPs:
 - Large untapped solar and wind potential exists in Kazakhstan, Uzbekistan, and Turkmenistan; Tajikistan and Kyrgyz Republic have additional biomass prospects.
 - Major hydro investments ongoing in Tajikistan, but non-hydro renewables share remains low (regional RE share: 3%).
 - Wind deployment is minimal; solar PV PPPs are beginning to gain momentum, notably in Kazakhstan (e.g., US\$98 million in recent PPP projects).

Central Asia Profile of Economy, Electrification and Sources

Country	Population (million) 2024	GDP per capita, PPP (current international \$) 2023	Power Consumption (kWh/capita, 2022)	Electrification Rate (%) 2023	Fossil Fuel (%) 2021	Hydro Share (%) 2021	Renewables Share (%) 2021
Kazakhstan	20.6	38,515.2	5,322	100	88.2	8.1	3.0
Kyrgyz Republic	7.2	7,298.1	1,975	100	14.1	85.9	0.0
Tajikistan	10.6	4,963.6	1,427	100	7.3	92.7	3.3
Turkmenistan	7.5	19,828.9	2,659	100	100.0	0.0	0.0
Uzbekistan	36.4	11,107.0	2,119	100	90.7	8.7	0.1
Central Asia	82.3	13,220.0	2,795	99.9	75	22	3

Source: Authors calculation from World Bank 2020

Renewable Energy Challenges for Central Asia

- Limited Energy Diversification:
 - Despite vast solar, wind, and hydro potential, most countries remain reliant on a dominant source: Kazakhstan (coal), Uzbekistan and Turkmenistan (gas), Tajikistan (hydro), and Kyrgyz Republic (hydro/oil).
- Financial and Technical Barriers:
 - Low-income states lack adequate financing and technical capacity to scale renewable energy, with state-owned utilities in Kyrgyz Republic and Turkmenistan deterring foreign investment (ADB, 2023).
 - Private sector and PPP involvement in renewables is still nascent, outside a few solar PPPs in Kazakhstan.
- Aging and Obsolete Infrastructure:
 - The energy sector remains dependent on Soviet-era equipment (1960s–70s), causing rising maintenance issues and inefficiencies since the 2000s.
 - Grid bottlenecks limit integration of new renewable projects and effective cross-border trade.
- Fragmented Regional Cooperation:
 - Breakdowns in the Central Asian Power System (CAPS) since the early 2000s (Turkmenistan exit in 2003, Uzbekistan in 2009) have further complicated power exchange and balanced development.
 - While resource-rich countries are largely energy self-sufficient, gaps persist for resource-poor members, underscoring the need for deeper cooperation.

Regional Electricity Cooperation within South Asia

Current Trade and Infrastructure:

- Regional trade focuses largely on petroleum, coal, and LNG, with cross-border electricity transfers still limited in scope (NREL, 2025; ADB, 2024).
- There are currently no inter- or intra-regional natural gas pipelines—LNG terminals are present only in India.
- Active electricity trade corridors:
 - India–Nepal and India–Bhutan (hydropower-driven bilateral agreements).
 - India–Bangladesh via high-voltage lines; planning underway for India–Sri Lanka undersea cable.
 - Nepal trading on Indian power exchange since 2021; Bhutan since 2022.
- Proposed or emerging links include:
 - Bangladesh–Nepal (via Indian corridor).
 - India–Sri Lanka (undersea/overland cable).
 - Bangladesh–Bhutan–India trilateral hydropower projects.
- Cooperation and Challenges:
 - Most cross-border power trade is bilateral and government-to-government; recent years show growth, with some evolving toward commercial arrangements.
 - Political/security tensions between India, Pakistan, and Afghanistan continue to restrict broader energy cooperation, especially with no direct electricity or pipeline links involving Pakistan and Afghanistan.
 - Despite shared vision and untapped hydro/renewable resources, progress on true regional market integration is constrained by security, regulatory, and diplomatic barriers (Singh et al., 2018; NREL, 2025).

PPPs and investment in various sectors/regions

Est. Infrastructure Investment Needs 45 DMCs, 2016–2030

Sector/Region	Baseline est. (\$bill 2015 prices)	Climate- adjusted est. (\$bill 2015 prices)
Power	11,689	14,731
Transport	7,796	8,353
Telecommunications	2,279	2,279
Water and Sanitation	787	802
Total	22,551	26,166

Central Asia	492	565
East Asia	13,781	16,062
South Asia	5,477	6,347
South East Asia	2,751	3,147
Total	22,551	26,166

Source: ADBI, 2017

PPPs investments by sub-sector (top) globally, 2003–2023

Row Labels	Count of Projects	Total Investment (US million)
Energy	577	140,817
Electricity	525	124,374
Electricity, Water Utility	2	-
Natural Gas	50	16,443
Information and communication technology (ICT)	11	12,524
ICT	11	12,524
Municipal Solid Waste	66	4,723
Collection and Transport	40	2,664
Integrated MSW	4	241
Treatment/ Disposal	22	1,818
Transport	113	100,702
Airports	41	51,446
E-Vehicle Charging Station	2	193
Ports	32	7,211
Railways	11	5,494
Roads	27	36,358
Water and sewerage	44	4,132
Treatment plant	5	694
Treatment plant, Water Utility	1	25
Water Utility	38	3,414
Grand Total	811	262,899

Authors calculation from PPI Database accessed 2025

PPPs and investment in various regions

PPPs investments by Sector in South Asia, 2003–2023

Row Labels	Count of TotalInvestment	Sum of TotalInvestment
Energy	727	183,585
Electricity	716	183,209
Electricity, Water Utility	1	0
Natural Gas	10	377
Information and communication technology (ICT)	13	1,168
ICT	13	1,168
Municipal Solid Waste	53	1,920
Collection and Transport	6	18
Integrated MSW	29	1,273
Treatment/ Disposal	18	629
Transport	575	137,031
Airports	19	15,080
Ports	55	13,186
Railways	10	7,873
Roads	491	100,893
Water and sewerage	25	2,004
Treatment plant	12	938
Water Utility	13	1,066
Grand Total	1,393	325,709

Authors calculation from PPI Database accessed 2025

PPPs investments by Sector in Europe and Central Asia, 2003–2023

Row Labels	Count of TotalInvestment	Sum of TotalInvestment
Energy	577	140,817
Electricity	525	124,374
Electricity, Water Utility	2	0
Natural Gas	50	16,443
Information and communication technology (ICT)	11	12,524
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Municipal Solid Waste	66	4,723
Collection and Transport	40	2,664
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Global Energy PPP by tech & region – 2000–2023 (\$ US Million)

Largest private-public partnership investments go to large hydro, solar, and wind technology-based electricity generation projects

PPPs in many RE technologies gaining prominence in many regions, especially in the last ten years

South Asia still receives a large share of PPP investments in the previous 20 years in energy, reaching \$ 183.6 billion, Central Asia clubbed with Europe received in energy 140.8 billion

Authors calculation from PPI Database
accessed 2025

Row Labels	East Asia and Pacific	Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa	Grand Total
Biogas	97	111	296			24	528
Biomass	5,442	416	5,343		533	1,093	12,827
Coal	63,512	25,595	4,238	4,035	100,790	830	199,000
Coal, Diesel		9,270					9,270
Coal, Diesel, Natural Gas	1,210						1,210
Coal, Natural Gas		4,374			2,996		7,370
Diesel	114	3	2,623	1,178	1,792	1,921	7,630
Diesel, Geothermal, Hydro, Large (>50MW), Wind						109	109
Diesel, Natural Gas	197		538	120	412		1,267
Diesel, Natural Gas, Other						196	196
Diesel, Waste			44				44
Geothermal	7,359	2,134	1,409			417	11,319
Hydro, Large (>50MW)	30,176	13,878	55,780		17,504	4,105	121,443
Hydro, Large (>50MW), Diesel, N/A						-	-
Hydro, Small (<50MW)	3,232	1,689	9,671		1,111	1,597	17,299
N/A	19,039	3,831	28,466	1,719	4,454	7,478	64,986
N/A, N/A		-					-
Natural Gas	22,916	20,255	22,092	6,932	13,987	7,483	93,665
Natural Gas, Diesel	250			180			430
Natural Gas, Hydro, Large (>50MW), Wind		2,539					2,539
Natural Gas, Other						172	172
Natural Gas, Steam	103	233	225				561
Natural Gas, Steam, Solar, CSP				315			315
Natural Gas, Steam, Solar, PV				158			158
Not Applicable	12,526	30,894	36,330	104	9,742	869	90,464
Not Applicable, Diesel, Wind			38				38
Not Applicable, N/A					-		-
Nuclear		-			559		559
Other	5,631	60	1,273	2,109	940	1,747	11,760
Solar, CPV		157	1,334	930	60		2,481
Solar, CSP	377			3,276	950	4,566	9,169
Solar, PV	19,664	9,531	21,403	4,684	14,829	11,799	81,910
Solar, PV, Biogas	17						17
Solar, PV, N/A				-		324	324
Solar, PV, Not Applicable			13				13
Solar, PV, Other	1,011						1,011
Solar, PV, Solar, PV						77	77
Solar, PV, Wind	190		260				450
Solar, PV, Wind, N/A						92	92
Steam			135				135
Waste	4,079	28	2,341	120	95	451	7,114
Wind	19,006	15,818	52,840	4,557	12,553	11,397	116,170
Wind, N/A	42						42
Wind, Not Applicable			378				378
Wind, Other	644						644
Wind, Solar, PV					280		280
Grand Total	216,834	140,817	247,069	30,416	183,585	56,746	875,468

South Asia energy PPP project, by tech and country – 2003 –2023 (\$ million)

Overall investments in PPPs totalled 183.6 US\$ Billion with more than half going to coal projects,

India dominates the region's totals, with coal projects alone accounting for \$92.6 billion, making coal historically the largest PPP investment category.

While coal, gas, and large hydropower have long been the main recipients, recent years show a decisive shift:

New PPP projects are increasingly focused on renewables, particularly solar (total \$14.8B) and wind (\$12.6B).

Hydropower remains significant, especially in Nepal, Bhutan, and India, totaling \$17.5B for large hydro.

Tech	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka	Grand Total
Biomass		9		107			334	83	533
Coal		579		92,628			7,059	525	100,790
Coal, Natural Gas				2,996					2,996
Diesel	2	572					1,097	122	1,792
Diesel, Natural Gas		412							412
Hydro, Large (>50MW)			403	9,936		2,541	4,625		17,504
Hydro, Small (<50MW)				328		476	38	269	1,111
N/A				3,122			1,332		4,454
Natural Gas	172	4,476		7,352			1,987		13,987
Not Applicable		62		7,472			2,208		9,742
Not Applicable, N/A				-					-
Nuclear							559		559
Other		481		20			439		940
Solar, CPV				60					60
Solar, CSP				950					950
Solar, PV	38	416		13,931	-	17	414	12	14,829
Waste				88			8		95
Wind				9,357			3,009	186	12,553
Wind, Solar, PV								280	280
Total	211	7,007	403	148,346	-	3,034	23,108	1,478	183,585

South Asia energy PPP project, by tech and year– 2003 –2023 (\$ million)

Labels	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Biomass				9	13	41	6	10	4	49	97	14			200						91	533
Coal		473	581	6,032	9,578	10,494	23,329	27,641	12,425	3,080	525		75	1,108	1,940	1,080	520	1,912	-			100,790
Coal, Natural Gas		2,996																				2,996
Diesel	2	62	60	32	225		839	108	43	176	40	115			26			64				1,792
Diesel, Natural Gas															412							412
Hydro, Large (>50MW)	408	269		2,490	3,969	1,186	1,135	462	509	1,402	229		368		3,588		647			842		17,504
Hydro, Small (<50MW)	65	79	92	26	43	109	15	210	101	9		164		26	151	21						1,111
N/A	41	30	1,302	22	2,510	234	221														94	4,454
Natural Gas	336	1,530	59	170	392	860	534	858	3,394	761		402	300	170		269	172	3,167		613		13,987
Not Applicable				18		87	406	910	493	2,429	58	875		994	147	186	1,658	275	23	1,148	37	9,742
Not Applicable, N/A	-																					-
Nuclear			559																			559
Other						439	51	40	183									207		20		940
Solar, CPV															60							60
Solar, CSP									186	652			113									950
Solar, PV								134	1,229	476	172	388	752	797	854	1,053	933	1,717	1,848	118	4,357	14,829
Waste	23		21	13	18	21																95
Wind		26		14	68	283	66	637	981	3,208	1,293	475	1,663	476	640	503	776			1,320	124	12,553
Wind, Solar, PV										280												280
Total	874	5,465	2,673	8,825	16,817	13,753	26,601	31,009	19,547	12,521	2,414	2,431	3,270	3,571	8,017	3,112	4,706	7,342	1,871	4,041	4,723	183,585

Central Asia PPP project by country – 2003–2023 (\$ million)

Central Asia (plus periphery) secured over \$10.3 billion in energy sector PPP investment from 2003–2023.

Unlike South Asia, investment has been primarily in hydropower (large hydro, \$2.2B), natural gas (\$2.1B) (not coal), and a significant upsurge in solar PV (\$2.8B) and wind (\$2.8B) in the last 5 years.

Uzbekistan leads renewables PPP investment, with \$1.6B in solar PV and \$2.1B in wind; while Kazakhstan and Georgia also show notable PPP projects in solar and hydro

Row Labels	Azerbaijan	Georgia	Kazakhstan	Kyrgyz Republic	Tajikistan	Uzbekistan	Grand Total
Biogas							-
Biomass							-
Coal							-
Coal, Diesel							-
Coal, Natural Gas							-
Diesel							-
Geothermal							-
Hydro, Large (>50MW)		1,175		118	940		2,233
Hydro, Small (<50MW)		102					102
N/A		233					233
N/A, N/A							-
Natural Gas						2,084	2,084
Natural Gas, Hydro, Large (>50MW), Wind							-
Natural Gas, Steam							-
Not Applicable		50		40			90
Nuclear							-
Other							-
Solar, CPV							-
Solar, PV	450		751			1,626	2,827
Waste							-
Wind	348	14	343			2,064	2,769
Grand Total	798	1,575	1,094	158	940	5,773	10,338

Central Asia PPP project by year – 2003–2023 (\$ million)

Early years (2003–15) saw few PPPs outside hydro, but now most new investments are renewables, particularly solar PV and wind—almost none in coal

Hydro still receives some investment, but it is no longer growing as quickly as solar or wind.

Row Labels	2003	2004	2006	2007	2008	2009	2011	2014	2015	2017	2018	2019	2020	2021	2022	2023	Grand Total
Hydro, Large (>50MW)			720	276	220		417		417	65						118	2,233
Hydro, Small (<50MW)		27		43		32											102
N/A	-		95	139													233
Natural Gas														1,002		1,082	2,084
Not Applicable					50			40									90
Solar, PV										52		429	245	228	250	1,622	2,827
Wind												151	140		1,945	533	2,769
Grand Total	-	27	815	458	270	32	417	40	417	65	52	580	385	1,230	2,195	3,354	10,338

Existing and Emerging Energy Cooperation in Central Asia

Legacy of Regional Grid and Pipeline Cooperation:

- Central Asia's intra-regional electricity and gas cooperation was stronger historically, with a shared Soviet-era grid enabling unified power flows until the early 2000s.
- Key historical and current cross-border projects include CASA-1000 and Central Asia–South Asia power transfers, TAPI gas pipeline, and TUTAP power transmission linking Central and South Asia (ADB, 2023; World Bank, 2025).

Recent Trends:

- Inter-regional energy links (e.g., power exports to Afghanistan, TAPI pipeline, and Chinese Belt and Road Initiative investments in RE and transmission) are now more prominent than new intra-regional integration.
- Large-scale renewable projects with cross-border elements, such as CASA-1000, represent a shift toward using energy trade and infrastructure as foundations for broader cooperation.

• Strategic Opportunities:

- Short-term: Electricity trading and gas pipelines continue to offer tangible cooperation gains for both regional stability and energy security.
- Long-term: Renewables (especially solar and wind) are expected to further catalyze integration, with potential for South Asia to offer technical, regulatory, and infrastructure expertise for Central Asia's transition.

• Energy sector cooperation still needs to develop:

- A regional power market and harmonized regulatory frameworks.
- Expanded supply availability and modern transmission infrastructure.
- Greater public-private and cross-border project development (ADB, 2023).

Conclusion and Regional Cooperation (1):

- South Asia:
 - The region has made decisive moves into renewables, especially solar and wind, leveraging PPPs and targeted policy support (feed-in tariffs, PPAs, subsidies), though coal and gas—and corresponding fuel imports—still dominate the energy mix (World Bank, 2025).
 - Smaller states (e.g., Bhutan, Nepal) continue to depend heavily on hydropower as their most viable renewable pathway.
- Central Asia:
 - Energy-rich countries are expanding investments into renewables (notably wind, solar, and hydro), while energy-poor states increasingly rely on electricity imports from hydropower-rich neighbors (ADB, 2023).
 - Most recent PPP investment has targeted renewables, signaling a strategic shift in market dynamics.

Conclusion and Regional Cooperation (2):

- Pathways for Deeper Technical Cooperation:
 - Both regions can advance inter-regional energy market integration by building new cross-border and regional grid infrastructure, including overland and potential underwater transmission, inspired by successful models like TAPI and CASA-1000.
 - Central Asia, with ample supply, can initially export electricity and gas to high-demand South Asia; South Asia, later, can offer expertise and soft infrastructure (such as regulatory standards and market tools) as technologies mature.
 - Pakistan and Afghanistan hold pivotal transit geographies—their engagement will be vital to maximize shared benefits from grid-based and renewable trade.
 - Joint regional platforms and PPPs, along with strategic financing (including Chinese-led BRI investments and multilateral support), are accelerating this transformation in both regions (OECD, 2018; World Bank, 2025).

Broader themes emerging from this research

- RE investment based on endowment to meet energy security aspirations
- Hydro in resource poorer countries in South and Central Asia
- Policy, legal reforms enabling PPPs
- Increasing solar and wind projects specially in India, Pakistan, Uzbekistan, Kazakhstan
- Market integration, harmonization and grid infrastructure upgrades
- Cross-border/regional cooperation, external RE financing

Thank you!