



August 2022

# National Innovation Pathway Round-up

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# National Innovation Pathway Round up – Republic of Korea

## Introduction

Mission Innovation members agreed to develop **National Innovation Pathways (NIPs)** to describe and build collective understanding on how each member plans to pioneer clean energy technologies to meet their climate and energy goals.

Each member has their own approach to developing and identifying innovation needs and priorities, with some already having undertaken extensive strategy development. The Roundup provides a **single location of summary information on countries' innovation priorities** utilizing existing sources of information so members and interested stakeholders can easily find key information of interest.

All MI members were asked to provide answers to a survey (Annex A) providing as much information as possible, with some questions being optional. The survey asked questions relevant to each element of the National Innovation Pathway described in the Joint Launch Statement:

1. Energy transition scenarios and priority national-level energy innovation needs / priorities until at least 2030;
2. Strategies or national-level plans to address these energy innovation needs / priorities, including institutional design and working internationally
3. Information on how Members will measure innovation outcomes and innovation ecosystem developments;
4. Members' preferred modes and methods of collaboration; and
5. Any further supporting evidence that was used to identify the energy innovation needs / priorities, such as analysis of domestic competitiveness, economic opportunities or national level climate and clean energy plans.

Members will be asked to refresh this document annually if significant changes to national policy have taken place.

# 1. Clean Energy Innovation Strategy

## 1.1 Summary

**Innovation is a priority for** many developed economies as lever for **socio-economic growth, global leadership, and achieving national ambitions**. As a result, **a framework for developing an effective innovation ecosystem** throughout the stages of the innovation journey **was developed**. We have identified two components in the **energy innovation ecosystem to be successful in KSA**:

- 1) Identifying **innovation focus areas** that support energy sector ambitions and address its challenges
- 2) Developing an innovation **enablement ecosystem** that catalyzes deploying innovative ideas
- 3)

The Innovation initiatives will include both **long-term (“develop-to-ready” the strategic focus areas that require longer-term research & development) and short-term (“ready-to-deploy” the mature innovative ideas requiring a push for commercialization) efforts** in the innovation focus areas and prioritized using defined criteria. An **Energy Innovation Steering Committee** with stakeholders from government, industry, and research **will govern the energy innovation** agenda to ensure alignment and effective delivery.

1. Defining an effective focused innovation requires having clear KSA energy sector strategic directions and priorities. A model was designed to analyse energy sector priorities, address challenges and mitigate risks, the model is utilized through engagements with energy pillars which are oil, gas, Refining and petrochemicals, power, renewables and nuclear, hydrogen and carbon.
2. We have created a functional innovation framework by defining the role of innovation in the energy ecosystem, identifying innovation focus areas and alignment with all energy pillars on projects and priorities and Establishing a robust innovation enablement system. We are also working to resolve pressing energy sector challenges and risks, increase the level of collaboration within the ecosystem, bridge R&D and industry gaps to create value, enable ecosystem entrepreneurship & embed innovation culture in the energy ecosystem.

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## 1.2 Methodology

The innovation strategy was developed and adopted by implementing several steps. One of the most important steps is to benchmark and embrace the best practices that were implemented globally by developed countries. Leading the innovative countries, we have created an integrated framework supporting focused innovation journey along four dimensions, knowledge, Resources & Policies, Users & Market, Network & Value Chain. Different elements of innovation framework dimensions were combined resulting in a successful innovation outcome. Secondly, we have integrated the four dimensions into the country framework and we have assessed the country strengths and weaknesses in each dimension. After that we have implemented a model where we will reinforce our strengths and eliminate our weaknesses by identifying and expediting the implementation of our strategic priorities, resolving our challenges and mitigating the risks. Moreover, the KSA energy ecosystem set several ambitious national targets that will require innovation solutions which are oil, gas, Refining and petrochemicals, power, renewables and nuclear, hydrogen and carbon. Finally, we have defined the energy innovation focus areas that follows a **“develop-to-deploy”** methodology via two types of innovation approaches, the first is **Develop-to-Ready** and the second is **Ready-to-Deploy**. This methodology will engage key stakeholders in workshops focused on integrated energy strategy, draft innovation focus areas jointly with all related stakeholders from the energy ecosystem, identify ideas/projects under each focus areas from different platforms and review with energy ecosystem leadership for alignment and endorsement, prioritize ideas/projects based on set criteria and develop execution plans and define key enablers needed for success.

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**Table 1: RELEVANT DOCUMENTS AND POLICIES**

<b>Document or policy name</b>	<b>Description of the document or policy</b>	<b>Specific outcomes, goals or targets identified in the document or policy</b>	<b>Year</b>	<b>Web Link(s)</b>
KSA. NDC	Saudi Arabia nationally determined contribution (NDC) under UNFCCC Paris Agreement	The Kingdom aims at reducing, avoiding, and removing GHG emissions by 278 million tons of CO <sub>2</sub> eq annually by 2030 - a more than two-fold increase versus the previous ambition as outlined in the Kingdom's INDC (130 million tons of CO <sub>2</sub> eq). Thus, ambition represents progression and the highest possible ambition. Furthermore, by supporting mitigation efforts in other countries (e.g., Middle East Green Initiative), Saudi Arabia's efforts extend beyond its borders.	2021	<a href="https://www4.unfccc.int/sites/nct/staging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf">https://www4.unfccc.int/sites/nct/staging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf</a>

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<p><i>Saudi Arabia Green Initiative (SGI)</i></p>	<p>SGI works with entities and organizations across the Kingdom to amplify their existing climate actions and create opportunities for new initiatives. SGI also bridges the gap between public and private sustainability efforts, identifying opportunities for collaboration and innovation.</p>	<p>SGI brings together environmental protection, energy transformation and sustainability programs to work towards three overarching targets to achieve a common goal of a green future.</p> <ul style="list-style-type: none"> <li>1- Reducing Emissions: Reduce carbon emissions by more than 278 mtpa by 2030.</li> <li>2- Greening Saudi: Plant 10 billion trees across Saudi Arabia</li> <li>3- Protecting land and sea: Raise protected areas to more than 30% of total marine and terrestrial area</li> </ul> <p>Protect at least 30% of the global ocean in Marine Protected Areas (MPAs) and Other Effective area-based Conservation Measures (OECMs) by 2030.</p> <p>Contribute to UNFCCC climate action by supporting and guiding sports actors in achieving global climate change goals and displaying climate leadership.</p>	<p>2021</p>	<p><a href="https://www.saudigreeninitiative.org/about-saudi-green-initiative/">https://www.saudigreeninitiative.org/about-saudi-green-initiative/</a></p>
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		<p>Cut global methane emissions by 30% by 2030 through the six-sector solution proposed by UNEP.</p>		
<p><i>Medial East Green initiative (MGI)</i></p>	<p>MGI is a catalyst for global impact, creating an economy of scale for climate action.</p>	<p>There are 3 pillars that defines MGI strategic environmental aims:</p> <ol style="list-style-type: none"> <li>1- Knowledge Transfer.</li> <li>2- Environmental Stewardship.</li> <li>3- Forward-thinking innovative climate solutions.</li> </ol> <p>Plant 50 billion trees across the Middle East (including 10 billion at home in Saudi Arabia). Restore an area equivalent to 200 million hectares of degraded land, helping reduce CO2 by 2.5% of global levels.</p> <p>To enable the achievement of the Middle East Green Initiative goals,</p>	2021	<p><a href="https://www.saudigr eeninitiativ e.org/about-middle-east-green-initiative/">https://www.saudigr eeninitiativ e.org/about-middle-east-green-initiative/</a></p>

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		<p>the Kingdom of Saudi Arabia announced during the summit that it will establish the following:</p> <ul style="list-style-type: none"><li>• Co-operative Platform to accelerate implementation of the Circular Carbon Economy (CCE)</li><li>• Regional Hub for Climate Change</li><li>• Regional Center for Carbon Extraction Use and Storage</li></ul> <p>The Kingdom additionally announced a regional initiative for clean fuel solutions for cooking for that will benefit more than 750 million people worldwide, and the establishment of a Regional Investment Fund for Circular Carbon Economy (CCE) technology solutions. The total investment in these two initiatives is approximately SAR 39 billion and the Kingdom will contribute to financing approximately 15% of it.</p>		
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## 2. Clean Energy Innovation Priorities

### 2.1 Overview of Clean Energy Innovation Priorities

**Table 2: CLEAN ENERGY INNOVATION PRIORITIES**

Innovation priority	Focus of innovation activity (tick all that apply)	Targets/Goals (if applicable)	Technologies or topics of interest	Total RD&D funding allocated, (include Budget years where applicable)	Planned demonstration Investments (include budget years and indicate if domestic or international spending where possible)	Links to relevant reports or plans
CCE Abatement: CCUS & Hydrogen	<input checked="" type="checkbox"/> Early-stage research <input checked="" type="checkbox"/> Applied research <input checked="" type="checkbox"/> product development <input checked="" type="checkbox"/> Demonstration <input checked="" type="checkbox"/> Commercialisaton Other:	CCUS: Total Co2 managed by 4R's which is reduce, reuse, recycle & remove is going to be 531 MtCO2 by 2040. Volume reduced of CO2 by 278 MtCO2 by 2030. Hydrogen: Total clean H2 production capacity 4 Mtpa by 2030.		Carbon Capture Tech. Carbon utilization. Sequestration. H2 production (e.g. Electrolysers) H2storage H2 transport H2 utilization		<a href="https://www.cce.org.sa/">https://www.cce.org.sa/</a>
CCE Avoidance & Removal: Renewable energy: Solar, Wind, Direct Air Capture	<input checked="" type="checkbox"/> Early-stage research <input checked="" type="checkbox"/> Applied research <input checked="" type="checkbox"/> product development <input checked="" type="checkbox"/> Demonstration <input checked="" type="checkbox"/> Commercialisation Other:	Energy mix, installed generation capacity up to 50 % by 2030 of the total energy generated.	Renewable generation and integration. Energy Storage. Direct Air Capture			<a href="https://www.kapsarc.org/research/publication/">https://www.kapsarc.org/research/publication/</a>

### 3. Private Sector Engagement (Optional)

The Saudi Arabia Ministry of Energy is coordinating and closely monitoring the following projects:

- **Geothermal Energy Exploration:**  
Some recent reports on geothermal energy show that Saudi Arabia is rich in terms of different geological characteristics and geothermal activity and is qualified to contribute effectively to the domestic energy supply. This geothermal exploration project aims to have a better understanding of the subsurface conditions in Al-Lith area and assess the possibility of having a geothermal reservoir. This project involves Preliminary and Geoscientific studies (Geological, geophysical, and geochemical studies) in collaboration with TAQA.
- **Cryogenic Carbon Capture Technology:**  
An internal study showed that an emerging technology that has not yet been commercially developed in global markets, and owned by one of the world's leading companies in the field of carbon management, the American Company Chart, is based on capturing and reusing cryogenic CO<sub>2</sub> more efficiently than traditional techniques, and its estimated cost is lower up to \$ 34 per ton of carbon dioxide. For this reason, the Ministry, in partnership with King Abdullah University of Science and Technology, the NEOM project and the American Company Chart, has adopted the development of a plan for a pilot plant with a lifespan of up to 5 years in a power plant adjacent to the industrial areas on the West Coast, with the aim of designing and constructing a 30- tons CO<sub>2</sub> capture unit and a cryogenic CO<sub>2</sub> production.
- **Direct Air Capture technology development in collaboration with ARAMCO and KAUST:**  
As part of KAUST Circular Carbon Initiative (CCI), the CO<sub>2</sub> Capture thrust focuses on the demonstration of direct air capture (DAC) technology encompassing metal-organic-framework (MOF) developed at KAUST and will collaborate with Aramco on the development and upscaling of new adsorbents to process design, cost estimation, environmental analysis and small-scale demonstration.

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- Membrane-based CO<sub>2</sub> capture study in collaboration with ARAMCO: Carbon Dioxide is being emitted as a Tail Gas of Sulfur Recovery Units (SRU). A membrane carbon capture unit is proposed on this stream which contains approximately 22% CO<sub>2</sub> by mole (wet basis). A typical carbon capture system design consists of a two-stage membrane process that, based on preliminary calculations, can produce a CO<sub>2</sub> product stream of at least 98% purity at a capture rate of approximately 90%. The introduced Membrane Carbon Capturing Technology is currently at TRL 6 where the technology needs to be assessed to determine its feasibility for this particular application before demonstration in a relevant environment.

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## 4. International Collaboration (Optional)

Please describe your strategic approach to international collaboration to tackle your clean energy innovation priorities (e.g. do you have an international strategy, or particular types of collaboration you are prioritising).

Saudi Arabia has joined the mission innovation believing that the mission innovation will act as catalyst to excel the investment in research, development and demonstration to make clean energy affordable, attractive and accessible to all this decade. The kingdom is an active member in three missions, the clean hydrogen mission and the green powered future mission (GPFM), along with co-leading the carbon dioxide removal mission (CDR), the CDR mission will catalyse the advancement in research and development in CDR technologies such as the direct air capture which is promising and important technology for Saudi Arabia.

Saudi Arabia has established a global collaboration with a variety of different world-wide countries, from the far East with Japan, Korea and China to the far west with Canada and USA. All the collaborations are directly working to protect the climate while sustaining the global energy security. The collaboration varies from one country to another. On the other hand, many collaboration opportunities are common between all countries. One of the most important collaborations is the circular carbon economy where we can collaborate on infrastructure development projects for carbon circular economy applications (such as CCUS, and DAC), also to identify areas of cooperation in relation to clean hydrogen technologies in relation to hydrogen transportation and storage, and exchange expertise and experiences to apply best practices in the field of hydrogen projects more over to develop policy, legislation and build awareness of the hydrogen economy. cooperation and exchange of experiences to promote innovation and the use of artificial intelligence in the field of energy

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## 5. National Energy Innovation Ecosystem (Optional)

**Table 3: CLEAN ENERGY INNOVATION INSTITUTIONS**

Institution name	Description of role	Innovation priority(ies) that they contribute to (taken from Table 2)	Description of funding modalities (e.g. grants, co-investment, where in tech development cycle focused)	Links
KFUPM KAUST KSU KAU	Execute & coordinates the R&D and innovation of key common technologies, cutting-edge leading technologies, modern engineering technologies and disruptive technologies, and take the lead in organizing major technology research.	CCE: CCUS & Hydrogen CCE : Renewable energy: Solar, Wind		1- <a href="http://www.kfupm.edu.sa/Default.aspx">http://www.kfupm.edu.sa/Default.aspx</a> 2- <a href="https://www.kaust.edu.sa/en">https://www.kaust.edu.sa/en</a> 3- <a href="https://ksu.edu.sa/">https://ksu.edu.sa/</a> 4- <a href="https://www.kau.edu.sa/Home.aspx">https://www.kau.edu.sa/Home.aspx</a>
KACST	Providing support for scientific research and technological development. Conducting applied scientific research and technological development. Coordinating national activities in the fields of science, technology and innovation. Strengthening local and international partnerships for technology transfer, localization and development. Providing	CCE: CCUS & Hydrogen CCE : Renewable energy: Solar, Wind		1- <a href="https://www.kacst.edu.sa/">https://www.kacst.edu.sa/</a>

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	consultations, services and innovative solutions. Investing in technology development and its commercial processes.			
KAPSARC	Advance the understanding of energy economics and to act as a catalyst for dialogue, charting a path to better welfare for societies, locally and globally.	CCE: CCUS & Hydrogen		<a href="https://www.kapsarc.org/research/publications/">https://www.kapsarc.org/research/publications/</a>
K.A.CARE	conducts applied research to serve sustainable development and provide recommendations regarding renewable energy and atomic energy on the national scale.	CCE : Renewable energy: Solar, Wind		<a href="http://www.kacare.gov.sa">www.kacare.gov.sa</a>
ARAMCO SABIC SEC ACWA POWER	Execute & coordinates the R&D and innovation of key common technologies, cutting-edge leading technologies, modern engineering technologies and disruptive technologies, and take the lead in organizing major technology research. and application demonstration of achievements.	CCE: CCUS & Hydrogen CCE : Renewable energy: Solar, Wind		1- <a href="https://www.aramco.com/?utm_source=googleads&amp;utm_medium=ppc&amp;utm_campaign=GO_KSA_Brand_EX&amp;gclid=Cj0KCQjwlemWBhDUARIsAFpIrlUsWFD6QMj8b-JaiG2zCLWyJEOHzZd2bdEU_BanGShrmYDXIMa5lcaArSMEAL">https://www.aramco.com/?utm_source=googleads&amp;utm_medium=ppc&amp;utm_campaign=GO_KSA_Brand_EX&amp;gclid=Cj0KCQjwlemWBhDUARIsAFpIrlUsWFD6QMj8b-JaiG2zCLWyJEOHzZd2bdEU_BanGShrmYDXIMa5lcaArSMEAL</a>

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## **Annex A – National Innovation Pathway Roundup Survey Questions**

**1.1 Summary:** Please provide a summary of your national clean energy innovation strategy i.e. the overall policies, framework and/or goals that help to define the innovation priorities you will describe in Section 2. We recommend including information about your national climate or energy targets (such as NDCs or renewable energy targets) as well as national innovation strategies and policies. You can share links to relevant documents in Table 1.

**1.2 Methodology:** Please describe the methodology to develop your national clean energy innovation strategy such as analysis, modelling or stakeholder engagement and include any links to relevant documents in Table 1. This will be used to help share learning between members.

**2.1 Overview of Clean Energy Innovation Priorities:** Please provide a list of your national clean energy innovation priorities (i.e. specific technologies, sectors or needs). Please complete Table 2 to provide information about where you are focusing in the innovation cycle for each priority; any targets or goals; RD&D interests; current allocated budgets (including specific demonstration funding) and links to relevant strategies or reports. In the text box following please provide a brief description of how you plan to respond to each innovation priority in the coming years, such as through future plans over the next 3-10 years to mobilise further investments for innovation, launch new major programmes and timelines for major demonstration projects.

**2.2 Tracking Progress:** Please describe how you plan to measure progress towards addressing your identified energy innovation priorities. Please describe any governance processes to manage and review energy innovation efforts and, where able, please list

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tracking indicators that are commonly used (e.g. such as patents, publications, rates of company formation, follow-on capital and private co-investment, technology performance upgrades).

**3. Private Sector Engagement:** Please can you describe your strategic approach and priorities to engagement with the private sector to address the clean energy innovation priorities identified in section 2. This could include for instance prioritising co-funding of RD&D initiatives; incubator/accelerator programs that are funded (in part or fully) by the private sector; tax credits and other fiscal incentives; initiatives that the private sector can engage with, grants, de-risking instruments such as loan guarantees etc.

**4. International Collaborations:** Please describe your strategic approach to international collaboration to tackle your clean energy innovation priorities (e.g. do you have an international strategy, or particular types of collaboration you are prioritising).

**5. National Energy innovation Ecosystem:** Please provide an overview of your national institutions, funders and organisations and describe how they contribute to tackling the innovation priorities identified in Section 2. Please either provide this information in the box or complete Table 3.

**6. Further Supporting Information:** Please add below any further information about your national energy innovation needs or approaches to tackling these that has not been covered above.





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