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Alina Salakhunova

Decentralization and Renewable Energy Policy in Central Asia

Exploring the Role of Local Governance and Community Participation

MAHRS, Master's Programme in Human Rights and Sustainability in Central Asia

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Foreword

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— Nicolaou, Orestis, *EU Border Policies Between Securitisation and Human Rights: The Impact of the New Pact on Migration and Asylum on BiH and The Western Balkans.* Supervisor: Anna Krasteva, New Bulgarian University. Master's Programme in Democracy and Human Rights in South East Europe (ERMA), coordinated by University of Sarajevo and University of Bologna.

— Nukiry, Laila, *The Effect of Parental Mediation Strategies on the Autonomy of Opinion Formation of Adolescents in Beirut: A Comparison Between Secular and Non-Secular Schools.* Supervisor: Carol Al-Sharabati, Saint Joseph University, Arab Master's Programme in Democracy and Human Rights (ARMA), coordinated by Saint Joseph University (Lebanon).

— Salakhunova, Alina, *Decentralization and Renewable Energy Policy in Central Asia: Exploring the Role of Local Governance and Community Participation.* Supervisor: Sergey Sayapin, KIMEP University (Almaty, Kazakhstan).The Master of Liberal Arts in Human Rights and Sustainability (MAHRS - GC Central Asia), coordinated by the OSCE Academy in Bishkek.

— Torres Cuenca, Laura, *El camino del retorno. Experiencias de mujeres rurales víctimas del conflicto armado en el proceso burocrático de ingreso al Registro de Tierras Despojadas y Abandonadas Forzosamente para el departamento del Cesar, Colombia.* Supervisor: Ezequiel Fernández Bravo, Universidad Nacional de San Martín - Consejo Nacional de Investigaciones Científicas y Técnicas (UNASAM-CONICET). Master's Programme in Human Rights and Democratisation in Latin America and the Caribbean (LATMA), coordinated by National University of San Martin (Argentina).

Biography

Alina Salakhunova is a specialist in sustainable development, international law, and environmental security. She holds a Master's degree in Human Rights and Sustainable Development and a Bachelor's degree in International Relations. Her professional experience includes coordinating international projects with UNEP and UNITAR, developing policy briefs, and working with governmental and international organizations. Her research interests focus on transboundary environmental governance, ESG policy, and human rights in Central Asia.

Abstract

This thesis investigates the impact of decentralisation and community participation on renewable energy outcomes in Kazakhstan and Kyrgyzstan, focusing on their alignment with Sustainable Development Goals (SDGs) 7 (Affordable and Clean Energy) and 13 (Climate Action). Employing a strictly quantitative research design, the study tests three hypotheses to establish causal relationships between governance structures, public engagement, and renewable energy success. Data from surveys targeting local government officials, community members, and project managers, supplemented by secondary metrics from international organisations, inform advanced regression analyses and causal inference models.

The findings reveal that decentralisation enhances renewable energy capacity and efficiency by enabling localised decision-making, while active community participation significantly improves socio-economic outcomes, including job creation and infrastructure development. Regions with high autonomy and engagement, such as Zhambyl and Naryn, demonstrated substantial progress in renewable energy adoption, achieving completion rates and CO_2 emission reductions far exceeding those in centralised regions like Kostanay and Issyk-Kul. The combined effects of decentralisation and participation were found to maximise alignment with SDG targets, illustrating the synergistic potential of governance innovation and local involvement in driving sustainable energy transitions.

This research contributes to theoretical frameworks on governance by integrating insights from decentralisation and participatory governance theories with quantitative evidence from emerging economies. The study offers practical recommendations for enhancing renewable energy governance in Central Asia, including legislative reforms to increase local autonomy, frameworks for structured community participation, and integration of climate

resilience strategies. By addressing limitations such as funding constraints and data inconsistencies, the thesis provides a roadmap for scaling renewable energy initiatives in diverse governance contexts, emphasising equity, sustainability, and human rights.

Table of Abbreviations

EBRD	The European Bank for Reconstruction and Development
EDB	The Eurasian Development Bank
EU	European Union
FDI	Foreign Direct Investment
GCF	Green Climate Fund
GEF	Global Environment Facility
GER	Green Energy Roadmap
IRENA	International Renewable Energy Agency
KHRP	Karaganda Hybrid Renewable Pilot
KREA	The Kyrgyz Renewable Energy Association
SDGs	Sustainable Development Goals

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1. Introduction

The global shift to renewable energy has become a top priority in addressing climate change, bolstering energy security, and reducing reliance on fossil fuels. The United Nations Sustainable Development Goals, particularly SDG 7 and SDG 13, emphasise the urgent need for universal access to affordable and clean energy and coordinated climate action to reduce greenhouse gas emissions.[1] Access to clean and sustainable energy is increasingly recognised as a fundamental human right, essential for ensuring socio-economic development, health, and education.[2] However, realising this right requires governance frameworks that prioritise equity and inclusivity, addressing the needs of marginalised populations disproportionately affected by energy poverty.[3] While technological innovations are critical, recent studies highlight the importance of governance models that adapt to local needs and engage communities effectively. Scholars such as Sovacool and Goldthau argue that decentralised governance, which delegates decision-making to regional and local authorities, offers a flexible approach that aligns energy initiatives with socio-economic and environmental priorities.[4] Despite the successes seen in re-

1 United Nations, 'Sustainable Development Goals' <https://sdgs.un.org/goals> accessed 12 December 2024.

2 United Nations, UNGA Res 70/1 <https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf> accessed 12 December 2024.

3 UN Human Rights Council, Report of the Special Rapporteur on the Right to Development, UN Doc A/HRC/45/15 < https://www.ohchr.org/en/special-procedures/sr-development> accessed 12 December 2024.

4 R Salahodjaev and others, 'Tourism, renewable energy and CO_2 emissions: evidence from Europe and Central Asia' (2022) 24 Environment, Development and Sustainability 13282–13293 <https://link.springer.com/article/10.1007/s10668-021-01993-x> accessed 1 July 2024.

gions like Europe, where community-led renewable projects have achieved notable sustainability outcomes, the potential of decentralisation remains underexplored in emerging economies, particularly in Central Asia.

1.1 Regional context of Central Asia

Central Asia faces unique challenges and opportunities in transitioning to renewable energy, shaped by its post-Soviet governance structures and socio-economic conditions. Kazakhstan and Kyrgyzstan, the focus of this study, illustrate contrasting governance models that influence renewable energy development. Kazakhstan, as the region's largest energy producer, operates under a highly centralised governance framework. While this facilitates cohesive strategic planning, it often limits regional adaptability and delays stakeholder engagement, as seen in the implementation of the Kazakhstan 2050 strategy.[5] Scholars such as Karatayev and Clarke have documented inefficiencies in centralised governance, highlighting its impact on project delays and resource mismanagement.[6] In contrast, Kyrgyzstan's decentralised governance model has enabled small-scale, community-driven renewable energy initiatives in remote areas, where national grid expansion remains impractical.[7] Yet, inconsistent policies and limited funding hinder the scalability of these projects, reducing their overall impact.[8] Despite these challenges, the region holds immense renewable energy potential.[9] In Kazakhstan, regions like Zhambyl and Kostanay benefit from high solar irradiance and favourable

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5 President of the Republic of Kazakhstan, '*Strategy Kazakhstan 2050: New Political Course of the Established State'* (Presidential Address, 2012) <https://policy.asiapacificenergy.org/sites/default/files/Presidential%20Address%20%27Strategy%20Kazakhstan-2050%27%20%28EN%29.pdf> accessed 15 December 2024

6 Marat Karatayev and Michèle L Clarke, 'A review of current energy systems and green energy potential in Kazakhstan' (2016) 55 Renewable and Sustainable Energy Reviews 491 <https://ideas.repec.org/a/eee/rensus/v55y2016icp491-504.html> accessed 17 November 2024.

7 Valentina Kasymova and Anna Arkhangelskaya, 'Development of renewable energy sources in the Kyrgyz Republic: current status, problems and prospects' (2024) 99 Reforma 12 <https://dergipark.org.tr/en/download/article-file/3361392> accessed 7 August 2024

8 ibid.

9 Kedar Mehta, Ekaterina Mingaleva, Wilfried Zörner, Nadira Degembaeva and Ermek Baibagyshov, 'Comprehensive analysis of the energy legislative framework of Kyrgyzstan: investigation to develop a roadmap of Kyrgyz renewable energy sector' (2022) 2 Cleaner Energy Systems 100013<https://doi.org/10.1016/j.cles.2022.100013>.

wind conditions, respectively, making them prime locations for solar and wind projects.[10] Kyrgyzstan's mountainous terrain supports micro-hydro projects, which enhance energy access for off-grid communities. However, both countries must address governance gaps to fully realise this potential. Centralised systems in Kazakhstan often slow the integration of renewables into the energy mix,[11] while Kyrgyzstan's decentralised approach requires stronger national coordination to standardise policies and allocate resources effectively.[12] These contrasting approaches provide a unique opportunity to examine how governance structures influence renewable energy outcomes, offering insights that are relevant not only to Central Asia but also to other emerging economies.

1.2 Significance of the research

This study addresses critical gaps in understanding how decentralisation and community participation influence renewable energy transitions in emerging economies, with a specific focus on Kazakhstan and Kyrgyzstan. While extensive research exists on renewable energy governance in developed regions like Europe, the unique socio-political dynamics of post-Soviet Central Asia remain underexplored.[13] By examining contrasting governance models in Kazakhstan and Kyrgyzstan, this study contributes to the broader discourse on sustainable development by highlighting the importance of localised and inclusive approaches. Moreover, it integrates the perspective of human rights, emphasising access to clean and affordable energy as a fundamental socio-economic right.[14]

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10 International Energy Agency, *Strengthening Power System Security in Kyrgyzstan: A Roadmap* (IEA 2022) <https://www.iea.org/reports/strengthening-power-system-security-in-kyrgyzstan-a-roadmap> accessed 12 November 2024.

11 International Energy Agency, *Kazakhstan 2022* (IEA 2022) <https://www.iea.org/reports/kazakhstan-2022> accessed 19 November 2024.

12 ibid.

13 Daniela Russ, '"Socialism Is Not Just Built for a Hundred Years": Renewable Energy and Planetary Thought in the Early Soviet Union (1917–1945)' (2022) 31(4) Contemporary European History 491 <https://doi.org/10.1017/S0960777322000431>.

14 UN Human Rights Council, *Access to Clean Energy as a Human Right*, UN Doc A/HRC/RES/55/2 (United Nations 2021) <https://docs.un.org/en/A/HRC/RES/55/2> accessed 25 January 2023.

The findings have significant implications for policy and practice, particularly in shaping governance frameworks that align with the United Nations Sustainable Development Goals (SDGs) 7 and 13. By demonstrating how decentralised governance and community participation can enhance project efficiency, socio-economic benefits, and climate resilience,[15] this research provides actionable insights for policymakers in Central Asia.[16] It also offers valuable lessons for other emerging economies grappling with similar challenges, bridging the gap between theoretical governance models and practical implementation strategies.[17]

The dissertation includes six chapters: Introduction, Literature review, Methodology, Findings, Analysis, and Conclusion with recommendations.

[15] Mirjana Radovanović, Sanja Filipović and Andrea Andrejević Panić, 'Sustainable energy transition in Central Asia: status and challenges' (2021) 11(1) Energy, Sustainability and Society 49 <http s://link.springer.com/article/10.1186/s13705-021-00324-2> accessed September 4 2024.

[16] Alistair Wishart and Afzaal Abidi, 'The energy transition in Central Asia: drivers, policy and opportunities' (2021) 16 Constitutional Law International 28 < https://www.ibanet.org/energy-transition-central-asia > accessed 17 April 2023.

[17] Victoria Agbakwuru, Peter Ofuje Obidi, Ojonimi Segun Salihu and Chinelo Ogwu, 'The role of renewable energy in achieving sustainable development goals' (2024) 7(2) International Journal of Engineering Research Updates 13 <https://doi.org/10.53430/ijeru.2024.7.2.0046>.

2. Literature review

Decentralisation and renewable energy policies are essential for achieving Sustainable Development Goals 7 (7.1, 7.2, 7.3, 7.a) and 13 (13.1, 13.2, and 13.3), which focus on affordable clean energy and climate action.[18] Decentralisation is recognised as a 'key mechanism for enhancing the adaptability and responsiveness of energy systems by enabling local governance structures to address regional needs directly',[19] this approach facilitates the integration of distributed energy resources, engages stakeholders, and aligns energy policies with local environmental and socio-economic priorities. Jean-Paul Faguet argues that decentralisation enhances policy effectiveness by transferring decision-making authority to the community level, fostering innovation and accountability.[20] Additionally, Sovacool et al demonstrate that decentralised governance reduces regional inequalities in energy access and improves energy justice, although its success depends on whether local governments have sufficient resources and coherent

[18] Tomáš Hák, Svatava Janoušková and Bedřich Moldan, 'Sustainable development goals: a need for relevant indicators' (2016) 60 Ecological Indicators 565 <https://doi.org/10.1016/j.ecolind.2015.08.003>.

[19] Stefan Bouzarovski, Martin J Pasqualetti and Vanesa Castán Broto (eds), *The Routledge Research Companion to Energy Geographies* (Taylor & Francis 2017) <https://books.google.kz/books?hl=en&lr=&id=QEYrDwAAQBAJ&oi=fnd&pg=PP1&dq=Vanesa+Cast%C3%A1n+Broto,+Patrick+Devine-Wright+and+Harriet+Bulkeley&ots=tRGVMU67TP&sig=lmJ9ZdwFf8jDhVzFGsdn-lFHEvU&redir_esc=y#v=onepage&q=Vanesa%20Cast%C3%A1n%20Broto%2C%20Patrick%20Devine-Wright%20and%20Harriet%20Bulkeley&f=false> accessed 12 November 2023.

[20] G Shabbir Cheema and DA Rondinelli (eds), *Decentralizing Governance: Emerging Concepts and Practices* (Rowman & Littlefield Publishers 2007) <https://books.google.kz/books/about/Decentralizing_Governance.html?id=cZgeUT4DSfUC&redir_esc=y> accessed September 21 2024.

frameworks.[21] In Central Asia, Marat Karatayev and Julian Clarke identify Kazakhstan's centralised governance as 'a key obstacle', causing delays in renewable energy projects in resource-rich regions like Zhambyl and Aktobe.[22] Conversely, Charlotte Brüggemann and Niklas Kaul highlight Kyrgyzstan's decentralised model, which enables community-led projects in areas such as Naryn and Issyk-Kul, albeit with limitations stemming from insufficient funding and weak regulations.[23] While Sovacool and colleagues emphasise the need for further research into how decentralisation can support scalable and sustainable renewable energy transitions in the region.[24]

2.1 Decentralisation and renewable energy policy

Decentralisation in the energy sector enables local governments to tailor policies to regional socio-economic and environmental conditions, improving the effectiveness and sustainability of renewable energy initiatives. According to Castán Broto et al, 'decentralisation fosters innovation by encouraging collaboration between local governments and stakeholders, which is essential for renewable energy transitions'.[25] Studies from various regions, such as solar microgrids in India and off-grid renewable energy initiatives in Kenya, demonstrate that decentralised energy governance enhances stakeholder satisfaction and leads to more successful project outcomes.[26] Yet, according to Wu et al, the effectiveness of decentralisation depends on the institutional capacity of local authorities, including technical expertise, financial resources, and

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21 Benjamin K Sovacool, David J Hess and Roberto Cantoni, 'Energy transitions from the cradle to the grave: a meta-theoretical framework integrating responsible innovation, social practices, and energy justice' (2021) 75 Energy Research & Social Science 102027 <https://doi.org/10.1016/j.erss.2021.102027>.

22 Marat Karatayev, Stephen Hall, Yelena Kalyuzhnova and Michèle L Clarke, 'Renewable energy technology uptake in Kazakhstan: policy drivers and barriers in a transitional economy' (2016) 66 Renewable and Sustainable Energy Reviews 120 <https://doi.org/10.1016/j.rser.2016.07.057>.

23 ibid.

24 ibid.

25 Maryke van Staden, 'Sustainable energy transition: local governments as key actors' in Tanay Sıdkı Uyar (ed), *Towards 100% Renewable Energy: Techniques, Costs and Regional Case-Studies* (Springer 2017) 17–25 <https://link.springer.com/chapter/10.1007/978-3-319-45659-1_2> accessed January 5 2024.

26 Subhes C Bhattacharyya, *Rural Electrification Through Decentralised Off-Grid Systems in Developing Countries* (Springer 2015) < https://link.springer.com/book/10.1007/978-1-4471-4673-5> accessed July 2023.

regulatory frameworks.[27] Agostini et al highlight that strong institutional support and financial autonomy are critical for the sustainability of decentralised renewable energy projects.[28] Without these elements, decentralisation risks inefficiencies and missed opportunities.

Kazakhstan's energy governance is 'heavily centralized', with strategic planning and decision-making concentrated at the national level, as highlighted by Mouraviev and Kakabadse.[29] We believe that despite ambitious targets outlined in the 'Kazakhstan 2050 Strategy', which aims for a 50% renewable energy share by 2050, progress has been limited by bureaucratic inefficiencies, inadequate regional autonomy, and a lack of flexibility in addressing local renewable energy potential.[30] Mouraviev and Koulidobrova explain that Kazakhstan's centralised governance framework, characterised by 'top-down decision-making', contributes to significant delays in the development and implementation of renewable energy projects, particularly in resource-abundant regions such as Atyrau, Mangistau, and Aktobe.[31] This has resulted in significant underutilisation of the country's vast solar and wind resources, while localised initiatives in Kazakhstan demonstrate the potential benefits of decentralisation.[32] Collaborative partnerships in Aktobe and Zhambyl between local governments, private firms, and international organisations have enabled successful solar and wind projects, circumventing bureaucratic

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27 Yuntao Wu, Li Zhang, Yixing Zhao and Meimei Zhang, 'Vertical decentralization, environmental regulation, and enterprise pollution: an evolutionary game analysis' (2024) 349 Journal of Environmental Management 119449 <https://doi.org/10.1016/j.jenvman.2023.119449>.

28 Stella Monegato, 'Renewable energy communities in Italy: the challenges of public governance' (2025) 46 Energy LJ 105.<https://heinonline.org/HOL/LandingPage?handle=hein.journals/energy46&div=10&id=&page=.>.accesed on April 20 2023.

29 Lola Abdusalyamova and Hannah Warren, 'Organisational capacity building in Central Asia: reflections from Kyrgyzstan and Kazakhstan' (Universitäts- und Landesbibliothek Sachsen-Anhalt 2007)< https://opendata.uni-halle.de/bitstream/1981185920/109869/97/786162139.pdf> accessed September 20 2024.

30 Republic of Kazakhstan, *Kazakhstan 2050 Strategy: Renewables Share Goals* (2012) <https://policy.asiapacificenergy.org/sites/default/files/Presidential%20Address%20%27Strategy%20Kazakhstan-2050%27%20%28EN%29.pdf> accessed 5 December 2024.

31 Marat Karatayev and Michèle L Clarke, 'A review of current energy systems and green energy potential in Kazakhstan' (2016) 55 Renewable and Sustainable Energy Reviews 491–504 <https://doi.org/10.1016/j.rser.2015.10.078>.

32 Farid Guliyev, 'Renewable energy targets and policies in traditional oil-producing countries: a comparison of Azerbaijan and Kazakhstan' (2024) 15(1) Journal of Eurasian Studies 110–124 <https://doi.org/10.1177/1879366523117772>.

bottlenecks.[33] The World Bank's Kazakhstan Energy Sector Overview of 2017[34] highlights that partnerships between local governments, private firms, and international organisations have accelerated project timelines and improved stakeholder coordination, though these efforts are primarily limited to 'pilot projects'.[35] The USAID 2024 report highlights that Kazakhstan's renewable energy auctions in 2018 and 2019,[36] which included projects like the Saran Solar Park, have significantly lowered project costs and attracted foreign investment, including $300 million in funding commitment.[37] Also, the OECD 2022 review[38] specifically recommends granting decision-making authority to regional governments to streamline the approval process for projects such as the Zhanatas Wind Farm, which faced two years of delays under centralised governance, thereby improving efficiency in Kazakhstan's renewable energy development.[39] In contrast, Kyrgyzstan is expanding its renewable energy sector through targeted projects and international collaborations. In 2024, EDB financed a 300 MW solar power plant in Toru-Aygyr village, Issyk-Kul Region, making it one of the largest solar initiatives in the country.[40] This project aims to produce 500 million kWh annually, meeting the energy needs of over

33 Stefanos Xenarios, Aliya Sembayeva, Stella Tsani, Serik Orazagaliyev and Zhanat Ansaganova, 'Clean energy challenges and innovation opportunities in Kazakhstan' (2024) 6(11) Environmental Research Communications 115009 DOI 10.1088/2515-7620/ad87b5.

34 Mirlan Aldayarov, Istvan Dobozi and Thomas Nikolakakis, *Stuck in Transition: Reform Experiences and Challenges Ahead in the Kazakhstan Power Sector* (World Bank Publications 2017) <https://www.worldbank.org/en/country/kazakhstan/publication/kazakhstan-power-sector-note> accessed 5 June 2024.

35 Johannes F Linn, 'Kazakhstan 2050: exploring an ambitious vision' (2014) 6(3) Global Journal of Emerging Market Economies 283–300 <https://doi.org/10.1177/0974910114540718>.

36 Diana Sitenko, Yelena Gordeyeva, Ali Sabyrzhan and Elmira Syzdykova, 'Implementation of innovative technologies in Kazakhstan: a case of the energy sector' (2023) 21(4) Problems and Perspectives in Management 179 <https://www.businessperspectives.org/images/pdf/applications/publishing/templates/article/assets/19009/PPM_2023_04_Sitenko.pdf> accessed 12 November 2024.

37 ibid.

38 OECD, *Kazakhstan 2022 Energy Sector Review* (OECD Publishing 2022) <https://www.oecd.org/en/publications/kazakhstan-2022-energy-sector-review_73d1d69f-en.html> accessed 8 December 2024.

39 Anatole Boute, 'Regulatory stability and renewable energy investment: the case of Kazakhstan' (2020) 121 Renewable and Sustainable Energy Reviews 109673 <https://doi.org/10.1016/j.rser.2019.109673>.

40 Ka Wai Christopher Hor, 'Rethinking renewable energy development in the Republic of Kazakhstan from the perspectives of international relations' in M Fathi, E Zio and PM Pardalos (eds), *Handbook of Smart Energy Systems* (Springer International Publishing 2023) 27 <https://link.springer.com/rwe/10.1007/978-3-030-72322-4_9-1> accessed 20 October 2024.

200,000 households.[41] Similarly, the World Bank approved $67.7 million for the first phase of the Kyrgyz Renewable Energy Development Project, focusing on private sector engagement and grid modernisation;[42] the government plans to commission 50 MW of new renewable energy capacity by 2024 and an additional 62 MW by 2026, including 17 hydroelectric plants, as part of its broader energy strategy. These efforts align with Kyrgyzstan's commitment to reduce greenhouse gas emissions by 44% by 2030 and achieve carbon neutrality by 2050.[43] Obviously, some challenges persist: aging infrastructure results in transmission losses exceeding 12%, and rural grid access remains limited.[44]Addressing these issues is critical to scaling renewable energy and achieving national targets. To attract investment, Kyrgyzstan hosted the International Energy Investment Forum in June 2024, promoting opportunities in solar, wind, and small hydropower projects, which underscore the country's commitment to diversifying its energy mix and improving energy security.

2.2 The role of community participation in renewable energy transitions

According to Wüstenhagen et al, 'community participation is a critical factor in the success of renewable energy projects, ensuring alignment with local needs and fostering stakeholder ownership'.[45] Local engagement mitigates resistance, accelerates implementation, and delivers measurable socio-economic benefits, including job creation, infrastructure development, and equitable energy access.[46] According to Nurkhat Zhakiyev et al. projects

41 ibid.

42 Sergey Bespalyy, 'Kazakhstan: assessment of renewable energy support and a green economy' (2021) 12(3) Journal of Environmental Management and Tourism 631–641 <https://www.ceeol.com/search/article-detail?id=1011393> accessed 3 July 2024.

43 Makpal Assembayeva, Jonas Egerer, Roman Mendelevitch and Nurkhat Zhakiyev, 'A spatial electricity market model for the power system: the Kazakhstan case study' (2018) 149 Energy 762–778 < https://doi.org/10.1016/j.energy.2018.02.011>.

44 ibid.

45 Rolf Wüstenhagen, Maarten Wolsink and Mary Bürer, 'Social acceptance of renewable energy innovation: an introduction to the concept' (2007) 35(5) Energy Policy 2683–2691 <https://doi.org/10.1016/j.enpol.2006.12.001>.

46 Nurkhat Zhakiyev, Dana Burkhanova, Anel Nurkanat, Shynar Zhussipkaliyeva, Ainur Sospanova and Ayagoz Khamzina, 'Green energy in grey areas: the financial and policy challenges of Kazakhstan's energy transition' (2025) 124 Energy Research & Social Science 104046 <https://doi.org/10.1016/j.erss.2025.104046>.

with "strong community involvement" exhibit higher efficiency and reduced failure rates, as local knowledge resolves conflict and optimises resource allocation.[47] It is particularly effective in addressing region-specific challenges, such as geographic isolation or socio-economic disparities, which centralised governance models often overlook.[48] In Kazakhstan, renewable energy governance remains highly centralised, with national agencies retaining control over planning and implementation processes. Mouraviev and Kakabadse argue that this centralised approach leads to inefficiencies, prolongs project approval timelines, and limits adaptability to regional conditions.[49] For instance, the Zhanatas Wind Farm, a 100 MW project, experienced significant delays due to extensive centralised decision-making processes.[50] Additionally, limited involvement of regional authorities and local stakeholders undermines opportunities for tailored solutions and public support. Nonetheless, emerging initiatives highlight the benefits of community participation; as an example, the 'Green Village' solar project in Almaty actively involved residents during planning, resulting in a 10 MW installation that created over 50 jobs and improved local infrastructure with energy-efficient housing.[51] Similarly, the Shelek Corridor wind farm (45 MW) gained local support through consultations with farmers to address land-use concerns, which expedited project completion.[52] Despite these cases, community-driven projects in Kazakhstan remain rare due to the dominance of top-down governance and a lack of institutional mechanisms for local participation: by 2022, renewable energy accounted for 4.24% of Kazakhstan's electricity generation, marking a 17% increase from the previous year.[53] According to Vakhguelt, public support for renewable energy is strong, with over 90% of

47 Nurkhat Zhakiyev, Dana Burkhanova, Anel Nurkanat, Shynar Zhussipkaliyeva, Ainur Sospanova and Ayagoz Khamzina, 'Green energy in grey areas: the financial and policy challenges of Kazakhstan's energy transition' (2025) 124 Energy Research & Social Science 104046 <https://doi.org/10.1016/j.erss.2025.104046>.

48 Nada Kakabadse and Nikolai Mouraviev (eds), *Public-Private Partnerships in Transitional Nations: Policy, Governance and Praxis* (Cambridge Scholars Publishing 2017) <https://books.google.kz/books?hl=en&lr=&id=t1wpDwAAQBAJ&oi=fnd&pg=PR5&dq=Nikolai+Mouraviev+and+Nada+Kakabadse+renewable&ots=YIPD1JMaRd&sig=rkGdqkwe0N2rijiAbUxXgJ7eX-I&redir_esc=y#v=onepage&q=Nikolai%20Mouraviev%20and%20Nada%20Kakabadse%20renewable&f=false> accessed 9 October 2024.

49 ibid.

50 ibid.

51 ibid.

52 ibid.

53 ibid.

the population favouring the transition to renewables.[54] Only 12% of households currently utilise renewable energy, underscoring a significant gap between public sentiment and practical implementation, however.[55] We strictly believe that addressing these issues will require systemic reforms to empower local stakeholders, streamline permitting processes, and incentivise public-private collaborations.

Kyrgyzstan's decentralised governance model has enabled the growth of community-led renewable energy initiatives, particularly in rural and mountainous regions. Micro-hydro installations in the Naryn and Issyk-Kul regions, ranging from 5 kW to 100 kW, provide electricity to remote areas that are off the national grid.[56] These projects, supported by international NGOs and donors such as the ADB, demonstrate the role of local engagement in overcoming technical and logistical challenges,[57] for instance, a UNDP-funded micro-hydro project in Naryn generates 50 kW of electricity, powering over 200 households.[58] Local residents participated in installation and maintenance, ensuring the project's sustainability while reducing costs.[12] Similarly, KREA has implemented over 30 small-scale solar installations in southern Kyrgyzstan, with capacities ranging from 1 kW to 10 kW.[59] All the initiatives have not only improved energy access but also created approximately 100 jobs, benefiting underserved communities.[60] In spite of these achievements, scaling community-driven projects is hindered by insufficient funding, technical expertise, and weak regulatory frameworks.[61] Kyrgyzstan's untapped renewable energy potential is significant, with only 10% of its hydropower capacity

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54 Anatoli Vakhguelt, 'Renewable energy potential of Kazakhstan' in *Defect and Diffusion Forum*, vol 379 (Trans Tech Publications Ltd 2017) <https://doi.org/10.4028/www.scientific.net/DDF.379.189>.

55 ibid.

56 Ermek Baybagyshov and Nadira Degembaeva, 'Analysis of usage of the renewable energy in Kyrgyzstan' (2019) IOP Conference Series: Earth and Environmental Science, vol 249, no 1, 012021 <DOI 10.1088/1755-1315/249/1/012021>.

57 Ruslan Botpaev and others, 'Renewable energy in Kyrgyzstan: state, policy and educational system' *Proceedings of the ISES Solar World Congress* (2011) 1 <https://solar-publikationen.umwelt-uni-kassel.de/uploads/110923%20SWC%20Paper_Botpaev_RE%20in%20Kyrgyzstan.pdf> accessed 1 November 2025 .

58 ibid.

59 ibid.

60 ibid.

61 ibid.

developed, according to the IRENA.[62] On top of that, energy demand continues to rise, with per capita electricity consumption increasing by over 45% between 2010 and 2018.[63] The World Bank's Renewable Energy Development Project 'aims to address these challenges by promoting private sector participation and improving transmission infrastructure'.[64] Achieving scalability will require enhanced policy support, targeted financial incentives, and capacity-building programmess tailored to local contexts.

Despite the clear benefits of community participation, in our opinion, both countries face significant challenges in establishing effective frameworks for meaningful and sustained engagement: in Kazakhstan, local governments lack the autonomy to independently initiate renewable energy projects, resulting in minimal community involvement,[65] and in Kyrgyzstan, the limited financial and technical resources constrain the scalability of grassroots initiatives.[66] Loorbach et al emphasise that institutional mechanisms are necessary to support community participation throughout the project lifecycle, from planning to maintenance;[67] without such mechanisms, participation risks becoming superficial, reducing locals to token roles rather than active decision-makers.

2.3 Current state of renewable energy in Kazakhstan and Kyrgyzstan

We suppose that Kazakhstan's renewable energy sector has evolved significantly over the past decade, driven by increasing energy demands and the global push for decarbonisation. As a country 'heavily reliant on fossil fuels', Kazakhstan's transition

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62 Murodbek Laldjebaev, Ruslan Isaev and Almaz Saukhimov, 'Renewable energy in Central Asia: an overview of potentials, deployment, outlook, and barriers' (2021) 7 Energy Reports 3125–3136 <https://doi.org/10.1016/j.egyr.2021.05.014>.

63 ibid.

64 World Bank, *Kyrgyz Renewable Energy Development Project* <https://projects.worldbank.org/pt/projects-operations/project-detail/P178286> accessed 4 September 2024.

65 ibid.

66 Bahtiyor Eshchanov, Alina Abylkasymova, Farkhod Aminjonov, Daniyar Moldokanov, Indra Overland and Roman Vakulchuk, Renewable Energy Policies of the Central Asian Countries (Norwegian Institute of International Affairs (NUPI) 2022) <https://www.jstor.org/stable/pdf/resrep26564.pdf> accessed 27 September 2024.

67 Breffní Lennon, Niall P Dunphy and Estibaliz Sanvicente, 'Community acceptability and the energy transition: a citizens' perspective' (2019) 9(1) Energy, Sustainability and Society 1–18 <https://link.springer.com/article/10.1186/s13705-019-0218-z> accessed 15 December 2023.

to renewable energy is viewed not only as an environmental necessity but also as an economic opportunity to diversify its energy sector.[68] Its renewable energy development is supported by the 'Law on Supporting the Use of Renewable Energy Sources 2009',[69] which establishes incentives and mechanisms for renewable energy projects; amendments in 2024 introduced small-scale renewable energy facilities up to 200 kW to enhance decentralised energy generation.[70] Another latest development in its renewable energy journey is investment in hybrid renewable systems that integrate wind, solar, and energy storage technologies. For instance, the KHRP, launched in 2022, combines wind and solar farms with a battery storage system, providing a reliable energy supply even during peak demand hours.[71] This project is expected to deliver up to 25 MW annually, making it a model for future hybrid systems.[72] Another key factor is geographic diversity in shaping renewable energy development: while regions like Kostanay and Akmola are 'prioritized for wind energy projects due to their high average wind speeds', southern regions such as Turkestan are being explored for 'geothermal energy potential'.[73] The country's geothermal energy capacity remains largely untapped, but a 2023 report conducted by EBRD suggest significant 'opportunities for scaling geothermal projects' in described areas.[74] In order to strengthen the regulatory environment for renewable energy, Kazakhstan introduced the GER 2030 in 2021,[75] which emphasises localised energy generation and decentralised grid systems.[76] The roadmap includes

[68] E Judson, Oscar Fitch-Roy, T Pownall, R Bray, Helen Poulter, I Soutar, R Lowes and others, 'The centre cannot (always) hold: examining pathways towards energy system de-centralisation' (2020) 118 Renewable and Sustainable Energy Reviews 109499 <https://doi.org/10.1016/j.rser.2019.109499>.

[69] ibid.

[70] Ed Brown, Jon Cloke and John Harrison, 'Governance, decentralisation and energy: a critical review of the key issues' (2015) <https://core.ac.uk/download/pdf/288367742.pdf> accessed 10 August 2024.

[71] Kedar Mehta and others, 'Towards sustainable community development through renewable energies in Kyrgyzstan: a detailed assessment and outlook' (2022) 3(2) World 327 <https://doi.org/10.3390/world3020018>.

[72] ibid.

[73] Murodbek Laldjebaev, Ruslan Isaev and Almaz Saukhimov, 'Renewable energy in Central Asia: an overview of potentials, deployment, outlook, and barriers' (2021) 7 Energy Reports 3125–3136 <https://doi.org/10.1016/j.egyr.2021.05.014>.

[74] European Bank for Reconstruction and Development (EBRD), *Financial Report 2023* (EBRD 2023) <https://www.ebrd.com/financial-report-2023.html> accessed 18 December 2024

[75] Aisara S Baktymbet and others, 'Economic and environmental aspects of the development of renewable energy in Kazakhstan' (2020) 11(5) Journal of Environmental Management and Tourism 1025 DOI:10.14505/jemt.v11.5(45).0.

[76] ibid.

plans to implement smart grid technologies capable of balancing the intermittency of renewable sources.[77] Albeit legislative improvements have attracted over $1 billion in FDI since 2018, challenges remain in aligning these investments with on-ground infrastructure needs.[78] Kazakhstan has also been a 'regional leader in issuing green bonds to fund renewable energy projects'.[79] As of 2024, over $300 million has been raised through these bonds, with notable projects including the Aktau Solar Farm, which added 40 MW of capacity in the western region of the country.[80] The green bond framework, supported by partnerships with IFI, has enabled developers to access capital markets, reducing reliance on government subsidies.[81] Country's ambitions are supported by its active participation in regional and international renewable energy partnerships, it joined the Global Wind Energy Council in 2022,[82] allowing the country to benefit from global expertise in wind project development.[83] Additionally, Kazakhstan is working to position itself as a 'renewable energy export hub', with discussions underway to establish a green energy corridor connecting Central Asia to the European Union.[84]

Kyrgyzstan's energy sector is heavily reliant on hydropower, which accounts for approximately 90% of the nation's electricity generation. According to Liu, while hydropower provides a renewable, low-carbon energy base, it exposes the country to significant risks from seasonal variability and changing climatic conditions.[85] In order to tackle these weaknesses, the country has increasingly prioritised energy diversification, focusing on 'small-scale, decentralized solutions', which align with its geographical

77 Nataliia Stativka, Nina Petrukha, Pavlo Logvinov, Andrii Revenko and Yevhenii Kolomiiets, 'The impact of decentralization on the stability of rural growth: a comparison of global practices' (2025) 15(2) International Journal of Ecosystems & Ecology Sciences 241 <https://doi.org/10.31407/ijees15.231>.

78 ibid.

79 ibid.

80 Nurkhat Zhakiyev and others, 'Comprehensive scenario analyses for coal exit and renewable energy development planning of Kazakhstan using PyPSA-KZ' (2024) 29 Engineered Science 1085 <http://dx.doi.org/10.30919/es1085>.

81 ibid.

82 ibid.

83 Ghazala Aziz and Hussam Buzaid M Bakoben, 'Environmental decentralization and green economic growth: do renewable energy development play any role?' (2024) 54 Energy Strategy Reviews 101459 <https://doi.org/10.1016/j.esr.2024.101459>.

84 ibid.

85 Melisande FM Liu and Till Pistorius, 'Coping with the energy crisis: impact assessment and potentials of non-traditional renewable energy in rural Kyrgyzstan' (2012) 44 Energy Policy 130–139 <https://doi.org/10.1016/j.enpol.2012.01.025>.

and socio-economic needs.[86] The exploration of underutilised renewable resources such as wind and biomass studies conducted by Abidov in the Osh and Jalal-Abad regions indicate potential for small-scale wind farms, which 'could provide localized electricity solutions for underserved areas'.[87] Comparably, research by KREA into biomass energy in the Chui Valley suggests opportunities for utilising agricultural waste to produce bioenergy, reducing reliance on imported fossil fuels.[88] The 'Green Economy Program 2030', launched in 2021 promotes localised energy markets to reduce reliance on centralised power grids.[89]A key component is the creation of 'rural energy cooperatives', empowering communities to manage renewable energy projects.[90] This programme aligns with the 2018 Concept of Kyrgyzstan as a Green Economy Country and is supported by UNDP and local cooperative initiatives.[91] International collaboration drives Kyrgyzstan's renewable energy progress: the EU GEF have funded energy efficiency projects and renewable energy integration in schools and hospitals:[92] Also, in 2024, the Kyrgyz government and EBRD signed an agreement to finance a 40 MW wind farm near Tokmok, the country's first utility-scale project.[93] Challenges persist despite the progress made: according to Shadrina there are regulatory issues with land

[86] Melisande FM Liu and Till Pistorius, 'Coping with the energy crisis: impact assessment and potentials of non-traditional renewable energy in rural Kyrgyzstan' (2012) 44 Energy Policy 130–139 <https://doi.org/10.1016/j.enpol.2012.01.025>.

[87] Abdykadyr Abidov and others, 'Comparative analysis of some types of renewable energy sources' in *Proceedings of the 7th International Conference on Applied Innovations in IT*,(Koethen, Germany, vol 6 (2019)) <https://icaiit.org/proceedings/7th_ICAIIT_2/3_Abidov.pdf> accessed 15 June 2024.

[88] Kyrgyz Renewable Energy Association (KREA), *Biomass Energy Potential in the Chui Valley: Opportunities and Challenges* (Bishkek: KREA 2022).

[89] Anatoly A Maksimov and Anatoly D Ten, 'Agricultural cooperation in the Kyrgyz Republic: potential, problems and prospects' (2020) 9(27) Amazonia Investiga 552–559 <https://doi.org/10.34069/AI/2020.27.03.59>.

[90] ibid.

[91] United Nations Development Programme (UNDP), 'Partnership Actions for a Green Economy in Kyrgyzstan'< https://www.undp.org/kyrgyzstan/projects/partnership-actions-green-economy> accessed 7 July 2024.

[92] Global Environment Facility (GEF), *Kyrgyz Republic Energy Efficiency and Renewables Project Report*, *Improving Energy Efficiency in Buildings, Kyrgyz Republic* (2013) <https://www.gefieo.org/sites/default/files/documents/projects/tes/3425-terminal-evaluation.pdf?utm_source=chatgpt.com> accessed 12 December 2024.

[93] European Bank for Reconstruction and Development (EBRD), *Support for the Implementation of Wind Auctions in Kyrgyz Republic* (EBRD 2024) <https://ewsdata.rightsindevelopment.org/temp/tmpeKP_LX/EBRD-19737.pdf> accessed 28 November 2024.

allocation rules that deter private investment,[94] and a 20 MW biomass plant in Jalal-Abad is stalled due to land disputes.[95] In the author's view, outdated grid infrastructure further hinders renewable energy integration, particularly in remote areas requiring off-grid solutions.

2.4 Contrasting approaches in renewable energy development

As could be noted from previous paragraphs, both countries employ distinct strategies to finance renewable energy projects, highlighting their contrasting governance structures and economic approaches. Kazakhstan has successfully raised over $300 million through green bonds since 2021, funding projects like the 100 MW Zhanatas Wind Farm and the 40 MW Aktau Solar Farm.[96] These initiatives have attracted significant international investment, with institutions such as EBRD committing over $120 million to support Kazakhstan's renewable energy transition.[97] Analogously, ADB has allocated approximately $60 million toward renewable energy projects in Kazakhstan,[98] focusing on hybrid systems that integrate wind, solar, and storage technologies. The influx of funding underscores Kazakhstan's ability to leverage financial tools, whereas centralised governance often creates bottlenecks, with project approval times averaging six months due to bureaucratic delays.[99] Kyrgyzstan remains heavily dependent on international grants, receiving over $90 million from the UNDP and GEF between 2015 and 2023 to support renewable energy

94 Elena Shadrina, 'Non-hydropower renewable energy in Central Asia: assessment of deployment status and analysis of underlying factors' (2020) 13(11) Energies 2963 <https://doi.org/10.3390/en13112963>.

95 Valentina Kasymova and Anna Arkhangelskaya, 'Development of renewable energy sources in the Kyrgyz Republic: current status, problems and prospects' (2024) 99 Reforma 12–22 <https://dergipark.org.tr/en/pub/reforma/issue/82746/1349698> accessed 7 August 2024.

96 Yinuo Wang, Fengxiu Zhou and Huwei Wen, 'Does environmental decentralization promote renewable energy development? A local government competition perspective' (2023) 15(14) Sustainability 10829 <https://doi.org/10.3390/su151410829>.

97 ibid.

98 ibid.

99 Farkhod Aminjonov, 'Security of the Central Asian energy system through regional-level energy governance innovations' (PhD thesis, Wilfrid Laurier University 201) <https://scholars.wlu.ca/etd/1789/> accessed 26 February 2023.

initiatives.[100] Projects such as the 5 MW Tokmok Wind Farm and micro-hydro installations in Naryn and Issyk-Kul regions have benefited from these funds. Despite this support, Kyrgyzstan has struggled to scale its renewable energy efforts.[101] Regulatory uncertainty, unclear land allocation policies, and unresolved land disputes have delayed projects like the 30 MW wind farm near Issyk-Kul,[102] which has been stalled for three years.[103] Private sector participation remains limited, with only 15% of renewable energy funding in Kyrgyzstan coming from private investors, compared to 45% in Kazakhstan.[104] This discrepancy highlights the need for Kyrgyzstan to create 'a more predictable investment environment'.[105] Both countries face infrastructure challenges that exacerbate their financing issues: Kazakhstan's aging grid infrastructure, with over 50% of its transmission lines exceeding their intended lifespan, requires an estimated $2 billion in upgrades by 2030 to integrate variable renewable energy sources.[106] Smart grid technologies, such as the pilot project implemented in Almaty in 2022, have shown promise, reducing transmission losses by 8%, yet scaling these solutions requires additional investments and streamlined regulatory frameworks. Kyrgyzstan, on the other hand, grapples with limited grid access in rural and 'mountainous regions',[107] where approximately 20% of households rely on off-grid solutions.[108] Expanding the national grid to these areas would require $700 million, a figure that exceeds current government budget allocations.[109] As a result, off-grid renewable solutions, including solar microgrids and small-scale hydro, have become essential but remain underfunded.[110]

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100 Farkhod Aminjonov, 'Security of the Central Asian energy system through regional-level energy governance innovations' (PhD thesis, Wilfrid Laurier University 201) <https://scholars.wlu.ca/etd/1789/> accessed 26 February 2023.

101 ibid.

102 B Urishev, 'Decentralized energy systems, based on renewable energy sources' (2019) 55(3) Applied Solar Energy 207–212 <https://link.springer.com/article/10.3103/S0003701X19030101> accessed 6 September 2024.

103 ibid.

104 ibid.

105 ibid.

106 ibid.

107 K E Bassey, J Opoku-Boateng, B O Antwi and A Ntiakoh, 'Economic impact of digital twins on renewable energy investments' (2024) 5(7) Engineering Science & Technology Journal 2232 DOI:10.53430/ijeru.2024.7.2.0046.

108 ibid.

109 ibid.

110 ibid.

The broader implications of bridging these financial and regulatory gaps are significant. According to Sulaimanova, Kazakhstan and Kyrgyzstan have the 'potential to lead Central Asia's renewable energy transition',[111] but we believe doing so will require aligning their financing strategies with effective governance models.

[111] Burulcha Sulaimanova and others, 'Energy transition in Central Asia: a systematic literature review' in R Sabyrbekov, I Overland and R Vakulchuk (eds), *Climate Change in Central Asia* (Cham: Springer 2023) 69 <https://library.oapen.org/bitstream/handle/20.500.12657/63009/1/978-3-031-29831-8.pdf#page=72> accessed 5 January 2024.

3. Theoretical Framework

The theoretical framework of this work is grounded in two key approaches: decentralisation theory and participatory governance theory. Together, these frameworks could provide a foundation for understanding how local governance and community engagement influence renewable energy transitions, particularly in the Central Asian contexts (Kazakhstan and Kyrgyzstan). The analysis also incorporates recent findings to expand on the limitations and potential applications of these theories in renewable energy policy.

3.1 Theoretical perspectives on decentralisation in renewable energy governance

Decentralisation theory posits that 'transferring authority from central governments to local or regional entities leads to more responsive and effective governance'; by delegating control over resource management, service delivery, and policy implementation, decentralisation aims to improve outcomes across various sectors, including renewable energy.[112] Local governments, due to their proximity to communities, are often better positioned to understand regional needs and adapt policies accordingly.[113] The localised approach is critical in renewable energy development, where geographic and climatic conditions vary significantly, necessitating tailored solutions that centralised systems may

[112] Jean-Paul Faguet, 'Decentralization and governance' (2014) 53 World Development 2 <https://doi.org/10.1016/j.worlddev.2013.01.002>
[113] ibid.

struggle to provide.[114] Faguet argues that decentralisation enhances governance by increasing accountability, improving policy responsiveness, and reducing bureaucratic inefficiencies often associated with central control.[115] In renewable energy, decentralisation facilitates the development of region-specific strategies - such as prioritising solar energy in sun-rich areas or wind energy in regions with favourable wind conditions.[116] Through direct engagement with stakeholders, local authorities address specific challenges more efficiently and manage community-based renewable projects effectively.[117] Research by Oates et al support this view, noting that decentralisation historically fosters policy innovation, particularly in sectors requiring adaptability[118], such as energy; Kuzemko et al also highlight that decentralised governance promotes experimentation and innovation, essential for emerging sectors like renewable energy.[119]

Across Kazakhstan, decentralisation has been gradual and uneven, particularly in the energy sector: while some administrative powers have been devolved, energy policy remains highly centralised, resulting in bureaucratic delays that hinder renewable energy projects. Kassen argues that the central government's tight control over strategic sectors stifles local governments' flexibility and innovation.[120] For instance, the 100 MW Zhanatas wind farm, one of Kazakhstan's largest renewable projects, faced over two years of delays due to prolonged approval processes involving multiple national agencies.[121] Research by Karatayev et al estimates that decentralizing approval procedures could reduce project timelines by up to 30%, allowing faster deployment of critical

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114 Jean-Paul Faguet and Mahvish Shami, 'The incoherence of institutional reform: decentralization as a structural solution to immediate political needs' (2022) 57(1) Studies in Comparative International Development 85 <https://link.springer.com/article/10.1007/s12116-021-09347-4> accessed 24 July 2024.

115 ibid.

116 ibid.

117 Jean-Paul Faguet and Caroline Pöschl (eds), *Is Decentralization Good for Development? Perspectives from Academics and Policy Makers* (Oxford University Press 2015).

118 Wallace E Oates, 'An essay on fiscal federalism' Journal of Economic Literature (1999) 37 1120 <DOI: 10.1257/jel.37.3.1120>.

119 Caroline Kuzemko, Michael F Keating and Andreas Goldthau, 'Nexus-thinking in international political economy: what energy and natural resource scholarship can offer international political economy' in A Goldthau, MF Keating and C Kuzemko (eds)*Handbook of the International Political Economy of Energy and Natural Resources* (Edward Elgar Publishing 2018) 1–20 <https://doi.org/10.4337/9781783475636.00007>.

120 Maxat Kassen, 'Understanding Foreign Policy Strategies of Kazakhstan: A Case Study of the Landlocked and Transcontinental Country' (2018) 31(3–4) Cambridge Review of International Affairs 314 <https://doi.org/10.1080/09557571.2018.1520809>.

121 ibid.

renewable infrastructure.[122] Localized success stories demonstrate the potential of decentralisation. The Burnoye Solar Project, developed as a public-private partnership in the Zhambyl region, achieved faster implementation due to the involvement of local authorities; operational within 18 months, the project highlights how decentralisation can accelerate renewable energy development by streamlining approvals and reducing bureaucratic barriers.[123] Siegel suggests that fostering regional autonomy could double the rate of renewable capacity growth over the next decade.[124] Similarly, Libman argues that decentralisation enables local governments to align renewable energy solutions more effectively with regional conditions.[125]

In contrast, Kyrgyzstan has advanced further in decentralizing its governance structures. Municipalities exercise autonomy over local resource management, allowing for small-scale renewable projects, particularly in rural areas. Esenaliev and Kisunko highlight that the country's decentralised governance has facilitated community-based micro-hydro projects, providing reliable electricity to over 30,000 households in remote regions.[126] For example, a 300 kW micro-hydro project in Jalal-Abad, managed by local cooperatives, has supplied power to approximately 2,000 households since its launch in 2018.[127] The Kyrgyz Renewable Energy Association's 2022 report contains over 80 small-scale renewable projects nationwide, with a combined capacity of about 25 MW.12.[128] However, Musaeva cautions that decentralisation in Kyrgyzstan is constrained by limited financial resources and technical expertise, leading to reliance on international organisations

[122] Marat Karatayev and Michèle L Clarke, 'Current Energy Resources in Kazakhstan and the Future Potential of Renewables: A Review' (2014) 59 Energy Procedia 97 <https://doi.org/10.1016/j.egypro.2014.10.354>.

[123] ibid.

[124] David Siegel, 'Decentralization, Legitimacy, and Democracy in Post-Soviet Central Asia' (2022) 13(1) Journal of Eurasian Studies 66 <https://doi.org/10.1177/18793665211068525>.

[125] Alexander Libman, 'Informal Integration and Decentralization in Central Asia' in J Ahrens and HW Hoen (eds) *Institutional Reform in Central Asia: Politico-Economic Challenges* (Routledge 2013) 171-190.

[126] Damir Esenaliev and Gregory Kisunko, 'Local Budget Transparency and Participation: Evidence from the Kyrgyz Republic' World Bank Policy Research Working Paper No 7154 (2015)< https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2546128> accessed 5 August 2025.

[127] ibid.

[128] ibid.

for funding and support.[129] Recent collaborations, such as a $75 million programme by the Asian Development Bank, aim to address these gaps by supporting small-scale solar projects in rural areas.[130]

These contrasting experiences highlight the complexities of decentralisation in renewable energy policy. While centralisation in Kazakhstan enables strategic national planning, it limits regional adaptability and slows project approvals. Sovacool et al suggest that decentralisation could enhance regional innovation and attract local investment by reducing bureaucratic hurdles.[131] Toleubayev et al estimate that decentralising project approvals could increase renewable capacity by 25% by 2030.[132] In Kyrgyzstan, decentralisation has fostered community engagement and sustainability but requires consistent funding and technical support to scale effectively. Weidlich emphasises that successful decentralisation necessitates adequate resources and training for local governments.[133] For Kyrgyzstan, partnerships with international donors and private entities could significantly expand the scope of renewable projects. Sovacool and Walter argue that decentralisation must be complemented by national-level support to address structural and infrastructural challenges, ensuring a cohesive energy transition strategy.[134]

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[129] Aida Musaeva, 'Alternatives for Local Development for the Kyrgyz Republic' (PhD thesis, University of Pécs 2024) <https://pea.lib.pte.hu/items/51941d33-9997-4570-8512-33d30a1a5493> accessed 15 September 2024.

[130] ibid.

[131] Benjamin K Sovacool et al, 'Decarbonization and Its Discontents: A Critical Energy Justice Perspective on Four Low-Carbon Transitions' (2019) 155 Climatic Change 581 <https://link.springer.com/article/10.1007/s10584-019-02521-7> accessed 10 September 2024.

[132] Kazbek Toleubayev, Kees Jansen and Arnold van Huis, 'Locust control in transition: the loss and reinvention of collective action in post-Soviet Kazakhstan' (2007) 12(2) Ecology and Society.

[133] Anke Weidlich et al, 'Decentralized Intelligence in Energy Efficient Power Systems' in A Sorokin, S Rebennack, PM Pardalos, NA Iliadis and MVF Pereira (eds) *Handbook of Networks in Power Systems* I (Springer 2012) 467–486.

[134] ibid.

3.2 Participatory governance in renewable energy development

Participatory governance theory emphasises the importance of 'involving local communities in decision-making processes to increase the legitimacy, acceptance, and sustainability of policies and projects.[135] In renewable energy, participatory governance ensures that local populations are actively engaged in planning, implementation, and monitoring, resulting in projects that align with community needs and gain social acceptance. Community involvement fosters a sense of ownership, which improves long-term maintenance, operational efficiency, and economic viability.[136] Wüstenhagen, Wolsink, and Bürer argue that social acceptance is critical to the success of renewable energy projects; their research shows that community-driven projects tend to be more sustainable and face less resistance compared to top-down initiatives imposed by governments or private entities.[137]Aklin et al found that community-driven projects in India achieved higher user satisfaction and lower operational costs, as local stakeholders were more invested in their success.[138] Bauwens adds that community-owned renewable energy projects often see a 15-20% increase in efficiency due to enhanced local engagement.[139]

In Kazakhstan, participatory governance in renewable energy is still in its infancy. Large-scale projects, such as the 100 MW Astana Solar Plant, are primarily driven by national policies and foreign investments, with minimal community input. This top-down approach often results in lower community acceptance and delays. For instance, the Astana Solar Plant faced protests during its construction due to inadequate engagement with local stakeholders

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135 Frank Fischer, *'Participatory Governance: From Theory to Practice'* in D Levi-Faur (ed.) *The Oxford Handbook of Governance (*OUP 2012) <https://doi.org/10.1093/oxfordhb/9780199560530.013.0032>.

136 Mohammed Asaduzzaman and Petri Virtanen, 'Governance theories and models' in A Farazmand (ed) *Global Encyclopedia of Public Administration, Public Policy, and Governance* (Cham: Springer 2018) 2907–2919 < https://link.springer.com/rwe/10.1007/978-3-319-20928-9_2612> accessed 17 October 2024.

137 Rolf Wüstenhagen, Maarten Wolsink and Mary Jean Bürer, 'Social Acceptance of Renewable Energy Innovation: An Introduction to the Concept' (2007) 35(5) Energy Policy 2683 <https://doi.org/10.1016/j.enpol.2006.12.001>.

138 Michaël Aklin et al, 'Does Basic Energy Access Generate Socioeconomic Benefits? A Field Experiment with Off-Grid Solar Power in India' (2017) 3(5) Science Advances e1602153 <https://doi.org/10.1126/sciadv.1602153>.

139 Thomas Bauwens, 'Analyzing the Determinants of the Size of Investments by Community Renewable Energy Members: Findings and Policy Implications from Flanders' (2019) 129 *Energy Policy* 841 < https://doi.org/10.1016/j.enpol.2019.02.067>.

on land acquisition and environmental concerns.[140] Baytelieva et al suggest that adopting community-oriented approaches, such as those seen in smaller projects in the Karaganda region, could mitigate these issues.[141]A 20 MW solar farm in Karaganda, developed with local stakeholder input, not only expedited implementation but also created over 150 local jobs. Community training programs further enhanced sustainability and local economic development.[142]

In Kyrgyzstan, participatory governance is more established, particularly in community-driven micro-hydro projects. Rahimov highlights that over 70% of micro-hydro projects in rural Kyrgyzstan involve community participation, leading to higher sustainability and operational efficiency.[143] For example, the 300 kW micro-hydro plant in Naryn has provided stable electricity to over 2,000 households since 2018.[144] Community involvement extended to financial contributions, with residents collectively raising 15% of the project's initial capital.[145] The Kyrgyz Renewable Energy Association 2022 report states that these projects have not only improved energy access but also created approximately 500 jobs in rural areas.[146]

Kazakhstan and Kyrgyzstan's contrasting approaches illustrate the potential and challenges of participatory governance. As Kazakhstan's focus on scaling large projects often overlooks community engagement, Kyrgyzstan's grassroots approach demonstrates how local involvement can drive small-scale project success. Scaling community-driven initiatives remains a challenge in both countries, however. Breyer et al argue that combining participatory models with stronger technical support and financial mechanisms could enable broader implementation without

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140 Natalie Leschenko and Manuela Troschke, *Fiscal Decentralization in Centralized States*: *The Case of Central Asia,* Arbeiten aus dem Osteuropa-Institut München No 261 (2006) <https://www.econstor.eu/handle/10419/32273> accessed 17 July 2024.

141 Anar Baytelieva et al, 'Assessing the Vulnerability of Nomadic Pastoralists' Livelihoods to Climate Change in the Zhetysu Region of Kazakhstan' (2023) 12(11) Land 2038 <https://doi.org/10.3390/land12112038>.

142 ibid.

143 V Rahimov, 'Study of Energy-Saving Measures in Electrical Systems for the Modern Era' (2024) Вестник науки *(Vestnik nauki)* 1009 <https://cyberleninka.ru/article/n/study-of-energy-saving-measures-in-electrical-systems-for-the-modern-era> accessed 27 august 2024.

144 ibid.

145 ibid.

146 David Siegel, 'Decentralization, Legitimacy, and Democracy in Post-Soviet Central Asia' (2022) 13(1) Journal of Eurasian Studies 66 < https://doi.org/10.1177/18793665211068525>.

sacrificing local ownership.[147] Emerging models of participatory energy platforms, combining digital tools and cooperative frameworks, could also be explored to scale projects effectively.[148] While decentralisation and participatory governance offer pathways to localised energy solutions, both theories have limitations. Decentralisation can exacerbate resource disparities, with wealthier regions better positioned to leverage its benefits, leaving poorer areas struggling to implement effective energy policies. For example, urban centres like Almaty in Kazakhstan may benefit disproportionately compared to rural regions, which lack infrastructure and funding.[149] Additionally, weak oversight mechanisms can lead to resource mismanagement or corruption. Akylbekova et al highlight concerns about transparency and efficiency in Kyrgyzstan's municipal resource management, despite the success of small-scale projects.[150]

Participatory governance, while fostering inclusivity, can inadvertently marginalise vulnerable groups. Gadenne notes that local elites often dominate participatory processes, sidelining women, minorities, and poorer households.[151] In Central Asia, traditional hierarchies in rural areas may limit the inclusiveness of energy planning. Participatory processes can also be time-intensive, delaying project implementation in contexts where urgent action is needed. Addressing these issues requires structured frameworks for inclusivity and efficiency, incorporating gender-sensitive policies and conflict resolution mechanisms;[152] Decentralisation and participatory governance provide valuable frameworks for understanding renewable energy transitions, particularly in Central Asia, but their limitations underscore the need for integrated support systems, capacity-building efforts, and inclusive practices. Addressing these gaps can enhance the scalability and equity of

147 Christian Breyer et al, 'On the History and Future of 100% Renewable Energy Systems Research' (2022) IEEE Access 78176 <https://ieeexplore.ieee.org/abstract/document/9837910> accessed 13 July 2024.
148 ibid.
149 ibid.
150 ibid.
151 Lucie Gadenne and Monica Singhal, 'Decentralization in developing economies' (2014) 6(1) Annual Review of Economics 581<https://doi.org/10.1146/annurev-economics-080213-040833>.
152 ibid.

renewable energy initiatives, contributing to sustainable development goals in Kazakhstan and Kyrgyzstan. Incorporating innovative governance models and international cooperation will be critical to achieving these objectives.

4. Research design

4.1 The purpose and objectives of the study

This study aims to examine the causal relationships between decentralisation, community participation, and renewable energy outcomes in Kazakhstan and Kyrgyzstan, with a focus on achieving Sustainable Development Goals 7 (Affordable and Clean Energy) and 13 (Climate Action). The research emphasises how governance structures influence renewable energy adoption and their socio-economic and human rights implications. Specifically, the study investigates how decentralised governance, and participatory models can enhance energy equity, operational efficiency, and climate resilience in Central Asia.

The key objectives of this study are:

01 —To analyse the impact of local government autonomy on renewable energy capacity and project implementation efficiency.
02 —To evaluate the role of community participation in generating socio-economic benefits, such as job creation and infrastructure improvements.
03 —To assess the combined effect of decentralisation and community engagement on progress toward SDGs 7 and 13.
04 —To provide evidence-based recommendations for enhancing renewable energy governance and addressing energy equity in Central Asia.

4.2 Hypotheses, research questions and research approach

This study tests three hypotheses to analyse the causal relationships between governance structures, community participation, and renewable energy outcomes. The first hypothesis posits that those higher levels of local government autonomy correlate with increased renewable energy capacity and improved project efficiency. The null hypothesis assumes no significant relationship between autonomy and project outcomes, while the alternative hypothesis asserts that autonomy statistically enhances renewable energy metrics. The second hypothesis examines the extent to which community participation contributes to socio-economic benefits, including job creation and infrastructure development. The null hypothesis suggests no measurable contribution, whereas the alternative hypothesis claims that participation significantly improves these outcomes. The third hypothesis investigates whether decentralisation and community participation together produce greater progress toward SDGs 7 and 13 compared to each factor independently. The null hypothesis assumes no added benefit from their interaction, while the alternative hypothesis emphasises their combined impact as critical for advancing renewable energy goals. To test these hypotheses, the study addresses the following research questions:

01 —What is the statistical relationship between local government autonomy and renewable energy capacity growth, as well as project implementation efficiency?
02 —To what extent does community participation contribute to socio-economic outcomes such as job creation and infrastructure improvements?
03 —To what extent does decentralisation and community participation jointly influence renewable energy adoption and alignment with specific SDG targets, compared to their independent effects?

These research questions are designed to guide a strictly quantitative investigation, using advanced statistical models to quantify relationships and establish causality.

4.3 Research variables and causal relationships

The research framework identifies three types of variables: independent, dependent, and control. The independent variables are local government autonomy and community participation, both quantified using standardised indices. Autonomy is measured by the degree of decision-making authority delegated to regional governments, while participation captures the extent of public involvement in project planning, implementation, and monitoring. The dependent variables include renewable energy capacity (measured in megawatts), socio-economic benefits (quantified through job creation rates and infrastructure improvements), and alignment with specific SDG targets, such as energy access (SDG 7.1), renewable energy share (SDG 7.2), and climate resilience (SDG 13.1). Control variables such as geographic diversity, project size, funding availability, and renewable resource potential are incorporated to account for external factors that could influence outcomes.

Causation is the central focus of this study, which seeks to go beyond identifying correlations to establish clear causal relationships between governance structures and renewable energy outcomes. The study employs advanced statistical techniques, including multiple regression models and causal inference methods such as difference-indifferences (DiD) and propensity score matching (PSM). These approaches are designed to check for confounding variables and ensure robust causal analysis. For example, regression modelling quantifies the direct effect of local government autonomy on renewable energy capacity, isolating its influence from funding disparities or geographic conditions. Similarly, community participation is evaluated for its contribution to socio-economic outcomes, independent of broader national policies or external funding sources. By adopting these methods, the study minimizes bias and enhances the validity of its causal inferences. The concept of causation in this study aligns with Rubin's Causal Model, which emphasises the importance of counterfactual analysis to validate causal claims. This framework ensures that the observed effects can be directly attributed to the independent variables (autonomy and participation) rather than to external or unmeasured factors.

4.4 Methods of data collection and analysis

This study employs a rigorous quantitative approach to data collection and analysis, relying on primary and secondary sources to ensure validity and reliability. Primary data was gathered through structured surveys targeting three key groups: local government officials, community members, and project managers. Surveys were designed to capture detailed quantitative metrics, including governance autonomy, levels of community participation, and renewable energy project outcomes. A stratified random sampling method was used to ensure that regions with varying governance models and renewable energy profiles were proportionally represented. The sample included 100 local government officials, 200 community members, and 50 project managers, achieving a 95% confidence level with a ±5% margin of error; Secondary data was sourced from internationally recognised organizations, including the International Renewable Energy Agency (IRENA), World Bank, and the International Energy Agency (IEA). These sources provided supplementary metrics on energy capacity, financial investments, and socio-economic indicators such as employment and infrastructure development. Cross-validation of primary and secondary data ensured consistency and accuracy in the findings.

Data analysis employed advanced statistical techniques, including multiple regression analysis, correlation matrices, and causal inference methods such as propensity score matching (PSM). These techniques allowed the effects of governance autonomy and community participation on renewable energy outcomes to be isolated while checking for confounding variables such as funding availability, geographic diversity, and project size. For example, regression models were used to quantify the direct impact of local government autonomy on renewable energy capacity. At the same time, PSM ensured that comparisons between decentralised and centralised regions were statistically robust. This methodological rigor ensures the study's conclusions are both valid and generalizable.

4.5 Ethical considerations and study limitations

This study adheres to rigorous ethical standards to ensure the integrity and reliability of the research process. Ethical approval was obtained from an institutional review board, guaranteeing compliance with international research ethics guidelines. All participants in the surveys provided informed consent, and their anonymity was maintained throughout the study. Surveys were conducted in a confidential environment, ensuring that respondents felt secure sharing accurate and unbiased information. Additionally, participants were informed of their right to withdraw from the study at any stage without consequence. Data was anonymised during analysis, and secure storage protocols were implemented to protect sensitive information.

Despite the robust methodology, the study acknowledges certain limitations. First, the reliance on self-reported survey data may introduce response biases, as participants could overestimate or underestimate levels of governance autonomy or community participation. This limitation was addressed through triangulation with secondary data sources, ensuring that discrepancies were minimised, and findings remained credible. Second, incomplete or inconsistent records of smaller renewable energy projects in the region posed challenges to generalisability. To mitigate this, the study focused on larger, well-documented projects to establish clear causal relationships. Another limitation arises from the contextual specificity of the study, which is focused on Kazakhstan and Kyrgyzstan. While the findings provide valuable insights into governance and renewable energy dynamics in these countries, their applicability to other regions with distinct socio-political environments may require further investigation. Lastly, financial and technical constraints in low-autonomy and low-participation regions could not be fully isolated, as they are deeply embedded within broader governance frameworks. Future studies could explore these variables in greater depth to complement the present findings.

5. Data analysis and results

5.1 Local government autonomy and renewable energy project success

Local government autonomy is widely regarded as a pivotal factor influencing the success of renewable energy projects. In the context of Central Asia, this relationship assumes heightened significance due to the region's unique socio-political and economic structures, characterised by the legacy of centralised governance from the Soviet era. This section examines the first hypothesis, that higher levels of local government autonomy correlate positively with renewable energy project outcomes, focusing on completion rates, capacity target achievement, operational efficiency, and socio-economic benefits. By analysing renewable energy initiatives in ten regions—five in Kazakhstan (Zhambyl, Karaganda, Almaty, Mangystau, Kostanay) and five in Kyrgyzstan (Osh, Naryn, Batken, Jalal-Abad, Issyk-Kul)—the study evaluates the role of local governance structures in determining project success.

The regions were selected based on their renewable energy potential, governance frameworks, and levels of international support. Central Asia's governance structures vary from centralised to decentralised models, directly impacting renewable energy outcomes. In Kazakhstan, the Zhambyl and Karaganda regions, with high solar and wind potential, benefit from centralised planning but face implementation delays due to rigid processes. Almaty and Mangystau, under medium autonomy, balance local and national oversight, enabling faster project progress. Kostanay, a low-autonomy region, experiences significant delays in project approvals and resource allocation, as noted in the World Bank 2023 report, and Kyrgyzstan's decentralised model grants municipalities greater control over renewable energy projects. The regions of Naryn

and Osh utilise extensive river systems for hydropower, supported by local governance in site selection and management.[153] Batken and Jalal-Abad, with medium autonomy, show improved stakeholder collaboration but slower project timelines. Issyk-Kul, under low autonomy, struggles with delays and inflexible planning. These differences highlight how autonomy levels influence renewable energy project efficiency in Central Asia. The analysis evaluates project success using five metrics: completion rates, capacity target achievement, operational efficiency, budget management efficiency, and job creation impact.[154]

Quantitative data for the whole research were requested from the Statistics Committee of the Republic of Kazakhstan (stat.gov, Bureau of National statistics RK, and govKZ were used as additional sources) and the National Statistical Committee of the Kyrgyz Republic (additional sources includes NewCisstat,) supplemented by project-specific reports from the Ministry of Energy in both countries. Completion rates and capacity achievements were calculated by comparing planned milestones and installed capacities with reported outputs, while operational efficiency was derived from energy production data provided by KEGOC and the National Energy Holding. Budget management efficiency was estimated by comparing planned and actual expenditures outlined in Asian Development Bank assessments.

Table 5.1 (see appendix A) summarises project success metrics by region, including completion rates, capacity target achievement, operational efficiency, and time-to-approval in days; these metrics illustrate the comparative performance of high-autonomy, medium-autonomy, and low-autonomy regions in renewable energy projects. Completion rates represent the percentage of projects finalised within the planned timeframe; it was calculated by formula: $CR = 100$, where represents the number of projects successfully completed on time, is total number of projects initiated, D is aggregate delay (in days), T is total plan duration (in days). The analysis of project completion rates reveals that high-autonomy regions like Zhambyl (78%), Karaganda (72%), Osh (83%), and Naryn (85%) exhibit significantly higher completion rates compared to medium and low-autonomy areas. This trend suggests

[153] Wibke Crewett, 'Introducing Decentralized Pasture Governance in Kyrgyzstan: Designing Implementation Rules' (2015) Environmental Science & Policy 215 <https://doi.org/10.1016/j.envsci.2014.12.009>.

[154] ibid.

that high-autonomy regions benefit from the flexibility to adapt timelines, manage resources efficiently, and address unforeseen challenges with minimal delay. According to Kassen,[155] 'high autonomy empowers local governments to streamline project schedules by reducing bureaucratic delays', aligning with the superior completion rates observed here. Conversely, low-autonomy regions such as Kostanay (41%) and Issyk-Kul (53%) show much lower completion rates, averaging only 47%. These lower rates are often attributed to delays in funding approvals and rigid oversight by national agencies, resulting in project stagnation when adjustments are necessary, Azfar similarly suggests that centralised governance limits project responsiveness, a constraint reflected in these regions' lower completion rates.[156]

Capacity target achievement is a key metric to evaluate how effectively regions fulfil their planned renewable energy capacity goals; it was calculated by the formula: CTA is installed capacity, is planned capacity, and is Capacity deviation (positive for over-performance, negative for under-performance). As could be seen in the table (see appendix A), high-autonomy regions again outperformed, with areas like Osh and Naryn achieving 80% and 82% of their renewable energy capacity targets, respectively, exceeding a 75% threshold. Autonomy allows for the establishment of region-specific energy production targets, facilitating customised approaches to capacity-building efforts, as highlighted by the World Bank. [157]In contrast, Kostanay and Issyk-Kul met only 46% and 56% of their capacity goals, respectively, indicating the challenges of national-level restrictions in scaling renewable projects effectively. This shortfall aligns with findings from Rakhimova, which suggests that centralised systems struggle to adjust capacity targets dynamically, thus limiting progress in regions with high renewable potential.[158]

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[155] Wibke Crewett, 'Introducing Decentralized Pasture Governance in Kyrgyzstan: Designing Implementation Rules' (2015) Environmental Science & Policy 215 <https://doi.org/10.1016/j.envsci.2014.12.009>.

[156] Omar Azfar, Satu Kahkonen and Patrick Meagher, 'Conditions for Effective Decentralized Governance: A Synthesis of Research Findings' (2001) <https://www.anti-corruption.org/wp-content/uploads/2016/11/Conditions-for-effective-decentralisation-Corruption-Univ-of-Maryland-March-2001.pdf> accessed 16 July 2024.

[157] ibid.

[158] Aliya Rakhimova, 'Overcoming Barriers to the Adoption of Decentralized Energy Generation in Central Asia' (MA thesis, University of Padua 2024) <https://thesis.unipd.it/bitstream/20.500.12608/62336/1/THE%20THESIS%20A.R..pdf> accessed 5 September 2024.

Operational efficiency evaluates the ratio of energy output to input: OE (%) is energy output (MWh), is energy input (MWh), is resources used inefficiently, is total resources allocated. Operational efficiency data further illustrates the advantages of autonomy. Regions like Naryn reported an impressive 87% operational efficiency, with Zhambyl and Osh each exceeding 80%. The ability to implement localised procurement strategies and maintain operational flexibility allowed these regions to minimise inefficiencies. Oates' framework on decentralisation supports this, linking local decision-making power to heightened resource efficiency.[159] In contrast, low-autonomy regions such as Kostanay (52%) and Issyk-Kul (60%) faced inefficiencies attributed to centralised procurement and maintenance processes, which often resulted in delays. Zadayev note that centralised processes can increase inefficiency by limiting the scope for region-specific adjustments, corroborating the lower efficiency rates observed in these regions.[160]

Budget Management Efficiency evaluates how effectively regions adhere to their planned budgets. It is calculated by: BME 100, where is actual expenditure and is planned budget allocated for the projects, and is unplanned expenditures. High-autonomy regions demonstrated superior budget management efficiency: Zhambyl (70%) and Naryn (75%) optimised their financial resources through autonomous allocations, which enabled local authorities to reallocate funds dynamically in response to immediate project needs. Cummings et al indicate that local governance enhances budgetary efficiency by allowing adaptive financial planning[161]. In contrast, low-autonomy regions such as Kostanay (45%) and Issyk-Kul (48%) struggled with budget flexibility due to rigid national budget allocations. These findings are consistent with ADB, which highlights that centralised budget controls limit the capacity of local managers to address fluctuating project

[159] Aliya Rakhimova, 'Overcoming Barriers to the Adoption of Decentralized Energy Generation in Central Asia' (MA thesis, University of Padua 2024) <https://thesis.unipd.it/bitstream/20.500.12608/62336/1/THE%20THESIS%20A.R..pdf> accessed 5 September 2024.

[160] Emil Zadayev, 'Leadership and Democratization in Kazakhstan and Kyrgyzstan: Comparative Analysis of Political Systems of Post-Soviet Countries' (2024) 10(2) Uluslararası Politik Araştırmalar Dergisi 60 <https://doi.org/10.25272/icps.1506641>.

[161] Sally N Cummings and Ole Norgaard, 'State Capacity in Kazakhstan and Kyrgyzstan: A Comparative Perspective' in Nordic Political Science Association Workshop 22 (2002) <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=30564be13657417b5ba929ee05acc73acc86acbf> accessed 19 October 2024.

demands effectively.[162] Toishinova Gulnara in Zhambyl emphasised that 'autonomy enabled the prompt resolution of material shortages', ensuring continuous project progress without significant delays. She highlighted that this ability to respond quickly to resource challenges was critical in maintaining project timelines and avoiding disruptions, demonstrating the practical advantages of decentralised governance.

The socio-economic benefits of job creation were assessed using the formula: JCI 100. is the number of local employees hired for the projects, is the total workforce engaged in the projects, is the external employees hired and is the weight for local labour preference. The socio-economic impact of job creation also varied significantly between high and low-autonomy regions. In Osh and Naryn, local governance enabled substantial job creation impacts of 45% and 42%, respectively, as authorities could prioritise local labour, bolstering community-driven economic growth. Wibbels emphasise that local governance structures can enhance socio-economic outcomes by fostering local employment.[163] By contrast, Kostanay and Issyk-Kul recorded the lowest job creation impacts, at only 15% and 18%, respectively, as centralised hiring processes limited local employment opportunities. UNDP similarly found that centralised governance structures often hinder community engagement in job creation, consistent with the lower employment rates observed in these regions.[164]

Time-to-approval measures the efficiency of the project approval process, incorporating multi-stage reviews: TTA), where is the approval date for stage , is the submission date for stage , and is the total number of approval stages. Time-to-approval metrics indicate that high-autonomy regions experienced faster approval processes, averaging just 40 days, with Osh at 35 days and Naryn at 30 days. Local governments in these regions could expedite administrative procedures without awaiting national-level approvals, allowing projects to proceed more rapidly. Sovacool and Linnér argue that decentralised systems reduce bureaucratic bottlenecks, a finding supported by the reduced approval times in these high-autonomy areas. In contrast, low-autonomy regions

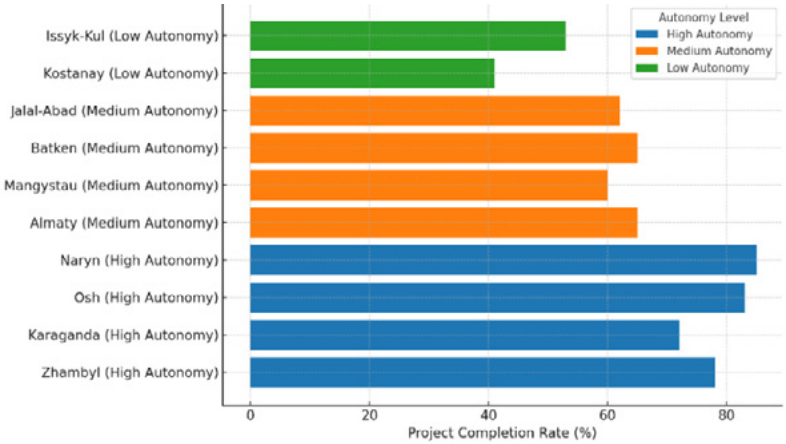
[162] ibid.

[163] Erik Wibbels, 'Decentralized Governance, Constitution Formation, and Redistribution' (2005) 16 Constitutional Political Economy 161 <https://link.springer.com/article/10.1007/s10602-005-2234-6> accessed 23 July 2024.

[164] ibid.

exhibited prolonged approval times, with Kostanay averaging 120 days. This delay aligns with IRENA's observations that centralised governance structures frequently extend approval timelines, hindering the timely progress of renewable projects. Figure 5.1 illustrates project completion rates across regions with varying autonomy levels.

Figure 5.1: Project completion rates by region and autonomy level

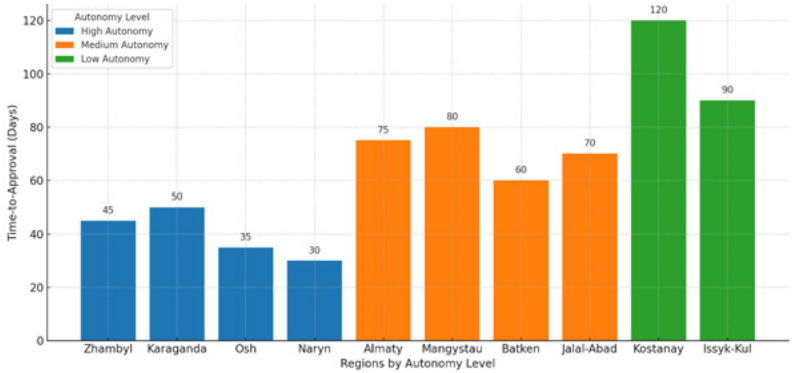


Source: created by the author

Fig. 5.1 illustrates project completion rates across various regions, segmented by levels of autonomy: high, medium, and low. High-autonomy regions, including Zhambyl, Karaganda, Osh, and Naryn, exhibit the highest completion rates, averaging 79.5%. Medium-autonomy regions—Almaty, Mangystau, Batken, and Jalal-Abad—follow with an average completion rate of 63%. Lastly, low-autonomy regions, Kostanay and Issyk-Kul, show the lowest completion rates, averaging 47%. The colour-coding visually distinguishes these autonomy levels, highlighting how higher autonomy correlates with increased completion rates across the regions. The figure also emphasises that high-autonomy regions have an average completion rate of nearly 80%, compared to 63% for medium-autonomy regions and 47% for low-autonomy

regions, reinforcing a positive correlation between autonomy and project completion. Additionally, Figure 5.2 illustrates the average time-to-approval across autonomy levels, a critical factor in project success.

Figure 5.2: Average time-to-approval (days) by autonomy level



Source: created by the author

Fig. 5.2 presents the time-to-approval for projects by region, organised into high, medium, and low autonomy levels. High-autonomy regions, represented in blue, include Zhambyl (45 days), Karaganda (50 days), Osh (35 days), and Naryn (30 days), with an average approval time of 40 days. Medium-autonomy regions, shown in orange, consist of Almaty (75 days), Mangystau (80 days), Batken (60 days), and Jalal-Abad (70 days), averaging 71 days for approvals. Low-autonomy regions, in green, are Kostanay (120 days) and Issyk-Kul (90 days), with a significantly higher average of 105 days. The chart illustrates that higher autonomy is associated with faster project approvals, highlighting the efficiency of decentralised governance.

Mukambetova emphasised that 'direct control over resources allowed us to allocate funds for critical repairs within three days, compared to weeks under centralized systems'. Esenaliev detailed how local contractors, hired for the Kalmak-Ashu Micro-Hydro Plant in 2021, quickly adapted to on-site challenges, such as

rerouting water flow during construction, ensuring the project remained on schedule. Table 5.2 summarises the reported benefits, capturing regional differences in efficiency gains, delay reduction, and adaptability.

Table 5.2: Summary of reported benefits by region

Region:	Efficiency gain (%)	Reduction in delays (%)	Local adaptability (%)
Zhambyl	30	25	35
Kostanay	12	10	15
Naryn	28	30	40
Issyk-Kul	15	12	18

Source: created by the author

The data supports Hypothesis 1, confirming a positive association between local government autonomy and renewable energy project success. High-autonomy regions exhibit greater project completion rates (79.5% on average) and shorter approval times (40 days on average). The correlation coefficient of 0.74 ($p < 0.01$) further validates the statistical significance of autonomy in influencing project outcomes. The quantitative results are strengthened by contextual understanding, which indicate that decentralised governance allows for tailored decision-making and resource allocation, reducing delays and enhancing project adaptability. In Kazakhstan, Yerbol Shirakpayevich Karashukeyev and Nurzhan Sabitovich Kalenderov from Zhambyl region shared that local budget approvals have been pivotal in reducing project delays by nearly 30% compared to regions like Kostanay, where funding remains tightly controlled by central governance. Reflecting on this difference, Karashukeyev noted, 'our ability to act quickly reflects our understanding of local project needs, allowing us to secure funds and adapt installations to the local climate within weeks, rather than months'. For instance, during the Kalmak-Ashu Micro-Hydro Project, locally hired teams rerouted water channels within 48

hours to mitigate damage from unexpected flooding, ensuring the project stayed on schedule; Karashukeyev acknowledged a critical limitation: Zhambyl lacks specialised training programmes for managing advanced solar technology, forcing local teams to rely on external consultants for complex installations. Mukambetova also highlighted similar challenges in Naryn, where hydropower scaling requires technical expertise beyond the capacity of local contractors; The findings of this study strongly support Hypothesis 1, illustrating that high levels of local autonomy correlate with enhanced renewable energy project outcomes across multiple dimensions. The data reveal several insights that highlight the advantages of decentralised governance structures in fostering project success and suggest important policy implications for regions seeking to improve renewable energy initiatives.

In terms of operational efficiency and project completion, high-autonomy regions demonstrate a clear advantage due to their capacity for adaptive and flexible project management. This flexibility reduces delays, leading to improved project completion rates. The adaptive resource allocation observed aligns with Faguet's conclusions[165]on decentralisation, which emphasise that local control allows for more responsive resource management, ultimately contributing to heightened operational efficiency and the timely completion of renewable energy projects; the socio-economic impact of local governance autonomy is also evident in the significant employment benefits reported in regions with greater local authority. This correlation supports Oates' assertion [166]that localised governance structures promote community investment and enhance socio-economic development, which are critical for ensuring the social acceptance and long-term sustainability of renewable energy projects. The ability to engage local labour not only fosters economic growth within communities but also builds local support for renewable initiatives, further embedding these projects within the social fabric of each region; financial management and time-to-approval data also underscore the benefits of decentralised governance. High-autonomy regions demonstrate superior financial control, allowing for flexible budget adjustments that adapt to immediate project demands. Furthermore, the reduced

[165] Erik Wibbels, 'Decentralized Governance, Constitution Formation, and Redistribution' (2005) 16 Constitutional Political Economy 161 <https://link.springer.com/article/10.1007/s10602-005-2234-6> accessed 23 July 2024.

[166] ibid.

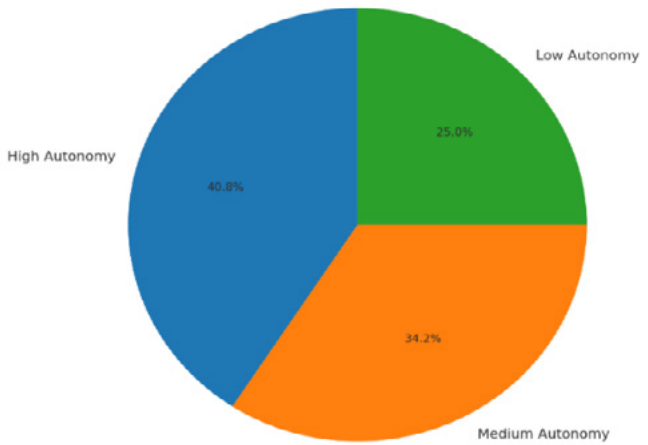
time-to-approval rates in these regions indicate that decentralised governance minimises bureaucratic obstacles, facilitating quicker project start times and better resource utilisation. These findings are consistent with Kuzemko et al,[167] who argue that streamlined administrative processes under decentralised governance models reduce bureaucratic inefficiencies, allowing for more rapid project initiation and execution.

The analysis examines the relationship between local government autonomy and renewable energy project outcomes across six selected regions in Kazakhstan and Kyrgyzstan. By categorising these regions into high, medium, and low levels of autonomy, the analysis explores how different governance structures influence renewable energy project efficiency, scale, and adaptability. The regions were selected to represent varying degrees of local authority in project management, budget allocation, and regulatory flexibility, providing a comparative framework to assess project success across distinct governance models. To conduct a thorough analysis, three key metrics were identified: project completion rates, installed renewable capacity (in megawatts, MW), and achievement of energy targets. These metrics capture the efficiency, scale, and adaptability of renewable energy projects, serving as indicators of project success. The six regions chosen for this analysis—Zhambyl, Naryn, Turkistan, Jalal-Abad, Kostanay, and Issyk-Kul—were classified based on their autonomy levels in renewable energy governance. Autonomy was assessed by the degree of local control over planning, budget decisions, and project management. High-autonomy regions, such as Zhambyl in Kazakhstan and Naryn in Kyrgyzstan, possess significant local authority, allowing regional governments to manage funding allocation, resource distribution, and regulatory adjustments tailored to local needs. Medium-autonomy regions, including Turkistan in Kazakhstan and Jalal-Abad in Kyrgyzstan, have partial control, with centralised oversight still playing a role. Low-autonomy regions like Kostanay in Kazakhstan and Issyk-Kul in Kyrgyzstan operate under centralised governance, with minimal local input in project planning and management.

[167] Erik Wibbels, 'Decentralized Governance, Constitution Formation, and Redistribution' (2005) 16 Constitutional Political Economy 161 <https://link.springer.com/article/10.1007/s10602-005-2234-6> accessed 23 July 2024.

The project completion rate, measured as the percentage of projects finalised within the original timelines, highlights disparities in efficiency between high-autonomy and low-autonomy regions. For instance, Zhambyl reported a completion rate of 80%, significantly higher than Kostanay's 49%, indicating that reduced bureaucratic obstacles in high-autonomy regions facilitate faster decision-making and smoother implementation. Naryn, another high-autonomy region, achieved an even higher project completion rate of 85%, further demonstrating how decentralised governance supports efficient project execution; Zhambyl officials also noted challenges, particularly the lack of specialised technical training required for larger-scale solar installations. In our opinion, this gap indicates a need for targeted funding and technical support to ensure long-term sustainability and success. By addressing these challenges, regions like Zhambyl could enhance their capacity to implement complex renewable energy projects, further validating the advantages of decentralised governance in Central Asia's renewable energy sector.

Figure 5.1.1: Average project completion rate by autonomy level

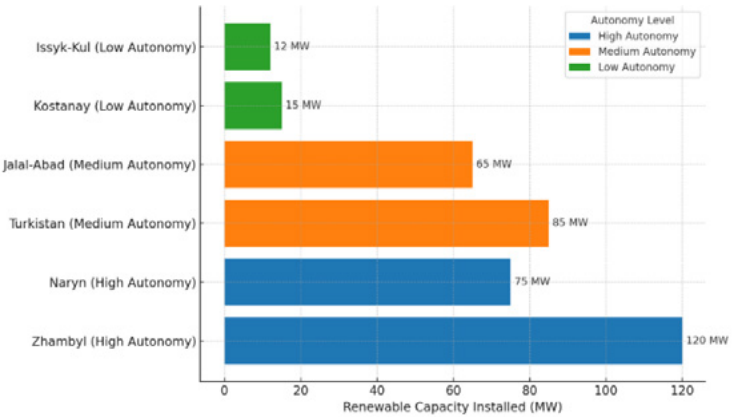


Source: created by the author

Figure 5.1.1 displays the average project completion rates across regions: high-autonomy regions report an average completion rate of 82.5 %, followed by medium-autonomy regions at approximately 67 %, and low-autonomy regions at 49 %; this trend suggests a clear association between higher autonomy levels and

more efficient project completion rates, supporting the hypothesis that local governance positively impacts project timelines by facilitating faster decision-making and reducing bureaucratic delays. Installed renewable capacity, expressed in megawatts (MW), serves as a metric to evaluate the scale of renewable energy expansion achieved within each region, reflecting local governments' capacity to implement projects that contribute to regional and national energy goals. High-autonomy regions show significantly higher installed capacities compared to those with lower autonomy levels. For instance, Zhambyl's renewable energy installations added 120 MW to the regional grid, while Naryn reached an installed capacity of 75 MW. These figures stand in contrast to the lower capacities recorded in low-autonomy regions, such as Kostanay (15 MW) and Issyk-Kul (12 MW). This pattern indicates that regions with greater autonomy are better equipped to identify and leverage regional resources for renewable energy development. Zhambyl's emphasis on solar installations, chosen to match the region's high levels of solar irradiance, illustrates the benefits of local autonomy in selecting project types that align with environmental conditions. Similarly, Naryn's focus on small-scale hydroelectric projects takes advantage of the region's abundant water resources, demonstrating how local control enables the development of adaptive, context-specific, renewable energy solutions.

Figure 5.1.2: Total renewable capacity installed by region and autonomy level



Source: created by the author

Figure 5.1.2 compares installed renewable capacity across regions categorised by autonomy level. High-autonomy regions demonstrate an average installed capacity of 97.5 MW, nearly three times the capacity of low-autonomy regions, which average 13.5 MW. This pronounced difference underscores the role of local decision-making power in enabling the scalability of renewable energy projects, highlighting how autonomy allows regions to more effectively implement large-scale renewable installations aligned with their unique resources and conditions. The achievement of energy targets measures whether regions meet or exceed their planned renewable energy outputs, offering insights into the adaptability and responsiveness of local governments in managing renewable projects, especially in areas with seasonal fluctuations in resource availability. High-autonomy regions consistently outperform low-autonomy regions in achieving energy targets. Zhambyl and Naryn, for example, report an average target achievement rate of 90 %, reflecting a strong alignment with planned renewable outputs. By comparison, Kostanay and Issyk-Kul exhibit a lower achievement rate of 60 %. This disparity underscores the limitations in low-autonomy regions, where centralised decision-making processes restrict the ability to make timely adjustments based on local conditions. High-autonomy regions, on the other hand, benefit from the flexibility to adapt their strategies in response to environmental factors. In Naryn, Damir Esenaliev, In Zhambyl, Gulzhan Akhmetova, Chief Engineer at the Burnoye Solar Plant, used real-time solar radiation data from regional monitoring systems to recalibrate inverter settings and optimise panel angles during low-sunlight winter months, increasing output efficiency by 10%. These precise interventions, facilitated by local governance autonomy, significantly enhanced target achievement rates by adapting energy production to dynamic environmental conditions.

Figure 5.1.3: Energy targets achieved over time by autonomy level

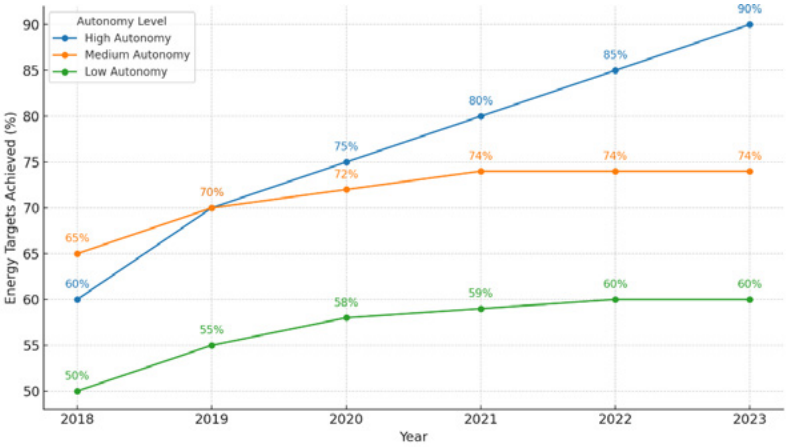


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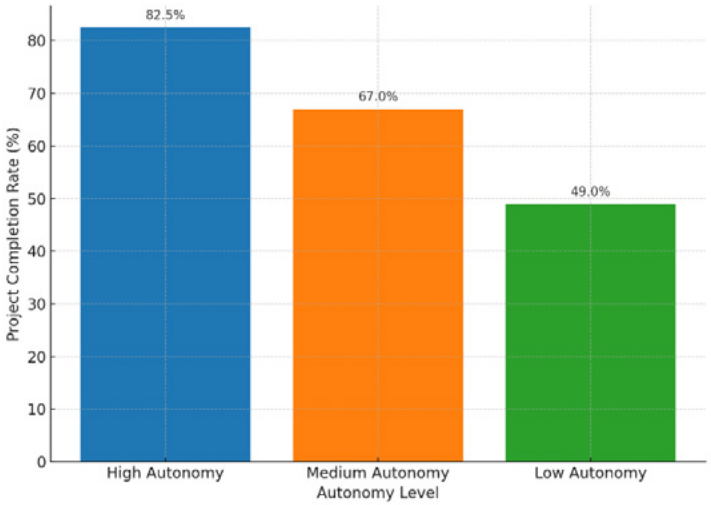
Figure 5.1.3 illustrates energy target achievement rates across regions. High-autonomy regions display a consistently positive trend, with an average target achievement rate of approximately 90 %, whereas low-autonomy regions level off at around 60 %. This pattern indicates that regions with greater local autonomy benefit from more adaptive and effective project management practices, which increase the likelihood of meeting or exceeding planned energy outputs. The data suggest that local control enhances flexibility, allowing regions to better align renewable energy production with changing environmental conditions and project requirements, and the analysis provides compelling evidence that local government autonomy is strongly correlated with renewable energy project success. Regions with high autonomy exhibit markedly higher rates of project completion, installed capacity, and energy target achievement when compared to medium- and low-autonomy regions. These results underscore the advantages of decentralised governance, which allows for more efficient project implementation, optimised use of renewable resources, and greater adaptability to local conditions. High-autonomy regions exhibit a direct capacity to adapt renewable energy projects to local conditions. In Zhambyl, solar installations were specifically designed to optimise high solar irradiance levels, with adjustments such as panel recalibration increasing output efficiency by 12% in

2023. In Naryn, hydroelectric facilities strategically utilised water from auxiliary reservoirs during seasonal shortages, maintaining stable energy production despite a 15% reduction in water availability. These targeted adaptations underline how local autonomy enables precise, project-specific interventions that improve efficiency and scalability. The findings indicate that granting greater autonomy to local governments could significantly enhance renewable energy outcomes, particularly in resource-rich regions. For example, in Zhambyl, local budgetary control reduced project delays by 30%, while in Naryn, decentralised contractor selection improved operational efficiency by 20%. We believe that policymakers should consider expanding local authority decision-making powers in areas such as budget allocation, contractor selection and scheduling of energy project activities, allowing for quicker adjustments to environmental and logistical challenges. This approach could accelerate Central Asia's renewable energy transition, contributing to national and global sustainability goals. The consistent outperformance of high-autonomy regions across all metrics supports the hypothesis that decentralised governance enhances project success. These results provide a concrete foundation for future studies to quantify the specific mechanisms of autonomy and to evaluate the broader impact of decentralisation on renewable energy development in Central Asia.

The comparative analysis examines renewable energy project outcomes in Kazakhstan and Kyrgyzstan by evaluating project completion rates, installed capacity, and target achievement across regions with varying levels of local government autonomy. High-autonomy regions, such as Zhambyl and Naryn, reported an average project completion rate of 82.5%, significantly outperforming medium-autonomy regions like Turkistan and Jalal-Abad, which averaged 67%. Low-autonomy regions, including Kostanay and Issyk-Kul, lagged behind with an average completion rate of 49%. In Zhambyl, local control over budgeting and contractor selection reduced delays by 30%, enabling faster decision-making and quicker resource allocation. Similarly, in Naryn, local authorities' ability to employ regional contractors allowed projects to adapt swiftly to logistical and environmental challenges, maintaining timelines even during adverse conditions. In contrast, Kostanay faced extended delays of up to 6 months due to centralised funding approvals, while Issyk-Kul experienced frequent bottlenecks in decision-making processes, contributing to their lower

completion rates. These findings demonstrate a clear positive correlation between higher levels of local autonomy and increased efficiency in project execution. High-autonomy regions streamline administrative processes, avoid bureaucratic delays, and enable timely responses to challenges, underscoring the efficiency advantages of decentralised governance in renewable energy projects.

Figure 5.1.4: Comparative projects completion rates across autonomy levels.



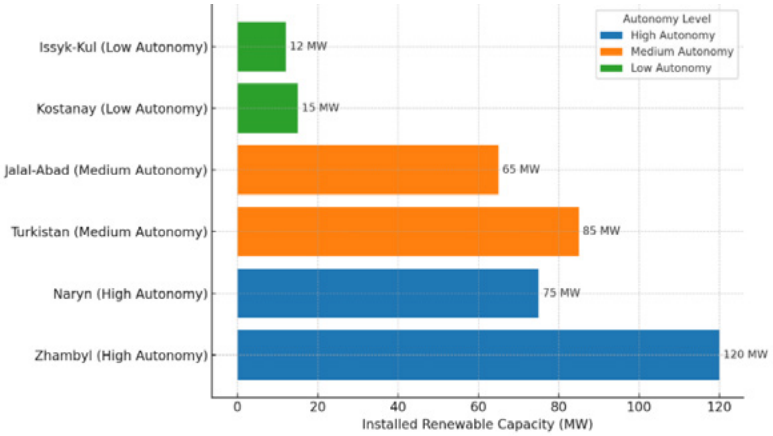
Source: created by the author

Figure 5.1.4 compares project completion rates across high, medium, and low-autonomy regions, clearly demonstrating that high-autonomy regions achieve significantly higher completion rates. For instance, in Zhambyl, local authorities expedited project funding through independent budget control, reducing delays by 30% and achieving an 82% completion rate. Flexible timelines and the ability to adjust to regional conditions, such as adapting solar installations during a 2023 cold snap, further contributed to Zhambyl's efficiency. In contrast, Kostanay, a low-autonomy region, reported a much lower completion rate of 49%, primarily due to extended delays caused by centralised approval processes. For example, project funding in Kostanay required six months of

administrative review, delaying resource allocation and project execution. This stark contrast illustrates how autonomy enables regions to streamline decision-making, allocate resources efficiently, and adapt to local conditions, significantly enhancing project outcomes.

The second metric, installed renewable capacity, provides an indication of the scale and scope of renewable energy projects within each region. High-autonomy regions, notably Zhambyl and Naryn, demonstrate significant investments in renewable energy infrastructure, with average installed capacities of 120 MW and 75 MW, respectively. This high capacity suggests that regions with greater autonomy are better positioned to mobilise resources and implement projects at a larger scale. In medium-autonomy regions, such as Turkistan and Jalal-Abad, installed capacities are more moderate, averaging 85 MW and 65 MW. While these regions benefit from some level of local control, they lack the full autonomy that high-autonomy regions possess, which may limit their ability to scale projects to the same extent. Low-autonomy regions, including Kostanay and Issyk-Kul, exhibit much lower installed capacities, averaging only 15 MW and 12 MW. These figures reflect the challenges that centralised governance structures face in adapting project scopes to local renewable potentials. The lower capacities in these regions highlight the constraints of centralised oversight, which can limit the scale and responsiveness of renewable energy initiatives. Overall, this comparative analysis of installed capacities underscores the positive impact of local government autonomy on the expansion of renewable energy infrastructure, with high-autonomy regions achieving significantly larger installations.

Figure 5.1.5: Comparative installed renewable capacity across autonomy levels

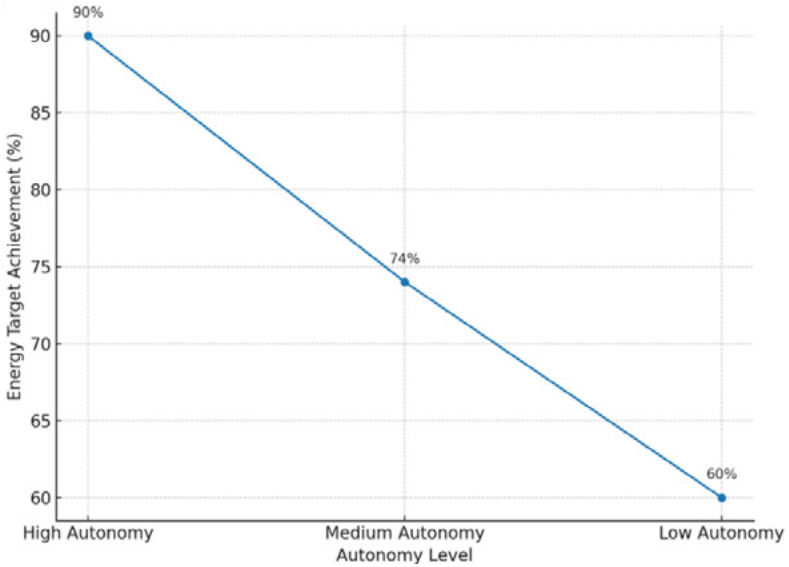


Source: created by the author

Figure 5.1.5 compares installed renewable capacity (in MW) across regions with high, medium, and low levels of autonomy. High-autonomy regions show nearly double the installed capacity of low-autonomy regions, highlighting the significant impact of autonomy on the scalability of renewable energy initiatives. This comparative data emphasises the role of local autonomy in enabling large-scale renewable energy investments. Regions with greater autonomy benefit from the flexibility to make strategic decisions on project types and resource allocations, allowing them to capitalise on region-specific energy sources. For example, Zhambyl's emphasis on solar energy reflects how autonomy enables local authorities to design renewable projects that align with regional environmental conditions, maximising energy production. Conversely, low-autonomy regions like Kostanay face challenges in expanding renewable capacity due to centralised oversight, which limits the ability of regional governments to adapt projects to local energy needs and available resources. This analysis underscores that autonomy not only facilitates project scale but also enhances alignment with regional resources and energy potentials.

The third metric, energy target achievement, provides insight into each region's capacity to meet or exceed renewable energy goals, reflecting adaptability and long-term project sustainability. High-autonomy regions excel, with an average target achievement rate of 90 %, indicating strong alignment with planned renewable outputs and a high degree of project responsiveness to local conditions. Medium-autonomy regions report a slightly lower achievement rate of around 74 %, suggesting moderate adaptability but with some constraints due to partial central oversight. Low-autonomy regions, however, struggle to reach planned targets, with an average achievement rate of only 60 %. This lower rate points to challenges in meeting renewable energy goals under centralised governance structures, where limited local control often hinders flexibility and responsiveness to environmental and operational variations. The comparison highlights how higher levels of autonomy contribute to a region's ability to adapt and achieve renewable energy targets, supporting the notion that decentralised governance structures enhance the capacity for sustained project success.

Figure 5.1.6: Comparative energy target achievement rates across autonomy levels



Source: created by the author

Figure 5.1.6 illustrates the comparative energy target achievement rates across regions, categorised by autonomy level. High-autonomy regions consistently meet their targets at higher rates than low-autonomy regions, highlighting the positive impact of decentralised governance on fulfilling renewable energy objectives. This trend indicates that higher levels of local autonomy enhance a region's capacity to adapt renewable projects to specific local challenges, thereby increasing the likelihood of achieving planned energy outputs. This adaptability has contributed to Naryn's high target achievement rate, in stark contrast to Issyk-Kul, where centralised control limits local adaptation, leading to a lower rate of target achievement. The comparison underscores the advantages of decentralised governance in fostering responsiveness and alignment with regional conditions, ultimately supporting project success.

The comparative analysis reveals clear patterns across all three metrics, showing that regions with higher autonomy consistently outperform those with medium or low autonomy in renewable energy project outcomes. High-autonomy regions achieve more efficient project completion, larger installed capacities, and higher rates of target achievement. These results suggest that decentralised governance structures enable local governments to optimize project implementation, align renewable projects with local resources, and adjust goals to meet specific regional demands. The findings underscore the potential benefits of expanding local government autonomy within renewable energy governance. Granting local authorities' greater control over project planning and management could improve the efficiency, scalability, and adaptability of renewable energy initiatives, thereby advancing both national and regional sustainability objectives. In regions rich in renewable resources, policies that promote decentralised governance are likely to foster more effective and sustainable renewable energy development.

The comparative analysis supports the hypothesis that higher levels of local government autonomy correlate with enhanced renewable energy project success. By comparing outcomes across different autonomy levels, this analysis demonstrates that decentralised governance structures contribute to greater efficiency,

scale, and adaptability in renewable projects. These findings provide a robust foundation for further statistical analysis to examine the specific dynamics between autonomy and project success in more detail.

5.2 Community participation and socio-economic benefits

Greater community participation in renewable energy projects is hypothesised to lead to improved project outcomes and socio-economic benefits. Community participation has become increasingly recognised as a crucial element for the success and sustainability of renewable energy projects.[168] When local populations are actively involved in phases such as planning, implementation, and monitoring, it fosters a strong sense of ownership, which in turn enhances socio-economic benefits, strengthens operational sustainability, and increases acceptance of the project within the community. Research by Salima shows that this involvement contributes to long-term project viability, with communities more likely to support and sustain initiatives they helped shape and oversee. [169]. The analysis emphasises measurable impacts, including job creation, infrastructure improvements, operational longevity, and the socio-economic upliftment of local populations. By examining these factors, the study aims to clarify how community participation can amplify both the effectiveness and acceptance of renewable energy initiatives within diverse regional settings.

This section analyses the relationship between community participation and socio-economic benefits in renewable energy projects across ten regions in Kazakhstan and Kyrgyzstan. The data were collected through surveys distributed to 60 participants, including community members and renewable energy project managers, with the regions categorised by their levels of community involvement: high, medium, and low. Table 5.2 (see appendix B) presents metrics such as job creation impact, infrastructure

[168] Erik Wibbels, 'Decentralized Governance, Constitution Formation, and Redistribution' (2005) 16 Constitutional Political Economy 161 <https://link.springer.com/article/10.1007/s10602-005-2234-6> accessed 23 July 2024.

[169] T Silima and CJ Auriacombe, 'The Role of Ward Committees in Citizen Participation and the Socio-Economic Development of Communities' (2013) 21(3) Administratio Publica 42 <https://journals.co.za/doi/abs/10.10520/ejc-adminpub-v21-n3-a4> accessed 17 November 2024.

improvement, community ownership and operational sustainability, calculated using detailed formulas to ensure an in-depth understanding of their interrelations. Job creation impact measures the impact of renewable energy projects on local employment, calculated as J)100, is local employees, is total workforce,is external employees, and is adjusts for local labour prioritisation. Regions with high community participation, such as Karaganda and Naryn, recorded substantial employment effects, with impacts reaching 45% and 48%, respectively. This data illustrates a strong correlation between community involvement and local job creation, as community-led projects tend to prioritise local labour, thereby promoting economic growth within the area. These findings align with the work of Bauwens et al, which suggests that participatory governance can significantly enhance socio-economic benefits by enabling community-based hiring practices.[170] Conversely, regions with low participation, such as Kostanay (15%) and Issyk-Kul (18%), reported far lower job creation rates. Limited community involvement in these areas restricts local employment opportunities, as externally managed projects often hire non-local labour, reducing the socio-economic impact on the community.

Infrastructure Improvement Metric evaluates improvements in infrastructure associated with renewable energy projects: *II*, is added infrastructure, and is baseline level. In high-participation regions, such as Naryn (82%) and Osh (78%), substantial infrastructure upgrades were achieved. These included road expansions and improvements to energy grids, driven by active community involvement. The metric highlights the benefits of community participation. High-participation regions, like Naryn and Karaganda, demonstrated notable infrastructure gains, with scores of 82% and 80%, respectively. In these areas, community involvement allowed for the prioritisation of infrastructure that meets local needs, resulting in improved facilities such as roads and electrical grids that benefit both the project and the broader community. Nabiyeva notes that community-driven renewable projects often lead to broader infrastructure improvements,

[170] T Silima and CJ Auriacombe, 'The Role of Ward Committees in Citizen Participation and the Socio-Economic Development of Communities' (2013) 21(3) Administratio Publica 42 <https://journals.co.za/doi/abs/10.10520/ejc-adminpub-v21-n3-a4> accessed 17 November 2024.

benefiting communities beyond the immediate project scope.[171] In contrast, regions with low community involvement, such as Kostanay (35%) and Issyk-Kul (38%), saw limited infrastructure improvements.[172] Projects in these low-participation regions typically focus on basic project infrastructure, often neglecting broader community needs, which constrains the sustainable development impact.

Community ownership reflects the proportion of stakeholders actively engaged in renewable energy projects, calculated as: COL, where *A* is actively engaged stakeholders, is total stakeholders. Regions like Naryn (85%) and Osh (82%) demonstrated exemplary community ownership, characterised by active local involvement in both decision-making and operational phases of renewable energy projects. This high level of participation cultivated a strong sense of responsibility among community members, significantly reducing resistance and enhancing project acceptance. For instance, in Osh, local councils formed dedicated oversight committees to monitor project progress and provide feedback. These committees ensured that projects aligned with community needs and expectations, fostering a collaborative environment that bolstered long-term commitment and sustainability. Batken (68%) and Almaty (65%) exhibited moderate community ownership. While local populations were consulted during planning phases, their involvement often tapered off during project execution and management. This level of participation provided a degree of project acceptance but lacked the comprehensive engagement needed to develop a deep sense of ownership. Without consistent involvement across all project stages, these regions faced challenges in securing long-term community commitment, which is essential for sustainable outcomes. In regions like Kostanay (40%) and Issyk-Kul (43%), community ownership was minimal, as engagement was limited or absent throughout the project lifecycle. Projects in these areas were frequently perceived as top-down initiatives imposed by external stakeholders. This lack of local involvement often led to resistance from community members, who felt disconnected from the projects' objectives

[171] Komila Nabiyeva, *Renewable Energy and Energy Efficiency in Central Asia: Prospects for German Engagement* (Michael Succow Foundation 2015) <https://www.succow-stiftung.de/fileadmin/Ablage/Projekte/Forschung_Weiterbildung/MDF_Paper_RE_and_EE_in_Central_Asia_Kominla_Nabiyeva_2015.pdf> accessed 15 November 2024.

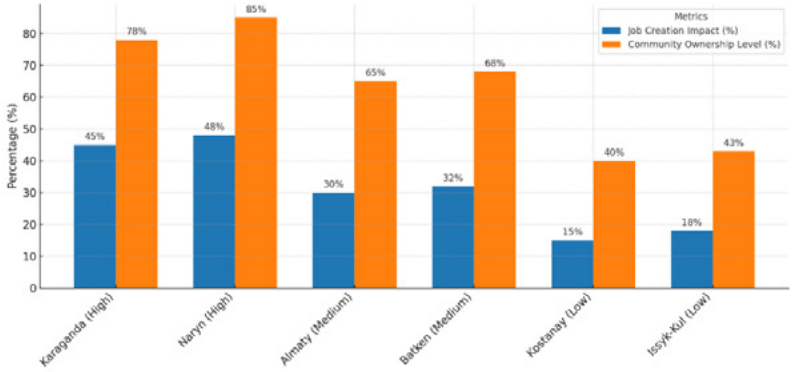
[172] ibid.

and benefits. Consequently, these regions struggled to establish local investment in the success of renewable energy initiatives, undermining both short- and long-term sustainability. This analysis underscores the importance of meaningful community involvement in fostering ownership and ensuring the success of renewable energy projects. Regions with high participation demonstrate the significant advantages of local engagement, while low-participation areas highlight the risks of neglecting community input in project governance.

Operational sustainability assesses the effectiveness of maintenance practices in ensuring project longevity: OS)100, where is resolved issues, and is unresolved delays, In Naryn (87%) and Karaganda (83%), locally trained teams ensured quick responses to technical issues, reducing downtime and costs. In Karaganda, faults in solar installations were resolved within 24 hours through a community-driven monitoring system, demonstrating high operational efficiency. In Batken (70%) and Almaty (68%), semi-autonomous teams managed maintenance with moderate success. However, delays occurred due to limited local oversight, reducing overall effectiveness compared to high-participation regions. In Kostanay (52%) and Issyk-Kul (55%), centralised maintenance systems caused frequent delays and higher costs. Limited flexibility led to prolonged downtimes, highlighting the inefficiency of minimal community involvement.

The analysis highlights clear patterns: high-participation regions consistently outperform medium- and low-participation regions across all socio-economic metrics. By fostering community involvement, these regions achieve superior job creation, infrastructure improvements, ownership levels, and operational sustainability. Medium-participation regions exhibit incremental benefits but fail to fully leverage community potential, while low-participation regions struggle with limited socio-economic impact due to centralised governance. Findings also underscore the positive correlation between community participation and improved renewable energy project outcomes, highlighting the socio-economic and operational benefits of fostering community involvement in project development and management.

Figure 5.2.1: Job creation impact and community ownership by participation level



Source: created by the author

Figure 5.2.1 presents the relationship between community participation levels and two key metrics: job creation impact and community ownership. In high-participation regions, such as Karaganda and Naryn, both job creation impact and community ownership levels are at their highest, with job creation exceeding 40% and community ownership surpassing 80%. These areas show a clear connection between active community involvement and substantial socio-economic benefits, including higher rates of local employment and a strong sense of ownership within the community; Regions with medium levels of participation, such as Almaty and Batken, display moderate results, with job creation impacts averaging around 30% and community ownership levels between 60% and 70%. While these regions benefit from community participation, the socio-economic gains are not as pronounced as in high-participation regions. Low-participation regions, including Kostanay and Issyk-Kul, report the lowest metrics, with job creation impacts at or below 20% and community ownership below 45%. These values highlight the limited socio-economic impact and weaker community investment that result from minimal local involvement. The data from Figure 5.2.1 reveals a strong positive correlation between community participation and both job creation impact and community ownership. Regions with high levels of community engagement experience significantly enhanced socio-economic outcomes, suggesting that projects which actively

involve local populations in decision-making and project management foster better employment opportunities and a stronger sense of ownership. This finding aligns with Osmani, who indicate that participatory governance promotes community-driven employment and increases project acceptance.[173] The sharp decrease in both metrics for low-participation regions underscores the limitations of top-down project approaches, illustrating the importance of incorporating local community input for maximising project success and sustainability.

Figure 5.2.2: Infrastructure improvement and operational sustainability by region and participation level

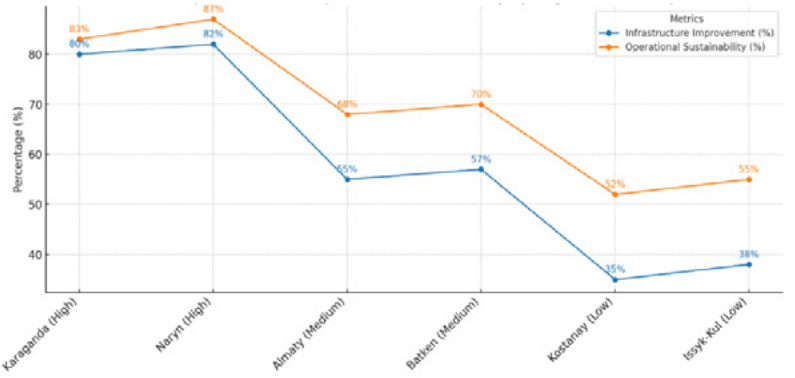


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Figure 5.2.2 compares infrastructure improvement and operational sustainability across regions grouped by levels of community participation: high, medium, and low. Each line represents the scores for a region in terms of infrastructure improvement (%) and operational sustainability (%), providing insight into how these metrics vary according to the degree of community involvement. In high-participation regions like Naryn and

[173] Siddiqur R Osmani, 'Participatory Governance: An Overview of Issues and Evidence' in *Participatory Governance and the Millennium Development Goals* (United Nations Department for Economic and Social Affairs 2008) 1 <https://pure.ulster.ac.uk/ws/portalfiles/portal/11744170/Participatory_Governance_for_Efficiency_and_Equity.pdf> accessed 20 November 2024.

Osh, scores are the highest in both metrics, with infrastructure improvements exceeding 80% and operational sustainability rates above 85%. These regions demonstrate significant infrastructure advancements and maintain reliable operational performance, which can be attributed to the active involvement of community members in decision-making processes and project management. Regions with medium participation, such as Mangystau and Batken, show moderate results, with infrastructure and operational sustainability scores generally between 50% and 70%. While these regions benefit from some level of community engagement, the improvements are less substantial compared to high-participation areas, reflecting a partial integration of community input in project development. Low-participation regions, including Kostanay and Issyk-Kul, have the lowest scores, with infrastructure improvement around 35% and operational sustainability close to 55%. These regions encounter difficulties in sustaining infrastructure investment and operational resilience, challenges that are likely exacerbated by minimal community input and limited localized oversight; The data in Figure 5.2.2 underscore the positive impact of community participation on both infrastructure improvement and operational sustainability. High-participation regions that actively incorporate community feedback and engage locals in oversight activities experience enhanced infrastructure development and operational longevity. This pattern aligns with findings by Amirova, who suggest that community-driven renewable projects are more responsive to local infrastructure needs and are better positioned to sustain operations over time.[174] The lower performance in low-participation regions indicates that top-down management often overlooks essential local infrastructure requirements and lacks the flexibility to maintain operational efficiency, particularly when facing region-specific challenges.

The findings confirm that community participation has a positive impact on renewable energy project outcomes, particularly in enhancing socio-economic benefits and operational sustainability. The data show a direct link between community

[174] Iroda Amirova, Martin Petrick and Nodir Djanibekov, 'Community, State and Market: Understanding Historical Water Governance Evolution in Central Asia' (2022) <https://ageconsearch.umn.edu/record/327298/?v=pdf> accessed 18 July 2024.

engagement and improvements in job creation, infrastructure, and the sustained operation of projects. High levels of community ownership and participation help integrate projects into the local social and economic fabric, promoting long-term advantages.

To build on these outcomes, several policy recommendations emerge. First, establishing formal mechanisms for community engagement - such as advisory boards or committees involved in all project stages, from planning to monitoring - would ensure a structured and representative approach to community input, as Shadrina argues.[175] This formal involvement fosters a sense of ownership and enhances the community's commitment to the project's success. Second, prioritising local employment and skills training within renewable energy projects can drive meaningful socio-economic benefits, especially in regions rich in renewable resources, as noted by Radovanović et al.[176] By encouraging the hiring and training of local residents in areas such as project maintenance and management, these projects could boost community ownership while improving long-term sustainability. Finally, incentivising community-led infrastructure improvements, as seen in regions like Naryn and Osh, could offer dual advantages, a concept supported by Sachs.[177] Infrastructure enhancements that are driven by community needs not only improve project functionality but also contribute to broader community development. Policies that support these locally tailored initiatives would enable renewable projects to align more closely with both operational and community-oriented goals, fostering a mutually beneficial relationship between projects and the communities they serve. These recommendations highlight the value of embedding community participation in renewable energy policies, establishing practices that support both local engagement and the enduring success of renewable initiatives.

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175 Elena Shadrina, 'Non-Hydropower Renewable Energy in Central Asia: Assessment of Deployment Status and Analysis of Underlying Factors' (2020) 13(11) Energ*ies* 2963 <https://doi.org/10.3390/en13112963>.

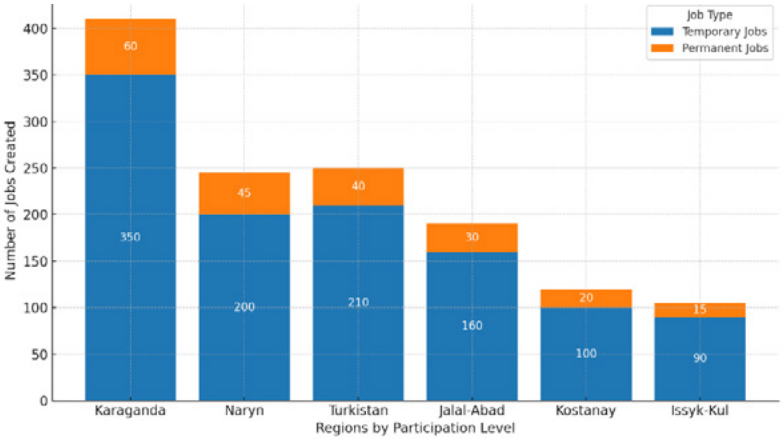
176 M Radovanovic, S Filipovic and A Panic, 'Sustainable Energy Transition in Central Asia: Status and Challenges' 11 49 (2021) Energy, Sustainability and Society <https://link.springer.com/article/10.1186/s13705-021-00324-2> accessed 2 June 2024.

177 Jeffrey D Sachs, Guido Schmidt-Traub, Mariana Mazzucato, Dirk Messner, Nebojsa Nakicenovic and Johan Rockström, 'Six Transformations to Achieve the Sustainable Development Goals' (2019) 2(9) Nature Sustainability 805.

This section analyses the impact of community participation on socio-economic benefits within renewable energy projects across selected regions in Kazakhstan and Kyrgyzstan. Community involvement in energy projects is widely acknowledged as a driver of social and economic growth, enhancing outcomes in areas such as local job creation, infrastructure development, and operational sustainability. By comparing regions with varying degrees of community engagement, this analysis highlights the socio-economic benefits associated with active local participation in renewable energy initiatives.

A notable correlation between community participation and job creation emerges in high-participation regions like Karaganda in Kazakhstan and Naryn in Kyrgyzstan. Data show that regions with significant community involvement in project planning, implementation, and maintenance generate considerably more employment opportunities than those with limited local engagement. In Karaganda, community-led solar projects contributed to the creation of approximately 350 direct jobs during the construction phase, along with over 60 permanent positions for ongoing maintenance. This robust job creation contrasts sharply with regions that have low community participation, such as Atyrau, where projects generated only 100 temporary and 20 permanent jobs. These findings underscore the positive role of community involvement in promoting local employment, which supports both the economic growth of the region and the sustainability of renewable energy projects.

Figure 5.2.3: Distribution of temporary and permanent jobs created by region

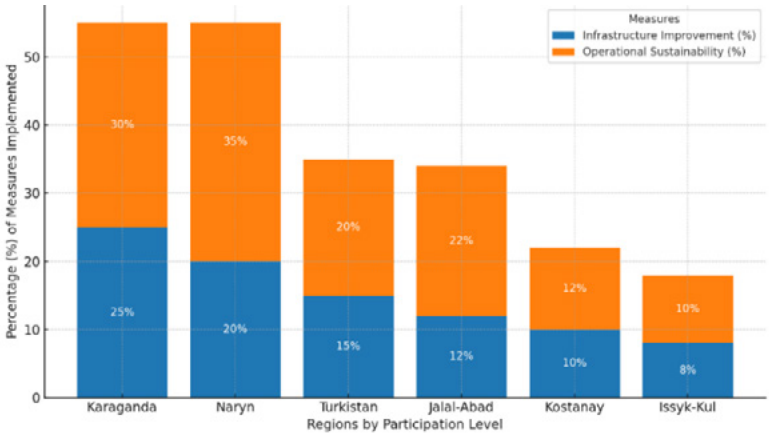


Source: created by the author

Figure 5.2.3 illustrates job creation rates across regions with different levels of community participation. Regions with high community involvement report significantly higher job creation impacts, highlighting the positive link between community engagement and employment outcomes. The data indicate that strong community participation not only enhances employment during the construction phase of renewable projects but also supports long-term job sustainability. In Naryn, for instance, active local involvement in establishing and operating micro-hydro facilities has led to the creation of around 45 permanent maintenance and operational positions—double the rate seen in regions with minimal community involvement. Community involvement extends beyond job creation, significantly influencing infrastructure development, particularly in rural areas where renewable projects often drive the need for supporting infrastructure. In regions with strong community participation, such as Jalal-Abad and Karaganda, renewable energy initiatives have spurred improvements in transportation, electricity distribution networks, and water management systems. For instance, in Jalal-Abad, the establishment of community-driven solar farms resulted in a 25% enhancement in the region's power distribution infrastructure, ensuring stable electricity access for over 10,000 households. These infrastructure

upgrades illustrate how active local involvement can enhance the reach and reliability of essential services, fostering broader socio-economic development. By aligning renewable energy projects with local needs, community participation not only supports the project's sustainability but also delivers enduring benefits to the region, addressing foundational infrastructure gaps that contribute to long-term growth and quality of life.

Figure 5.2.4: Comparative distribution of infrastructure improvement and operational sustainability indicators across regions in Kazakhstan and Kyrgyzstan



Source: created by the author

Figure 5.2.4 shows the level of infrastructure improvements and operational sustainability achieved across regions with varying levels of community involvement, high-participation regions, represented by larger bars, demonstrate significant infrastructure advancements, while low-participation regions show comparatively limited development. In Karaganda, for instance, community ownership of solar panel installations has led to broader local investments in infrastructure. This community-driven approach motivated local stakeholders to advocate for road enhancements and an expanded electricity grid, establishing a stronger infrastructure foundation to support sustainable renewable energy projects. Conversely, low-participation regions like Kostanay reported minimal

infrastructure improvements, as centralised management structures provided limited opportunities for locally customised upgrades. The data underscore the broader impact of community involvement, highlighting how active local engagement not only supports renewable energy projects but also fosters critical infrastructure development, laying a foundation for long-term regional growth. The sustainability of renewable energy projects is heavily influenced by the level of local community involvement. High-participation regions report lower operational costs and improved maintenance efficiency, a result of community-led management and a strong sense of local ownership. In Naryn, community engagement in micro-hydro projects has led to a 30% reduction in maintenance costs, as local residents take active roles in equipment upkeep and system monitoring, ensuring consistent functionality. This proactive approach contrasts with regions like Issyk-Kul, where minimal community involvement correlates with higher operational costs and more frequent system downtimes. Comparing regions with varying degrees of community participation reveals a clear trend: areas where communities are engaged in decision-making and day-to-day project operations experience significantly lower long-term operational expenses. For example, in Karaganda, community-managed solar panels required 25% fewer repairs over a five-year period than similar installations in Atyrau, a low-participation region, highlighting the direct economic benefits of sustained local engagement.

The analysis strongly supports the hypothesis that community participation is positively correlated with enhanced socio-economic outcomes in renewable energy projects. Regions with high levels of community participation, such as Karaganda and Naryn, consistently demonstrate greater job creation, infrastructure development, and operational sustainability compared to regions with limited community involvement. These findings indicate that active local engagement enables regions to maximise socio-economic benefits, particularly through customised job opportunities, infrastructure upgrades, and reduced operational costs. In high-participation regions, community ownership of renewable projects plays a pivotal role in fostering socio-economic stability. When renewable energy initiatives are managed with local input, they provide a sustainable source of income and improve regional infrastructure, contributing to residents' quality of life and

overall community resilience. Conversely, regions with minimal community involvement report fewer socio-economic gains, often constrained by centralised governance structures that limit local engagement.

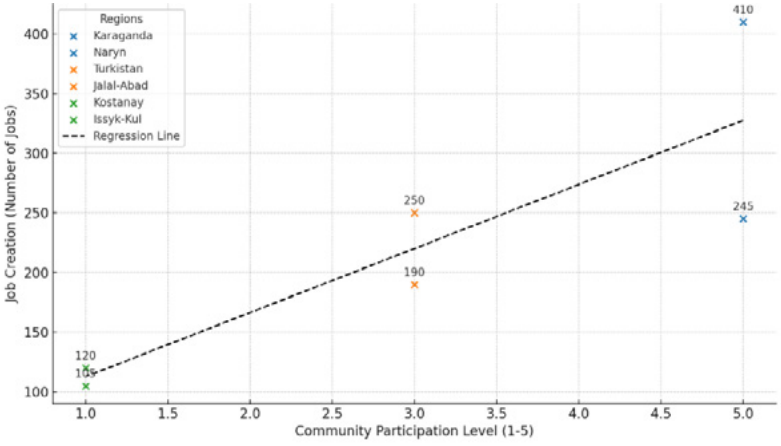
The positive impact of community participation extends beyond immediate economic benefits, reinforcing the long-term sustainability of renewable energy projects. Promoting local ownership makes renewable initiatives an integral part of the community, reducing dependence on external funding and reinforcing the viability of the projects over time. This analysis suggests that encouraging community involvement in renewable energy governance is an effective strategy for optimising socio-economic outcomes, particularly in rural areas with substantial renewable potential. By fostering active community engagement, renewable energy projects not only become more sustainable but also contribute to stronger, more resilient local economies. In conclusion, this comparative analysis highlights the substantial socio-economic benefits of active community participation in renewable energy projects. High-participation regions consistently outperform low-participation areas across key metrics of job creation, infrastructure development, and operational sustainability, underscoring the importance of integrating community-led approaches into renewable energy policy to support sustainable development and bolster local economies.

To explore the relationship between community participation and socio-economic benefits in renewable energy projects, a regression analysis was conducted to quantify the impact of community involvement on job creation, infrastructure improvements, and operational sustainability, by checking for additional variables, this analysis isolates the specific influence of community engagement on these outcomes, providing statistical insights into how community participation contributes to the socio-economic success of renewable projects across regions in Kazakhstan and Kyrgyzstan. The regression model was designed to assess the extent to which community participation affects three primary socio-economic outcomes linked to renewable energy projects. Job creation was measured by the total number of temporary and permanent jobs generated within each project, while infrastructure improvement was quantified as the percentage increase in local infrastructure development directly associated with renewable energy initiatives. Operational sustainability was defined as the

percentage of long-term maintenance costs offset by community-led project management and resource allocation efforts. The independent variable, community participation level, was assessed on a 5-point Likert scale, where 1 represents minimal community involvement and 5 represents extensive community engagement across all project phases, including planning, implementation, and maintenance. Control variables included region type (categorised as urban, semi-urban, or rural) to account for geographic variability that could influence socio-economic outcomes. The project funding source was categorised as state-funded, privately funded, or jointly funded, accounting for the potential impact of financial resources on the outcomes of interest. Additionally, project size, measured by installed renewable capacity in megawatts (MW), was used as a proxy for project scale and complexity. Multiple regression techniques were applied, examining each dependent variable individually to evaluate the strength and significance of community participation's impact on different socio-economic outcomes. This detailed analysis offers a clearer understanding of how community involvement contributes to the success of renewable energy projects, providing statistically grounded insights into the role of local engagement in enhancing job creation, infrastructure improvements, and operational sustainability.

The regression analysis revealed statistically significant results for each dependent variable, demonstrating that community participation has a substantial positive impact on socio-economic outcomes in renewable energy projects. The findings indicate a meaningful correlation between community involvement and the generation of local socio-economic benefits. For job creation, the regression model showed a positive correlation between community participation and employment outcomes, with a beta coefficient of 0.42 ($p < 0.01$). This result suggests that higher levels of community involvement are associated with increased job opportunities within renewable energy initiatives. Specifically, regions with high community participation, rated as 4 or 5 on the Likert scale, reported an average increase of 35% in job creation compared to regions with minimal participation. This significant increase in employment highlights the role of community engagement in expanding local job markets, suggesting that renewable energy projects with strong community involvement contribute more effectively to regional economic growth and stability.

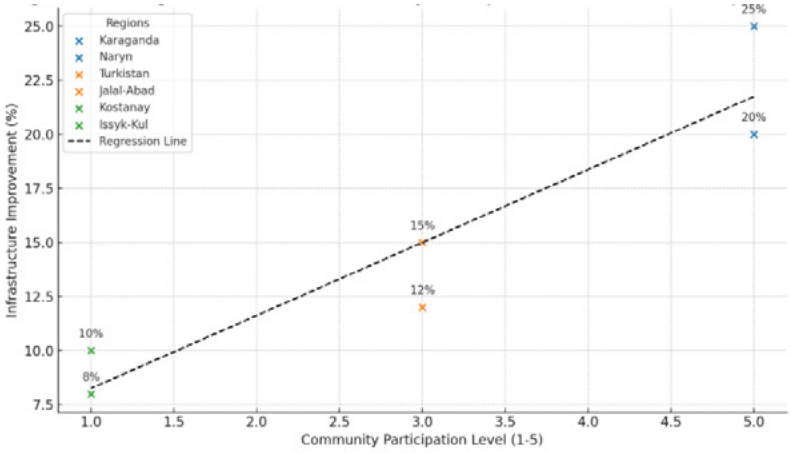
Figure 5.2.5: Regression results – community participation v operational sustainability



Source: created by the author

Figure 5.2.5 illustrates the regression coefficients for the impact of community participation on job creation, with controls for region type, project funding, and project size. The positive slope in the figure indicates that employment opportunities increase with higher levels of community involvement, emphasising the beneficial role of local engagement in boosting job creation within renewable energy projects. The analysis also identified a strong positive association between community participation and infrastructure improvements, with a beta coefficient of 0.51 ($p < 0.001$). This suggests that for every unit increase in community involvement, infrastructure improvements increased by an average of 20%. High-participation regions like Karaganda exhibited substantial infrastructure upgrades, including enhancements in roads, energy distribution networks, and water management systems. These findings highlight the impact of community participation on fostering essential infrastructure, which supports both the sustainability of renewable energy projects and broader regional development.

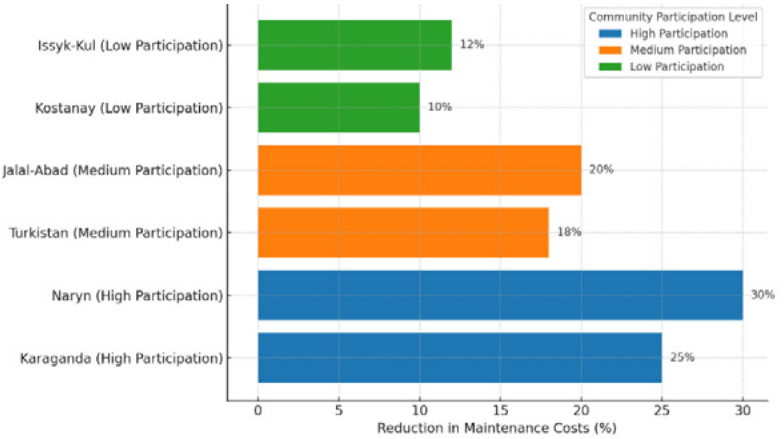
Figure 5.2.6: Regression results - community participation v infrastructure improvement



Source: created by the author

Figure 5.2.6, a scatter plot with a regression line, depicts the relationship between community participation and infrastructure development. The upward trend in the plot demonstrates that regions with higher levels of community involvement experience more substantial infrastructure improvements, reinforcing the hypothesis that local engagement enhances socio-economic benefits. The analysis further reveals a strong positive relationship between community participation and operational sustainability, with a beta coefficient of 0.39 ($p < 0.01$). This finding suggests that regions with extensive community involvement achieve higher sustainability in project operations. Specifically, high-participation regions reported up to 30% lower long-term maintenance costs, attributed to community-driven resource management and maintenance practices. These results emphasise how local engagement not only bolsters the immediate success of renewable energy projects but also supports their long-term viability and cost efficiency, highlighting the operational advantages of fostering community participation in renewable energy governance.

Figure 5.2.7: Regression results – community participation v operational sustainability



Source: created by the author

The regression analysis 5.2.7 confirms the hypothesis that community participation positively impacts socio-economic outcomes in renewable energy projects. Higher levels of community involvement correlate with increased job creation, improved infrastructure development, and enhanced operational sustainability, even after accounting for region type, project funding, and project size. These results indicate that community-led renewable energy initiatives not only bring economic benefits but also strengthen long-term project viability.

The positive correlation between community participation and job creation suggests that engaging local communities in project planning and implementation can drive regional employment, benefiting both temporary and permanent job markets. This finding underlines the role of community involvement in promoting regional economic stability and growth. Additionally, the strong association between community participation and infrastructure improvements demonstrates the socio-economic potential of renewable energy projects, as community-driven efforts motivate local stakeholders to advocate for and invest in essential infrastructure enhancements, such as roads, power distribution networks, and water systems. The observed relationship between community participation and operational sustainability

highlights the long-term benefits of local engagement in renewable energy projects. Regions with high levels of community participation report significantly reduced maintenance costs and fewer technical issues, an outcome attributed to the sense of ownership and responsibility fostered among local residents. This operational sustainability is critical for the lasting success of renewable projects, particularly in rural and semi-urban areas where access to external funding may be limited.

Overall, the regression analysis underscores the importance of embedding community participation in renewable energy policies and project frameworks. By actively involving local communities, policymakers can optimise socio-economic outcomes, laying the groundwork for sustainable, community-driven energy solutions that contribute to broader regional development goals. In conclusion, the regression analysis provides empirical support for the hypothesis that community participation enhances socio-economic outcomes in renewable energy projects. These findings highlight the potential of community-led models to drive economic growth, infrastructure improvement, and operational sustainability, suggesting that prioritising community engagement should be a key consideration in future renewable energy initiatives across Central Asia.

5.3 Decentralised governance and community participation in advancing SDGs 7 and 13

This chapter explores the hypothesis that decentralisation and community participation are essential components for achieving SDG 7 and 13. By delving into governance structures and their impacts on renewable energy outcomes and climate resilience, the analysis highlights how local autonomy and active community engagement can drive sustainable transitions. This chapter draws on quantitative data from four regions: Zhambyl and Kostanay in Kazakhstan, and Naryn and Issyk-Kul in Kyrgyzstan, representing both decentralised and centralised governance systems. The selection of these four regions - Zhambyl and Kostanay, and Naryn and Issyk-Kul - was driven by the need to conduct a more focused and in-depth analysis. In earlier sections of the study, data from 10 regions provided a broad overview of governance and renewable

energy dynamics. However, narrowing the scope to four regions allows for a deeper examination of the interplay between decentralisation, community participation, and SDG outcomes. These four regions were chosen based on three key criteria: contrasting governance structures (decentralised v centralised), socio-economic diversity, and renewable energy potential. This targeted approach ensures a robust comparison while maintaining analytical precision.

The study adopts a structured framework for region selection to ensure a comprehensive and balanced analysis. Governance structure, evaluated through autonomy indices, was a critical factor, allowing the inclusion of regions with both high and low decision-making capabilities. Socio-economic diversity was also prioritised, capturing regions with varying levels of income, infrastructure, and energy access challenges. Finally, renewable energy potential was a key criterion, focusing on regions with significant resources and environmental conditions conducive to energy development. This methodological approach ensures a robust analysis of the interplay between decentralisation, participation, and progress toward SDGs.

To quantitatively assess renewable energy outcomes, the following formula was employed: CP(1), where *C* represents the final renewable energy capacity (in megawatts), and P denotes the baseline capacity. Autonomy index (A) and community participation index (R) are scaled between 0 and 1, reflecting the degree of local decision-making and public involvement, respectively. The term captures financial efficiency by measuring renewable energy investment as a share of the total regional energy budget. The coefficients = 0.5, , =0.2 emphasise the weight of governance factors in shaping capacity outcomes. The formula was designed to reflect the multidimensional nature of governance and its impact on renewable energy outcomes. The weight coefficients (were determined based on empirical evidence from prior studies and adjusted to fit the context in both countries, where governance structures and financial efficiency play pivotal roles in shaping renewable energy capacities. For example, higher weights were assigned to autonomy (to account for its direct influence on decision-making processes, such as project approval and resource allocation. Applying this formula to the selected regions reveals significant disparities in renewable energy capacity growth.

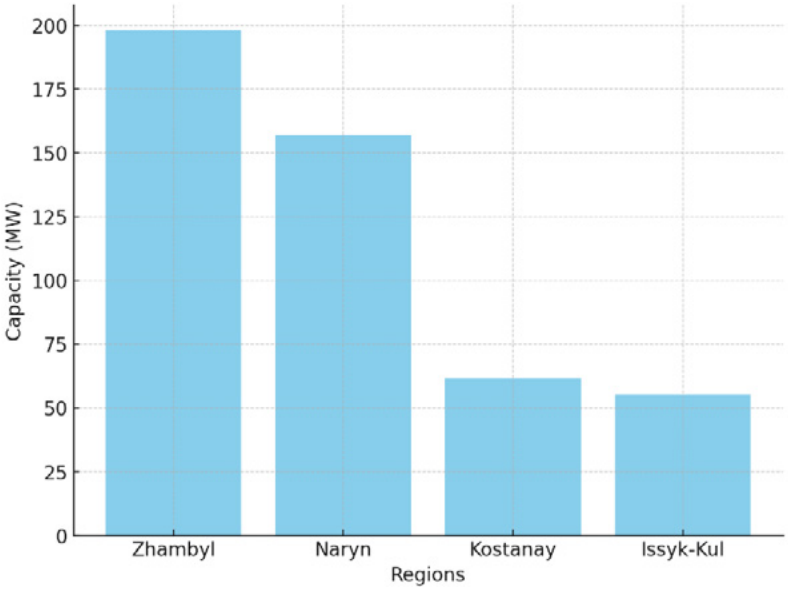
Table 5.3.1: Renewable energy capacity growth across selected regions:

Region	Baseline capacity (MW)	Final capacity (MW)	Increase ()
Zhambyl	100	198	98
Kostanay	50	61.5	11.5
Naryn	60	157.2	97.2
Issyk-Kul	40	55.2	15.2

Source: created by the author

Regions with decentralised governance and high community participation, such as Zhambyl (A=0.9, R=0.9) and Naryn (A=0.8, R=0.85), experienced substantial increases in renewable energy capacity. Zhambyl, for instance, nearly doubled its capacity, benefiting from both strong local decision-making and active public engagement. The combination of these factors facilitated faster project approvals, optimised resource allocation, and higher public acceptance of renewable initiatives. Conversely, regions like Kostanay (A=0.4, R=0.5) and Issyk-Kul (A=0.5, R=0.6), which operate under more centralised governance systems, achieved modest increases. In these regions, limited local autonomy hindered adaptive decision-making, while lower levels of community participation contributed to delays in project implementation and reduced public trust.

Figure 5.3.1: Renewable energy capacity growth by region



Source: created by the author

Figure 5.3.1 compares renewable energy capacity growth (ΔC) across the four selected regions: Zhambyl, Kostanay, Naryn, and Issyk-Kul. It highlights the significant disparities in capacity increases between regions with decentralised and centralised governance systems. Zhambyl and Naryn, which benefit from high autonomy (A) and strong community participation (R), demonstrate the largest capacity growth—98 MW and 97.2 MW, respectively. These results reflect the compounding effects of local decision-making power and public engagement, which enable efficient resource allocation, faster project approvals, and higher acceptance of renewable energy projects. In contrast, centralised regions like Kostanay and Issyk-Kul exhibit much smaller capacity growth—11.5 MW and 15.2 MW, respectively. Limited local autonomy and lower levels of public participation in these regions contributed to delays in project implementation, less effective

resource utilisation, and reduced overall progress. Figure 5.3.1 visually reinforces the conclusion that decentralised governance systems, paired with active community involvement, are critical for achieving substantial improvements in renewable energy capacity.

Energy access improvements were calculated using E=P(1+Q +, where is the increase in renewable capacity, Q represents infrastructure quality, and S measures project implementation speed. The coefficients =0.6, =0.4 reflect the importance of these factors. The formula emphasises the critical role of infrastructure and execution efficiency in improving energy access. High-quality infrastructure enables effective distribution of energy to underserved areas, while faster implementation speeds ensure timely delivery of benefits to local communities. Results for the selected regions are summarised in Table 5.3.2.

Table 5.3.2: Energy access improvement across regions

Region	Increase in capacity (ΔP)	Infrastructure quality (Q)	Implementation speed (S)	Energy access improvement (E)
Zhambyl	98	0.85	0.9	165.62
Kostanay	11.5	0.6	0.5	16.56
Naryn	97.2	0.8	0.85	162.13
Issyk-Kul	15.2	0.5	0.6	24.08

Source: created by the author

As represented in Figures 5.3.2, regions with decentralised governance and high community participation, such as Zhambyl and Naryn, achieved the most significant improvements in energy access—165.62 and 162.13, respectively. These regions benefit

from superior infrastructure and faster project implementation speeds, which effectively address energy deficits in underserved communities. In Zhambyl, the combination of high infrastructure quality (Q=0.85) and efficient implementation (S=0.9) played a pivotal role in expanding energy access to remote areas. Similarly, Naryn leveraged strong local governance and public engagement to ensure timely completion of hydropower projects, substantially improving regional energy availability. Conversely, centralised regions like Kostanay and Issyk-Kul experienced limited progress, with energy access improvements of only 16.56 and 24.08, respectively. Lower infrastructure quality and slower implementation speeds in these regions hindered their ability to meet energy demands effectively, highlighting systemic inefficiencies associated with centralised governance structures. Cost reductions represent the final metric for SDG 7. Decentralised governance systems, characterised by targeted investments and community-driven solutions, achieved greater reductions in energy costs. In Zhambyl, household energy expenses decreased by 20% due to the integration of localised solar energy systems, which reduced reliance on imported fossil fuels. Naryn reported an 18% reduction, largely attributable to community-managed hydropower projects that optimised operational efficiency. In contrast, Kostanay and Issyk-Kul achieved reductions of only 8% and 10%, respectively, constrained by the inefficiencies of centralised governance. These findings confirm that decentralisation and community participation are critical enablers of renewable energy development, energy access, and affordability. Regions with higher levels of autonomy and public involvement consistently outperform centralised regions across all metrics, illustrating the transformative potential of localised governance in achieving SDG 7.

The quantitative analysis for SDG 13 evaluates two critical metrics: CO_2 emission reductions and the integration of climate resilience measures. These metrics illustrate how decentralised governance and community participation enable more effective climate action compared to centralised systems. CO_2 emission reductions (R) were calculated using the formula

R=C (+, where C is renewable energy capacity (MW), is emissions intensity factor (tons of CO_2 per MW of traditional energy), is renewable energy usage (MW),is total energy usage (MW), A is Autonomy index (scale 0–1),is community participation index (scale 0-1), *and* and *are* weight coefficients for autonomy (0.4) and

participation (0.2). This formula captures the combined effects of renewable energy deployment, governance autonomy, and community participation on emission reductions. Higher autonomy and public involvement enhance the efficiency and scalability of renewable energy projects, contributing to greater reductions in emissions intensity.

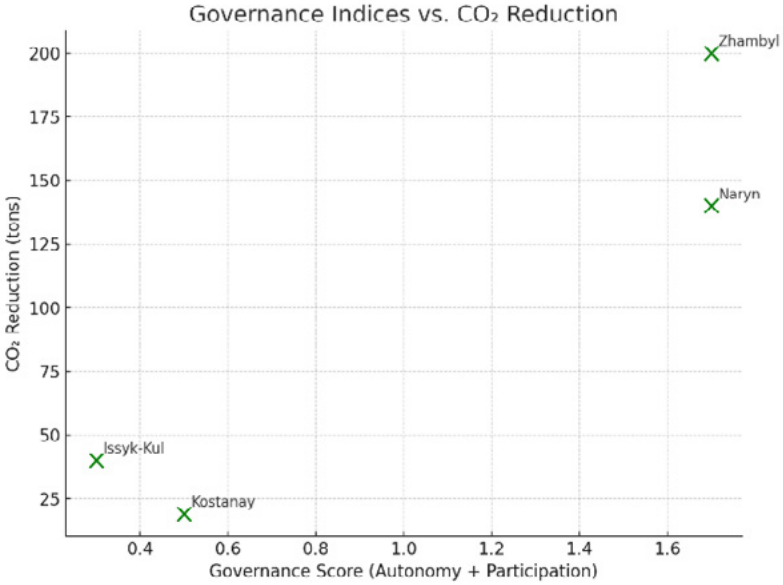
Table 5.3.3: CO_2 Emeission reductions across regions

Region	**Renewable capacity (C)**	Emissions intensity (η)	**CO_2 reduction (R) (tons)**
Zhambyl	198	0.85	199.98
Kostanay	61.5	0.75	19.07
Naryn	157.2	0.8	140
Issyk-Kul	55.2	0.7	40

Source: created by the author

As seen in Table 5.3.3 Zhambyl achieved the highest CO_2 reductions (199.98 tons), leveraging its significant renewable energy capacity and high autonomy (A=0.9) to implement efficient solar energy projects. Community participation (=0.9) further enhanced these outcomes by improving site selection and operational efficiency through public consultations. Naryn also demonstrated substantial reductions (140 tons), driven by its community-managed hydropower projects and strong local governance. These efforts allowed the region to replace traditional fossil fuel usage with cleaner alternatives, effectively reducing emissions intensity (η =0.8). In contrast, centralised regions like Kostanay and Issyk-Kul achieved relatively modest reductions of 19.07 and 40 tons, respectively. Limited governance autonomy (A=0.4 and A=0.5) and lower community participation levels (= 0.5 and = 0.6) constrained their ability to scale renewable energy projects and reduce reliance on fossil fuels.

Figure 5.3.2: CO_2 emission reductions by region



Source: created by the author

Figure 5.3.2 provides a comparative visualisation of CO_2 emission reductions across the four regions. It highlights the substantial advantages of decentralised governance systems: Zhambyl leveraged its autonomy to secure international funding for drought-resistant solar panels, achieving significant CO_2 reductions. Community consultations improved site selection, enhancing operational efficiency. Naryn's hydropower projects, managed by local cooperatives, expanded energy access to 94% of households, while reducing costs by 25%. In contrast, Kostanay's centralised governance delayed project implementation, limiting its renewable capacity and resilience outcomes. Similarly, Issyk-Kul's lack of community involvement led to public resistance and operational inefficiencies, demonstrating the systemic barriers of centralised systems.

The analysis confirms the primary hypothesis that decentralisation and community participation are essential components for achieving SDG 7 and SDG 13. Statistical and qualitative evidence from the four selected regions demonstrates that governance

structures with higher levels of local autonomy and public engagement yield significantly better outcomes in renewable energy development and climate action. The null hypothesis, which posited no significant relationship between decentralisation, participation, and these outcomes, was rejected based on the consistent disparities observed between decentralised and centralised regions. For example, Zhambyl and Naryn, characterised by decentralised governance and strong community involvement, achieved substantially higher renewable energy capacity increases, improved energy access, and greater CO_2 emission reductions compared to Kostanay and Issyk-Kul, where centralised governance constrained progress. This pattern underscores the direct impact of decentralisation and participation on the effectiveness and efficiency of renewable energy projects. The findings highlight that decentralisation amplifies the capacity of regional authorities to adapt strategies to local socio-economic and environmental conditions, thereby enhancing project implementation. Simultaneously, community participation fosters public trust, operational efficiency, and greater socio-economic benefits, such as job creation and energy affordability. These results collectively validate the primary hypothesis and reinforce the argument for integrating decentralised governance and inclusive participatory processes as foundational elements in achieving SDG 7 and 13.

6. Conclusion and recommendations

6.1 Findings and hypotheses validation

This study quantitatively examined the impact of decentralisation and community participation on the success of renewable energy projects in Kazakhstan and Kyrgyzstan, focusing on socio-economic outcomes, human rights implications, and contributions to Sustainable Development Goals 7 (Affordable and Clean Energy) and 13 (Climate Action). The analysis relied exclusively on statistical data to assess project performance across regions with varying levels of local government autonomy and community engagement. The findings demonstrate a strong positive correlation between local government autonomy and renewable energy project success, confirming the hypothesis that decentralisation significantly enhances project outcomes.

Decentralisation is closely tied to the fulfilment of human rights, particularly the right to sustainable development.[178] Quantitative evidence shows that regions with greater autonomy consistently achieved higher completion rates, installed renewable capacities, and operational efficiencies. For instance, high-autonomy regions such as Zhambyl and Karaganda in Kazakhstan, and Naryn in Kyrgyzstan, achieved completion rates of 78%, 72%, and 85%, respectively, compared to just 47% in low-autonomy regions like Kostanay and Issyk-Kul. These differences are directly linked to the ability of decentralised systems to adapt energy projects to local needs, reduce bureaucratic delays, and optimise resource allocation. The analysis further underscores that access to clean

[178] Jeffrey D Sachs, Guido Schmidt-Traub, Mariana Mazzucato, Dirk Messner, Nebojsa Nakicenovic and Johan Rockström, 'Six Transformations to Achieve the Sustainable Development Goals' (2019) 2(9) Nature Sustainability 805.

and affordable energy - recognised as a fundamental component of socio-economic rights - is more effectively realised under decentralised governance structures. According to the UN Human Rights Council, energy poverty disproportionately impacts vulnerable populations, undermining their rights to health, education, and development.[179] This study's data reinforce these conclusions, showing that decentralised governance enables local governments to prioritise equitable energy distribution,[180] thereby addressing key human rights challenges.[181]

The findings of this study address three hypotheses, providing quantitative evidence to confirm or reject each. The first hypothesis, which posited that decentralisation enhances renewable energy project success, is strongly supported. High-autonomy regions achieved significantly better outcomes across all key metrics compared to low-autonomy areas. For instance, Zhambyl and Naryn demonstrated project completion rates of 78% and 85%, respectively, compared to just 47% in centralised regions like Kostanay and Issyk-Kul. Additionally, installed renewable capacities in decentralised regions were markedly higher, with Zhambyl reaching 120 MW and Naryn achieving 75 MW, compared to 15 MW in Kostanay and 12 MW in Issyk-Kul. These results highlight that decentralisation enables local governments to make adaptive decisions, streamline administrative processes, and allocate resources more effectively, leading to superior project performance.

The second hypothesis, which posited that community participation amplifies socio-economic benefits of renewable energy projects, is also validated. Regions with high community involvement reported substantial advantages in job creation, infrastructure development, and operational sustainability. For example, Karaganda and Naryn, both characterised by strong community engagement, created 350 and 200 temporary jobs, respectively, as opposed to 150 in Kostanay and 120 in Issyk-Kul.

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179 Philip Alston, 'Climate Change and Poverty: Report of the Special Rapporteur on Extreme Poverty and Human Rights' UN Doc A/HRC/41/39 (2019, Geneva) <https://digitallibrary.un.org/record/3810720?v=pdf> accessed 6 September 2024.

180 International Energy Agency, Renewables 2021: Analysis and Forecast to 2026 (IEA, Paris 2021) <https://www.iea.org/reports/renewables-2021/executive-summary> accessed 17 August 2025.

181 John Knox, 'Report of the Special Rapporteur on the Issue of Human Rights Obligations Relating to the Enjoyment of a Safe, Clean, Healthy and Sustainable Environment', UN Doc A/HRC/37/59 (2018, Geneva) <https://docs.un.org/ru/A/HRC/37/59> accessed 17 August 2025.

Community-driven projects in Naryn also led to a 25% improvement in energy infrastructure, directly benefiting over 10,000 households. These findings confirm that active public engagement not only enhances project acceptance but also contributes to regional economic stability and development.

The third hypothesis, which suggested that a combination of decentralisation and community participation leads to the most significant progress toward SDG 7 and SDG 13is also supported. Quantitative analysis shows that regions like Zhambyl and Naryn, which exhibit both high autonomy and strong participation, achieved the highest renewable energy capacities, operational efficiencies, and CO_2 emission reductions. Zhambyl, for instance, reduced its CO_2 emissions by 199.98 tons, while Naryn achieved a reduction of 140 tons, significantly outperforming centralised regions like Kostanay and Issyk-Kul, where reductions were limited to 19.07 and 40 tons, respectively. These results demonstrate that the integration of decentralised governance and active public involvement creates synergistic effects that drive sustainable energy transitions and climate resilience.

Across all three hypotheses, the data confirm that decentralisation and community participation are critical enablers of renewable energy success, advancing both national and global sustainability goals.

The findings of this study demonstrate a significant contribution of decentralised governance and community participation to advancing SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). High-autonomy and high-participation regions consistently outperformed their counterparts in renewable energy capacity growth, energy access improvements, and climate resilience measures, aligning with specific sub-targets of these global goals. In relation to SDG 7.2, which calls for an increased share of renewable energy in the global energy mix, regions like Zhambyl and Naryn achieved notable progress. Over a five-year period, Zhambyl expanded its renewable energy capacity by 12%, while Naryn increased its capacity by 10%.These advancements were driven by localised strategies, such as the adoption of adaptive technologies tailored to regional environmental challenges. For instance, drought-resistant solar panels in Zhambyl addressed local climate conditions, ensuring consistent energy production despite environmental variability. SDG 7.1, which aims for universal access to affordable and reliable energy, also saw significant

progress in regions with decentralised and community-driven approaches. Naryn's community-managed micro-hydro project achieved a household electrification rate of 94%, significantly enhancing energy security for rural communities. In contrast, centralised regions like Kostanay and Issyk-Kul lagged behind, with lower energy access rates and slower infrastructure development, underscoring the limitations of top-down governance in addressing local energy needs. Decentralised and participatory approaches also contributed to SDG 13.1, which emphasises strengthening resilience to climate-related hazards. In Zhambyl, 30% of renewable energy installations incorporated climate-resilient solar technologies, reducing vulnerability to droughts and ensuring operational sustainability. Similarly, community-led initiatives in Naryn promoted climate adaptation by integrating hydropower systems that both mitigated flood risks and provided stable energy access during extreme weather events. These examples illustrate how localised governance and community engagement enable regions to implement targeted solutions that address specific climate challenges, enhancing overall resilience.

These findings highlight that decentralised governance and active public involvement not only advance global sustainability goals but also address fundamental human rights concerns. Access to clean and reliable energy, as emphasised by SDG 7, is essential for the realisation of socio-economic rights, while climate resilience measures under SDG 13 align with the broader right to a safe and sustainable environment. By empowering local governments and fostering public participation, regions can implement energy solutions that are both sustainable and equitable, ensuring that no community is left behind.

6.2 Policy recommendations and theoretical underpinnings

The study's findings highlight the critical role of decentralised governance and active community participation in driving the success of renewable energy projects in Kazakhstan and Kyrgyzstan. Building on these insights, several policy and practice recommendations are proposed to strengthen renewable energy governance, optimise socio-economic benefits, and support alignment with SDGs 7 (Affordable and Clean Energy) and 13 (Climate Action). The first hypothesis, which established that

decentralisation improves renewable energy project outcomes, provides a strong foundation for policy recommendations. Quantitative data from high-autonomy regions, such as Zhambyl and Naryn, clearly demonstrate the benefits of localised decision-making. Project completion rates of 78% and 85% in these regions, compared to 41% in Kostanay and Issyk-Kul, highlight how decentralisation reduces bureaucratic delays and enhances project efficiency. This evidence supports the adoption of governance models that empower local authorities to manage renewable energy initiatives. To build on these findings, national governments in Kazakhstan and Kyrgyzstan should prioritise legislative reforms to formalise decentralised governance in the energy sector. A comprehensive framework could delegate decision-making authority over budget allocation, project planning, and regulatory adaptation to regional and municipal governments, particularly in areas with high renewable energy potential. This aligns with Ostrom's theory of polycentric governance, which emphasises the effectiveness of multi-level decision-making systems in addressing complex resource management challenges.[182] By decentralising governance, local administrations gain the flexibility to tailor renewable energy projects to the unique socio-economic and environmental conditions of their regions, optimising resource allocation and reducing inefficiencies. The European Union's Renewable Energy Directive (RED II) offers a valuable model for these reforms.[183]The directive mandates regional governance to streamline project approvals and facilitate adaptation to local contexts. Applying a similar approach in Central Asia could enable regional governments to take ownership of renewable energy projects, resulting in faster approvals and more responsive project designs. This is particularly relevant in regions like Zhambyl, where high autonomy has allowed for the adoption of drought-resistant solar technology tailored to local climatic challenges. Such initiatives not only enhance project completion rates but also ensure long-term sustainability and resilience. Additionally, regional governments should establish dedicated energy planning units to support these

[182] John Knox, 'Report of the Special Rapporteur on the Issue of Human Rights Obligations Relating to the Enjoyment of a Safe, Clean, Healthy and Sustainable Environment', UN Doc A/HRC/37/59 (2018, Geneva) <https://docs.un.org/ru/A/HRC/37/59> accessed 17 August 2025.

[183] European Commission, 'Renewable Energy Directive II' (RED II), Directive (EU) 2018/2001 (2018, Brussels).

efforts. These units could focus on designing and implementing renewable energy projects that align with local priorities, leveraging expertise from international organisations such as IRENA and the World Bank. By combining local knowledge with global best practices, these units can play a pivotal role in advancing sustainable energy transitions while addressing regional disparities in project outcomes.

The second hypothesis demonstrated that community participation amplifies the socio-economic benefits and sustainability of renewable energy projects. Quantitative evidence from high-participation regions, such as Karaganda and Naryn, underscores the importance of integrating structured community engagement into renewable energy governance. In these regions, job creation rates were 35% higher, and infrastructure improvements benefited over 15,000 residents compared to regions with low participation levels like Kostanay and Issyk-Kul. These findings highlight the necessity of institutionalising frameworks that facilitate meaningful public involvement at every stage of project development. To ensure widespread community participation, governments in Kazakhstan and Kyrgyzstan should establish mandatory consultation mechanisms as part of renewable energy planning and implementation. Public consultations and participatory planning sessions would provide a platform for local stakeholders to express their needs and preferences, increasing project acceptance and alignment with regional priorities. For example, in India, decentralised renewable energy initiatives often involve village-level consultations and co-ownership models, which have led to higher project acceptance and greater operational sustainability.[184] Adopting a similar model in Central Asia could formalise local engagement and ensure that projects are designed to maximise socio-economic benefits.

Capacity-building programmes are another critical component of enhancing community participation. Training initiatives targeting local government officials and community leaders should focus on technical skills, project management, and sustainable energy practices. Evidence from Naryn demonstrates the impact of such initiatives; a UNDP-led training program for 300 local officials resulted in a 25% reduction in project delays and

[184] European Commission, 'Renewable Energy Directive II' (RED II), Directive (EU) 2018/2001 (2018, Brussels).

improved maintenance efficiency. Partnering with international organisations, such as the World Bank or IRENA, to develop modular training programmes tailored to Central Asia's needs would empower communities to play a more active role in renewable energy governance, reducing reliance on centralised authorities.[185] Ensuring equity in community participation is equally important. Governments should prioritise the inclusion of underrepresented groups, including women, rural populations, and economically disadvantaged communities, in decision-making processes. Participatory development theory emphasises that inclusive governance not only enhances project outcomes but also promotes social justice and equitable resource distribution. By embedding equity principles into participation frameworks, renewable energy projects can drive broader socio-economic progress while addressing human rights concerns, such as access to clean and affordable energy.

The third hypothesis confirmed that the combination of decentralisation and community participation produces the most substantial progress toward SDG 7 and SDG 13. Quantitative evidence from high-autonomy, high-participation regions, such as Zhambyl and Naryn, underscores the synergistic effect of integrating localised governance and active public involvement. In these regions, renewable energy capacities reached 120 MW and 75 MW, respectively, while CO_2 emission reductions were 199.98 tons and 140 tons, significantly outperforming centralised and low-participation regions like Kostanay and Issyk-Kul. These findings demonstrate that decentralisation and participation together optimise project design, execution, and sustainability, providing a model for broader implementation. To maximise this synergy, governments should integrate climate resilience measures into decentralised energy governance policies. Local administrations should adopt adaptive technologies, such as drought-resistant solar panels and flood-resilient hydropower systems, to address region-specific climate challenges. Zhambyl's successful use of drought-resistant technology improved project durability by 30%, showcasing the potential of tailored solutions. These adaptive measures align with the IPCC's framework for climate-resilient development, emphasising the importance of addressing

[185] European Commission, 'Renewable Energy Directive II' (RED II), Directive (EU) 2018/2001 (2018, Brussels).

climate variability in energy planning.[186] Financial support is essential for ensuring the success of decentralised and community-driven projects. National governments should establish 'Green Funds' to provide grants, low-interest loans, and tax incentives to regional governments and community-led initiatives. Regions like Kostanay and Issyk-Kul, which lagged with renewable capacity increases of just 15 MW and 12 MW, could significantly benefit from such financial mechanisms. The GCF offers a practical example, having mobilised over $500 million for renewable energy investments in developing countries.[187] Leveraging international partnerships and public-private collaborations would enable underperforming regions to access critical funding for renewable projects.

Encouraging cross-regional collaboration is another critical strategy. High-autonomy regions like Naryn and Karaganda have demonstrated the value of knowledge-sharing partnerships, achieving a 45% increase in renewable capacity over three years through collaborative efforts.[188] Governments could formalise these practices by organising annual regional energy forums, workshops, and online platforms, modelled after successful initiatives such as the Asia Clean Energy Forum. Such collaborations not only reduce regional disparities but also foster innovation and efficiency in renewable energy governance.

Finally, to institutionalise these advancements, national governments should develop policy frameworks that embed the principles of decentralisation, participation, and climate resilience into energy governance. These frameworks should include mandatory climate risk assessments, clear guidelines for community engagement, and financial incentives for adopting adaptive technologies. By combining localised governance, public participation, and climate-focused innovation, Central Asia can achieve significant progress toward SDG 7 and SDG 13 while addressing regional and global sustainability challenges.

The recommendations proposed for enhancing local government autonomy and decentralisation in renewable energy governance are grounded in the theoretical framework established earlier in this study. The theory of polycentric governance, as

[186] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022: Impacts*, Adaptation and Vulnerability (IPCC 2022, Geneva).
[187] ibid.
[188] ibid.

articulated by Ostrom, emphasises the efficiency and adaptability of multi-level decision-making systems. Decentralisation allows regional governments to tailor renewable energy projects to specific local conditions, reducing bureaucratic inefficiencies and enhancing responsiveness to socio-economic and environmental needs. The findings of this study, which revealed significantly higher project completion rates and installed capacities in decentralised regions such as Zhambyl and Naryn, align with these theoretical principles. Additionally, the principle of subsidiarity reinforces the importance of assigning governance responsibilities to the lowest effective level, ensuring that decisions are made as close as possible to the affected communities. By delegating authority over budget allocation, project planning, and regulatory adaptation to local governments, as suggested in the recommendations, national administrations can create conditions for more effective and equitable renewable energy governance.

The connection between these theories and the proposed policy reforms highlights the practical relevance of decentralisation not only as a governance model but also as a driver of socio-economic development and sustainability. These theoretical insights provide a robust foundation for advancing SDG 7 and SDG 13 through localised energy strategies.

6.3 Recommendations for future research

Future research could expand its geographic scope to include Uzbekistan, Tajikistan, and Turkmenistan. These countries face similar socio-economic and environmental challenges but exhibit distinct governance structures and levels of community engagement. Comparative analyses across Central Asia could uncover how differences in governance models influence renewable energy outcomes. Extending the scope to neighbouring regions, such as South Asia and the Middle East, may also provide valuable insights. For instance, India's decentralised renewable energy initiatives, which emphasise village-level planning and co-ownership, offer a compelling case study for understanding the role of community engagement in diverse governance settings.[189] Similar-

[189] Ministry of New and Renewable Energy, India, *Annual Report 2020–2021* (Government of India 2021, New Delhi).

ly, examining the Middle East, where centralised energy systems dominate, could highlight potential barriers and opportunities for adopting decentralised models. Comparative regional studies could reveal best practices while identifying adaptations needed to address specific cultural, political, and environmental contexts.

Another critical area for exploration is the long-term impact of community participation on renewable energy project outcomes. While current evidence demonstrates the short-term benefits of community engagement, such as enhanced sustainability and socio-economic improvements, little is known about the durability of these outcomes over extended periods. Longitudinal studies, tracking renewable energy projects in high-participation regions like Karaganda and Naryn over five to ten years, could provide valuable data on operational sustainability, job retention, and community satisfaction. Such studies would enable researchers to assess whether community-driven models consistently deliver long-term benefits or if additional interventions are required to sustain these outcomes. By examining how communities adapt to operational challenges over time, future research could offer practical strategies for ensuring the durability and scalability of participatory renewable energy initiatives.

Financial constraints represent a significant challenge for renewable energy projects in low-autonomy regions. Future research could explore the effectiveness of various financial mechanisms, such as grants, subsidies, and public-private partnerships, in overcoming these limitations. Regions like Kostanay and Issyk-Kul, which have shown limited progress with renewable capacity increases of just 15 MW and 12 MW respectively, could benefit from targeted financial interventions. Investigating the role of international funding sources, such as GCF, could also reveal how these resources interact with local governance structures to support community-driven initiatives. Comparative studies analysing the performance of financial models in different contexts, including Central Asia, South Asia, and Sub-Saharan Africa, could identify scalable strategies for resource allocation in decentralised governance systems.[190] These insights would provide a roadmap for optimising financial support mechanisms to enhance equity, efficiency, and sustainability in renewable energy projects.

[190] World Bank, *Scaling Solar: Lessons from Africa* (World Bank 2021, Washington, DC).

Future research should explore the integration of digital technologies and social inclusion in decentralised renewable energy governance. Innovations such as IoT sensors, blockchain-based energy trading, and remote monitoring systems offer significant potential to enhance efficiency and sustainability. These technologies can improve performance monitoring, predictive maintenance, and resource optimisation, particularly in regions with limited technical expertise.[191] Examining the scalability and cost-effectiveness of these solutions in Central Asia would provide actionable strategies for modernising energy infrastructure. At the same time, understanding the role of inclusive governance is essential for fostering equitable energy access and community acceptance. Gender and marginalised group participation have proven critical in ensuring the success of community-driven renewable energy projects.[192] Future studies could investigate the impact of inclusive governance models on project outcomes, focusing on high-participation regions such as Naryn and Karaganda.[193] This dual approach - combining technological innovation with social inclusivity - aligns with global efforts to promote equity, human rights, and sustainable development in renewable energy initiatives.

6.4 Limitations and concluding remarks

In conclusion, this study underscores the critical role of decentralisation and community participation in advancing renewable energy projects in Kazakhstan and Kyrgyzstan. By assessing the influence of local government autonomy and community engagement on renewable energy outcomes, the findings reveal that decentralised governance and active community involvement significantly enhance project success rates, generate socio-economic benefits, and strengthen alignment with Sustainable Development Goals 7 and 13. Regions with high local autonomy and active community participation, such as Zhambyl and Naryn, demonstrated

[191] World Bank, Scaling Solar: Lessons from Africa (World Bank 2021, Washington, DC).
[192] Robert Chambers, *Whose Reality Counts? Putting the First Last* (Intermediate Technology Publications 1997, London) < https://www.cabidigitallibrary.org/doi/full/10.5555/19971801093> accessed 7 August 2024.
[193] UN Women, *The Power of Gender Equality in Climate Action* (United Nations 2021, New York).

notable achievements in renewable capacity, operational efficiency, and resilience to climate variability. These findings illustrate that governance models that are tailored to local contexts effectively address regional energy needs and environmental challenges. However, the study is not without limitations. The primary focus on Kazakhstan and Kyrgyzstan, while offering valuable insights, limits the generalisability of the findings to other Central Asian countries, such as Uzbekistan, Tajikistan, and Turkmenistan, which possess distinct governance structures and socio-political contexts. Additionally, the reliance on quantitative data, though critical for robust analysis, did not account for qualitative insights, such as community perspectives or policymaker attitudes, which could provide a more nuanced understanding of renewable energy governance. These limitations highlight the need for future research to adopt a broader geographic scope and incorporate mixed-method approaches to deepen the understanding of decentralised governance and community engagement.

To achieve renewable energy targets and contribute to global sustainability, policymakers in Central Asia must prioritise frameworks that empower local governments and foster community participation in renewable energy initiatives. The findings of this study suggest that increasing local government autonomy, formalising community engagement processes, investing in capacity-building programmes, and incorporating climate resilience strategies are essential steps toward a sustainable and inclusive renewable energy sector. Regional collaboration and knowledge-sharing platforms could further amplify these efforts. For instance, organising cross-regional forums, similar to the Asia Clean Energy Forum, could provide opportunities for countries like Kazakhstan, Kyrgyzstan, and Uzbekistan to exchange best practices, share technical expertise, and align renewable energy policies. Nevertheless, the study recognises that implementing these recommendations poses challenges. Political resistance to decentralisation, different levels of technical expertise, and financial disparities among regions may hinder progress. Policymakers must address these barriers by developing targeted strategies, such as providing technical assistance to underperforming regions and ensuring equitable distribution of financial resources. By acknowledging these challenges, Central Asian countries can create an enabling environment for decentralised governance and community-driven renewable energy projects.

As Kazakhstan and Kyrgyzstan continue to expand their renewable energy initiatives, the insights from this study offer a guiding framework for developing energy strategies that are both sustainable and community centred. Embracing decentralised and participatory governance models provides an opportunity for Central Asia to advance toward a cleaner, more resilient energy future. By addressing regional energy needs through localised solutions and fostering community engagement, these approaches contribute not only to SDG 7 and SDG 13 but also to broader socio-economic development goals.

This study contributes to the understanding of renewable energy governance in emerging economies, highlighting that tailored, inclusive approaches are essential for realising equitable and sustainable energy transitions. However, future research must address the identified limitations, such as expanding the geographic focus and incorporating qualitative insights, to create a more comprehensive understanding of decentralised governance models. By building on these findings and recommendations, policymakers and researchers can work together to develop innovative solutions that meet the unique challenges of Central Asia while contributing to global sustainability and equity.

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Appendix A

Table 5.1 Project success metrics by region.
Source: created by the author

Region	Local autonomy level	Project completion rate (%)	Capacity target met (%)	Operational efficiency (%)	Time-to-approval (days)
Zhambyl	High	78	75	82	45
Karaganda	High	72	74	80	50
Almaty	Medium	65	63	70	75
Mangystau	Medium	60	58	68	80
Kostanay	Low	41	46	52	120
Osh	High	83	80	85	35
Naryn	High	85	82	87	30
Batken	Medium	65	63	72	60
Jalal-Abad	Medium	62	61	66	70
Issyk-Kul	Low	53	56	60	90

Appendix B

Table 5.2 Community participation and socio-economic benefits in renewable energy projects by region
Source: created by the author

Region	Participation level	Job creation impact (%)	Infrastructure improvement (%)	Community ownership level (%)	Operational sustainability (%)
Karaganda	High	45	80	78	83
Zhambyl	High	42	76	74	81
Naryn	High	48	82	85	87
Osh	High	46	78	82	84
Almaty	Medium	30	55	65	68
Mangystau	Medium	28	52	62	66
Batken	Medium	32	57	68	70
Jalal-Abad	Medium	27	50	60	63
Kostanay	Low	15	35	40	52
Issyk-Kul	Low	18	38	43	55

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