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Mainstreaming Water, Energy, and Food in National and Municipal Policies in Selected Countries in the MENA Region

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1. Introduction

In order to achieve sustainable management in water, energy, and food, the WEF nexus approach has been widely accepted in MENA countries as the most influential and appropriate solution. This procedure will reduce trade-offs and build synergies. Despite this, challenges and constraints are still faced, where progress in its implementation in the region remains limited. Hence, the following recommendations are proposed.

1. Bridging the nexus science-policy interface gap by establishing a research network.
2. Creating a forum for nexus governance best practices in order to bridge the institutional framework gap.
3. Establishing collaborative capacity building programs to bridge the nexus capacity gap.
4. Forming research and development teams to promote nexus technology implementation.

2. Benefit of NEXUS approach in the future condition of MENA region

Being one of the most energy intensive, water and food deficient regions in the world, the [MENA](#) region is one where all three sectors are indistinguishably linked. This interdependence is intensifying with time as the demand for resources increases due to external factors such as population growth, industrial expansion, inefficient WEF supply chains, and the expected impacts of climate change. It is valid that sustainability and security are endangered if the sectors keep getting addressed independently without recognizing the trade-offs with other sectors. For instance, achieving food security by domestic production without due consideration to the limitations of water resources will lead to over-exploitation, deterioration, and loss of water resources. Eventually, it will also lead to the loss of agricultural productivity and the deterioration of the agriculture sector. Hence, the strong interdependencies of the three sectors calls for replacing the existing conventional silos policy and decision making approach, when addressing the management of these three vital sectors, through nexus thinking and an approach that integrates planning and management across sectors to reduce trade-offs and build synergies. Such an approach will improve resource efficiency in the MENA region and provide larger sustainability levels for its resources. It will also help the region's countries achieve their commitments toward the Sustainable

[Development](#) Goals (SDGs) and Paris 2015 Climate Summit. The water-energy-food nexus approach addresses the resource challenge in the MENA region, while achieving the countries' global mandates as defined by the SDGs. Moreover, this is achieved by adopting integrated resource planning and management of these three vital sectors while minimizing environmental risks. This will achieve a green, circular, and low carbon economy in MENA region countries'. The benefit of the NEXUS approach is recognized; however, the current situation presents very minimal implementation in the MENA region. In order to implement such an approach in the future. Some of the following steps need to be taken:

- Analyzing existing policies and strategies, and how can they be shaped more sustainably
- Serving countries' requirements and needs to secure relevance
- Conducting consultations to secure multi-stakeholder involvement, defining ownership and roles, which will guarantee long-term sustainability.
- Designing measurable and tangible outcomes.
- Youth and gender inclusion with focus on adding value and impact in this field, while focusing on the environment
- Linking with countries of focus to create synergies and utilizing available knowledge.

2.1 Components that ensure a WEF nexus enabling environment.

- WEF Nexus [Scientific](#) Aspects: in order to support evidence based policy making – it is important to bridge the nexus knowledge gap through the role of scientific research. This will result in identifying trade-offs and possible synergies.
- WEF Nexus Governance Aspects: establishing a nexus institutional structure for nexus planning and management, in order to mainstream nexus policies in existing sectoral policies.
- WEF Nexus capacity aspects: developing institutional and individual capacities for nexus planning and management.
- WEF Nexus Investment Aspects: forming policies, legislation, and regulations that involve the private sector to implement and adopt WEF nexus innovations.
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2.1.1 WEF Nexus Scientific Aspect

The WEF nexus integration in the policy cycle in the MENA region, can be implemented through a set of measures, including:

- Bridging the knowledge gap of the WEF nexus at the national and regional levels by understanding and quantifying the inter-linkages between water, energy, and food.
- Identifying and analysing the WEF nexus [cross](#)-sectoral interactions, trade-offs, and risks.
- Adopting a WEF nexus approach policymaking to increase policy coherence among the three sectors and climate change policies to provide integrated solutions and mitigate nexus-related risks.
- Implementing integrated planning and management that reduces trade-offs and builds synergies across the three sectors.
- Adopting the water-energy-food nexus approach in the planning and management of these three sectors to reduce the risk of supply in all three sectors and enable the region to move toward higher levels of resource efficiency, equity, and sustainability.

2.1.1 WEF Nexus Governance Aspects

However, adopting an integrated nexus approach to resource management requires vital factors, including the coordination and collaboration among institutions. Therefore, it is significantly essential to bridge the institutional framework gap. The [institutional](#) framework governing the elements of the WEF nexus in the majority of MENA countries is mostly fragmented. This has in the past, and even today, delayed the comprehensive and inclusive management of these interlinked three sectors. This fragmented institutional framework has also led to a sectoral approach to policy planning and, consequently, fragmented policies.

On average, in the MENA region and in focus countries, there are directly/indirectly related to WEF management. In addition, the fragmentation also exists within the sectors themselves. For instance, water management (groundwater, surface water desalination, and waste water), and the users associated (municipal, agricultural, and industrial) are governed by various institutions with limited coordination among them. This is also the case in the

energy sectors, where many organizations don't have coordination mechanisms between them. Hence, strengthened mechanisms are essential to implement WEF nexus approach effectively. The institutional structures and governance can be enhanced through integrated resources management by such means:

- Analysing current national institutional arrangements and identifying the weaknesses and gaps that limit the implementation of WEF nexus approach in the focus countries.
- Working towards empowering current institutions that are already developing and implementation WEF strategies or policies. This will ensure the development of a comprehensive WEF nexus national strategy, a key element of which is data homogenization and sharing.
- Enhancing [coordination and collaboration mechanisms](#) among institutions to mainstream the WEF nexus approach at local, national, and MENA regional levels; this does not necessarily require the establishment of new institutions for the WEF nexus.

2.1.3 WEF Nexus capacity aspects

Moreover, it is also important to bridge the capacity gap. The design of the management of these primary resources needs to be careful, in order to ensure that securing one of these primary resources does not compromise the others. Hence, the development of a multi-stakeholder platform is important to achieve linkages and opportunities. When the complex interlinkages and dependencies of the WEF nexus are understood, it is easier to translate them into solution and synergies that increases nexus system thinking and problem solving. Other external pressures that drive nexus, such as climate change, population growth, and political factors, call for the impending need to create capacity building programs and knowledge management systems at all levels involved. These platforms can only be created by building capacity at different levels, including institutional, academic, and private sectors. Many MENA countries have competent professionals in the fields of water, energy, and food/agriculture, and there is no need for new staff for the WEF nexus. It is highly necessary to create an inter-sectoral capacity building program and cooperate among these professionals.

To achieve integrated policy making, the multi-sectoral teams should be equipped with qualitative and quantitative frameworks. This will contribute in understanding the challenges and exploring potential synergies of the WEF nexus. WEF nexus system thinking and nexus mainstreaming into sectoral policies can be enhanced by the following:

- The development of WEF [capacity building programs](#) to create competencies in dialogue and conflict resolution, data management and analysis, and an understanding of the WEF nexus at technical and policy levels.
- Identifying tools and data sets for scale specific conditions and goals (local, national, and regional).
- Applying outcomes from holistic nexus tools and comprehensive data sets to guide the management of water, energy, and food resources.

2.1.4 WEF Nexus Investment Aspects

The introduction of new and appropriate technologies can improve resource efficiency and productivity in the water, energy, and food sectors, and contribute to their collective security and sustainability. For example, implementing technologies to reduce food waste and enhance water use efficiency is an example of clear synergy among sectors. It shows how an efficiency enhancement in one sector can lead to less consumption in the others. However, [technological and innovative solutions](#) within the WEF nexus, where two or three components of the nexus are integrated as inputs to each other, not only enhance resource efficiency but also expand the available natural resource base. Thus, they contribute even more to the sustainability and security of the three sectors.

3. NEXUS mainstreaming in MENA countries

Nevertheless, there are some good examples of the adoption of innovative solutions within the nexus in many MENA countries. These include integrated seawater energy and agricultural systems, renewable energy generation from domestic wastewater, solar desalination, agriculture waste-to-energy, landfill-gas-to-energy, and aquaponics-energy. These pioneering projects demonstrate that the potential and benefits of technology and innovation are fully harnessed within the WEF nexus and must therefore be funded, scaled up, and replicated. Enhancing the role of technological innovation in taking up WEF nexus

projects can happen through encouraging the scaling up and replication of on-going WEF nexus related projects. In addition, building capacity for policymakers and institutionalize regional knowledge management systems to share best practices on the WEF nexus. Enhancing and deepening the understanding of WEFE Nexus interdependence by countries and stakeholders is important. As this concept has been understood at a deeper level, several steps have been taking to ensure cross-sectorial cooperation when developing policies, and forming technical agendas. The MENA region follows a procedure of action lines that provide outcomes with local solutions that may be replicated and up-scaled.

WEFE Nexus technical solutions can be in the form of:

1. Improving natural resources management
2. Increase resources' use efficiency
3. Raising crop productivity 'per drop' and 'per KWh'
4. Mobilizing alternative sources to increase the local water budget, etc.

3.1 Opportunity of NEXUS mainstreaming and income generation

Following the COVID-19 situation, unemployment in the MENA region has significantly increased, especially within youth and women. Adopting the WEFE technical solutions will provide solutions that will positively impact this situation, while achieving sustainability objectives. Income generating opportunities, new jobs ([green/blue jobs](#)), new skills, new job fields (sustainable agriculture, integrated urban water management, industry, tourism), and new markets will be presented (approximately 50 million jobs will be created in the MENA, including technical/managerial). This, however requires the correct support, political will, planning tools, and investment. Therefore, focusing on potential employment and entrepreneurship opportunities that are related to WEFE Nexus mainstreaming, will provide income generation and will create a new market in the long-term with more youth and women involved (equal participation). Hence, following the drastic impact that COVID-19 had on the economy, this presents an opportunity for a green recovery that tackles many challenges.

3.2 Future of nexus mainstreaming: examples form focus countries

When tackling future nexus mainstreaming, the options differ due to different factors.

3.2.1 Jordan

Some of these options could include focusing on [sustainable agriculture](#) through the harvesting of rainwater and greywater, recycling, the reuse of brackish water, solar powered desalination, coupled with renewable energy sources for agriculture and food production and/or water supply of off-grid communities for access to safe drinking water. In addition to achieving sustainable agriculture, this can be done by considering environmental needs as well and optimizing existing infrastructure like common rainwater harvesting systems (wadi's). Also, increased capacity and efficiency can be achieved through small dams. Moreover, reusing treated wastewater for food production is effective, while creating new income generation and market creation opportunities through integrating resource efficiency options. In order to understand how WEF sectors are effected by land uses and changes in water infrastructure, there should be a development of a nexus decision support tool which integrates data on water, energy, food, and climate.

3.2.2 Lebanon

As for [Lebanon](#), it is important to understand the proposed actions and policy relevant priorities on the National level, in order to present a projected future condition. To begin, the national policy needs to be better informed through relevant assessments and knowledge production including a review of all proposed and existing waste water treatment plants to asses' potential for reuse in the area. In addition, conducting a socio-economic assessment is necessary, this can be implied through potential reuse including valorising and assessing acceptability in order to select the most appropriated inform policy. Moreover, on the regional level, it is important to work towards common export/import norms so that processes become uniform across the region since trade policies is key for WEF nexus implementation. Not mentioning achieving common certification for WEF produced food.

3.2.3 Tunisia

Like Jordan, [Tunisia](#) faces the option of optimising the efficiency of water distribution networks, powered by renewable sources. In addition to developing a decision support tool that enhances energy efficiency in water distribution networks, connecting dams.

3.3. Examples of potential projects from focus countries

3.3.1 Jordan

Central Jordan Valley – Utilisation of non-conventional water resources for green house farming

There are approximately [90,000 greenhouses](#) in the Jordan Valley. This poses a clear opportunity to explore irrigation powered by solar energy throughout non-conventional water resources. This project focuses mobilising non-conventional water sources for food production. This can happen through testing crop productivity by variable sources of water, including brackish, rainwater, and treated wastewater. In addition to evaluating how these sources can increase food production and protect soil health. Considering that the Jordan valley is an area with many greenhouses, the opportunity to explore harvesting rainwater from greenhouse domes (and using them as collection surfaces), is clear, whereas this will propose potential income generation opportunities for new farmers, and with the clear Nexus benefits proposed, there will be a new market for rainwater harvesting presented.

[Mafraq, Jordan](#) – This project focuses on enhancing water harvesting in arid regions, by improving food security and sustainable natural resources. This area is inhabited by vulnerable Syrian and Jordanian communities. Hence, the project aims towards increasing the availability of water through several techniques including rainwater harvesting techniques to ensure irrigation of crops for animals, and improving the efficiency of irrigation through solar energy. Not mentioning, increasing rainwater retention and storage capacities for dams, testing the productivity of crops and the degree of climate resilience. Choosing to optimise existing and current water infrastructure, rather than building a new one is more sustainable. This project will achieve water security while creating income generating sources for farmers. Another Nexus opportunity is animal waste composting, as this will also prevent leaching and groundwater pollution.

3.3.2 Lebanon

[Zahleh \(Bekaa region Lebanon\)](#) – Local wastewater treatment plant with high energy cost is a potential to gear towards an integrated approach of renewable energy use and reuse of treated water in area (seeking low investment cost and replicability on national level).

3.3.3 Tunisia

[North Tunisia](#) – Optimising the water distribution network through renewable sources, and decreasing electricity consumption levels in specific pumping stations; this can be done through installing solar panel energy systems. This can result in energy efficiency and reduction of energy costs, while distributing water to farmers in the area, which benefits local farmers and guarantees water and food security.

4.0 Aligning the Nexus into the development and economic plans

Water, food and energy security are crucial for sustainable long-term economic growth and human wellbeing and there are strong linkages between all three. Activities in one sector may influence or even constrain economic growth in the others. Additionally, competition for scarce resources can lead to price pressures with short-term consequences and to irreversible ecosystem changes that impact on resource security over a longer timescale.

WEF securities are highly linked and in particular in the semi-arid Arab region, which is energy rich (fossil and solar energy), water scarce, food deficient, and economically and environmentally vulnerable to climate change. The Nexus approach is meant to operate as a catalyst for dialogue between the political economy and the supply chain, and to assist with the move from conflict and competition for natural resources into a cooperative zone in which synergistic solutions can be leveraged. The nexus approach implicitly focuses on policy coherence, thus on identifying hotspots where a specific policy, technology or consumption pattern can be assessed and evaluated. It then focuses on generating a platform for dialogue between multiple levels of stakeholders to enable them to reach informed decisions regarding those synergistic solutions.

In order to shift from concepts, ideologies, and theories to implementation, it is necessary to identify the economic sectors of the Nexus that can benefit from a change in the development phases. In economic terms, water is characterized as a common good that has no substitutes. The fair distribution of this particular resource is governed by social equity and efficient

allocation. In the MENA region, where freshwater resources are scarce and need to be allocated efficiently to supply the domestic, agricultural, energy and industrial sectors, the Nexus can provide ways forward through trade-offs and an understanding of the different stakes involved. Addressing productive sectors and related natural resources separately leads to high opportunity costs across different uses as well as increased transaction costs between the Nexus sectors. Hence, when implementing (or developing) a WEF Nexus approach, the minimization of high transaction costs should be at the core of the considered economic measures. Furthermore, water provision and energy distribution have the characteristics of monopolies, which are highly regulated and produce both positive and negative externalities. Positive externalities may exist for water provision in terms of benefits to public health, while negative externalities may exist in energy and food production (point and diffuse pollution). With regard to water management, the pricing of water should include social, environmental and cultural values that are difficult to estimate or to translate into monetary terms. Water services are strongly subsidized in most regions of the MENA, and water prices mostly reflect investment and maintenance costs but do not include the opportunity cost or scarcity of the resource. Although water pricing is a necessary instrument, it is not sufficient due to the inelastic nature of water demand (increasing prices cannot substantially decrease consumption) and the need to provide sufficient subsidies to lower the costs to households and farmers.

In general, the WEF Nexus has the potential to create new employment opportunities. However, there is some scepticism that the new jobs that can be created in the medium term will only be for a limited number of skilled workers, while unemployment might be created in other competitive sectors (e.g., agriculture). A significant barrier to the technical implementation of the WEF Nexus is the absence of precise and uniform data for the whole region. Several countries have only low levels of data availability and accuracy, while detailed socio-economic and climate data are necessary to conduct a sectoral and inter-sectoral WEF Nexus analysis. Regarding the emergence of new employment opportunities, there is a need to accelerate the process of water management in that direction. Investment at R&D on Nexus approaches could also on its own induce a positive economic effect by creating more jobs while providing solutions. Investing in new efficient technologies (e.g., renewable energy for water-related activities and innovative farming practices for water and energy efficiency in agriculture) within a Nexus approach can create job opportunities, or at the least prevent

job losses for several sectors in a region. In defining the right focus for R&D it is important to have good links between the knowledge parties and the technology users. To prevent purely academic exercises, research linked to viable business cases is needed and real life demonstrations, adopting a bottom-up approach before upscaling, can be considered. Further development of and innovation in the agricultural sector can play a central role in enhancing Nexuses, while in parallel mainstreaming and coordinating across sectorial policies. Other sectors could be further developed, attracting additional investments and producing new jobs within a Nexus framework, such as monitoring and auditing. Furthermore, desalination technologies and the smart use of ecosystems (wetlands) to collect and store water and carbon could also provide positive economic opportunities. The role of governments is of great importance for the Nexus implementation, since they can speed up the process by providing funding or subsidies for new technologies that contribute to the welfare of society which otherwise would not easily reach the markets. The creation of jobs depends on the sector to which water is allocated (e.g., water for irrigation can provide more jobs than hydropower energy production). However, there should be a balance between efficiency and equity in the employment opportunities created. Promoting a better policy for water resource allocation through the use of the Nexus approach could also have a negative impact on employment. The implementation of the Nexus should explicitly take account of this and do everything possible to alleviate it.

In regards to aligning nexus concepts into economic plants moving from a sectoral approach to holistic approach; the following points need to be considered.

- Engaging stakeholders to build awareness and capacities about the interconnected nature of the elements of the WEF nexus, share ways to minimize trade-offs, explore synergies and suggest actions for changing behaviours with regard to the nexus and with regard to other actors whose well-being relies on services and products associated with elements of the nexus. This includes community-level empowerment and implementation to local actors that are actually using core resources to focus on more sustainable consumption.
- Improving policy development, coordination and harmonization to account for trade-offs and build on the increased interconnectedness of WEF. Part of this process is promoting, identifying and eliminating contradictory policies.

- Governance, and integrated and multistakeholder resource planning to promote cross-sectoral and cross departmental approaches to planning and working with stakeholders at different levels to improve public sector-led governance, planning and information
- Promoting innovation to identify technological choices and investments that explore WEF synergies and could be implemented to achieve desired changes on the ground.
- Influencing policies on trade, investment in environment/climate by focusing on improving ecosystem management to increase resource productivity, thus contributing to poverty alleviation and green growth. Specific investments could include;
 - I. Market-led resource pricing to account for local impacts (social and environmental costs of resource exploitation) and global impacts (contribution to climate change).
 - II. Investments in “smart” environmentally and socially sound infrastructure, especially that which is adaptive and focused at the regional level. A key part of these investments should be investing in natural infrastructure. Specific attention is being devoted to climate-related infrastructure development in irrigation, hydropower generation and flood management.
 - III. Promoting more effective waste management by reducing waste and using it in more diverse ways in production.
 - IV. Stimulating development through economic incentives, including working with local stakeholders, and poor and rural populations to provide incentives to manage ecosystems.

In addition, financing the WEF Nexus is another considerable component of economic growth. The public sector is the appropriate institutional body for providing a holistic orientation and long term perspective of the WEF Nexus, as well as for appropriating funds to support the initiation and establishment of a WEF Nexus approach. In this case the use of public funds should be justified with a specific investment plan that incorporates reduced opportunity costs to other public investments. Generally, Nexus investments can potentially be justified when they are profitable and low risk in terms of economic and social welfare, regulated by the state. However, the participation of the private sector is indispensable, involved already at the planning phase and the R&D process. Overall, it is essential to encourage the involvement of the private sector from the beginning in the planning phase, because its knowledge is important for providing sustainable market solutions, innovations, and better operational arrangements. Public-Private Partnerships, although debatable, should be fostered in a consistent manner providing a factor for either further increasing welfare or

achieving the same goal more efficiently and cost effectively. If there are no obstacles and uncertainties and profitability emerges, then firms will invest without public involvement. However, when market conditions are not conducive to investments by private firms, government, universities and knowledge institutes should still invest for public welfare, and market-related shortcomings and share funding uncertainties should be corrected through the appropriate policies. An example of financing Nexuses are the investments in multiple-use water supply systems that support different user needs (water for Water, Sanitation and Hygiene (WASH), water for irrigation, water for small-scale hydropower, water storage for climate change mitigation, healthy wetlands, and aquatic ecosystems), improving people's access to and effective use of water resources. However, this should also be accompanied by training sessions, capacity and trust building, and most importantly, in dialogue with the people eventually benefitting or losing from these investments.

Moreover, this is most pertinent in the case of the MENA region, where in several countries, the role of women in public life, as well as their access to medium or high-level positions within the set hierarchy, especially in public administrations, may be challenging due to social norms and cultural particularities, while their political representation remains low. Similar is with their unequal participation in the formal labour force, the high levels of unpaid work, the limited or non-existing entrepreneurship opportunities, all of which affect -if not determine- their economic independence. Even though important steps are being made in most of the countries in the region for a wider -a more equal- inclusion of women in social and political life. Gender-responsive planning for the water-energy-food (WEF) nexus acknowledges and addresses power differentials among men and women in the water, energy and food sectors in the MENA region. For gender integration to be meaningful, government initiatives must acknowledge the different roles of women and men, and support voices and engagement in policy and decision-making processes. This should also entail creating outcomes that support functional as well as strategic gender needs. It is important to ensure that women are equal partners with men in decision-making over development, technology choice, financing and other aspects of water management, food and energy security, and climate change adaptation. In addition to carrying out reforms at the local level to effectively integrate gender-aware and participatory approaches into local and regional businesses, especially to empower women. Research on the water-energy-food nexus suggests that gender perspectives are often left out of the framework. This can be seen in the categorizations which

group together all farmers, manufacturers, water users, policy makers and agricultural or energy corporations, and how these groups plan and make decisions, regardless of other factors such as gender, class, ethnicity and geopolitical location. Policy makers need to involve women in decision-making processes to ensure that both women and men's gender-specific needs and issues are considered. Further work should be done to integrate gender analysis into the water-energy-food nexus around gender impacts from national to local scales.

5.0 Recommendations and conclusion

Despite the fact that the nexus approach to policy planning and opportunities in the MENA region are fairly different, but the priorities in various countries are very similar. For instance, due to its climate conditions and availability of land, Jordan is considered more ready to use solar energy. Such opportunities could present entry points for the countries to mainstream WEF nexus approach. In terms of the level of progress made in degree of WEF nexus mainstreaming amongst the focus countries, it is rather different. Whereby, some countries are actively seeking more integrated policies, arising from different needs or drivers, while others are still lagging behind with no clear vision for integrated policies. Existing strategies in the MENA region both on national and regional levels should be revisited and modified to have a more integrated approach. In addition, further efforts are needed to ensure proper implementation of the few existing strategies that are already integrated. A "nexus" approach should be considered as guidance to the design of any project, in particular the conceptual stages while looking for possible "integrated" alternatives for what is currently being proposed. The nexus approach is not only about reducing tradeoffs and improving efficiencies between the different sectors it asks for a complete rethinking of the purpose of the project and how it contributes to resource security in general.

The following concepts are common requirements if advanced nexus will be implemented:

- Conducting a baseline assessment of the WEF sectors. Accounting for water is a key issue that private sector should consider. Water must be valued, and risks of water scarcity quantified and incorporated into financial modeling for all businesses and industries.

- Exploring alternative uses for treated wastewater (including in urban areas) and working on treated wastewater quality assurance.
- Enhancing exchange of data and improved monitoring data is key for the implantation of WEF nexus.
- Increasing the awareness of local communities and stakeholders such as farmers in order to increase social acceptance and buy in. A participatory approach and increasing accountability could be drivers to a behavioral change towards unconventional methods of applying the nexus.
- Private-Public partnerships with social equity provisions could help in advancing the implementation of the nexus and mobilizing resources towards its financing.
- Identifying, studying, proposing, and promoting regional water-energy-food nexus projects and areas of cooperation that have significant mutual economic and social benefits to each party. Such initiatives will increase the rate of cooperation and constructive dialogue in the region, thus building confidence and trust. Furthermore, regional mega projects should also be considered such as desalination, large-scale conveyance, cross-border renewable energy generation, and large-scale irrigation efficiency initiatives. Mega projects would require high levels of trust among country partners to commence. However, once initiated, they would act as a long-lasting bond between countries and a cause for continuous cooperation and collaboration.