HIGH-LEVEL DIALOGUE ON ENERGY

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THEME REPORT ON

INNOVATION, TECHNOLOGY AND DATA

TOWARDS THE ACHIEVEMENT OF SDG 7 AND NET-ZERO EMISSIONS

EXECUTIVE SUMMARY

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1 PRIORITY RECOMMENDATIONS

This report aims to align international action on energy innovation, technology development and deployment, and data collection and use with the achievement of SDG 7 by 2030 and net-zero carbon emissions by 2050. The report provides an overview of the present status of energy innovation; it proposes actionable recommendations with priority results and action areas; and it assesses the catalytic impacts that such actions can have.

Innovation is a dynamic series of processes: it results from complex, interconnected systems influenced by multiple actors and institutions at different levels, including governments, the private sector, academia, civil society, and end users. Innovation is not just about technology, but also about policy and planning, and the finance, business and social domains.

Better systems of data collection and application that are open, reliable, and complete are necessary to accelerate the effective development of inclusive energy policy, planning, and systems. Digitalization and Industry 4.0 technologies can also act as enablers for transformational change.

There are significant and persistent policy, technology, finance-related, and social challenges to energy innovation, technology development and deployment, and data improvement. Existing technologies are under-deployed, and approximately half of the technologies necessary to meet the 2050 target are still in the early stages of development and demonstration.

Energy innovations present positive transformational potentials for achieving universal energy access and for net-zero emissions: innovations should follow four key principles:

- **Set an ambitious vision**: Align innovation, policy, finance, and action with the achievement of SDG 7 targets by 2030 and net-zero emissions by 2050;
- **Integrate sustainability**: Ensure that social, economic, and environmental sustainability are considered in the design, implementation, and monitoring of energy innovations;
- **Act locally**: Ensure that innovations are customized to the local context so that energy innovations fulfil the needs and aspirations of local stakeholders and end users; and
- **Leave no one behind**: A diversity of needs, based on geography, gender, equity, age, and marginalized populations should be considered, and issues such as the digital divide, affordability, and capacity development should be addressed.

With these principles in mind, five key recommendations are presented:

RECOMMENDATION 1

Align energy innovation governance and international cooperation with meeting the targets for 2030 and 2050

National and local energy-innovation governance and international cooperation around mission-oriented policies and strategies must be strengthened. This process should be informed by evidence and science-based targets, and backed by long-term predictable funding and financing that drive 'homegrown' innovation; and it should be guided by the principles of a just transition.

RECOMMENDATION 2

Expand the supply of energy innovation that addresses key gaps

To increase the supply of clean energy innovation, international cooperation and national commitments in partnership with the private sector need to be enhanced. Expanded innovation should be based on targeted, sustained, outcome-based funding for research, design, development, and demonstration that is proportional to the challenge at hand and sets solid milestones for scaled-up commercial adoption.

RECOMMENDATION 3

Increase the demand for clean and sustainable energy technologies and innovation

Demand for clean and sustainable energy technologies and innovation through market-oriented policies, harmonized international standards, and carbon pricing mechanisms needs to be accelerated. This will enable infrastructure, fiscal incentives, access to finance, regional and local green value chain development, and commitments to public and private procurement of clean energy technologies.

RECOMMENDATION 4

Leverage digitalization for innovation, while addressing the digital divide

An inclusive and integrated enabling environment should be developed for innovation that can leverage digitalization for financial and social innovation into new business models that not only improve affordability, reliability, and accessibility to clean energy technologies, but also strengthen capacity and knowledge around digital technologies to address the digital divide.

RECOMMENDATION 5

Improve the collection, management, and application of data and data systems

Enhance data systems and energy-planning workflows and analytics: (i) to better inform energy policies, planning, and regulations; direct investment decisions and monitoring, evaluation, and reporting in order to address disparities; and (ii) to effectively manage synergies and trade-offs in energy access, technologies, and security among vulnerable and marginalized communities.

If all stakeholders adopt and act urgently on these recommendations, in tandem with the recommendations of the other technical working groups, the catalytic impact is expected to be a rate of energy innovation consistent with achieving SDG 7 by 2030 and net-zero emissions by 2050: this will also create jobs, economic growth, and a more inclusive energy sector in terms of both the needs and the participation of women, youth, and marginalized groups.

2 RESULTS AND ACTIONS MATRIX

PRIORITY RESULTS	PRIORITY ACTION AREAS	STAKEHOLDER ACTIONS			
		Public	Private	Civil Society	International organizations
Priority Result 1 Energy innovation governance, cooperation, and capacity are aligned with the 2030 and 2050 targets.	1.1 Implement, and monitor mission-oriented energy innovation visions and ecosystems. This will ensure policy coherence by aligning the objectives and impacts of energy innovation with binding commitments (to SDGs and in NDCs).	Develop, implement, and monitor visions and energy innovation ecosystems in a participatory manner	Actively engage in the development, implementation and monitoring of energy innovation visions and ecosystems.	Actively engage in, and provide support for, the development of energy innovation visions and ecosystems.	Facilitate international cooperation and development assistance to countries through open data knowledge sharing platforms and peer-to-peer learning.
	1.2 Adopt existing or develop international technical standards and quality-control requirements. Harmonize these with energy supply and demand policies and regulations at the national level.	Adopt internationally harmonized technical standards and quality-control requirements, and/or develop national ones.	Apply international or national technical standards and quality-control requirements.	Support localization of international standards and the development of national standards.	Develop and/or support the adoption of international or national standards and quality- control requirements; and facilitate access of developing and least-developed countries to state-of-the-art quality and testing infrastructure.
	1.3 Strengthen local and national ecosystems to support 'homegrown' energy innovations and green value chains.	Develop national policies, regulations, local and national coordination mechanisms and institutional arrangements; this will support homegrown energy innovations and bring together stakeholders from the public and private sectors, academia, and civil society, on both the energy supply and demand sides.	Invest in local RD&D. Support local technical capacity building. Partner with governments and universities to develop local innovations and homegrown technologies.	Mobilize women, communities, youth, and vulnerable groups to shape and lead local energy innovation. Support connectivity between different actors.	Develop a comprehensive global assessment of energy innovation programmes to learn from collective experience and establish best practices. Facilitate international cooperation and technical assistance to countries with nascent capabilities to build homegrown energy innovation capabilities, develop an understanding of the concept of inclusiveness, and be able to connect to global ecosystems.

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	1.4 Develop programs that provide opportunities and build capacity among professionals, including youth and women. Programs will be on the supply and demand sides of energy innovation and of data collection and monitoring.	In partnership with the private sector, academia, and civil society, develop national programs for young professionals and women related to the supply and demand sides of energy innovations. Promote and finance inclusive energy incubators and start-up centres.	Provide opportunities for young professionals to work in energy innovation programs in partnership with government and civil society. Develop programmes that address the gender gap, in order to enhance the engagement of women in the energy sector and their career advancement within it.	Support the development of energy innovation programs targeting young professionals and women in partnerships with government and the private sector.	Facilitate international cooperation and quality standards for curricula development and certification and accreditation schemes. Enable access to affordable, high quality professional qualifications for low-income earners and disadvantaged groups (e.g. women and youth). Facilitate South–South technology transfer.
	1.5 Foster multi-sector partnerships for energy technology innovation and enable cooperation through open access policies, best practices, and knowledge exchange.	Champion open access policies and facilitate the establishment of multi-sector energy innovation partnerships.	Participate in and support global and multi-sector energy innovation partnerships.	Participate in global, national, and local multi-sector energy innovation partnerships.	Facilitate inter-governmental and global multi-sector energy innovation partnerships.
Priority Result 2 The rate of technology research, development, and demonstration is increased to be consistent with meeting the 2030 and 2050 targets.	2.1 Implement sector- specific commercial-scale pilot and demonstration projects that takes into account user benefits, especially those for women and vulnerable groups.	Facilitate the development of pilots and demonstration projects at the national and local levels. Create partnerships with the private sector and academia around commercialization pathways.	Support pilot and demonstration projects. Create partnerships with government and academia around development and commercialization pathways.	Participate in pilot and demonstration projects, both as a beneficiary and in decision-making. Create partnerships between academia, the private sector, and government around commercialization pathways.	Facilitate international cooperation and a level playing field for all countries to participate in technology development and benefits. Facilitate the removal of technical and trade barriers, as well as barriers to accessibility. Support the diffusion and scale-up of successful pilot schemes and demonstrations, in addition to evaluation support in this regard.
	2.2 Strengthen commitment to predictable, sustained, outcome-based funding in RD&D and invest in portfolios of key technologies and innovations to accelerate early-stage development to commercialization. Strengthen energy system reliability, resilience, and/or security.	Develop enabling policies and institutions for home-grown RD&D and the development of energy innovations that include all key actors along value chains. Establish mechanisms for evaluating progress on innovation policy outcomes, making data available to researchers and adjusting programmes accordingly.	Provide financial support and/or implement home-grown RD&D.	Provide local and regional input on needs and risk assessment.	Facilitate cross-border cooperation, public–private collaboration, and sector- specific consensus, particularly for sectors of a global nature (such as aviation, cement, iron and steel) that cannot be transformed through national policy alone.

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	2.3 Approve the creation of the International Energy Innovation Fund to address the lack of financial resources for localized energy innovations in developing countries.	Approve the creation of the International Energy Innovation Fund. Establish an Energy Innovation Fund to encourage the development of homegrown solutions to energy needs.	Provide financial support to the International Energy Innovation Fund.	Provide input on local and national energy innovation funding needs.	Champion and facilitate inter-governmental support for the establishment of an International Energy Innovation Fund.
	2.4 Increase research and education opportunities directed at energy innovation for women, youth, and marginalized groups in science, technology, and innovation (STI).	Develop and/or enhance education and research programs that support women, youth, and marginalized groups in STI.	Create positions, internships, and support programmes (e.g., mentoring, capacity-building programmes) for women, youth, and marginalized groups in STI.	Create positions and internships for women, youth, and marginalized groups in STI. Enhance awareness of the need for and benefits of involving women, youth, and marginalized groups.	Facilitate and enhance global opportunities for women, youth, and marginalized groups in STI.
	2.5 Ensure that international and national systems are in place for open communication and knowledge dissemination among the research community and the public of knowledge created from publicly funded RD&D.	Participate in and support global and multi-sector energy innovation partnerships.	Participate in and support global and multi-sector energy innovation partnerships.	Participate in global, national and local multi-sector energy innovation partnerships.	Facilitate global and multi-sector energy innovation knowledge-sharing partnerships.
Priority Result 3 Drastic stimulation of demand for and development of infrastructure for clean energy innovation to ensure economies of scale in line with meeting the 2030 and 2050 targets.	3.1 Support the development of international, regional, and national markets through internationally harmonized standards, financial facilities, pricing mechanisms, and awareness-raising.	Adopt national measures to support national markets.	Apply national and international measures in support of market development.	Raise awareness on market development measures.	Facilitate cooperation and international coordination of measures to develop sustainable energy innovation in regional, national, and international markets.
	3.2 Increase funding for clean energy technologies and innovation by committing to the procurement of clean energy technologies and greening supply chains.	Develop/implement green energy public procurement plans.	Develop/implement green private procurement plans and green supply chains.	Actively engage in developing, promoting, and ensuring the broad application of demand-side measures.	Develop international standards that provide technical assistance to governments and the private sector in developing-green procurement plans and green supply chains.
	3.3 Mainstream inclusive energy-innovation policy, planning, and development of enabling infrastructure to provide increased accessibility and affordability at national and sub-national levels.	Develop energy- innovation policies that are predictable and flexible. Ensure planning is inclusive, taking into account the needs of women and vulnerable groups.	Ensure planning is inclusive, taking into account the needs of women and vulnerable groups.	Mobilize communities to incorporate local knowledge into energy innovation policy and planning.	Facilitate North–South and South–South cooperation and technical assistance to countries that are sustainable and inclusive.

PRIORITY RESULTS	PRIORITY ACTION AREAS	STAKEHOLDER ACTIONS			
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	3.4 Require energy suppliers to integrate costs, activities, and partnerships related to productive use of energy (PUE) into their project designs and/or business models.	Embed PUE in the development of policies and programmes dedicated to energy innovation and facilitate access to high-risk, early-stage financing for innovators and entrepreneurs.	Drive innovations around PUE to increase the commercial viability of energy-supply systems, while triggering local economic growth in the target communities.	Advocate implementation of their PUE to governments, private sector, and international organizations. Mobilize the community to increase social acceptance around innovation approaches for PUE.	Provide technical assistance to support governments and the private sector to develop clean energy supply plans that integrate PUE. Facilitate international pooling of resources for high-risk, early- stage financing for innovators and entrepreneurs. Facilitate data-access and sharing for clean energy supply.
	3.5 Make energy tariffs accessible to energy users, particularly in developing countries, taking into account women, youth, and marginalized groups.	Develop smart subsidies, at least at the beginning of clean energy deployment, and in developing countries in particular. Develop Public-Private Partnerships (PPPs) to include tariff subsidies.	Develop joint solutions with energy end users and governments. Develop Public-Private Partnerships (PPPs).	Participate in the development of solutions to make energy tariffs affordable.	Support the development of multi-stakeholder solutions to make energy tariffs affordable.
Priority Result 4 Significantly increased access to, and adoption of, clean energy digital solutions and innovation by all.	4.1 Invest in the development of adequate digital infrastructure supported by digital transformation roadmaps for energy and across sectors.	Ensure policies and regulations are flexible to accommodate new technologies and innovations, with consideration for system-wide benefits. Develop capacity and facilitate cross-department collaboration on digitalization.	Develop pilot projects and monitor the impact of digitalization and Industry 4.0 technologies on energy demand.	Advocate to governments and the private sector the needs of women, youth, and marginalized groups, and provide input on these issues.	Provide technical assistance to governments and the private sector in supporting the adoption of sustainable digital solutions and innovation for energy systems.
	4.2 Strengthen local access and capacity with targeted support to address the skills gap in digital literacy through curriculum development, training, and reskilling programs and paying particular attention to women, youth, and marginalized groups.	Support existing or create new national collaborative mechanisms aimed at bridging the digital divide. Develop partnerships with academia and the private sector that support training and skills development.	Support existing and/or develop new national collaborative mechanisms aimed at bridging the digital divide.	Support development of programs that aim to bridge the digital divide, as well as participation in them.	Facilitate and support existing international and/or national development of collaborative mechanisms that aim to bridge the digital divide and/or support new ones.
	4.3 Increase international and interdisciplinary collaboration and dialogue among stakeholders at global and national level to bridge the digital divide and enhance system resilience against cyber-security risks.	Organize and support interdisciplinary collaboration and dialogue between energy-innovation stakeholder groups on cyber-security risks.	Participate in and support interdisciplinary cooperation and dialogue between energy-innovation stakeholder groups on cyber-security risks.	Participate in interdisciplinary cooperation and dialogue between energy innovation stakeholder groups on cyber-security risks.	Participate in and support interdisciplinary cooperation and dialogue between energy-innovation stakeholder groups on cyber-security risks.

PRIORITY RESULTS	PRIORITY ACTION AREAS	STAKEHOLDER ACTIONS			
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Priority Result 5 Substantial increase in the availability, reliability, validity, and completeness of open data and enhanced workflows for planning, deployment, and accessibility of clean-energy and energy-efficiency technologies and solutions.	5.1 Improve data architecture, interoperability, and management to drive meaningful and sustainable innovations by leveraging international standards to enhance data quality and security.	Develop high quality data architecture, management, and governance for clean energy and energy efficiency innovations.	Support the development of high-quality data architecture, management and governance for clean- energy and energy- efficiency innovations.	Provide community input on data architecture and management.	Support the establishment of a new global open-source centre for collecting traditional and emerging types of data. Facilitate the development of international standards, guidelines, and capacities for the adoption of good-quality and interoperable data architecture, management, and governance for clean-energy and energy-efficiency innovations.
	5.2 Leverage data and evidence towards the scaling up of energy innovations through the use of Industry 4.0 (i.e., big data, artificial intelligence, internet of things) technologies, and national and global data platforms.	Make adequate use of Industry 4.0 technologies and data platforms in data generation for planning energy innovations.	Combine data with Industry 4.0 solutions to support energy planning and operational efficiencies.	Advocate for inclusive application of data and Industry 4.0 technologies in the design of energy policies, planning, business models, and innovation.	Facilitate cross-country cooperation in the use of Industry 4.0 technologies and data platforms in planning energy innovations. Support countries in ensuring that data systems are safe, transparent, are non-discriminatory, and respect privacy.
	5.3 Invest in multi-sectoral approaches to data collection, sharing, and monitoring in a disaggregated form by making use of digital technologies, innovations and better integration of available data to take account of local contexts, site-specific information, relevant identity groups, and spatial elements.	Include disaggregated data in the design of energy innovations, policies, and programs, while respecting the need to anonymize the personal data of citizens/users.	Include disaggregated data in the design of energy innovations.	Participate in disaggregated data collection, where appropriate. Support accountability and transparency measures in the collection and application of data.	Facilitate the adoption of common and comparable methodologies for collecting data in a disaggregated form and for the integration of available data on energy- innovation policies and programs. Support accountability and transparency measures in the collection and application of data.
	5.4 Ensure data on energy innovations and workflows are made publicly available with consideration for data sensitivity.	Develop rules and modalities to make data on energy innovations publicly available. Adopt and develop standards and planning principles to enhance accountability.	Where possible (confidentiality clause) make data on energy innovations available to the public.	Consult publicly available data where appropriate.	Support platforms, processes, and policies to make energy innovation data publicly available. Support the development and adoption of standards to enhance accountability.

Note: Energy innovation pathways are not linear; different emphasis is needed on different aspects of innovation (e.g. supply, demand, knowledge) along the way. It is therefore difficult to set time-bound and quantitative milestones for actions to achieve results related to the recommendations mentioned above. As an example, the IEA publication, *Tracking clean energy innovation: A framework for using indicators to inform policy* (2020) proposes a series of metrics with possible ways to measure progress, but without setting any time-bound or quantitative target in that respect. The same rationale has been followed in developing the result and action matrix presented in the rest of this report.

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