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MAKING A NEW GENERATION OF ENERGY SYSTEMS HAPPEN

COLLECTIVE ACTION FOR AN EFFICIENT AND EQUITABLE SYSTEM

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An energy system that meets both climate and social targets requires structural changes. There is unprecedented momentum behind a shift in how we make, model, and manage energy, enabled by digitalisation and distributed energy solutions. Now is the right time to facilitate a new generation of energy systems, integrating both centralised and decentralised energy solutions. For that, we need to remove barriers in national and global financial, legislative, and political systems.

Proponents of the new energy systems can break down silos and create an ecosystem to advocate for:

1. **A global one-stop-shop (OSS) for those wanting to invest in new generation energy systems, including a facility for country-level pathway analysis.** This facility can build on existing international initiatives, collaborate with national OSS services, and provide a suite of knowledge and technical assistance.
2. **Champion governments in delivery of decentralised, new generation energy systems to convene regional delivery summits.** This could start on the sidelines of the Africa Climate Summit and SDG Summit in September 2023, or the Climate and Energy Summit in October 2023.
3. **Global delivery targets and tracking measures for the new generation of energy system** based on models and analysis that account for distributed energy integration and leveraging existing platforms for accountability.
4. **A global commission to review the best financing options for new generation, consumer-led systems**, including options to scale funding.

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A fundamental shift is happening in energy systems

The energy transition brings structural changes beyond switching from fossil fuels to renewables. The way energy is made, modelled, and managed, is shifting from systems shaped by centralised, large-scale power plants, to systems with a wider range of actors that can accommodate, work with, and benefit from, efficient, decentralised solutions (Figure 1).

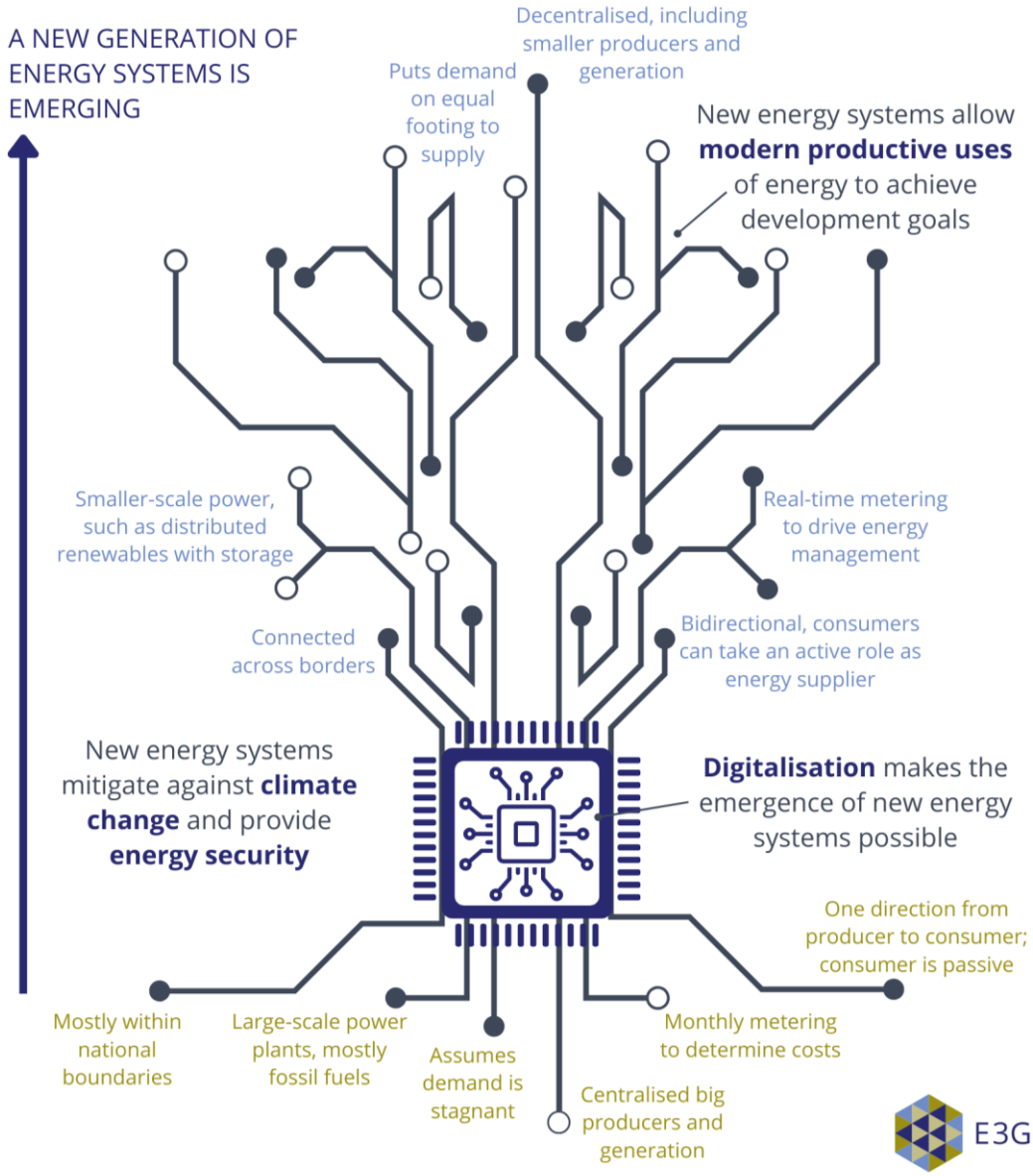

Figure 1: The structural changes emerging in the energy system[1]

[1] Adapted and modified from Carbon Neutral Cities Alliance, 2016, **Energy System Transformation Playbook**; Aryblia et al., 2018, **Energy Atlas 2018**; Sokona et al., 2023, **Just Transition: A Climate, Energy and Development Vision for Africa**; Integrate to Zero, 2022, **A blueprint for integrating clean energy**

New generation energy systems have the potential to integrate decentralised solutions with large centralised clean power systems. Distributed applications have remained highly competitive during the energy crisis, more so than utility-scale projects, which helped to carry the growth of renewables as a sector.[2] Advancements in digitalisation enable the development of integrated systems that provide the necessary flexibility and better coordinate supply and demand for grids dominated by renewables.

Engaging with these structural changes head-on can drive twenty-first century infrastructure and energy planning, and address the injustices of our current energy system. These developments over the next decade will be crucial to mitigate against increasingly intense and frequent climate impacts on energy infrastructure, and pressures on energy security. The resulting systems will allow modern productive uses of energy, for which there is a growing need to achieve development goals. This model offers more ownership for underserved communities and transforms energy systems for, and with, people at the centre of it.[3]

The benefits of a new generation of energy systems

Integrating centralised and decentralised energy solutions can accelerate the just energy transition, and foster an energy system that is:

> **Affordable**: More efficient systems reduce customers' bills,[4] and generate payback by placing them in a more active role (prosumer). In Great Britain, the widespread use of integrated energy solutions could reduce costs by 25% compared to a non-integrated approach.[5]

> **Efficient**: Electrification of end uses brings higher efficiency. When coupled with demand responsiveness systems, it also reduces energy use directly from the customer's side.

> **Equitable**: Distributed systems can help achieve sustainable development goals by quickly expanding quality access to rural and peri-urban communities and giving local developers and communities more access to

[2] IEA, 2023, **Renewable Energy Market Update – June 2023**

[3] Consumers International, 2023, **White Paper – Consumer Protection and Empowerment for a Clean Energy Future**, **CLEAN: Consumer Led Energy Action Network**

[4] Wilson et al., 2020, **Granular technologies to accelerate decarbonization**

[5] Cornwall Insight, 2023, **Integrate to Zero: Carbon and cost reduction opportunities from integrated energy in GB**

technologies. They generate more jobs; empower customer engagement, ownership and control in decision-making; support resilient agri-food systems; and deliver better access to healthcare, clean water, and education. People-centred and distributed energy systems can break economic dependencies and debt spirals, while fostering participation and democratising energy decisions, supporting local economic development.[6]

> **Net zero aligned:** Distributed renewables such as solar, wind, and air-source heat pumps at scale contribute to achieving net zero targets faster by diffusing into the market quicker than large-scale technologies.[7] Demand-side measures can lower emissions in the electricity sector by 70% by 2050.[8]

> **Resilient**: Integrated, distributed energy systems help increase grid flexibility and resilience. Distributed energy systems can also reduce reliance on fuel imports.

The components of a new generation of energy systems: combining large-scale and distributed solutions

The new generation of energy systems integrates distributed and flexible components with the large-scale generation and strengthened grids of the existing system (Figure 2). While these are not the only components necessary to deliver climate and development goals,[9] they are critical to achieving emission reductions in the power sector and expanding access to energy for modern productive uses.

This section provides details on each component of the new energy systems, along with examples of how these components are already reshaping energy systems and providing multiple benefits to people.

[6] AMDA, 2022, **Benchmarking Africa's Minigrids Report**; Efficiency for Access, **Agriculture and Energy Efficiency**; Ingram et al., 2022; **Improving Rural Livelihoods, Energy Access, and Resilience Where It's Needed Most: The Case for Solar Mini-Grid Irrigation in Ethiopia**; Power for All, 2022, **Powering Jobs Census 2022**; Wilson et al., 2020, **Granular technologies to accelerate decarbonization;** The Rockefeller Foundation, 2021, **Transforming a Billion Lives: The Job Creation Potential from a Green Power Transition in the Energy Poor World;** Sokona et al., 2023, **Just Transition: A Climate, Energy and Development Vision for Africa**

[7] Wilson et al., 2020, **Granular technologies to accelerate decarbonization**

[8] IPCC, 2022, **Climate Change 2022: Mitigation of Climate Change - Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change**

[9] For example, clean cooking solutions including biogas or liquefied petroleum gas (LPG) are still important in meeting Sustainable Development Goal 7.

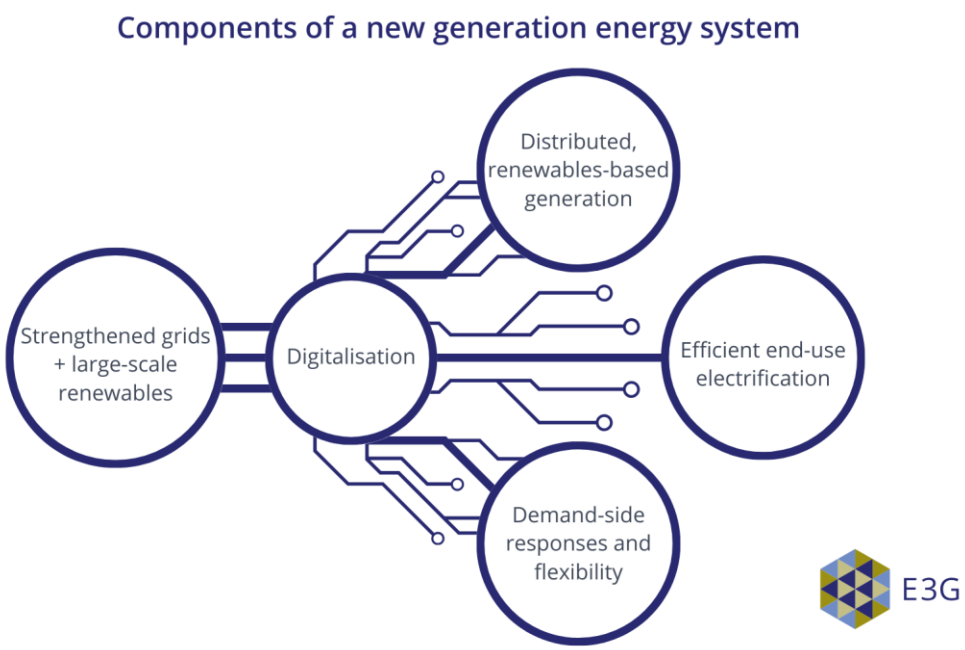

Figure 2: Local, efficient, integrated energy systems will be grounded in distributed, responsive solutions that are closer to people's lives.

Distributed, renewables-based generation

The new generation of energy systems shifts from dependence on centralised, large-scale power production and distribution, to include more distributed power producers.

> **Distributed solar power charges ahead**. Distributed solar applications are on track to account for half of global deployment of solar PV in 2023.[10] Distributed or off-grid solutions such as mini-grids and solar home systems have already improved energy access for over 100 million people. They have provided an estimated $12.9 billion in savings on energy expenditure, and generated $7 billion in additional income to customers since 2010.[11] Solar mini-grids can provide electricity to nearly half a billion people and be the least-cost solution to close the energy access gap by 2030.[12] Despite this, current energy system models have not fully considered the role of distributed solar in meeting climate goals.[13]

[10] IEA, 2023, **Renewable Energy Market Update – June 2023**

[11] GOGLA, 2021, **Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data**

[12] ESMAP, 2022, **Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers**

[13] Creutzig, F. et al., 2017, **The underestimated potential of solar energy to mitigate climate change.**; Joshi et al., 2021, **High resolution global spatiotemporal assessment of rooftop solar photovoltaics potential for renewable electricity generation**

> **Employing and empowering the next generation of workers.** Scaling access to distributed renewables could create over 25 million new jobs in Asia and Africa – 30 times more than through comparable investments in large-scale fossil fuels.[14]

Efficient, end-use electrification

A decentralised, decarbonised power system will require rapid growth in end-use electrification. This creates more efficient systems, expands access and extends services to previously underserved communities, and allows energy users to control and engage their systems more. This can also provide more productive uses of energy, which empowers people.

> **Adapting to increased demand and changing profiles.** Globally, we are expected to see 350 million electric vehicles by 2030.[15] With a warming world, energy demand for space cooling will more than triple by 2050 – consuming as much electricity as all of China and India.[16] Without action to address energy efficiency, this explosion in demand will likely burden unprepared infrastructure. Investing in more efficient cooling appliances alone could cut this demand in half.[17]

> **Improving quality of life, powering healthcare and the agri-food sector.** In a survey of more than 1,600 off-grid customers in Bangladesh, 81% said their family's quality of life had improved because of their fan.[18] Meanwhile, establishing proper cold chains could raise food supply by 15% in developing countries.[19] In the health sector, about 64% of the healthcare facilities in 63 low- and middle-income countries still require a new connection or a backup power system. Decentralised renewables are expected to address this and therefore improve healthcare services for almost 1 billion people.[20]

Demand-side response and flexibility

A decentralised and largely electrified system both requires and allows demand response. Flexibility can address the intermittency of renewables and meet fluctuating demand, such as high cooling demand during extreme heat events.

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[14] The Rockefeller Foundation, 2021, **Transforming a Billion Lives: The Job Creation Potential from a Green Power Transition in the Energy Poor World**

[15] IEA, 2022, **Technology and Innovation Pathways for Zero-carbon-ready Buildings by 2030**

[16] IEA, 2018, **The Future of Cooling**

[17] Ibid

[18] Efficiency for Access, **Advancing Access to Cooling in a Warming World**

[19] Efficiency for Access, **Advancing Access to Cooling in a Warming World**

[20] IRENA & WHO, 2023, **Energizing health: accelerating electricity access in health-care facilities**

> **Battery costs fall and deployment surges.** In 2022, expenditure on battery storage exceeded $20 billion. However, this growth is concentrated, with the United States, China, and Europe accounting for 90% of spending.[21]

> **Flexibility builds energy and economic resilience.** Power outages due to unreliable grids are projected to cause a loss to gross domestic products (GDP) in emerging markets and developing economies (EMDE) of $1.3 trillion by 2030.[22]

Strengthened grids

In the new generation of energy systems, strengthening grid infrastructure will support the deployment of large-scale renewables, demand-side measures, and flexibility services. Inadequate investment in grid infrastructure remains a barrier worldwide not only to faster growth in new renewables capacity, but also to maximising generation potential from existing power plants. It is estimated that 80 million kilometres of new grid are needed by 2050 to reach net zero emissions – enough to replace the entire global grid today.[23] Specifically, developing countries would need to increase their current spending on renewable grids up to five times, reaching at least $300 billion by 2030, to get to net zero emission pathways.[24]

> **Wait times and lagging investment slow transition.** Inadequate grid infrastructure has increased waiting times for renewable projects by up to ten years. In the UK, Spain, and Italy more than 150 GW of wind and solar projects are stuck in the grid connection queue.[25] Grid investment in EMDEs (excluding China) has been low in recent years: the 2019–2022 average annual spend was around a third lower than in 2015–2018.[26] The rapid expansion of wind and solar PV needs to be accompanied by policies and market rules supporting grid infrastructure and flexibility investment.

> **Curtailment signals that upgrades are needed**: An increasing amount of electricity generation from wind and solar PV is being curtailed in many markets, particularly where grid infrastructure and system planning lag behind.[27]

[21] IEA, 2023, **World Energy Investment 2023**

[22] IEA, 2023, **Unlocking Smart Grid Opportunities in Emerging Markets and Developing Economies**

[23] BNEF, 2023, **A Power Grid Long Enough to Reach the Sun Is Key to the Climate Fight**

[24] IEA, 2022, **World Energy Outlook 2022**

[25] BNEF, 2023, **A Power Grid Long Enough to Reach the Sun Is Key to the Climate Fight**

[26] IEA, 2023, **World Energy Investment 2023**

[27] IEA, 2023, **Renewable Energy Market Update – June 2023**; Snell, 2022, **Vietnam struggles to quit coal as renewable energy faces hurdles**

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Digitalisation

Digitalisation allows energy systems to interact seamlessly with heterogenous systems and technologies – including solar rooftops, electric vehicles, storage, and grids. Machine learning, smart meters and other digitalisation tools can support the integration of higher shares of renewables and better match supply and demand**.** Digital technologies can extend the lifetime of grid assets and save an estimated $1.8 trillion of grid investment globally through 2050.[28]

> **Business opportunities are growing.** Grid-related investment in digital technologies has grown by over 50% since 2015. However, the pool is still largely untapped, representing under 20% of total grid investment. Smart chargers accounted for only 1.5% of all charging facilities in 2021. Digitalisation also opens opportunities for new business models, including energy as a service (EaaS) and virtual power plant services for distributed energy resources. This provides new revenue streams for companies while enhancing system-wide efficiency and demand-side flexibility.[29]

> **Countries are in a race to the top.** The energy sector is not yet fully utilising the opportunities digitalisation offers. Utilities are leveraging only 2–4% of the data collected from consumers.[30] However, the tide is turning. India has launched a scheme to improve the quality and reliability of power supply through the deployment of digital technologies, including more capacity building.[31] In the EU, building automated control systems will be compulsory from 2025 for non-residential buildings using cooling or heating equipment consuming over 290 kW at peak times.[32] The European Commission has released its Digitalisation of Energy action plan.[33] Brazil,[34] Australia,[35] and Spain,[36] among others, have launched regulatory sandboxes.

[28] IEA, 2023, **Unlocking Smart Grid Opportunities in Emerging Markets and Developing Economies**

[29] IEA, 2022, **Digitalisation**

[30] Ibid

[31] Government of India's Ministry of Power, 2021, **Revamped Distribution Sector Scheme: A Reforms-Based and Results-Linked Scheme**

[32] European Building Automation Controls Association, 2019, **Guidelines for the transposition of the new Energy Performance Buildings Directive (EU) 2018/844 in Member State**

[33] European Commission, 2022, **Commission sets out actions to digitalise the energy sector to improve efficiency and renewables integration**

[34] Brazil Electricity Regulatory Agency (ANEEL), 2021, **Public Consultation n.º 49/2021**

[35] Australian Energy Regulator, 2022, **Regulatory Sandboxing – Energy Innovation Toolkit**

[36] Government of Spain's Ministry for the Ecological Transition and the Demographic Challenge, 2022, **The Government approves the Royal Decree on regulatory innovation in the electricity sector**

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Bringing champions together: aligning to tackle common barriers

Individually, the components of the new generation energy systems have received significant attention and action from dedicated organisations and coalitions. A non-exhaustive mapping of organisations and initiatives (Table 1) reinforces the case that these are critical priorities to achieve climate and development goals.

Table 1: Solutions relating to components of the new generation of energy systems (non-exhaustive list of organisations and initiatives)

Components of the new generation of energy systems	Examples of energy system solutions	Organisations, coalitions, and initiatives driving action
Distributed renewables generation	Microgrids, minigrids, solar home solutions (SHS), solar photovoltaics rooftop, small independent power producers (IPPs), air source heat pump (ASHP)	**GOGLA (Global Off-Grid Lighting Association)**, **AMDA (African Minigrid Developers Association)**, **Renewable Energy Performance Platform (REPP)**, **Sustainable Energy for All (SEforALL)**, **CrossBoundary Energy**, **Alliance for Rural Electrification (ARE)**, **Power for All**, **Consumer International CLEAN Initiative**, **Energy Unlocked**, **IRENA**
Demand-side responses and flexibility	Smart meters, battery storage, smart electric vehicle charging	**ISGAN (International Smart Grid Action Network)**, **3DEN (Digital Demand-Driven Electricity Network)**, **Open Energi**, **Grid Beyond**, **Flexitricity**, **RMI VPP Programme**
Efficient end-use electrification	Air conditioners, residential heat pumps, cooking, lighting, refrigerators, solar water pumps, electric motors	**CLASP**, **European Heat Pump Association (EHPA)**, **Mission Efficiency**, **Cool Coalition**, **Clean Heat Forum**, **Clean Cooking Alliance**, **Clean Cooling Collaborative**, **Green Scene Energy**, **Distributed Renewable Energy-Agriculture Modalities (DREAM)**, **African Centre of Excellence for Sustainable Cooling and Cold Chain (ACES)**, **Global Alliance for Building and Construction**, **United for Efficiency**, **Electrify America**, **Rewiring America**
Strengthened grids	Minigrids, microgrids, smart grids	**Green Grids Initiative (GGI)**, **Global Power Sector Transformation Consortium (G-PST)**, **National Grid**

However, these individual distributed solutions face common barriers, which have slowed progress across the board. Aside from strengthened grids, the components of the new generation of energy systems are often seen as individual technologies: small, niche, and difficult to scale. Existing legislation, permitting requirements, business models, and financing are designed for utility-scale projects, which slows the expansion and scaling of distributed solutions.

> **Local systems lack political attention to deliver a more suitable policy framework.** Politically, distributed solutions attract less support than large power plants. Governments often need new skills and technologies to deploy the solutions, which are in competition with other priorities. Many of these solutions are seen as overly technical by decision-makers; this has been the case for efficiency, flexibility, integration, and – to a lesser degree – digitalisation and smart technologies. The lack of clear, long-term direction-setting hampers investor confidence and raises the issue of interoperability between different energy solutions. It also retains the institutional inertia and incumbency in the energy sector.

> **The current institutional systems and markets are not designed to incorporate distributed systems**. Lack of markets tailored for smaller solutions results in high entry costs and lack of upfront capital, including hurdles to securing finance, permitting, and generating stable income.[37] Market design frameworks tend to require minimum bid sizes, excluding distributed energy. This cumbersome process makes it difficult and expensive for financiers to deploy necessary capital, slowing commitments to the sector.[38]

> **Minimal awareness, and a lack of skilled labour and knowledge ecosystem, are hindering advancement in technology and innovation.** Low awareness of the importance of distributed solutions and integration leads to a persistent lack of skilled labour, resulting in fewer products and services suitable for smaller end users.

[37] UKRI, 2023, **Smart local energy systems: Insights from UKRI-funded innovation projects.**

[38] E3G, 2022, **How multilateral development banks can boost small-scale energy solutions**; Project LEO, 2021, **Policy and Regulatory Review**

Advocating for a new generation of energy systems: recommendations for action

To overcome the common barriers, actors driving advocacy and deployment of the variety of distributed solutions need to work together in support of new generation energy systems. Making these systems a reality means bringing together multiple dispersed actors. Collective action is needed to drive and support governments and financial institutions to promote distributed solutions.

The second half of 2023 presents clear opportunities to bring this discussion to the international political agenda, from the Africa Climate Summit to the UN Climate Ambition Summit and COP28.

An ecosystem of advocates can call on governments and financial institutions to take four core actions to accelerate the transition to new energy systems that meet climate and development goals.

1. A global one-stop-shop (OSS) for new generation energy systems, including a facility for country-level pathway analysis.
The OSS can:

> Bring together and build on the work of existing initiatives including, for example, Integrate to Zero's platform, Sustainable Energy for All (SEforAll)'s Energy Transition Offices, IRENA's renewable energy roadmaps, or the Global Power Sector Transformation Consortium (G-PST).

> Link with national OSS advisory services to enhance knowledge and improve collaboration.

> Provide knowledge and technical assistance services on financing, guidance on technology choices and procurement, and better modelling that includes the role of distributed and integrated systems in meeting energy, climate, and development goals.

A whole-system and value chain lens is necessary, which means this knowledge base will look beyond feasibility, cost savings, and emissions reduction potential, to incorporate social wellbeing and ecological constraints.[39] This should, for example, also consider possible conflict with other legacy energy policies, and

[39] Mulugetta et al., 2022, **Africa needs context-relevant evidence to shape its clean energy future**; Sokona et al., 2023, **Just Transition: A Climate, Energy and Development Vision for Africa**

make sure the new energy systems do not benefit only better off consumers and leave low-income consumers dependent on the old system with higher prices.

The facility should enable sharing of best practices, for instance: working to improve consistency in standards in distributed technologies; integrating capacity building into programme design; or including outreach programs that promote revenue-enhancing appliances.[40]

2. Champion governments, such as Kenya, Nigeria, and Nepal,[41] to convene regional delivery summits on new generation energy systems.
Through these summits, relevant ministries and agencies, finance providers (including development financial institutions and philanthropies), and high-level politicians can hear and make the case for the broad development benefits of investing in distributed systems and convey the political significance of those systems to national priorities. We have previously identified how governments are able to integrate these systems into their national development plans.[42] Summits can also increase coordination between key ministries in the planning process, including ministries of energy, development, trade and finance. Government agencies responsible for customer protection should also be involved to make sure the new system benefits consumers and balance the interest of the different groups.

Summits should lead to fostering technology transfer, and spur innovation and research to ensure shared benefits and resilient development, for instance by building local value chains. To enable economies of scale, they could focus on building up regional supply chains and labour markets, ensuring preferential trade conditions or harmonised trade standards for key components and inter-institutional exchange (e.g., on market design, integration into development plans). A first summit could take place on the sidelines of the Africa Climate Action Summit and SDG Summit in September 2023, or the Climate and Energy Summit in October 2023.

The delivery of a new generation of energy systems will only work with people actively participating in it. For instance, it touches upon the way we heat and cool spaces, to how we get around, or how we cook. Summits should bring non-

[40] Faeth and Banda, 2023, **Productive Uses of Energy in African Agriculture Could Reduce Poverty**

[41] E3G, 2023, **Six building blocks to integrate small-scale energy solutions into development planning Comparing the approaches of Kenya, Nepal and Nigeria**

[42] Ibid

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state actors to deliver community engagement and education campaigns, to improve energy literacy, enhance agency, and empower people in energy system decision-making.

Governments need to acknowledge the reform and innovation needed in energy policy and regulations to accommodate the scaling up of distributed solutions and integration with centralised systems. The Regulator for Energy Transition Accelerator (RETA) could play a key role, especially in developing the appropriate national guidelines to address common challenges including permitting and licensing.

3. Global delivery targets and tracking measures for the new generation of energy system.

These should include targets for demand-side resources, energy efficiency, flexibility, and distributed renewables, based on models and analysis that account for distributed energy integration. The targets should build on the existing set of targets established by the International Energy Agency's (IEA) Net Zero Roadmap, the Breakthrough Agenda, and Race to Net Zero. For example, a target to at least double energy intensity by 2030 aligned with the IEA Net Zero scenario.

The delivery goals should also include a finance target, in particular for development banks who play a vital role in ramping up and driving investments in distributed energy systems – yet, incentives for them are often set to focus on large-scale investments. Meanwhile, the surrounding governance should leverage accountability from existing platforms, such as under the Global Stocktake.

4. A global commission to review the best financing options for new generation, consumer-led systems.

International finance institutions (IFIs), including the multilateral development banks (MDBs) – in consultation with civil society organisations and industry – can review the best business models (ESCO, Paygo, franchising, and so on) to scale funding and recommend a set of options with a working group that takes this forward. This could include convening IEA's exchange rate risk platform, Get Invest platform, The Private Financing Advisory Network (PFAN), and philanthropy.

IFIs, including MDBs, need to increase coordination with other financiers to fill data gaps, co-develop programmes, and share best practices. IFIs also need to

strengthen partnerships with national and sub-national financial institutions to effectively channel the much-needed finance for these solutions, while enhancing transparency and standardisation, and allowing aggregation of demand.[43] Such aggregation can lower the overall costs for both developers and customers, and ultimately achieve economies of scale in the sector.

Another critical action is to facilitate local currency lending and denominate power purchase agreements in local currencies, which can help to mitigate risks from foreign currency exposure.

By breaking down silos and working together towards the common agenda above, advocates can address barriers and elevate the political importance of an integrated, new generation of energy systems.

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About E3G

E3G is an independent climate change think tank with a global outlook. We work on the frontier of the climate landscape, tackling the barriers and advancing the solutions to a safe climate. Our goal is to translate climate politics, economics and policies into action.

E3G builds broad-based coalitions to deliver a safe climate, working closely with like-minded partners in government, politics, civil society, science, the media, public interest foundations and elsewhere to leverage change.

More information is available at **www.e3g.org**

[43] E3G, 2022, **How multilateral development banks can boost small-scale energy solutions**