Lessons Learned for the U.S. Context

AN ASSESSMENT OF UK AND AUSTRALIAN OPEN NETWORKS INITIATIVES

A Report of the
Energy Systems Integration Group's
Distributed Energy Resources Task Force

August 2022

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

About ESIG

The Energy Systems Integration Group is a nonprofit organization that marshals the expertise of the electricity industry's technical community to support grid transformation and energy systems integration and operation. More information is available at https://www.esig.energy.

ESIG Publications Available Online

This report and other ESIG publications are available at https://www.esig.energy/reports-briefs.

Get in Touch

To learn more about the topics discussed in this report or for more information about the Energy Systems Integration Group, please send an email to info@esig.energy.

Lessons Learned for the U.S. Context: An Assessment of UK and Australian Open Networks Initiatives

A Report of the Energy Systems Integration Group's Distributed Energy Resources Task Force

Prepared by

Jennifer Gorman, Strategen
Matt McDonnell, Strategen
Jason Brogden, Independent Consultant
Mark Patterson, Strategen

Project Leadership

Priya Sreedharan, GridLab, Task Force Chair
Matt McDonnell, Strategen, Project Director
Debra Lew, Energy Systems Integration Group
Obadiah Bartholomy, Sacramento Municipal Utility District, ESIG DER Working Group Chair

Acknowledgments

Randolph Brazier, Energy Networks Association
John Philpotts, formerly of the Australia Energy Networks Association and Strategen

Disclaimer

The views contained in this report do not represent the views of any of the task force organizations and cannot be attributed to any single task force member.

Task Force

Astrid Atkinson, Camus Energy
Steve Beuning, Guzman Energy
Randolph Brazier, Energy Networks Association
Tricia DeBleeckere, Minnesota Public Utilities Commission
Jeff Dennis, Advanced Energy Economy
Michael DeSocio, New York Independent System Operator
Erik Ela, Electric Power Research Institute
Marcus Hawkins, Organization of MISO States
Nicholas Heine, Electric Power Research Institute
Steve Heinen, Vector Limited
Ric O'Connell, GridLab
Andrew Owens, New York State Department of Public Service
Ryan Quint, North American Electric Reliability Corporation
Doug Smith, Independent System Operator of New England
Priya Sreedharan, GridLab
Kristin Swenson, Midcontinent Independent System Operator

Suggested Citation

Energy Systems Integration Group. 2022. *Lessons Learned for the U.S. Context: An Assessment of UK and Australian Open Networks Initiatives.* A Report of the Distributed Energy Resources Task Force. Reston, VA. https://www.esig.energy/der-integration-series-Australia-UK.

This work was supported by funds from the Energy Foundation and GridLab.

Production management/editing: Karin Matchett/tomorrowsfootprint.com

Design: David Gerratt/NonprofitDesign.com

Contents

List of Abbreviations

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
DMO	Distribution market operator
DNO	Distribution network operator
DSO	Distribution system operator
ENA	Energy Networks Association (UK)
ENA	Energy Networks Australia
ESO	Electricity System Operator (UK)
FERC	Federal Energy Regulatory Commission (United States)
Ofgem	Office of Gas and Electricity Markets (UK)
OpEN	Open Energy Networks Project (Australia)
TSO	Transmission system operator

PHOTOS

Cover: © iStockphoto/mayichao

p. 1: © iStockphoto/3alexd

p. 3: © iStockphoto/NiseriN

p. 9: © Alamy/adrian arbib

p. 12: © iStockphoto/alexsl

Executive Summary

Distributed energy resources (DERs)—generation, storage, electric vehicles, and responsive load connected to the distribution system—can provide a range of economic, reliability, and security benefits to electricity systems. Unlocking these benefits, however, requires concerted and coordinated action among electricity regulators, electric distribution companies, bulk power system operators, retailers and other service providers, customers, and equipment manufacturers.

In the United States, efforts to coordinate among different stakeholders are taking place in several arenas, for instance, through the development of new distribution interconnection standards, through federal and state regulatory proceedings, and through the development of new business models to provide grid services from DERs. However, these efforts have often been piecemeal, in both their coverage and geographic scope. The Federal Energy Regulatory Commission's (FERC's) Order 2222, for instance, provides regulatory support for DER participation on the supply side of bulk power markets via aggregation, but offers less guidance on state-level regulations to support implementation, and does not address other potential models for DER participation in wholesale markets. The uncoordinated nature of efforts to better integrate DERs into U.S. electricity markets and operations has limited the pace of progress on DER integration.

A focused, national-level initiative, or a series of initiatives, around DER integration in the United States could accelerate progress toward achieving the benefits of more integrated distribution and transmission systems.

A focused, national-level initiative, or a series of initiatives, around DER integration in the United States could accelerate progress toward achieving the benefits of more integrated distribution and transmission systems. This kind of initiative could apply lessons from the experience of two similar efforts in other countries: the United Kingdom's (UK's) Open Networks Project and Australia's Open Energy Networks (OpEN) Project. This report provides an assessment of these two initiatives, with the goal of distilling insights that may be instructive for the development of a national initiative around DER integration in the United States. This report is the second in a series of three reports by the Energy Systems Integration Group on DER integration in the United States. The first examines the changes in

regulation, market rules, and operating practices needed to better integrate DERs into U.S. electricity markets and operations, identifying gaps to DER integration that could be addressed in a national-level initiative. The third report describes how a national-level initiative to facilitate DER integration into power systems in the United States might be focused, structured, and implemented.

Open Networks Projects in Australia and the UK

The Australian OpEN Project and the UK's Open Networks Project to address DER integration have a common goal of optimally transitioning from a predominantly centralized and fossil fuel–based system to one that is increasingly decarbonized, digital, and distributed. While each project had (or has) unique, country-specific elements, they shared an overarching focus on transmission-distribution coordination, and explored how to identify, define, and implement additional network capabilities that can better enable the provision of core grid services from DERs.

The UK Open Networks Project was initiated with an understanding that increased flexibility in the electricity grid was critical to meet long-term power system decarbonization goals, and it sought to better enable customer adoption of DERs. The UK project is ongoing, and is working to facilitate transmission-distribution system coordination, enable demand-side flexibility service markets, and establish standardized data transparency and sharing between DER providers and network operators. The UK project determined that distribution network providers would need to embrace a set of enhanced system functions and capabilities that collectively represent a distribution system operator (DSO). A key outcome of the UK project thus far has been the identification and ongoing implementation of eight functional and system requirements for DSOs.

In Australia, world-leading adoption levels of DERs led to a need to ensure reliable operation in a high-variable-renewable, high-DER system. It also spurred a desire to better understand how network and market operators can facilitate innovation, encourage competition, and reduce barriers to entry into the system. Working with stakeholders in a three-year process, the Australian OpEN project identified three least-regrets actions that distribution network service providers need to implement: define network visibility requirements and constraints for DERs exporting power to the distribution system, create industry guidelines for DER operating envelopes for export limits, and develop communication requirements for dynamic DER operation.

TABLE ES-1
Key Drivers for Open Networks Projects in the UK and Australia

Key Drivers in the UK	Key Drivers in Australia
• To achieve long-term power system decarbonization goals • To enable the uptake of DER technologies by allowing customers to take advantage of these new technologies to lower their costs and provide flexibility for the grid • To provide common services and define processes for DER participants to encourage service provision to meet networks' needs • To use DER services as a low-carbon, cost-effective alternative to network investment	• To ensure system reliability and consumer affordability in the face of rapid DER growth • To identify system requirements in the formation of a two-way system • To obtain a better understanding of how network and market operators can reduce barriers to DER entry into the system, facilitate innovation, and encourage competition

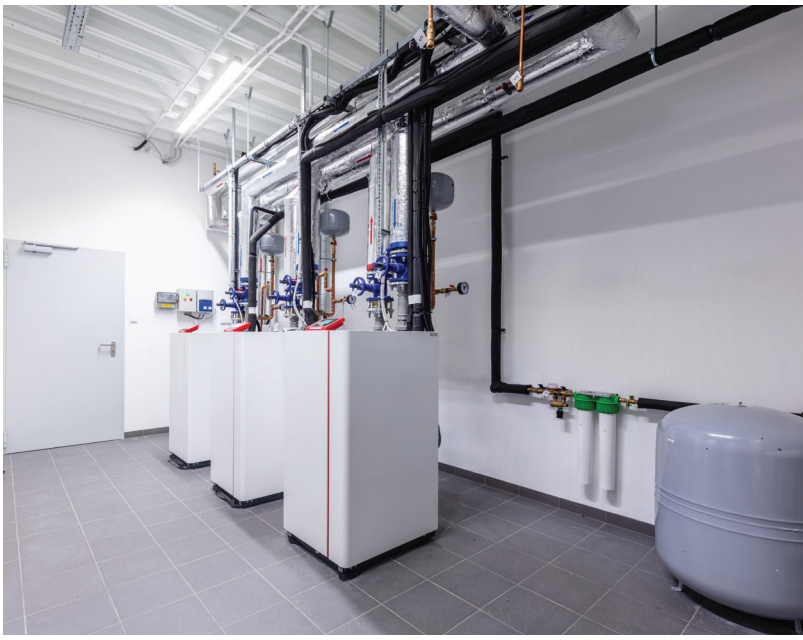
Source: Energy Systems Integration Group.

The catalysts for national action around DER integration in the two regions are listed in Table ES-1.

Key Insights from Australia and the UK for a U.S. Initiative

The U.S. electricity sector differs from those in Australia and the UK in a variety of ways, with implications for the design of a U.S. DER integration initiative. The United States has a much larger electricity system, with more diverse ownership and industry structure, and regulatory authority in the United States is more diffuse and complex. As a result, a DER integration initiative in the United States would need to be carefully and strategically designed, to enable diverse and meaningful participation across states and stakeholders while also producing actionable results that can be adopted at scale.

Unlike in Australia and the UK, creating a single model for distribution system operations in the United States is not feasible, because of the U.S. electricity sector's diversity of organizations and operating practices. Instead, U.S. bulk system operators will need to be able to accommodate multiple models. Developing a limited number of potential models for distribution system operations at the outset of a U.S. initiative would help to frame and focus discussion on the DSO functions and capabilities required for different models. For instance, these models could range from a "limited DSO," where the distribution operator plays a more passive role in DER operations, to a "total DSO" in which the DSO actively manages DERs and acts as a super aggregator for DER participation in bulk power markets.



Key Takeaways

The successes and challenges of the efforts in Australia and the UK provide a useful reference for the development of U.S. initiatives on transmission-distribution coordination and DER integration into markets and system operations. The United States can draw from the following takeaways from these projects:

1. **Start with a clear statement of purpose and objectives.** Clarity from the outset aligns stakeholders, establishes the project's value proposition, and maintains transparency. In the UK, the project management team develops project initiation documents for public consultation at the beginning of each year, which ensures that all interested parties are on the same page and driving toward common outcomes.

2. **Establish central delivery capability.** The UK and Australian projects have or had dedicated full-time project managers to take responsibility for project delivery and coordinate resources and efforts from elsewhere in the industry.

3. **Define and pursue quick wins.** A national initiative on DER integration into markets and operations can gain critical momentum by defining and producing tangible, early outputs. Once a project of this type demonstrates its ability to generate actionable insights for regulators, electric utilities, and DER providers, it can adapt to new objectives that surface in the course of its work and deliver value to the entire sector. In the UK, least-regrets actions focused on transmission-distribution interfaces and data transparency, and in Australia they focused on network visibility and operations requirements.

4. **Prioritize targeted stakeholder engagement.** Creating a "social system" and supporting processes is foundational to enabling stakeholders whose perspectives or goals may conflict to collectively engage on complex problems and work through key decisions around trade-offs. The UK's public consultation process and well-defined core project governance demonstrate effective stakeholder engagement that could inform a U.S. initiative.

5. **Work toward early alignment.** Participants must be closely aligned on what the project will achieve, its key success metrics, and all underpinning assumptions. Their "non-negotiables" must be thoroughly discussed and explicitly documented before the project begins.

6. **Develop fit-for-purpose tools.** Both the Australia and UK projects developed a range of alternative future electricity network models informed by a grid architecture model; however, due to the inherent limitations of this modeling, neither project undertook the comprehensive cyber-physical-market structural analysis required to establish real-world extensibility

and scalability of the alternatives.[1] Since this modeling would be costly and time consuming without resulting in tangible outcomes, a U.S. effort would likely be able to forego the significant cost and commitment of this detailed modeling.

7. **Ensure process agility.** In energy sector terms, DERs constitute a fast-moving environment with multiple drivers for different parties (e.g., customer, commercial, regulatory) and continually advancing knowledge, so it will be crucial for the project's focus to adapt. The UK project, for example, redefines the focus of each workstream annually.

8. **Engage parties who have the authority to effect change.** Given how these projects engage with rapidly changing and highly complex challenges to the traditional electricity supply chain, it is crucial to involve the parties who have the authority to implement decisive structural action. In Australia, the leadership of the Australian Energy Market Operator and Energy Networks Australia was important to understand the position of the networks, but the Australian Energy Regulator was not involved; therefore, actionable steps were not taken. In contrast, in the UK, the government and energy regulator were deeply involved in the project, which led to tangible outcomes.

Potential Near-Term Actions for Delivering Flexibility on the Distribution System

As in the Australian and UK projects, part of a U.S. initiative could focus on identifying nearer-term least-regrets actions that are common across alternative DSO models, from enhancing data-sharing to upgrading distribution monitoring capabilities. In both Australia and the UK, one focus of near-term action has been on developing incremental approaches to delivering flexibility on the distribution system, through flexibility service contracts in the UK and operating envelopes in Australia. This near-term focus would also be appropriate in a U.S. context, building on recent interconnection rules for export limits on behind-the-meter solar and storage systems, feasibility analyses, and pilots on flexible interconnection.[2]

Part of a U.S. initiative could focus on identifying nearer-term least-regrets actions that are common across alternative DSO models, from enhancing data-sharing to upgrading distribution monitoring capabilities.

Similar to the UK project's future-focused approach, a U.S. DER integration initiative could also have a parallel track focused on the longer-term evolution of DSO functions and capabilities. This dual focus of near-term least-regrets actions and longer-term DSO development would allow a U.S. initiative to deliver tangible near-term results, while at the same time making headway on longer-term issues that may require more time to resolve—from joint operating procedures involving DSOs and independent system operators, to federal-state jurisdiction issues, to distribution open access regulations. The third report in this series examines the potential design and areas of nearer-term and longer-term focus for a U.S. national-level initiative on DER integration in greater detail.

1 Such as an approach to holistic structural analysis of the power system based on the Network of Structures model developed by the Pacific Northwest National Laboratory.

2 See, for instance, Avangrid's Flexible Interconnect Capacity Solution pilot described at https://www3.dps.ny.gov/W/PSCWeb.nsf/All/B2D9D834B-0D307C685257F3F006FF1D9, and EPRI (2020; 2021).

Introduction

Distributed energy resources (DERs)—generation, storage, electric vehicles, and responsive load connected to the distribution system—can provide a range of economic, reliability, and security benefits to electricity systems. Unlocking these benefits, however, requires concerted and coordinated action among electricity regulators, electric distribution companies, bulk power system operators, retailers and other service providers, customers, and equipment manufacturers.

In the United States, efforts to coordinate among different stakeholders are taking place in several arenas, for instance, through the development of new distribution interconnection standards, through federal and state regulatory proceedings, and through the development of new business models to provide grid services from DERs. However, these efforts have often been piecemeal, in both their coverage and geographic scope. The Federal Energy Regulatory Commission's (FERC's) Order 2222, for instance, provides regulatory support for DER participation on the supply side of bulk power markets via aggregation, but offers less guidance on state-level regulations to support implementation and does not address other potential models for DER participation in wholesale markets. The piecemeal nature of efforts to better integrate DERs into U.S. electricity markets and operations has limited the pace of progress on DER integration.

A focused, national-level initiative, or a series of initiatives, around DER integration in the United States could accelerate progress toward achieving the benefits of more integrated distribution and transmission systems. This kind of initiative could draw lessons from the experience of two similar efforts in other countries: the United Kingdom's (UK's) Open Networks Project and Australia's Open Energy Networks (OpEN) Project. This report distills insights from these two initiatives that would be instructive for the development of national initiatives around DER integration in the United States.

The piecemeal nature of efforts to better integrate DERs into U.S. electricity markets and operations has limited the pace of progress on DER integration.

Open Networks Projects in Australia and the UK

The Australian OpEN Project and the UK's Open Networks Project were both initiated to address DER integration, with a common goal of optimally transitioning from a predominantly centralized and fossil fuel–based system to one that is increasingly decarbonized, digital, and distributed. While each project has (or had) unique, country-specific elements, they share an overarching focus on transmission-distribution coordination, and explore how to identify, define, and implement additional network capabilities that can better enable the provision of core grid services from DERs.

The UK Open Networks Project was initiated with an understanding that increased flexibility in the electricity grid was critical to meet long-term power system decarbonization goals, and it sought to better enable customer adoption of DERs. The UK project is working to facilitate transmission-distribution system coordination; enable demand-side flexibility service markets; and establish standardized data transparency

and sharing between DER providers and network operators. The UK Open Networks Project determined that distribution network providers would need to embrace a set of enhanced system functions and capabilities that collectively represent a distribution system operator (DSO). A key outcome of the UK project thus far has been the identification and ongoing implementation of eight functional and system requirements for DSOs.

In Australia, world-leading adoption levels of DERs led to a need to ensure reliable operation in a high-variable-renewable, high-DER system. It also spurred a desire to better understand how network and market operators can facilitate innovation, encourage competition, and reduce barriers to entry into the system. Working with stakeholders in a three-year process, the Australian OpEN project identified three least-regrets actions that distribution network service providers need to implement: define network visibility requirements and constraints for exporting power to the distribution system, create industry guidelines for DER operating envelopes for export limits, and develop communication requirements for dynamic DER operation.

The catalysts for national action around DER integration in the two regions are listed in Table 1.

TABLE 1
Key Drivers for Open Networks Projects in the UK and Australia

Key Drivers in the UK	Key Drivers in Australia
• To achieve long-term power system decarbonization goals • To enable the uptake of DER technologies by allowing customers to take advantage of these new technologies to lower their costs and provide flexibility for the grid • To provide common services and define processes for DER participants to encourage service provision to meet networks' needs • To use DER services as a low-carbon, cost-effective alternative to network investment	• To ensure system reliability and consumer affordability in the face of rapid DER growth • To identify system requirements in the formation of a two-way system • To obtain a better understanding of how network and market operators can reduce barriers to DER entry into the system, facilitate innovation, and encourage competition

Source: Energy Systems Integration Group.

Applying Insights from the UK and Australia to the U.S. Context

The U.S. electricity sector differs from those in Australia and the UK in a variety of ways, with implications for the design of a U.S. DER integration initiative. The United States has a much larger electricity system, with more diverse ownership and industry structure, and regulatory authority in the United States is more diffuse and complex. As a result, a DER integration initiative in the United States would need to be carefully and strategically designed, to enable diverse and meaningful participation across states and stakeholders while also producing actionable results that can be adopted at scale.

A DER integration initiative in the United States would need to be carefully and strategically designed, to enable diverse and meaningful participation across states and stakeholders while also producing actionable results that can be adopted at scale.

This report is the second in a series of three reports on DER integration in the United States. The first examines the changes in regulation, market rules, and operating practices needed to better integrate DERs into U.S. electricity markets and operations, identifying gaps to DER integration that could be addressed in a national-level initiative. The third report describes how a U.S. national-level initiative to facilitate DER integration into power systems might be focused, structured, and implemented.

An Assessment of Open Networks Projects in Australia and the UK

The Australian and UK open networks projects took different approaches and had, or are having, different outcomes. Here we examine each country's project's drivers, design, implementation, and outcomes. This discussion forms the basis for the final section outlining key takeaways from each project for the United States.

The UK's Open Networks Project

Project Overview

Electricity networks in the UK have been rapidly changing as the UK moves from a traditional one-way power system to a more smart, flexible energy system. Driven by three key factors—decarbonization, digitalization, and decentralization—the UK Open Networks Project is an ongoing project exploring the steps necessary to deliver a more efficient and cost-effective clean energy system. The Open Networks Project is a key component of delivering the government's decarbonization policy set out in the Office of Gas and Electricity Markets' (Ofgem) and the Department for Business, Energy, and Industrial Strategy's Smart Systems and Flexibility Plan; the government's Industrial Strategy; and the Clean Growth Strategy (Ofgem, 2017; Government of UK, 2017b, 2017a).

There are currently more than 30 GW of distributed generation resources connected to distribution networks in the UK, with the uptake of other DERs—especially electric vehicles—increasing rapidly (Ofgem, 2021). As demand patterns shift due to the adoption of new technologies, network operators will play a more active role in managing and operating their networks. This shift has been seen in the UK with increased levels of flexibility from DERs contracted for distribution network services over the last few years.

Driven by three key factors—decarbonization, digitalization, and decentralization—the UK Open Networks Project is an ongoing project exploring the steps necessary to deliver a more efficient and cost-effective clean energy system.

Distribution network operators in the UK procure four kinds of active power flexibility services: Sustain, Secure, and Dynamic for ahead-of-time services, and Restore for network restoration post-event. While flexibility services are a relatively new market in the UK, this market has grown rapidly in the past few years, from 116 MW in 2018 to 1.6 GW in 2021. The majority (64 percent) of these services are provided by non-renewable generation, with 15 percent from storage, 2 percent from demand response, and the remainder from aggregation and unknown sources (ENA, 2021a).

The Energy Networks Association's Open Networks Project was initiated in 2017 as the association's TSO-DSO project to reflect its initial objectives of furthering the transition of distribution network operators (DNOs) to DSOs, providing clarity regarding the interface between DSOs and transmission system operators (TSOs), and improving the customer experience. DNOs are companies in the UK that own and operate the network of towers, transformers, cables, and meters that carry electricity from the national transmission system

and distribute it to end users. DSOs, in contrast, are envisioned to be necessary in a high-DER grid, but it is not yet clear what actor will serve in this role. This report uses the term DSO to refer to the entity that is responsible for operating the distribution system, which could be a distribution utility or, as on the transmission system, a separate organization.

The TSO-DSO project's name was changed to Open Networks in 2017 to reflect its broadening objectives as the project adapted to continue to deliver the most benefits to stakeholders. The publication in late 2017 of Ofgem and the Department for Business, Energy, and Industrial Strategy's Smart Systems and Flexibility Plan; the government's Industrial Strategy; and the Clean Growth Plan prompted an expansion of the Open Networks Project to encompass the delivery of economic benefits to the UK. These expanded objectives included helping to create the marketplace for products and services to deliver cost-effective energy to UK businesses as part of the government's Industrial Strategy, ensuring that existing electricity network assets are fully utilized with capacity made available to customers as soon as practicable, and realizing the economic potential of smarter networks.

Lead Organizations

The project is led by the transmission and distribution operators via the Energy Networks Association and brings together the electric grid operators, the energy regulator Ofgem, the UK government, academics, and industry trade associations (Ofgem, 2021). By coordinating through the Energy Networks Association, the project was able to take into account any differing views across the network operators, as they all have individual drivers and regulated business plans to deliver against. Currently, about 30 full-time-equivalent staff positions are allocated to work on the project, with a small number of central resources provided by the Energy Networks Association (three to four full-time equivalents) for project management and communications, and the bulk of resource time provided by the network companies.

Objectives

The Open Networks Project seeks to enable the uptake of DER technologies by homes, businesses, and communities in the UK by allowing customers to take advantage of these new technologies to lower their costs and provide flexibility for the grid through bidding for flexibility services to network operators. Four new standard DNO flexibility services have been defined through Open Networks with all DNOs tendering for these services through an Open Networks–defined standard process and contract. The driver for the network companies is to support their regulatory submissions through a single vision and to provide common services and processes to DER owners to encourage them to provide grid services to meet the networks' needs. The Open Networks' 2022 Project Initiation Document states, "Our vision is to ensure networks are at the forefront of the UK's transition to net zero, working proactively with the government, Ofgem, and industry to identify, drive, and deliver the changes required for networks to become smart, flexible, and net zero–ready efficiently whilst maximizing customer benefits" (ENA, 2021b).

The project is led by the transmission and distribution operators via the Energy Networks Association and brings together the electric grid operators, the energy regulator Ofgem, the UK government, academics, and industry trade associations.

Scope

The project was initially focused on improving transmission-distribution interfaces. The first year of work developed engineering standards to allow for the use of flexible resources in network investment planning and released an improved Statement of Works process (also called an interconnection study in other systems) that is appropriate for larger volumes of DERs. The first year of work also defined a DSO, developed eight key DSO functions, and created a roadmap for the evolution from traditional network operation to new DSO functions, including the steps that network and system operators need to take in the short, medium, and longer term. In the second year of the Open Networks Project, development work started on enabling flexibility service

markets and unlocking the potential value from data transparency; these efforts became a larger focus once the quick wins of transmission and distribution coordination had been achieved through collaborative development in Open Networks (for example, operational data exchange standards). The Open Networks Project has since developed a DSO implementation plan, continuing with improvements to transmission and distribution processes and opening up markets for flexibility services for DERs.

It was important in the UK context to align on a future model of a dynamic, two-way power system so that the regulated electric utilities could plan toward this in their next rate plan window (2023-2028). As such, the goals of the project are to: (a) open local flexibility markets to demand response, renewable energy, and new low-carbon technology, and remove barriers to participation; (b) provide opportunities for these flexible resources to rapidly connect to the networks; (c) make data available to allow owners and developers of these flexible resources to identify the best locations to invest; and (d) deliver efficiencies between the network companies to plan and operate secure and efficient networks.

Each year, the UK Open Networks Project defines its priorities and divides them among a number of workstreams, each with annual deliverables. In 2021 these workstreams were (ENA, 2021b):

- **Flexibility Services (Workstream 1A)**, which worked to define and develop transparency and standardized approaches across DNOs in their procurement of flexibility services, as well as deliver consistency with the Electricity System Operator (ESO). This workstream designed changes to enable and encourage new markets and platforms for flexibility, and investigated potential conflicts between flexible connections that are managed through active network management systems and procured via flexibility services.
- **Whole Electricity System Planning and T-D (Transmission-Distribution) Data Exchange (Workstream 1B)**, which monitored industry developments to maintain processes on investment planning and data exchange. In addition, this workstream supported new areas of work on the visibility of DERs on the networks and also supported the development of new license requirements to make planning and operational data available to non-network stakeholders.
- **Customer Information Provision and Connections (Workstream 2)**, which focused on improving customer experience and ensuring that processes and information meet customer requirements.
- **DSO Transition (Workstream 3)**, which furthered the development and implementation of the least-regrets pathway to distribution system operation, identifying and addressing potential conflicts of interest and unintended consequences.
- **Whole Energy System (Workstream 4)**, which provided a key forum to discuss interactions between electricity and gas networks, with a focus on delivering tangible whole system change in the short term through enhanced coordination across the networks.
- **Communications and Stakeholder Engagement (Workstream 5)**, which promoted stakeholder engagement and communications for the Open Networks Project.

Stakeholder Engagement

The UK Open Networks Project consists of a core steering group, which includes representatives from all of the Energy Networks Association's electricity network members as well as Ofgem and the Department

for Business, Energy, and Industrial Strategy, and an advisory group with more than 40 experts from across the energy industry supply chain, including energy retailers, generators, traders, DER providers, technology/platform providers, consumer advocates, and academics.[3] High-priority items are proposed by the steering group, reviewed by the advisory group, and then discussed with stakeholders via consultations, stakeholder forums, webinars, and guest presentations. Key outputs that set the direction for future development—such as annual project initiation documents and the Future Worlds Impact Assessment (see below)—are subject to open consultation, giving anyone the opportunity to respond to proposals and placing the burden on the Energy Networks Association to justify the proposed direction of work. The association supports the consultation process with multiple stakeholder events including several question-and-answer sessions. All of the Open Network Project's deliverables are made public and are easily accessible on the Energy Networks Association's website.

Notable Outcomes

MODELING OF FIVE DIFFERENT FUTURE WORLDS

In 2018, the UK Open Networks Project undertook an exercise to model its five "Future Worlds" using the Smart Grid Architecture Model (SGAM) methodology and a licensed Enterprise Architect tool to capture the outputs. The results of this modeling exercise were used to highlight the differences between the five alternative future worlds and identify common processes and interfaces on which to focus for improvements, and they feed into an impact assessment to set the pathway for future DSO development.

The future worlds modeled were (ENA, 2018):

- **World A, DSO Coordinates:** The DSO would take a central role for all distribution-connected parties and serve as a neutral market facilitator for all DERs. The DSO would also provide services on a locational basis to the Electricity System Operator.
- **World B, Coordinated DSO-ESO Procurement and Dispatch:** The DSO and the Electricity System Operator would work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resources.
- **World C, Price-Driven Flexibility:** Distribution network flexibility would be achieved through changes developed through Ofgem's reform of electricity network access, and forward-looking charges would improve access arrangements and price signals for customers.
- **World D, ESO Coordinates:** The Electricity System Operator would take a central role in the procurement and dispatch of flexibility services as the neutral market facilitator for DERs. DSOs would inform the Electricity System Operator of their operating constraints and requirements.
- **World E, Flexibility Coordinator:** A national (or potentially regional) third party would act as the neutral market facilitator for DERs, providing efficient services to the Electricity System Operator and/or DSO as required.

Across all of the markets, the UK Open Networks Project highlighted the need for a neutral market facilitation as an important principle, to ensure operational efficiency and fairness. The project also emphasized the need for network owners and operators to work together to ensure safe, secure, and efficient design and operation of systems, including optimization of existing network assets and management of network congestion and capacity.

A cost-benefit analysis of the five future worlds showed that by 2030 Worlds A and B appeared to be capable of performing relatively better than the others, because of their more rapid development and because they can exploit synergies between network and system operation at the distribution level to deliver greater benefits from access to flexible DERs. By 2050, the performance of the future worlds was similar.

3 A list of advisory group members can be found at https://www.energynetworks.org/assets/images/Resource%20library/ON21-PRJ-AG%20Open%20Networks%20Advisory%20Group%20Membership%20List%20(05%20Jul%202021).pdf.

CONSENSUS THROUGH TRANSPARENCY AND CONSULTATION

Through information-sharing and transparency on the overall Open Networks annual work plan and workstream deliverables, the Open Networks Project built consensus around the use of Future World B as the start of all paths to DSO transition.

The project used the advisory group to engage a wide range of stakeholders through the development process, and all finalized documentation was made openly available through the Energy Networks Association website. As noted above, key outputs that set the direction for future development (such as the annual project initiation documents and the Future Worlds Impact Assessment) are subject to open consultation, giving anyone the opportunity to respond to proposals and placing the burden on the Energy Networks Association to justify the proposed direction of work. The association supports the consultation process with multiple stakeholder events including several question-and-answer sessions.

In the process of deciding which of the future worlds to use, the Energy Networks Association analyzed the responses to the Future Worlds Impact Assessment, published its response, and ran a public briefing event (ENA, 2019). The clear preference from respondents was for World B: that the DSO transition should begin with the development of DSO-ESO coordination. This was considered a least-regrets path, building upon existing practices while delivering on the association's commitments to flexibility. This approach does not preclude the use of other models in the future as a better understanding is gained of the liquidity of flexibility markets and the impact of charging reforms for connection and use of distribution networks.

A key focus of the UK Open Networks Project has been information- and data-sharing between DER providers and network operators, proposing an embedded capacity register and queue management.

STANDARDIZATION OF INFORMATION- AND DATA-SHARING

A key focus of the UK Open Networks Project has been information- and data-sharing between DER providers and network operators. Deliverables to improve standardization and facilitate interconnection include (ENA, 2022):

- **Embedded capacity register**, to standardize publicly available information about connected resources and services
- **Queue management**, to improve the management of the DER interconnection queue in order to ensure that only active and viable projects are under consideration

DEFINING EIGHT DSO FUNCTIONS

The Open Networks Project concluded that a DSO would be a key component necessary to deliver the benefits of smart energy technologies and services. A key outcome of Workstream 3 in 2018 was the identification of a comprehensive list of eight no-regrets functional and system requirements for DSOs, independent of the market model. Within these, associated activities were defined as follows (ENA, 2018):

- **System coordination:** Handling coordination between the DSO and the Electricity System Operator, and/or independent DSOs; coordination between the DSO and local energy systems and coordination of local network services; and coordination among electricity and gas networks to enable whole system planning
- **Network operation:** Ensuring that network power flow remains within thermal limits to minimize losses and manage future risk
- **Investment planning:** Doing traditional investment planning; coordinating between the DSOs, the Electricity System Operator, and the TSOs to identify whole electricity system options, including commercial DER options as well as distribution network investment
- **Connections and connection rights:** Carrying out activities directly related to the provision of DER connections to distribution networks and the management of fair and cost-effective DER access

to the distribution network such as the design of connections, putting in place connection agreements with clearly defined access rights, and the ongoing management of these agreements

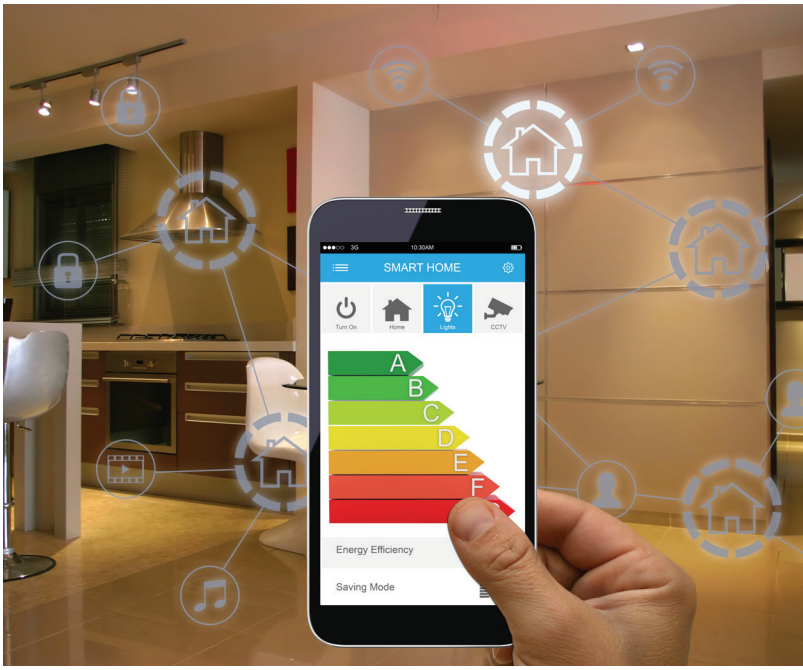
- **System defense and restoration:** Carrying out short-term contingency planning between DNOs and the Electricity System Operator, ongoing regional development programs, and the delivery of an accelerated loss of mains protection change program[4]
- **Services and market facilitation:** Assessing the value of flexibility, defining new services, and supporting the operation of the markets and systems needed to provide these services. DSOs would also need to support the market participants through information provision.
- **Service optimization:** Identifying network requirements, understanding the limitations of network assets, and facilitating flexibility services through the smart use of networks and DER solutions
- **Charging:** Developing charges for the connection and use of distribution networks, developing transmission charges and distribution costs in whole system charges, and managing transmission costs at the grid supply point

Key Takeaways

The UK Open Networks Project highlights the importance of nearer-term and longer-term balance, stakeholder engagement, and process agility.

Nearer-Term and Longer-Term Balance

The UK Open Networks Project has taken a future-oriented approach to the integration of DERs into markets and operations, focusing on how future DSO models could work to deliver benefits to network operators, DER owners, and other stakeholders. This future-focus allowed the UK to avoid being caught in low-level incremental change, and the initial focus on possible DSO models led to consensus on a model (Future World B) that provides a practical target to guide the Open Networks Project's activities and discussion.



Thus, the UK has been able to deliver quick wins around tangible near-term changes, while at the same time providing detailed implementation plans for longer-term change. These results built confidence that the UK Open Networks Project was making a real difference.

Stakeholder Engagement

The Open Networks Project models transparency and deep stakeholder engagement. All information and deliverables are shared online throughout their development, and key proposals are released for public consultation and comment to ensure that affected stakeholders who were less involved in the day-to-day project have the opportunity to provide input. The UK's transparent approach has been important for driving the group toward consensus as well as for the wider acceptance of Open Networks proposals across all stakeholders. Without this broad buy-in, the Open Networks Project might have been seen as introspective within the network community and been less widely accepted, which would have hindered the ability of the networks to make change. Increased transparency and openness of data also increases the opportunity for DER participation in markets.

4 The Accelerated Loss of Mains Change Programme provides funding to some DERs to assist them in making hardware changes required by September 2022. See https://www.energynetworks.org/industry-hub/engineering-and-technical-programmes/accelerated-loss-of-mains.

The UK's significant level of buy-in appears to have been strengthened by the multi-year commitment of the key sponsors and the extensive structured engagement with diverse stakeholders including customers, network operators, and government. This has been enhanced by a focus on the contributions that demand-side flexibility can make to the UK's performance-based utility compensation framework.

Process Agility

The culture of the UK's project is one of adaptability, and this has also been key to its ongoing success. Through the duration of the UK Open Networks Project thus far, there has been increasing deployment of DERs and increased potential for networks to use DERs for efficient planning and operation. These developments influenced the project's shift from a focus on internal transmission-distribution interfaces to more outward-facing procurement and the use of DER services to deliver network efficiencies (called flexibility markets in the UK). As a result, flexibility services procured by DNOs increased by a factor of 10 from 2018 to 2021.[5]

If projects like Open Networks cannot adapt, they lose their relevance. Open-minded leadership and robust governance and decisionmaking are key to being able to change focus and direction in order to maximize the benefits to networks and all stakeholders. The collaboration and level of discussion across the DNOs has enabled them all to benefit from best practices and shared learning. In the UK, the standardization in approaches across DNOs has provided more opportunity for standardized market products and better commercialization of assets for DER market participants that operate across multiple DNOs.

Australia's OpEN Energy Networks Project

Project Overview

Australia's Open Energy Networks Project (OpEN) was driven largely by increasing grid instability and coordination issues caused by Australia's world-leading uptake of rooftop solar PV. These emerging issues were forecast to grow with the continued uncoordinated growth of DERs and were already causing increasing issues at both localized and centralized (large-scale) levels of the network. This effort was especially pertinent in Australia as DERs are, currently, generally uncoordinated with limited real-time visibility for system operators and distribution networks. The OpEN project was particularly important for distribution networks to assess future investments necessary to deal with large volumes of DERs, as well as for identifying how distribution networks and the Australian Energy Market Operator (AEMO) could coordinate and share visibility of aggregated DERs as aggregations emerge across the system.

Australia's OpEN project emerged out of the Electricity Network Transformation Roadmap (ENTR) undertaken between 2015 and 2017 (CSIRO and ENA, 2017; ENA, 2017a). The roadmap's modeling showed that if the deployment of DERs was not fully optimized and managed, the cost to consumers would be more than AU$100 billion by 2050. If, however, DER deployment was optimized and its operation managed, it would have the potential to save households AU$414 annually on electricity bills in the same time frame (ENA, 2020).

The Electricity Network Transformation Roadmap was jointly developed and funded by Energy Networks Australia and the Commonwealth Scientific and

The Australian OpEN project was important for distribution networks to assess future investments necessary to deal with large volumes of DERs, as well as for identifying how distribution networks and the Australian Energy Market Operator could coordinate and share visibility of aggregated DERs as aggregations emerge across the system.

5 Ofgem defines flexibility as modifying generation and/or consumption patterns in response to an external signal (such as a change in price) to provide a service within the energy system. Examples of flexibility services include time-of-use tariffs, distribution and transmission charge management, dynamic containment, and short-term operating response. See ENA (2021a).

Industrial Research Organisation (CSIRO), Australia's national applied science agency, and involved successful collaboration with several hundred stakeholders to develop an unprecedented level of consensus on a path forward for the sector. Informed by the roadmap's focus on intelligent networks and markets, OpEN then became a collaboration between Energy Networks Australia and AEMO. The project was modeled on the UK Open Networks Project and used several of the same consultants and analytical tools, but took place over a shorter period of time. Unlike the ongoing effort in the UK, Australia's OpEN project was a discrete three-year effort and has now concluded.

Lead Organizations

The OpEN project was led by Energy Networks Australia, the national industry body representing Australia's electricity transmission and distribution and gas distribution networks, and AEMO, which operates the National Electricity Market and the Wholesale Electricity Market.

Objectives

OpEN's objectives were to identify system requirements in the formation of a dynamic, two-way system; obtain a better understanding of how network and market operators can reduce DERs' barriers to entry into the system; and facilitate innovation and competition. The project also sought to ensure system operability and consumer affordability in the face of rapid DER growth (ENA and AEMO, 2018).

Scope

The OpEN project assessed the ability of distribution markets to (ENA, 2020):

- Enable greater market access to energy and service markets for DERs
- Enable customers to benefit from contracting with network service providers for DER services
- Ensure efficient investment in DERs to deliver a lower-cost energy system for all customers

Notable Outcomes

FRAMEWORKS FOR DER COORDINATION

Initially, three models or frameworks for distribution-level optimization and system-level dispatch of DERs were developed: the single integrated platform, the two-step tiered model, and the independent DSO. Qualitative stakeholder feedback on these three models suggested the need for a fourth, hybrid model, which was a conceptual cross between the single integrated platform and the two-step tiered frameworks and involved a two-sided marketplace. A central market platform would act as the key data exchange platform between market participants (including network operators), collecting bids and offers from energy resources (such as DERs via aggregators/retailers) and making them available to AEMO and the DSO for whole system co-optimization.

Each of the four structural frameworks envisioned the creation of two new roles to deliver optimization of DERs, and the key difference between frameworks pertained to the entity that performed these roles. The roles were: (1) the DSO, with visibility of power flows and DERs on the distribution network, which would manage the network operating envelopes, identify when network issues emerged, and act; and (2) the distribution market operator (DMO), which would manage the distribution-level market, optimizing the provision of services and energy from DERs within operating envelopes provided by the DSO.

As articulated by EA Technology, one of the lead consultants to the OpEN project, the approach to modeling these potential frameworks for DER coordination using the Smart Grid Architecture Model provided a "structured and coherent way to describe, visualize, and interpret the DSO frameworks by capturing the interactions between different actors from a high-level business context down to the detail of what information is exchanged, [and] using what communication methods" (EA Technology, 2019).

LEAST-REGRETS ACTIONS

While the OpEN project did not definitively establish a preferred future structural model, three least-regrets actions were identified that Australian distributed

network service providers would need to implement under any future conditions (AEMO and ENA, 2019). These actions are to:

- Define network visibility requirements and network export constraints
- Establish an industry guideline for operating envelopes for export limits
- Define communication requirements for operating envelopes

Operating envelopes provide a relatively incremental approach to managing DERs, by providing upper and lower bounds on the export and import of power to and from the distribution system. Operating envelopes can be dynamic, with envelopes changing over time as system conditions change.

Stakeholder Engagement

The OpEN project engaged stakeholders including transmission and distribution members, retailers, regulators, market bodies, and customer representatives.

Industry stakeholders participated at various stages of the project through a series of workshops, discussion papers, and a consultation to identify the approaches, capabilities, and actions required to facilitate increased DER integration and provide the building blocks for any future market framework. Stakeholder feedback was extensive throughout the project (ENA and AEMO, 2018). With the launch of the OpEN consultation paper in mid-2018, collaboration and feedback were invited through a nation-wide series of workshops. A key outcome from the workshops was the development of the fourth structural framework, the hybrid model, noted above (AEMO and ENA, 2019).

Another tangible example of stakeholder collaboration was the OpEN issues register. At the functional specification workshops, the OpEN team compiled a register of stakeholder concerns regarding the Smart Grid Architecture Model designed for each framework (AEMO and ENA, 2019). EA Technology then identified key issues from the register considered to be in scope of the future framework design and consolidated these in its report for Energy Networks Australia.

Despite its efforts to involve stakeholders, OpEN was criticized by consumer groups as not sufficiently incorporating diverse customer engagement in its original structural design and subsequent execution. As the project proceeded, a perception also developed of a widening gap between the key project sponsors, together with growing concerns about process transparency and decision traceability.

Key Takeaways

Australia's OpEN project followed the successful Electricity Network Transformation Roadmap project, which was a collaboration between Energy Networks Australia and the Commonwealth Scientific and Industrial Research Organisation, Australia's national science agency. It was modeled on the UK Open Networks Project and used several of the same consultants and analytical tools, but differed in that the project's duration was finite.[6]

The OpEN project benefitted from targeted stakeholder engagement, which led to the development of the hybrid model in collaboration with multiple stakeholder groups. However, the project was criticized by consumer groups as not sufficiently incorporating diverse customer engagement.

The Australian project highlighted a range of least-regrets priorities focusing on visibility and operating envelopes. As such, the OpEN project has led to valuable efforts across the industry including the development of several technology demonstration projects.

6 By design, the OpEN approach focused on only a limited subset of the Network of Structures—a model developed by the Pacific Northwest National Laboratory in the United States for performing comprehensive structural analysis of the power system and/or future structural models—that collectively make up and dynamically influence the operation and coordination of the power system as a whole.

While no ultimate agreement between Energy Networks Australia and AEMO was achieved on the most suitable future model or agreed-upon next steps, the project highlighted a range of least-regrets priorities that have subsequently been pursued, focusing on visibility and operating envelopes. As such, the OpEN project has led to valuable efforts across the industry including the development of several technology demonstration projects.

Comparison of the UK and Australian Open Networks Projects

The UK and Australian open networks projects differed on multiple fronts, from their motivators, regulatory structures, and business models, to the scope of their efforts and their outcomes. Table 2 provides a summary.

Although the UK and Australian Open Networks projects differed in a number of ways, they also

TABLE 2
A Comparison of Key Aspects of the Australian and UK Open Networks Projects

	Australia	UK
Background and motivation	The aim was to ensure system operability and customer affordability in the face of rapid DER growth, specifically solar photovoltaics.	The aim was to achieve aggressive carbon targets and preempt regulatory action by leveraging customer-side resources to deliver system flexibility.
Utility regulation and business model	The network has distinct transmission, distribution, and retail entities; the network uses a single national regulatory framework; network operators use multi-year rate plans. DER integration is managed by regulated networks and AEMO (AEMO is responsible for system operation and dispatch).	RIIO program (revenue = incentives + innovation + outputs) is a significant driver for network activities. The network has distinct transmission, distribution, and retail entities with a single national regulatory framework.
Scope of effort and process	It was a discrete three-year project focused on consensus on preferred structures and approaches to DER coordination. Stakeholders were engaged via workshops and discussion papers. The project focused on the evaluation of costs and benefits of four potential grid operation coordination models for DERs.	It is an ongoing project with focus areas re-scoped and selected annually. The scope is confirmed with a steering group, regulators, and stakeholders. The project grew to five or six workstreams and 25 to 40 products with dedicated staff of about four full-time equivalents at the Energy Networks Association and a dedicated full-time equivalent from networks. It initially focused on defining DSO functions, actions, and gaps.
DSO models	Among four possible models, a hybrid independent system operator-DSO model was preferred, but no formal consensus was reached on the best future model.	"World B," coordinated DSO-ESO procurement and dispatch, was chosen as the preferred target from among five different options.
Enabling transmission-distribution integration	The focus was on real-time coordination and dispatch with DER providers. A priority was establishing visibility of DERs through data sharing and standardized procedures to enable real-time operations.	The focus was on enabling DER interconnection and market participation. Procurement and interconnection of DERs was standardized to reduce hurdles for DER providers.
Achievements and recommendations	Recommendations were made for least-regrets integration and coordination that apply regardless of the entity taking on the distribution market operation role.	Rolling product development and finalization are part of an annual process. A focus is maintained on standardization, interconnection, and planning activities that encourage DER participation.

converged in several important respects. One notable commonality was a focus on defining several possible future models of distribution operations in a high-DER electricity system and building consensus around an optimum pathway for future grid development. Both projects also identified the need for improved interconnection policies and approaches, coordinated transmission-distribution operations, and greater opportunity for DERs to support core electricity system requirements. These commonalities will be important to consider for a U.S. effort.

Eight key takeaways that could inform a U.S. initiative pertain to transmission-distribution coordination and DER integration into markets and system operations (see Table 3, p. 16).

TABLE 3
International Insights to Inform a U.S. DER Integration Initiative

Key Insight	Description	Context from Australia's and the UK's Open Network Projects
Clear statement of purpose and objectives	Clarity from the outset of the project is necessary to align stakeholders, establish the project's value proposition, and maintain transparency.	The UK project management team develops project initiation documents for public consultation before each year of the project begins, which ensures that all interested parties are driving toward common outcomes.
Central delivery capability	A full-time project management team is needed to coordinate stakeholder alignment and maintain the project's momentum.	The UK and Australian projects have/had dedicated full-time project managers to take responsibility for project delivery and to coordinate resources and effort from elsewhere in the industry.
Quick wins	Defining tangible, early outputs helps the project gain critical momentum.	The UK and Australian initiatives did not wait for consensus on models for distribution system operations to develop and deliver least-regrets improvements.
Targeted stakeholder engagement	Broad, targeted stakeholder engagement enables stakeholders with different perspectives and needs to collectively engage on complex problems and work through decisions involving important trade-offs, creating buy-in and traction.	Australian experience demonstrated that a purely technical approach can struggle to gain traction without broader stakeholder engagement and practical applications; the UK public consultation process more effectively engaged stakeholders.
Early and ongoing alignment with stakeholders	Participants must be closely aligned on the project's aims, its metrics of success, and all underpinning assumptions.	Each year the UK public consultation process publishes stakeholder responses to the project initiation document, and subsequently publishes an updated document that addresses stakeholder concerns.
Fit-for-purpose modeling and analysis	Detailed technical modeling and benefit-cost analysis can be targeted to specific questions throughout the process, rather than needing to be done at the outset to provide a framework for different options.	Both the Australian and UK projects developed a range of alternative future electricity network models. However, both projects determined that undertaking the comprehensive analysis required to accurately compare alternatives would have been costly and time-consuming, without generating tangible outcomes.
Process agility	Because DER is a fast-moving environment with multiple drivers and rapidly changing knowledge, the project's focus should be adaptable.	Particularly in the UK, where Open Networks is a longer-running initiative, the project has annually redefined the focus of each workstream (e.g., flexibility services, electricity system planning, customer connections) to stay relevant.
Involvement of decisionmakers	It is crucial to involve the parties that have the authority to implement decisive structural action based on the work undertaken.	In Australia, the Australian Energy Regulator was not involved, so actionable steps were not taken; rather, the project outcome was several recommendations for future work. In contrast, in the UK, the government and energy regulator were very involved in the project, and this led to tangible outcomes.

Source: Energy Systems Integration Group.

Takeaways for the United States

A U.S. initiative for DER integration into markets and operations could very productively draw from experiences in the Australian and UK Open Networks projects. Here, we provide a high-level comparison of the regulatory and market structures in the three regions, which will impact how lessons learned in one are transferrable to another. We then summarize eight key takeaways for a U.S. effort and point to near-term, least-regrets actions that could start now.

Comparison of Regulatory and Market Structures

While Australia and the UK differ from the United States in many respects, including having distinct market and regulatory structures, the experience of Open Networks projects in Australia and the UK can help inform the development of a similar initiative in the United States. Table 4 (p. 18) presents a high-level comparison of the Australian, UK, and U.S. electric utility landscapes and market structures.

While the UK and Australia each have a national wholesale electricity market and a similar regulatory construct, the United States is composed of numerous, differentiated market structures, both with and without wholesale markets. Given the diverse market and regulatory structures present in the United States, a national initiative related to DER integration would likely require an approach and focus adapted for the specific needs and characteristics of heterogenous jurisdictions across the country.

Unlike in Australia and the UK, creating a single model for distribution system operations in the United States is not feasible because of the U.S. electricity sector's diversity of organizations and operating practices. Instead, U.S. bulk system operators will need to be able to accommodate multiple models. Developing a limited number of potential models for distribution system operations at the outset of a U.S. initiative would help to frame and focus discussion on the DSO functions and capabilities required for different models. For instance, these models could range from a "limited DSO," where the distribution operator plays a more passive role in DER operations, to a "total DSO" in which the DSO actively manages DERs and acts as a super aggregator for DER participation in bulk power markets.

Key Takeaways

The successes and challenges of the efforts in Australia and the UK provide a useful reference for the development of U.S. initiatives. Takeaways from these projects from which the United States can draw include the following:

1. **Start with a clear statement of purpose and objectives.** Clarity from the outset of the project is necessary to align stakeholders, establish the project's value proposition, and maintain transparency. It is important to not only establish objectives but also remain aligned with them as the project unfolds, to ensure that the project delivers the intended outcomes. The UK provides a strong example of this. The project management team develops project initiation documents for public consultation at the beginning of each year, which ensures that all interested parties are on the same page and driving toward common outcomes.
2. **Establish central delivery capability.** Both the UK and Australian projects have or had dedicated full-time project managers to take responsibility for project delivery and to coordinate resources and

TABLE 4

Comparison of U.S, UK, and Australian Electric Utility Landscapes

	Australia	UK	United States
Regulatory system			
	National	National	Federal
Key regulatory bodies	Australian Energy Regulator (AER)	Office of Gas and Electricity Markets (Ofgem)	Federal jurisdiction: Federal Energy Regulatory Commission (FERC) State and municipal jurisdiction: Public service commissions, municipal and cooperative governing bodies
Regulatory framework	Multi-year regulatory rate plans	Performance-based regulation: RIIO framework (revenue = incentives + innovation + outputs)	Varies by state
Industry structure			
Transmission	Regulated monopoly	Regulated monopoly	Regulated monopoly
Distribution	Regulated monopoly	Regulated monopoly	Regulated monopoly
Generation	Competitive	Competitive	Varies across and within states
Retail market	Competitive	Competitive	Varies by state
Wholesale markets*	Gross pool, zonally priced market run by the National Electric Market Operator	Net pool, zonally priced market, with a balancing market run by the National Electricity System Operator	Gross pool, LMP-based (locational marginal price–based) market run by independent system operators

* In markets with gross pool settlement, all generation and loads are settled at market clearing prices; in markets with net pool settlement, only imbalances are settled at market prices. In zonal markets, market prices do not fully reflect congestion costs; in locational marginal price–based markets, congestion costs are reflected in market prices.

Source: Energy Systems Integration Group.

efforts from elsewhere in the industry. Without a central delivery capability, a project may not efficiently produce high-quality outputs.

3. **Define and pursue quick wins.** While the ultimate success of a national initiative on DER integration into markets and operations will require a multi-year resourcing and funding commitment, the project can gain critical momentum by defining and producing tangible, early outputs. Once a project of this type demonstrates its ability to generate actionable insights for regulators, electric utilities, and DER providers, it can adapt to new objectives that surface in the course of its work and deliver value to the entire sector. Both the UK and Australian initiatives did not wait for consensus on a structural model to develop and deliver least-regrets improvements. In the UK these focused on transmission-distribution interfaces and data transparency, and in Australia they focused on network visibility and operations requirements.

4. **Prioritize targeted stakeholder engagement.** A project that fails to incorporate multiple loops of substantive and transparent multi-stakeholder engagement is at significant risk of failing to achieve the critical alignment among stakeholders that is required to enable decisive action.[7] Creating the "social system" and supporting processes is foundational to enabling stakeholders whose perspectives or goals may conflict to collectively engage on complex problems and work through key decisions around trade-offs. A purely technical approach, as seen in Australia, can struggle to gain traction without strong ties to community needs and practical applications, while a public consultation process and well-defined core project governance, as

7 Where this is achieved, a 10-fold return on investment becomes possible. See ENA (2017b).

seen in the UK, embodies more effective stakeholder engagement.

5. **Work toward early alignment.** Participants must be closely aligned on what the project will achieve, its key success metrics, and all underpinning assumptions. Participants' "non-negotiables" must be thoroughly discussed and explicitly documented before the project begins. Annually, the UK public consultation process documents and publicly publishes stakeholder responses to the project initiation document, and subsequently publishes an updated document that addresses stakeholder concerns.

6. **Develop fit-for-purpose tools.** Both the Australian and UK projects developed a range of alternative future electricity network models informed by a grid architecture model. However, due to the inherent limitations of this modeling, neither project undertook the comprehensive cyber-physical-market structural analysis required to establish real-world extensibility and scalability of the alternatives.[8] Since this modeling would be costly and time-consuming without resulting in tangible outcomes, a U.S. effort would likely be able to forego the significant cost and commitment of this detailed modeling.

7. **Ensure process agility.** In energy sector terms, DERs constitute a fast-moving environment with multiple drivers for different parties (e.g., customer, commercial, regulatory) and continually advancing knowledge, so it will be crucial for the project's focus to adapt. Particularly in the UK where Open Networks is a longer-running initiative, it has been essential to redefine the focus of each workstream annually in order to stay relevant.

8. **Engage parties who have the authority to affect change.** By definition, these projects engage with rapidly changing and highly complex challenges to the traditional electricity supply chain. It is crucial, therefore, to involve the parties who have the authority to implement decisive structural action. The market actors that can implement project recommendations must be deeply involved and committed to enacting real change. In the Australian context, the leadership of AEMO and Energy Networks Australia was important to understand the position of the networks, but the Australian Energy Regulator was not involved; therefore, actionable steps were not taken, and the project outcome was recommendations for future work. In contrast, in the UK, the government and energy regulator were deeply involved in the project, and this led to tangible outcomes.

Potential Near-Term Actions for Delivering Flexibility on the Distribution System

By analyzing the UK and Australian open network efforts, this report provides insights on design elements that could make a similar effort in the U.S. productive and fruitful. These lessons include the importance of structuring a multi-stakeholder initiative: having the appropriate entities participating, ensuring the effort is well funded and can leverage deep technical expertise, and allowing for flexibility in how the initiative evolves. A DER integration initiative in the United States would also need to be designed to accommodate the U.S. electricity sector's diverse stakeholders and federalist division of regulatory authority. Because of the U.S. sector's diversity, there will not be a single model for future distribution system operations; bulk system operators will need to accommodate multiple models. Developing a limited number of potential future models at the outset of a U.S. initiative would help to frame and focus dialogue.

Similar to the Australian and UK Open Networks projects, a U.S. initiative could focus on addressing nearer-term, least-regrets issues, including those associated with implementation of FERC Order 2222 at the distribution level. In addition, both the Australian and UK projects focused on enabling flexibility services at the distribution level, which could be an appropriate next step for the United States as well, for instance, through static and (in some cases) dynamic export limits for DERs. In parallel to tackling nearer-term issues, a U.S. initiative could also be future-focused, like the UK Open Networks Project, beginning to develop consensus on longer-term issues—more active distribution system operations, federal-state regulatory jurisdiction, distribution open access requirements—that may require more time to resolve.

8 Such as an approach to holistic structural analysis of the power system based on the Network of Structures model developed by Pacific Northwest National Laboratory.

References

AEMO and ENA (Australian Energy Market Operator and Energy Networks Australia). 2019. *Open Energy Networks Interim Report: Required Capabilities and Recommended Actions*. Melbourne, Australia. https://www.energynetworks.com.au/assets/uploads/open_energy_networks_-_required_capabilities_and_recommended_actions_report_22_july_2019.pdf.

CSIRO and ENA (Commonwealth Scientific and Industrial Research Organisation and Energy Networks Australia). 2017. *Electricity Network Transformation Roadmap.* Canberra, Australia. https://www.energynetworks.com.au/projects/electricity-network-transformation-roadmap/.

EA Technology. 2019. *Open Energy Networks Project Report*. Prepared for Energy Networks Australia. Capenhurst, UK. https://www.energynetworks.com.au/resources/reports/ea-technology-open-energy-networks-project/.

ENA (Energy Networks Association). 2018. *Open Networks, Future Worlds: Developing Change Options to Facilitate Energy Decarbonisation, Digitisation and Decentralisation.* London, UK. https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws3-14969-ena-futureworlds-aw06-int.pdf.

ENA (Energy Networks Association). 2018. *Open Networks Workstream 3: Product 2; Functional and System Requirements.* London, UK. https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws3-p2-dso-functional-requirements.pdf.

ENA (Energy Networks Association). 2019. "Open Networks Response to Impact Assessment Consultation." Presentation. London, UK. https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-impact-assessment-consultation-onp-response.pdf.

ENA (Energy Networks Association). 2021a. ON21-WS1A-Flexibility Figures 2021 Full Update (30 Jul 2021); Flexibility Figures Across Great Britain as of July 2021 that Demonstrate the Scale and Size of Local Flexibility Markets. London, UK. https://www.energynetworks.org/industry-hub/resource-library/?search=ON21-WS1A-Flexibility+Figures+2021+Full+Update+%2830+Jul+2021%29&id=267.

ENA (Energy Networks Association). 2021b. "Open Networks Project: 2021 Project Initiation Document." London, UK. https://www.energynetworks.org/assets/images/ON21-PRJ-PID%20Project%20Initiation%20Document%20(post-consultation)-v4.0%20FINAL.pdf.

ENA (Energy Networks Association). 2022. "Customer Connections." London, UK. https://www.energynetworks.org/creating-tomorrows-networks/open-networks/customer-connections.

ENA (Energy Networks Australia). 2017a. Electricity Network Transformation Roadmap Final Report. Melbourne, Australia. https://www.energynetworks.com.au/resources/reports/electricity-network-transformation-roadmap-final-report.

ENA (Energy Networks Australia). 2017b. *Research Impact Evaluation: Future Grid Forum and Electricity Network Transformation Roadmap Case Study*. Melbourne, Australia. https://www.csiro.au/-/media/About/Files/Impact-assessment/2017/Impact-Evaluation-2017-Future-Grid-Forum-pdf.pdf.

ENA (Energy Networks Australia). 2020. *Open Energy Networks Project: Energy Networks Australia Position Paper*. Melbourne, Australia. https://www.energynetworks.com.au/resources/reports/2020-reports-and-publications/open-energy-networks-project-energy-networks-australia-position-paper.

ENA and AEMO (Energy Networks Australia and Australian Energy Market Operator). 2018. *Open Energy Networks: Consultation on How Best to Transition to a Two-Way Grid that Allows Better Integration of Distributed Energy Resources for the Benefit of All Customers.* Melbourne, Australia. https://www.energynetworks.com.au/resources/reports/open-energy-networks-consultation-paper.

EPRI (Electric Power Research Institute). 2020. "Principles of Access for Flexible Interconnection Solutions: Rules of Curtailment." White paper. Palo Alto, CA. https://www.epri.com/research/programs/067418/results/3002018506.

EPRI (Electric Power Research Institute). 2021. *The Value of Flexible Interconnection for Solar Photovoltaics Enabled by DERMS: Detailed Techno-Economic Analysis in New York State*. Palo Alto, CA. https://www.epri.com/research/programs/067418/results/3002018505.

Government of the UK. 2017a. "Clean Growth Strategy." Policy paper. London, UK. https://www.gov.uk/government/publications/clean-growth-strategy.

Government of the UK. 2017b. "The UK's Industrial Strategy." London, UK. https://www.gov.uk/government/topical-events/the-uks-industrial-strategy.

Ofgem (Office of Gas and Electricity Markets). 2017. *Upgrading our Energy System: Smart Systems and Flexibility Plan.* London, UK. https://www.ofgem.gov.uk/publications/upgrading-our-energy-system-smart-systems-and-flexibility-plan.

Ofgem (Office of Gas and Electricity Markets). 2021. *Case Study (UK): Open Networks in the Future, Flexible Energy System.* London, UK. https://www.ofgem.gov.uk/publications/case-study-uk-open-networks-future-flexible-energy-system.

Lessons Learned for the U.S. Context: An Assessment of UK and Australian Open Networks Initiatives

A Report of the Energy Systems Integration Group's Distributed Energy Resources Task Force

---

The report is available at https://www.esig.energy/der-integration-series-Australia-UK.

To learn more about the recommendations in this report, please send an email to info@esig.energy.

The Energy Systems Integration Group is a nonprofit organization that marshals the expertise of the electricity industry's technical community to support grid transformation and energy systems integration and operation. More information is available at https://www.esig.energy.

ESIG
ENERGY SYSTEMS INTEGRATION GROUP