UNEZA
UTILITIES FOR NET ZERO ALLIANCE

High level statement

Building a resilient and diverse clean energy technology supply chain

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Statement on building a resilient and diverse clean energy technology supply chain

We, leading global utilities and power companies, as members of the Utilities for Net Zero Alliance (UNEZA) are united in our mission to overcome barriers to achieving net zero ambitions by 2050, at the latest, and near-term emission reduction targets.

We affirm the vital role that utilities will play to advance this transition, recognizing that the utility sector looks dramatically different in 2050 relative to today. Global trends across the energy sector indicate that by 2050 electricity will meet over 50% of energy needs.[1]

The direction is clear. Following the Global Stocktake outcome and COP28 Global Renewables and Energy Efficiency Pledge,[2] we support this shared vision in collaboration with others to triple the world's installed renewable energy generation capacity to at least 11,000 GW by 2030.[3]

Achieving these ambitious targets presents unprecedented global challenges, but also unprecedented opportunities. According to the International Renewable Energy Agency (IRENA), investment for power grids and flexibility requires USD 720 billion per year and investment in renewable power generation capacity requires USD 1550 billion per year on a global basis to stay within 1.5°C Scenario by 2030.[5] We note that the bulk of investment required to drive the energy transition will need to be mobilized from the private sector, with support from national and international financial institutions.

Collectively, the members of UNEZA are investing to build out the modern power systems needed for a climate neutral future. UNEZA adopted the **Roadmap to 2030**, which targets a total increase of renewable energy capacity within their portfolios to 849GW by 2030[1], an increase of 2.6 times relative to 2023.

As a collective, medium term demand signal to encourage capacity expansion among OEMs as a collective grid infrastructure capex plan to 2030 that will serve as a basis to equipment manufacturers to scale up production in support of grid development, UNEZA members have committed investments of more than 116 bn USD per year, including **60 bn USD per year in renewables** and over **56 bn USD in grids** for the coming years.[2]

Such an enormous build-out will place extreme pressure on clean energy technology supply chains globally. Clean energy supply chains include the material sourcing, production, transport, and installation of the technologies that generate, transmit, transform, store, or use clean energy, such as wind turbines, solar panels, batteries, HVDC systems, and transformers.

Enabling the transition to clean energy hinges on these clean energy technology supply chains. As demand for these technologies increases significantly, the main challenges encountered when ensuring resilient supply chains are: 1) the availability of critical minerals and materials, 2) scaling up manufacturing capacity, and 3) development of a skilled workforce. With each challenge comes the opportunity for new investment, new value chains, and newly created skilled jobs.

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[1] UNEZA members may work jointly on projects between now and 2030 which may alter the total net impact of renewables additionally within the group

[2] Averaged annualized investments from members with investment commitments. Commitment timelines vary from 2025 – 2030. The demand signal targets are aggregated based on individual plans of the UNEZA members as per different baseline year and reporting formats. The targets will be periodically updated to represent the Alliance' ambition.

Action is needed from policymakers through policy, regulatory and business model innovation, to accelerate progress and mobilize greater investment. This is required at the international, regional, national, and local level.

UNEZA, under the guidance of IRENA and the UN Climate Change High-Level Champions, in partnership with the Green Grids Initiative and the Global Renewables Alliance, has developed recommendations for policymakers to support industry to scale up global supply chains to meet these challenges (see Annex).

As UNEZA, we call on governments to urgently implement the following recommendations.

ANNEX:

Supply Chains Recommendations for Policy Makers, by technology

This annex sets out recommendations for policymakers to address intersecting supply chain challenges, alongside recommendations on a sector-by-sector basis, covering:

- *Power Grids*
- *Wind Energy*
- *Solar Energy*
- *Hydropower*
- *Storage*

Recognising the Ten Principles of the UN Global Compact, collectively, and across each sector, we intend to advance respect for human rights consistent with the United Nations Universal Declaration of Human Rights, and intend to respect relevant fundamental rights, including on the prohibition of slavery, child labour and forced labour.

Supply Chain Recommendations for Policy Makers: Power Grids

1. **Leverage global supply chains and free trade to the extent possible:** Political decisions play an important role in the transformation of clean energy supply chains. The current shift by governments towards increasing the resilience of domestic supply chains in the form of on-shoring or friend-shoring combined with trade and tariff barriers is notable. As are the financial incentives available, through the resurgence of industrial policies and strategies, for businesses to expand existing or create new domestic manufacturing capacity. Nonetheless, even as local footprints are being strengthened; it is essential that policy makers ensure that manufacturers can continue to leverage their global supply chains. A functioning global supply chain based on free trade to the extent possible, enabling manufacturers of critical grid technologies from transformers to HVDC converter stations, to leverage their resources across the world, will be needed to ensure a speedy build-out of a renewable energy future.

2. **Forward looking, integrated power system development planning combined with multi-project approvals and permitting is needed:** Coordinated, forward looking and holistic power system planning is required to deliver on the renewables deployment, as well as the grid development, refurbishment and modernization needed to meet global climate and energy goals. While some regions already have integrated grid planning, this is usually carried out at country level first and then combined to develop a regional plan looking out 10 years.[9] Longer-term strategic power system plans (such as, up to 20 or 25 years) are required, which are developed on a regional basis and consider cross-sectoral demand growth as well as cross-border needs. Policy makers must play a key role in enabling such coordinated and forward-looking planning approaches. This long-term view will provide visibility and certainty on the grid investment and associated supply chain capacity requirements, while also facilitating anticipatory investments. Anticipatory investments will reduce costs and infrastructure build-out in the longer term, offering savings to governments whilst reducing ineffective supply chain pressure. In addition, based on long-term holistic plans, policy makers and regulators can then enable a shift away from single project approvals and permitting approaches. Multi-project approvals and permitting will help ensure the speed and scale necessary across the development pipeline.

3. **Enhance resilience of land, sea and air infrastructure:** Major disruptions to land, sea or air infrastructure due to factors such as changing climate conditions or geopolitics will create a ripple effect across global supply chains, introducing cost increases and delivery delays. In G20 countries alone, land transport infrastructure currently moves over 66 billion ton-km per day.[10] As supply chain capacity ramps up, and the physical size of equipment increases e.g. transformers, associated transport infrastructure must develop at the same speed and scale. Policy makers must ensure that transport infrastructure such as railways, roads and ports are planned, built and operated to ensure that critical and heavy grid technologies can be transported seamlessly, without creating unnecessary barriers.

4. **Standards and common technical specifications can facilitate improved supply chain resilience; however, implementation is crucial**. The use of standards and common technical specifications can be essential to enhancing supply chain resilience. They help ensure the safety, security, and interoperability of electrical installations, and encourage investments in electricity infrastructure, while speeding up project delivery. Today, manufacturers face almost as many special design requests as there are projects. The use of international standards and common technical specifications, combined with a streamlining and simplification of tendering processes, could help drive the modularization and reduction of design variations that are necessary to achieve economies of scale and reduce the strain on component supply chains and on manufacturers' engineering capacities. However, the benefits of standards can only be leveraged if they are implemented, and their proper use

is verified through testing and certification. Many standards are readily available, and policy makers and regulators can play an essential role in incentivizing the use of these standards in the procurement process.

5. **Policy makers and regulators must maintain a healthy skills supply chain**: More than 66 million people were working in the energy sector in 2021, accounting for almost 2% of formal employment globally.[11] Clean energy jobs now account for more than half of employment in the sector. However, in parallel, the sector is experiencing a growing skills gap as we try to navigate massive grid and generation capacity additions while also managing more complexity. Policy makers must focus on four specific areas to ensure there are skilled people to power the energy transition: university education; vocational education and training; cross industry transitions including reskilling and upskilling initiatives, and migration[12]. Policy makers must anticipate clean energy workforce needs, make the sector more visible and attractive to young people, and collaborate with relevant stakeholders to calibrate high-level education and vocational education and training to meet those needs. Reskilling and upskilling initiatives should be supported through energy transition skills academies and collaborations. Depending on the region, migrant workers could be an important contributor to a larger skills pool. Policy makers must also ensure that infrastructure from housing to schools and retail facilities are available when businesses plan significant job creation in a particular area.
6. **Policy, regulatory and business model innovation is essential:** The concept of innovation is not only applicable to technologies. Leveraging new and innovative business models, as well as policy, regulatory and financing approaches, e.g. *programmatic procurement* or *capacity reservation contracts* as recently awarded by companies such as Tennet (EU), SSE (UK)[13] and Grid United (US), can help address some short/medium term supply chain challenges. Such agreements ensure project developers secure their supply of technologies, while technology providers, and their own suppliers, have a much-needed long-term planning horizon, improving their ability to control and harden their supply chains through factory capacity investments or other measures. By applying a common approach to such framework agreements and associated technology specifications, where it makes sense, the strain associated with multiple design variations across projects is minimized, as well as the squeeze on technology providers' engineering capacities. In addition, projects can benefit from increased speed of delivery and improved scalability. Policy makers and regulators play an essential role in creating an enabling environment (from policies to regulatory frameworks and new financing approaches) for such innovative approaches to thrive. Innovation could also be in the form of capacity reservation contracts or other efforts to derisk the supply chain e.g. use of recycled materials or strengthening local value chains. Market stakeholders (including regulated utilities) must have the space to explore and implement these innovations and should also be recognized for these efforts in terms of tariff support or other appropriate means.

Supply Chain Recommendations for Policy Makers: Wind Energy

1. **Address barriers to wind industry growth in land, grids and permitting to increase volume and predictability.** Complex and time-consuming permitting procedures, grid bottlenecks and impractical pricing signal at auctions must be addressed to shore up the wind energy supply chain and create an enabling environment for future production capacity investment. Policy makers are asked to collaborate closely with the wind energy industry and civil society to find short, medium and long term solutions to these challenges.

2. **The wind industry must standardise and industrialise.** The wind sector must industrialise and scale, with designs becoming global and modular[15]. To achieve this, the rapid development of new turbine models will need to slow down towards 2030 to the extent needed to ensure that OEMs can capitalise on their R&D investments and the supply chain can use equipment for more than a few years, while also achieving economies of scale and maintaining a competitive LCOE. Policy makers can help promote more standardization to help reduce complexity, while ensuring a sustained focus on innovation in parallel.

3. **Build a green and sustainable wind energy supply chain to embrace the circular economy.** The wind industry must ensure the effective use of resources and materials, reduce environmental impact during the manufacturing and turbines' operational life span, and eventually achieve carbon neutrality throughout the entire wind energy value chain. Developing and using recyclable materials and components for the wind turbine is one of the most important steps to achieve the supply chain security and social responsibility.

4. **Regionalisation will be needed to support growth and resilience, while maintaining a globalised wind supply chain.** With a growing push from countries and regions towards the diversification of supply chains, combined with reshoring and regionalisation, the wind industry will profit from building out regional supply hubs where possible to provide alternative sources for the materials and components needed to deploy additional wind capacity. This activity should focus on the strategic areas where global resilience is currently low and concentration risk is high e.g. gearboxes, generators, power converters, castings and rare earth materials.

   Policy makers must ensure that measured reshoring activity is accompanied by models to keep trade flowing within and between regions, supporting individual nations in enhancing their capacity to deliver at scale, ensuring flexible access to needed materials, components and services, and providing stronger wind demand drivers across borders. This will be particularly important for the future growth of the offshore wind sector, where manufacturing, installation and operations and maintenance (O&M) services all benefit greatly from regional collaboration and cross-border learning.

   Policy makers should adopt a balanced approach between fostering regional supply chain security and accounting for the global interlinkages of the wind energy supply chain. Regions will need to pursue supply diversification strategies, reshore/onshore some segments and grow their own capacities. But this should not manifest in measures that outright block current trade flows and interrupt or delay deployment. The time needed to reshore, or nearshore manufacturing must not be underestimated.

5. **The market must provide clear and bankable demand signals.** Markets must develop credible build-out trajectories in the shape of concrete and transparent targets, as they will be key to supply chain investment. These must be stable, bankable and much stronger than they are today. By stating clear targets and auction schedules or yearly capacity additions over a long horizon stretching beyond

2030, policymakers will be able to grow wind power demand as needed through communicated targets for electrification, decarbonisation, sector coupling and storage, involving the broader industry in building renewables ecosystems.

In addition, policy makers should look towards establishing public funding schemes that aim to scale the wind industry. While there are ample opportunities to acquire public funding for R&D or innovation activities, there is a notable lack of funding schemes dedicated to scaling up manufacturing and infrastructure.

6. **Trade policy should aim to build competitive industries, not push higher costs onto end-users.** Collaboration and trade must be protected to foster healthy future wind pipelines. Supply chain capacity utilization remains key to cost reduction and is only possible if resources can be shared across regions, with competitive cost positions and limited trade barriers. Markets will benefit from public investment into workforce skills and infrastructure, while prescriptive regulation against cross-border trade could reduce industry growth and increase costs. This will ultimately be paid for by households, commercial and industrial consumers, cities, and other consumers of electricity.

   Rather than increasing trade barriers, policy makers should focus on incentivizing strategic segments of the domestic industry, creating a more attractive market environment by ensuring adequate pricing and returns, making competitive finance available and removing bureaucratic barriers.

7. **Evolution of the power market underpins further wind growth.** In order to provide the certainty needed to attract investment, an evolution of the power market is needed to better address the requirements of renewable generation. Long2-term operating margins must be ensured through awards based on solutions with higher system value – such as a better production profile – rather than strong competition for the lowest price per MWh. The broader societal benefits of wind energy could also be considered to further stimulate innovation and domestic value creation.

   Creating secure and sustainable supply chains for wind power will allow the industry to continue to expand and create multiplier effects in sustainable employment opportunities, industrial growth and economic productivity around the world. This would not only bring closer the global climate change mitigation goal of tripling renewables but also ensure the provision of significant socioeconomic value along the way.

Supply Chain Recommendations for Policy Makers: Solar Energy

1. **Resilient, diversified and low-cost global solar value chains should be developed as a priority to safeguard against market and price shocks**. Currently, the concentration of the global solar supply chain in certain regions presents a lack of resilience in the supply chain to exogenous shocks. There is oversupply in some parts of the value chain, such as modules, while shortages persist in others. For example, in certain regions, there are few module cell producers meeting only a fraction of local demand, despite having producers of high-grade polysilicon. While we build out local manufacturing, policy makers must ensure that the solar industry can continue to leverage the global supply chains which have been developed.
2. **Any solar industrial strategies and value chain localisation policies should be supported by a robust evidence base and incentivise free, fair and open exchange in solar**. Policy makers can support value chain localisation through the use of various types of incentives. For example, subsidies to support operating costs, tax deductions, and export credits for solar PV equipment are all examples of incentives. All of the measures mentioned above have been implemented notably in China, USA, and India.
3. **Value chain localisation efforts must be tied to the need for globally integrated and diverse supply chains.** Whilst local value chains should primarily look to serve local and regional markets, their position in a globally resilient and diverse supply chain must also be leveraged. As such, policy makers should aim to avoid barriers to trade, to the extent possible, as they will have a detrimental effect on the global supply of components needed to build out solar at the rate required to achieve the tripling of renewable energy installed capacity by 2030. In parallel, international cooperation on manufacturing projects and technology exchange should be incentivised by policy makers.
4. **Sustainability is a vital aspect of solar supply chains and strong Environmental, Social and Governance (ESG) principles and criteria should be applied to ensure transparency**. Being able to track the impacts of supply chains will be vital to building trust in the solar industry and ensuring that solar fulfils its global potential. To help this, policy makers should encourage and promote the use of tools such as the Solar Stewardship Initiative to ensure that high traceability and ESG standards are observed. In this regard, establishing minimum requirements for cross-border sales is crucial. Moreover, private sector engagement in these initiatives is vital to ensuring that exemplary standards on human rights and low-carbon solar supply chains are recognised and rewarded by investors.
5. **Rationalisation of solar value chains across different regions will ensure that all countries participate in the green economy transition**. Policy makers must ensure that industrial strategies on solar value chains should not lead to isolationism at the expense of creating globally diverse and resilient supply chains. Concretely, sections of the value chain should only be localised where it makes sense to do so. Such actions should be based on data and analytics (such as through mapping of relative capabilities). For example, it would make sense to investigate localising polysilicon production in areas that have ready access to silicon metal and quartz mining and low-cost electricity. Moreover, it does not make sense for every country to produce inverters for local consumption and export as this will lead to significant oversupply, high costs and inefficiencies. Avoiding overcapacity in a single area when investigating the potential for value chain localisation will ensure that the economic and social opportunities offered by this can be more evenly distributed.

6. **Technology transfer can support the development of diversified solar supply chains particularly in emerging markets and developing economies**. Technology transfer can help the global south to leap-frog technologies moving themselves forward rapidly through the adoption of modern systems without going through intermediary steps and thereby accelerating sustainable development. Research & Development (R&D) and Research & Innovation (R&I) activities play an indispensable role in boosting the roll out of increasingly efficient solar PV technologies. Efforts should be made by policy makers to foster global research initiatives, to ensure that groundbreaking research and innovations experience swift market uptake across all markets.
7. **Solar PV systems are more than just solar PV panels and significant opportunities also lie in balance of plant/balance of system value chains**. Whether it be cables, mounting structures, trackers, combiner boxes, or inverters, there are several significant value chains apart from PV panels that make up a solar system. These other value chains could offer policy makers low-hanging fruit to quickly scale up diversification of supply chains as in some cases they can be linked to pre-existing industries. Moreover, these components are no less vital than ingots, cells, and wafers to a PV system and offer opportunities to those countries who have lower chances of localising the silicon value chain.

Supply Chain Recommendations for Policy Makers: Hydropower

1. **Scaling up a mature supply chain:** As a technology with a long history, hydropower has a mature supply chain which has been used to a relatively steady stream of work. IRENA's 1.5°C Scenario suggests that if the world is to completely decarbonize and meet the climate goals set in the Paris Agreement, hydropower installed capacity, including pumped storage hydropower, should more than double by 2050.[16] While the growth rate is not what other renewable technologies are facing, it will nonetheless require significant investment in capacity and the training of a new generation of employees. This will, however, build on the solid foundation of a century of development. One of the main challenges is to manage increasing lea d times in a sector that already has extended build times and build schedules that can change in the face of issues discovered during the construction process. Policy makers should plan on a long-term basis, giving developers of hydro technologies strong indications of when new capacity will be needed so that development and build schedules can accommodate these realities.

2. **Policy makers should provide targeted market support to encourage the growth of capacity and capability in the supply chain**. This may result in new entrants or the consolidation of existing smaller suppliers, but the overall aim should be to promote rational investment in production. Some issues relate to existing production capacity being concentrated in some countries, when the demand will need to be more widespread. Any trade barriers that prevent that capacity being used should be addresses, and cross-border investment from players with the necessary capability should be encouraged. Given the need to grow the sector, some form of market support may be needed by policy makers to promote the growth of the new capacity required in order to meet potential supply bottlenecks.

3. **Decarbonising hydropower build**: Hydropower is already a low-carbon source of power, mainly due to the ability to amortise the carbon invested in building it over a very long lifetime. It is, however, especially reliant on concrete and steel, which are carbon intensive. To avoid emissions in the shorter term as part of the shift towards net zero, these materials will need to be decarbonized. However, they are currently produced by 'hard to abate' industrial processes. Investment in innovative new means to produce these materials with a strong focus on making hydropower even lower carbon will drive the energy system's emissions even closer to zero. Support for innovation should be increased by policy makers, and additional uplifts in deployment incentives should be considered for projects with lower embodied carbon emissions. In the longer term, mandates on the use of such materials or limits on embodied emissions for projects to qualify for incentives could be considered to drive the market further.

4. **Critical mineral supply**: Hydropower is less dependent on scarcer materials like lithium or rare earth metals, but nonetheless adds to the demand for copper, aluminium and high-quality steel. The fact that hydro sites are often remote from demand also entails long transmission line infrastructure. Policy makers will need to include these considerations in their long-term planning, and work with the industry to secure strategic supplies of the necessary materials alongside the overall supply chain capacity referred to above.

5. **Workforce recruitment:** Like the technology, the hydropower workforce is also mature, with an age profile that skews towards the older end of the working population. The industry will have to work hard on its attractiveness to a new generation of employees, while ensuring that the knowledge of those approaching retirement is retained and passed on. There are universities and colleges which specialize

in hydro technology, but these will have to expand their intake significantly. Where policy makers wish to exploit hydro resources on their path to net zero, close collaboration with relevant institutions will be paramount to ensure a suitable pool of skilled workers with the appropriate knowledge.

Supply Chain Recommendations for Policy Makers: Storage

As the world moves towards power systems, and increasingly whole energy systems, that are dominated by variable sources of renewable energy like solar PV and wind, the need for flexible technologies will become increasingly important. Storage is therefore essential for managing high penetrations of renewables. Short-duration energy storage supports our power system by balancing supply and demand and mitigating blackout risks, while long-duration energy storage (LDES) can discharge energy continuously as electricity or heat for 8 hours or more.

As wind, solar, and other renewables become the most cost-effective forms of generation, the demand for LDES systems increases to address supply and demand imbalances. Analysis by the Long Duration Energy Storage Council indicates that up to 8 TW of LDES may be necessary by 2040 in the most cost-effective pathway to achieving net zero emissions, potentially saving up to USD 540 billion annually in system costs.

Equally, in a world of increased renewable generation, energy storage technologies can play an important role in maximizing the amount of variable renewable energy which can be harnessed and put to productive use, thereby minimizing both wasted energy and balancing costs.

Storage technologies come in four main 'families': electrochemical, mechanical, thermal, and chemical.

- **Electrochemical storage** includes a very wide range of batteries. Battery energy storage systems (BESS) are currently the most prevalent and rapidly expanding energy storage solution globally, taking advantage of the fact that battery storage can be built in a matter of months and in most locations. BESS capacity has more than doubled year-on-year, adding a total of 42 GW battery storage capacity in 2023. However, total global installed battery storage capacity will need to increase fourteenfold by 2030 from 86 GW in 2023 to 1 200 GW in a net zero scenario.[17] Beyond lithium-ion, technologies such as flow batteries often require very common minerals (e.g. zinc, iron) with limited supply chain concerns. Components (pumps, tanks, acids) are common and easily attainable. While the supply chains for some emerging technologies are still being developed and as such are not fully defined, they are similar to flow batteries in that most are based on abundant materials and simpler components. Although recycling facilities for iron, vanadium or zinc-based batteries are yet to be deployed, it is expected that metals could be recovered from the batteries via either pyrometallurgical or hydrometallurgical systems.
- **Mechanical energy storage** works in systems that use heat, water or air with compressors, turbines, and other machinery. Currently, the most widely deployed large-scale mechanical energy storage technology is pumped storage hydropower (PSH). Other well-known mechanical energy storage technologies include flywheels, gravity-based, compressed air energy storage (CAES), and liquid air energy storage (LAES). They do not typically have supply chain constraints, with easily accessible 'fuel' (water, air) and commonly available components.
- **Thermal energy storage (TES)** converts electric energy from the grid into thermal energy that is stored in inexpensive materials to be used later in the form of heat, cold or reconversion back into electricity. The materials used are typically very common and easily available (including cement, sand and rocks).
- **Chemical energy storage** sees energy stored in the form of chemical bonds. Hydrogen supply chains are being developed globally and the basic raw material for 'green' hydrogen, produced from electrolysis, is water.

The following are recommendations for policy makers to address storage supply chain challenges:

1. **Regulators and planners should work with Industry to maximize alignment between the development of renewable capacity and energy storage (including timing and location)**. Collaboration alongside a mandate to deliver clean energy can help to reduce market inefficiencies and supply chain distortions. Additionally, enhancing profitability requires developing the market for time-shifting products and implementing forward contracts for dispatch services.
2. **Cross-sectoral and power systems-harmonized investment needed:** Crucially, urgent investment in storage can help to provide power system flexibility and resilience as the pace of deployment of renewables increases and the importance of flexible energy grows. Policy makers should set ambitious targets for the deployment of storage technologies with the introduction of mechanisms to provide long term revenue visibility and removal of barriers that artificially constrain deployment. Sending these signals to the market will encourage investment in existing and developing supply chains. For example, with green hydrogen storage, policymakers should ensure that this is brought forward as part of an integrated hydrogen system strategy to ensure that the needs of producers and users of hydrogen can be met.
3. **Diversification of storage technologies:** the diversity of the four main storage technology 'families', (thermal, electrochemical, mechanical and chemical) provides a means to mitigate supply chain risk. Many storage technologies use very commonly available raw materials and components, including minerals such as iron and zinc, mediums such as cement and sand, and components such as pumps and tanks, making it easier to address geopolitical constraints or upstream environmental or wider ESG challenges. By enabling the deployment of a breadth of technologies, policy makers can take advantage of this diversity to reduce the risk of constraints affecting any one type.
4. **Skills development:** Unlock investment in developing skills and capacity by sending clear demand signals: in order to fully reap the benefits of diverse storage technologies supply chains need to be developed at scale with investment in both people and technology.
5. **Provide long term revenue visibility:** The investment case for storage is often linked to price arbitrage. The presence of storage on the system should smooth out prices by responding to periods of high supply and demand. This can create a barrier to investment in a long-term storage asset, where the spread between supply and demand decreases, and subsequently impacts the growth of the storage sector. Policy makers must play an essential role in providing revenue visibility and certainty, that will support the creation of sustainable supply chains.
6. **Strengthening recycling:** While storage technologies are not typically at risk of supply chain constraints due to widespread availability of raw materials and components, and long-life spans, policy makers can further strengthen resilience by incentivizing the build-out and scaling of recycling facilities. Early lessons can be learned through the conversion of existing chemical storage to low-carbon chemical storage, building supply chain experience and knowledge, e.g. natural gas geological storage to hydrogen geological storage.

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