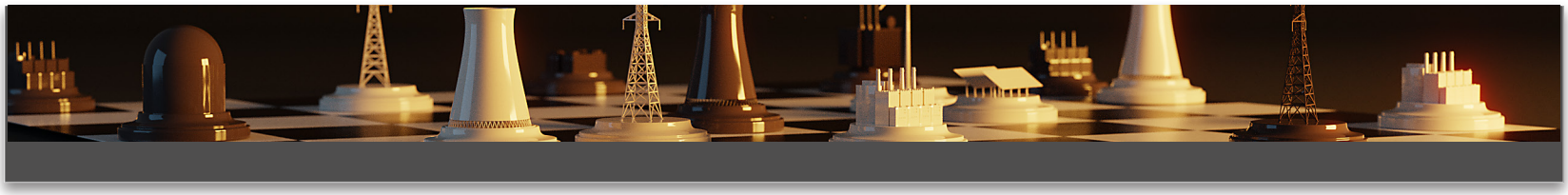
EPRI

TOWARD NET ZERO: **The Evolving Utility Business Model and Possible Future Scenarios**



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1. EXECUTIVE SUMMARY

Transformation of the energy system is expected to make a substantial contribution to meeting local, national, and international commitments to address climate change. Many aspects of the transformation are being debated as stakeholders consider options and trade-offs to ensure that good climate, economic, and social outcomes are achieved.

Utilities might not be immune to the impact of change; in fact, they will play a critical and central role in delivering it. The nature and pace of change is expected to be driven by several competing and complementary factors, meaning that utilities will have choices and can engage actively so that their future is shaped by design, not by accident or omission.

The drivers and responses will span all aspects of utilities and the sectors they serve. This reflects the high degree of sector coupling—between electricity, heat, transportation, and industry, for example. The utility will likely no longer be bounded by the customer meter.

Energy system transformation can be characterized by high degrees of uncertainty. New ways of working might be needed to address arising challenges and opportunities. This means looking beyond the traditional boundaries of the business or relying on traditional business models. New players will be active in reshaping the competitive landscape. An alternative view is the possibility of nationalization, which would imply radical change in some countries.

Utilities likely will be required to provide services and resources that ensure the availability of energy even where markets, competition, regulation, technology, and customer choice put pressure on revenue streams. There are lessons that can be taken from other sectors, such as telecommunications, where optimization of markets for consumers through extensive competition has led to a significant reforming of the value chain.

The complexity of this transformation can be viewed through a set of scenarios that seek to promote discussion about possible futures. These scenarios are illustrated in Figure 1.

It is likely that individual utilities will see aspects of more than one of these scenarios in their business or will find that they migrate from one to another over time and in response to a changing environment. This presents not only threats but also opportunities for those willing to pursue them. The scenarios offered in this report provide a way to frame thinking about possible futures and how best to address these threats and opportunities.

TECHNOLOGY and SYSTEM INNOVATION		CLOSED	OPEN
	PROACTIVE	**Utilities Lead** Utilities see the opportunity to respond to corporate drivers and sector mandates in a transformative way and assume a leadership role and benefit from growth.	**Utilities Disrupt** Utilities see the opportunities in transformation, and actively and assertively seek to achieve value and benefit.
	REACTIVE	**Utilities Follow** Utilities respond to mandates but largely act in an incremental and evolutionary way.	**Utilities Retreat** Utilities build on traditional strengths either by preference or because of externally imposed constraints in an environment of strong competition.
		BUSINESS ENVIRONMENT	

Figure 1. *Energy system transformation scenarios for utilities*

A review of the changing landscape leads to the following recommendations for utilities as they consider ways to ensure their sustainability and ongoing contribution to the communities they serve:

- A strong starting point for considering the potential opportunities presented by transformation is for utilities to undertake deep review of their strategic purpose, direction, and aspirations; their resources to deliver their preferred strategy; the environment in which they operate; and their ability to effect change. Current offerings might be sustainable, but they need to be placed in the context of the changing environment. Utilities can decide what role they want to play and what markets they want to serve and focus on, and, if appropriate, develop new offerings that could displace or enhance existing ones.
- Utilities could gain new insights by approaching their strategy development backward from the future and not seek the perfect business model before acting. There could be an approach that develops and implements a "living roadmap" and then actively monitors and measures activities and events to drive learning and adaptation. Iteration and agility will be key success factors.
- Utilities are likely to benefit if they take a systems-oriented approach in considering evolution or change pathways and in executing the chosen strategy. There is no room for siloed behaviors as the landscape of interactions and dependencies that will affect decision making becomes more complex and the stakes become higher. The decision on which path to follow will depend on the appetite and ability to compete with a variety of other players and to develop and deliver compelling offers.
- Utilities could explore new techniques for decision making under uncertainty, such as artificial intelligence as applied by organizations like Faculty AI[1], and new approaches, such as those espoused in the Utility 2050 thinking.[2]
- Utilities might want to consider relationships with partners and partner ecosystems to provide needed capabilities; enable interesting, differentiated offerings; and support sustained competitive advantage.

These recommendations are served by the scenarios. The process of drawing together the right stakeholders to engage in discussion using the scenarios as a shared reference point to facilitate understanding is a valuable step in the transformation journey.

[1] https://faculty.ai/ai-for-energy-transition-and-environment/

[2] https://foresighttransitions.co.uk/energy-transitions-and-futures/

2. INTRODUCTION

Energy utilities play an essential economic and societal role today and will continue to do so. Their journey to a decarbonized future will exert new pressures, create new challenges, and open new opportunities. One vision for the future would see the boundaries of the utility redrawn, innovative technologies deployed, new players delivering new services, and the competitive landscape altered. The environment in which such a future would emerge would be characterized by a high degree of uncertainty. One key area that utilities may consider is the impact on current business models and how these may change as part of the anticipated transformation.

A review of the utility landscape is a valuable starting point in identifying potential scenarios for the future and supporting the ongoing discussion that will be needed to enable thinking, planning, and action. EPRI has undertaken such a review; this report presents our findings and recommendations. The report is intended as a thought-piece to be used to contribute to discussion between utilities and other stakeholders as the transformation of the energy sector unfolds. It focuses on the relationship between the future energy landscape and new utility business scenarios and related business models that could be revealed and enabled. Importantly, it takes a holistic view of the outcomes required or expected by key stakeholder communities to inform the perspective.

This report does not attempt to provide rigorous modelling of future scenarios or financial analysis of business models, nor does it impose specific time frames. Instead, it highlights options and puts them in the context of possible future scenarios for sector change. The report:

- Summarizes some of the key drivers of the transformation of the energy system
- Describes the outcomes that key stakeholders might seek
- Considers some of the challenges and opportunities that utilities could face as they transform in pursuit of identified outcomes
- Proposes possible scenarios that can frame future context for utilities
- Identifies business model options that could arise from the scenarios
- Presents high-level recommendations for considering potential decisions

This report complements the portfolio of work EPRI has undertaken, has in progress, and has planned. The research on which it is based builds on the findings from the Utility Business Model (UBM) Working Group. In 2020, four organizations joined to sponsor the UBM Working Group—The Smart Electric Power Alliance, EPRI, Gridwise Alliance, and Grid Forward (The Working Group Collaborative). The group is attended by utility members across the world and holds monthly virtual sessions to discuss important energy innovations that have demonstrated the potential for success in integrating new technology into utility operational processes, planning, and designing a model for prudent investment, enabling revenue generation, and meeting policy directives for new utility constructs. A report is available that synthesizes the outcome of 11 Webcast sessions held between October 2020 and 2021.[3]

[3] https://www.epri.com/research/products/000000003002023073

3. THE CHANGING LANDSCAPE FOR UTILITIES

The energy sector is beginning a journey of profound transformation, reflecting local, regional, national, and international ambitions and action. The central driver for change is the climate emergency and the need to decarbonize energy supply and demand, both of which rely substantially on fossil fuels today. The move to clean energy is likely to depend heavily on electrification and sources of electricity that are low-carbon.

Drivers and Influences

Against this background and the broad commitment at all economic and social levels, the key drivers of the energy sector's transformation can be identified:

- **Decarbonization** to contribute to the deep reduction of greenhouse gas emissions as expressed in political and social commitments, not only in the energy system but in sectors coupled to it, such as heating and transportation.
- **Reliability and resilience** of energy supply in the face of increased economic and societal dependence on energy and the increasing risks arising from climate change.
- **Technology**-enabled opportunities to provide new services and reduce costs, particularly opportunities arising from digitalization.
- **Consumer and citizen expectations** that are reflected in affordability and availability of energy for all and supported by a desire for high-quality customer service.
- **Finance and investment requirements** to achieve revenues and profits that can sustain viable returns in an uncertain and complex environment.
- **Policy and regulation** that interpret global, national, and local interests and set the direction, framing, and rules that describe the transformation that is expected and establishes the context for change.

In addition to these key drivers, other highly influential factors might guide the nature and pace of energy sector transformation:

- Transformation of the energy system to a decarbonized future should be fair and equitable; no one should be excluded or left behind. This requires an understanding of diverse needs and a commitment from all stakeholders to the **principle of a just transition**.
- The impact of decarbonization is not limited to reduction in greenhouse gas emissions; there are also **significant co-benefits** that can be achieved if interventions are well executed. These benefits are particularly valued by citizens and governments.
- Transformation of the energy system is seen as a **source of economic growth**. The benefits can be measured in both economic and social terms as jobs are created and communities grow and prosper.
- **Energy price increases and volatility arising from geopolitical dependencies and dynamics** are creating demand for change in the energy system and exerting strong influence over thinking on transformation. This emphasizes the matters of affordability and security of supply and could affect risk-based choices.
- **Social awareness** of energy and energy transformation will grow. Consumers and individuals might demand action and reflect this in their political capacity.

Framing Change

Utilities should explicitly account for these drivers and influences in establishing their view of future purpose and direction. The following attributes are offered as a useful framing for utilities as they consider possible futures and approaches to transformation:

- **Strategy**: Focus on markets and customers where competitive advantage can be sustained, and do so in what is an uncertain and unpredictable environment.
- **Carbon**: Commit to delivery of decarbonized energy and to decarbonizing their businesses.
- **Resilience**: Satisfy economic and social needs for reliable and resilient sources of energy.
- **Reputation**: Respond to consumers' and citizens' needs, and act in a way that builds positive, trust-based relationships and respect in the community.
- **Risk**: Identify, evaluate, mitigate, and manage the interdependent technical, operational, and commercial risks that arise with change.
- **Financial**: Be financially robust and sustainable, following best corporate practice.
- **Innovation**: Be innovative, drawing on the best that technology has to offer and applying it in the most effective and efficient ways.
- **Policy**: Operate within the policy structures and engage positively with policymakers.
- **Regulation**: Maintain constructive relationships with regulatory bodies and comply with the spirit and rule of regulation.

These drivers, the responses to them, and the outcomes sought are deeply interconnected. The transformation is a whole-system opportunity and will be most successful if approached systematically. Utilities should understand not just the individual drivers and their respective responses, but also the interactions, dependencies, and trade-offs between them.

The Changing Utility

The role of the energy utility today is largely perceived to be twofold: first to provide a safe, resilient supply of energy that is affordable for all, and second, to run stable, sustainable businesses that serve the needs of citizens, customers, shareholders, governments, employees, the economy, and society broadly.

Utilities have a third role that is expected to strengthen in the future: to achieve decarbonization outcomes that satisfy relevant local, regional, national, and international mandates while acting as a good corporate organization and citizen. In doing this, utilities will be obliged to respond to the drivers and influences of energy system transformation and to do so in a way that works with and respects the needs of other key stakeholders. This presents both challenges and opportunities for utilities with the skill and appetite to pursue and seize them.

Energy system transformation is anticipated to include interventions spanning the following (drawing from the work of the UK Climate Change Committee[4]):

- Energy efficiency to reduce demand across the economy
- Societal choices that lead to a lower demand for carbon-intensive activities
- Digitalization
- Decarbonization of generation using renewables, nuclear, clean gases, and hydro
- Extensive electrification, particularly of transportation and heating
- Emphasis on heat and buildings

[4] https://www.theccc.org.uk/

- Development of a hydrogen economy to service demands for some industrial processes, for energy-dense applications in long-distance HGVs and ships, and for electricity and heating in peak periods
- Carbon capture use and storage in industry, with bioenergy, and very likely for hydrogen and electricity production

Supporting expressions of needed change are described in the European Technology and Innovation Platform Smart Networks for Energy Transition **ETIP SNET R&I Implementation Plan 2022–2025**[5] and the **Future Power System Architecture** work of the Energy Systems Catapult in collaboration with the Institution of Engineering and Technology.[6]

The pathway pursued by each utility will depend on its specific political, regulatory, and commercial environment and on the resources it has available. It cannot be assumed that the utility will retain its traditional space nor its original functions. In fact, it is possible that policy and regulation pressures will see that this is not the case, with the creation of new markets and the emergence of a competitive landscape. Alternatively, as geopolitics and other considerations emerge more strongly, it is possible that nationalization will be pursued in some jurisdictions.

More information describing the key utility functions and how they might change is provided in Appendix A, "Electricity Utility Evolution."

[5] ETIP SNET, R&I implementation plan 2022-2025 - Publications Office of the EU (europa.eu)

[6] https://es.catapult.org.uk/report/review-of-future-power-system-architecture-fpsa-functions/

4. ACHIEVING NEEDED OUTCOMES FOR STAKEHOLDERS

One definition of a utility is "a company that provides a service such as an electricity or gas supply."[7] The simplicity of this definition disguises the complexity of utilities' structure, operations, and relationships with the communities they serve.

The high-level model of the energy sector shown in Figure 2 can be used to describe the context in which utilities operate. The manifestation of this model varies across jurisdictions, reflecting local history, politics, and circumstances.

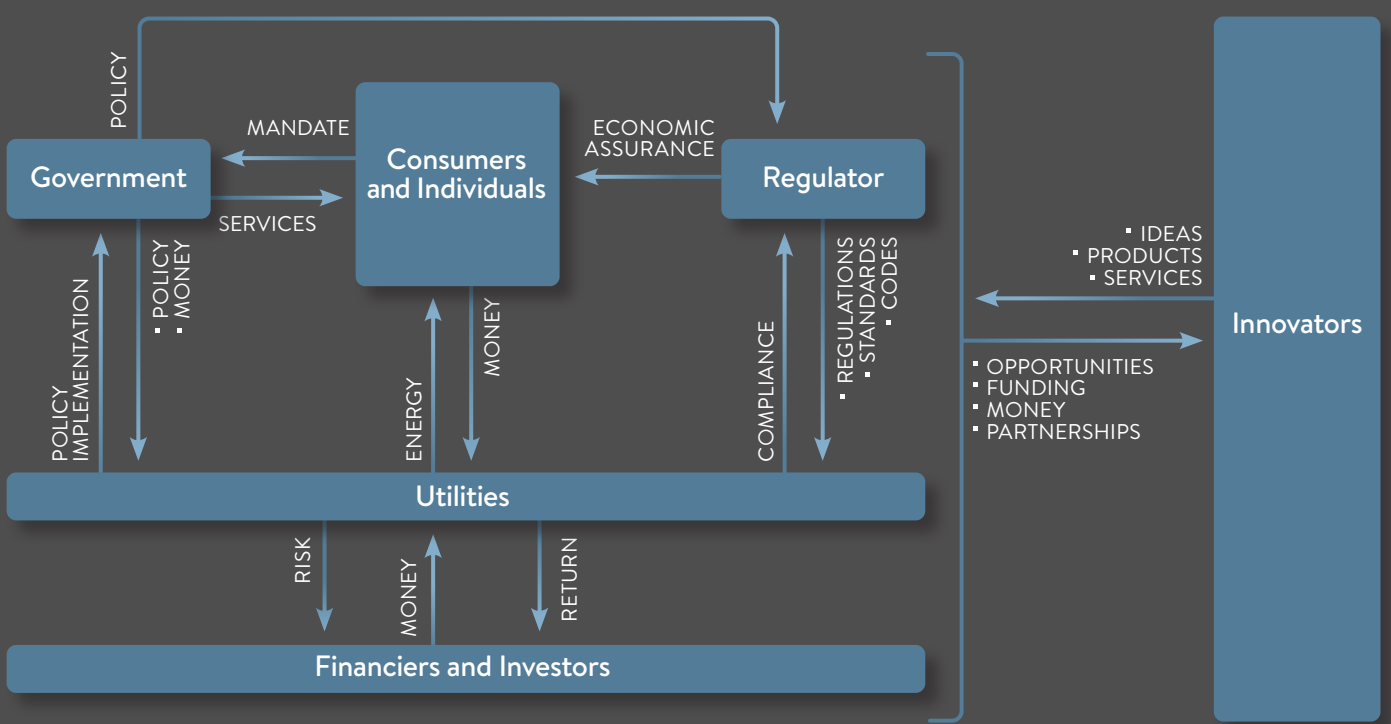

Figure 2. *Energy sector model*

[7] https://dictionary.cambridge.org/dictionary/english/utility

The model illustrates key groups of stakeholders and the interactions between them. The structure and behaviors might vary, but this abstraction can clarify the future energy landscape and business models that will exist. It also helps structure the outcomes that stakeholder groups might seek. The major stakeholder groups are as follows:

- **Consumers and individuals**: industrial, commercial, and domestic users of energy in all its forms; members of society that are committed to ensuring the well-being of their families and communities; the ultimate beneficiaries of all other stakeholders' efforts.
- **Utilities**: public, private, or hybrid businesses that deliver energy services to industrial, commercial, and domestic customers; fully or partially regulated as often operating in monopoly circumstances; carry obligations to customers for providing affordable energy to all who request it.
- **Government**: elected bodies that reflect the interests of citizens; operate at local, regional, and national levels and could be influenced by or obliged to international initiatives; provide the policy and legislative frameworks in which the energy sector operates; focused on achieving outcomes for society and the economy.
- **Regulators**: bodies that provide the framework in which the energy sector operates and the mechanisms for ensuring compliance and potentially good outcomes for consumers and society; interpret and enforce the policies of governments; have influence or control over the business environment in which utilities operate.
- **Innovators**: organizations of all sizes that bring new ideas, products, and services to support and enable change; contribution can be technology, value proposition, business model, operations process, policy, regulation, investment mechanism, among others; can be found in the other stakeholder groups referenced.
- **Financiers and investors**: public and private sources of funding and investment to enable businesses to become established, grow, and be sustained; includes traditional and innovative mechanisms and approaches; guided by appetite for risk and the expectation of commensurate returns.

Change in the energy system can be informed and guided by the outcomes that these key stakeholder groups seek and that respond to the key drivers of transformation. Considering the implications of the drivers on each stakeholder group could enable overarching outcomes to be summarized that reflect a whole-systems view; these outcomes are summarized in Table 1. Supporting detail for each driver of change is provided in Appendix B.

Table 1: *Stakeholder outcomes*

Stakeholder	Outcome Sought
Consumers and individuals	▪ Energy supply that offers high levels of comfort and convenience to support a broad spectrum of economic and social needs and preferences. ▪ Affordable energy for all. ▪ Resilient supply. ▪ Responsible behaviors from those who deliver their energy services.
Utilities	▪ Services that consistently satisfy climate, economic, and social needs. ▪ Trust-based relationships with consumers, citizens, and communities. ▪ Sustainable business models established; corporate futures secured. ▪ Opportunity to thrive.
Government (at all levels)	▪ Demonstrable progress in addressing the climate emergency successfully and achieving a "good" net zero. ▪ Successful response to economic and societal demands, balancing the need to deliver with the complexities of politics. ▪ Energy transformation is being leveraged to support economic growth and provide resilience.
Regulators	▪ Measurable progress in addressing the climate emergency. ▪ Robust, healthy energy sector. ▪ Compliance with established rules, standards, and codes. ▪ Best practice is being followed, and there is fairness and integrity in the industry.
Innovators	▪ Rich and varied opportunities to commercialize good ideas. ▪ Environment that encourages and supports sustainable businesses. ▪ Opportunities to apply technology and creativity to enable and accelerate needed change. ▪ Support for fair and equitable transition of the energy system.
Financiers and investors	▪ Substantial opportunities to provide finance and investment. ▪ A level of certainty that enables risk to be assessed and priced. ▪ Sustainable returns that reflect the risks taken. ▪ Alignment with economic and social context and direction.

5. CHALLENGES AND OPPORTUNITIES FACING UTILITIES

The new energy system value chain reveals challenges and opportunities that stimulate response from utilities. There are key themes that emerge:

- The absolute need to achieve a decarbonized energy system
- Implications of the new architecture of the system
- Complexity of system integration and operation
- Changing consumer needs and values
- Changing nature and shape of demand
- Changing competitive landscape
- Potential of technology-enabled opportunities
- Critical role of policy and regulation and the need for reasonable certainty
- Financial and investment sustainability

Questions that may be implicit in considering demand are perhaps of particular interest to the utility:

- Materiality of demand reduction and efficiency measures
- Materiality of self-generation, consumption, and storage
- Requirement to provide insurance to consumers for their service, either in energy or financial terms

The challenges and opportunities to utilities can be considered from the perspective of the attributes that frame their response to the drivers of energy system transformation, being mindful of the outcomes that all key stakeholders may be seeking to achieve. These challenges and opportunities are described in Table 2. Further information is provided in Appendix C.

Table 2. *Challenges and opportunities for utilities*

Aspect	Challenges for Utilities	Opportunities for Utilities
Strategy: Focus on markets and customers where competitive advantage can be sustained, and do so in what is an uncertain and unpredictable environment.	It might be difficult to make decisions that will ensure a viable, sustainable business given the high degree of uncertainty that characterizes the energy landscape.	Transformation gives the potential for using more interactive, adaptive approaches to creating or taking a new position in the sector and for business and operational refresh.
Carbon: Commit to delivery of decarbonized energy and to decarbonizing their businesses.	Utilities must decarbonize themselves and serve the needs of dependent sectors that will be relying on utilities to support achieving carbon obligations.	The utility can be a decarbonization leader.
Resilience: Satisfy economic and social needs for reliable and resilient sources of energy.	System reliability and resilience might be difficult to ensure in an increasingly complex, renewables-biased system, whereas economic and social dependency on energy is growing.	New architectures, technical innovation, and rethought operational and commercial practices can be exploited to deliver resilient differentiated services and needed outcomes.
Reputation: Respond to the needs of consumers and citizens, and act in a way that builds positive, trust-based relationships and respect in the community.	Consumers are changing. They will have choice about what they buy from utilities and how they interact with them, if at all.	The utility must carefully segment customers and look outside traditional customer sets to create differentiated offerings that respond to identified and evolving needs.
Risk: Identify, evaluate, mitigate, and manage the interdependent technical, operational, and commercial risks that arise with change.	Complexity, uncertainty, and pace of change will make risks harder to identify, analyze, price, and address.	Business and operations processes based on adaptive and iterative principles and practices will help the utility to manage risk in a changing landscape.
Financial: Be financially robust and sustainable, following best corporate practice.	The ability to ensure revenue and profit streams can be threatened by consumer change and the impacts of the actions of policy makers and regulators who act in response to interests and stimuli beyond those of utilities.	Transformation can create increased or new opportunities to generate revenue and profit, through new service offerings, business models or partnership arrangements.
Innovation: Be innovative, drawing on the best that technology has to offer and applying it in the most effective and efficient ways.	Innovating or acquiring innovation must be timed well to avoid the risk of stranded assets and depends on skills that may not be easily acquired and retained.	Deployment of well-selected innovations can create competitive advantage and pace; use of trials, pathfinders, and living labs can help mitigate associated risks.
Policy: Operate in the policy structures and engage positively with policymakers.	Policy for decarbonization may not be clear or certain and may result in unintended consequences.	Engagement between policymakers and utilities may inform policy development and enable utilities to prepare for change proactively in the interests of all stakeholders.
Regulation: Maintain constructive relationships with regulatory bodies and comply with the spirit and rule of regulation.	The pace of regulatory change may be surpassed by the pace of change being initiated or championed by other parties, creating business and operational stress and confusion.	Engagement with regulators should emphasize that a transforming and transformed energy system requires robust utilities and needs positive action from the utilities to deliver sector outcomes.

6. FUTURE UTILITY SCENARIOS

Future utility scenarios provide a way of organizing and describing the context in which utilities are likely to be required to operate and to reveal options for how they might choose to participate. In doing this, they should acknowledge the current body of thinking and action that utilities and their partners have deployed in responding to the drivers of energy system transformation and in addressing identified challenges and opportunities.

The scenarios offered in this report are intended to help frame discussion about strategy and options and inform decision-making. They are respectful of the individual and shared outcomes that all key stakeholders may be seeking to achieve. To that end, the scenarios are underpinned by a spectrum of possibilities for each key group of stakeholders. These possibilities do not mean that stakeholders have abandoned their primary outcomes, but they help understand their view of how outcomes might be achieved. These possibilities are described in Appendix D.

Note that the detail of these scenarios and the circumstances they describe will vary in emphasis in business environments across Europe, North America, and worldwide. However, it is intended that they will help illuminate options and priorities across different regions.

The scenarios are intended to be supportive of taking a whole-system view on energy system transformation for the benefit of all. They seek to bring a degree of consistency to needed discussions and engagement. The proposed scenarios express a future view as a matrix, as shown in Figure 1. The axes seek to capture the dimensions of change over which the utility might be able to exert some degree of influence, but not control:

- **Business environment**: The business environment brings together implications of relevant aspects of policy, regulation and markets, consumer behaviors, and the responses of the finance and investment environment that underpin change.

  A *closed business environment* is characterized by a more traditional model where utilities are treated largely as providers of public good rather than as freely competitive entities. They are subject to stronger regulation that is likely to be rules-based. Their business models are oriented to a return on investments in infrastructure. Competitive forces are limited, and the utility will be constrained in their ability to offer services other than those at the core of their business. The financial and investment context draws on the certainty of returns. Nationalized utilities are at one end of this spectrum of options.

An *open business environment* is one that the orientation is to open competition and the introduction of new players. Regulation is still present in rule form for certain aspects, such as safety and consumer protections, but it adopts a lighter-touch, principles-based approach otherwise. Policy encourages this structure and actively enables or encourages market development and action. Utilities may still carry certain obligations to provide at least minimal levels of service and to ensure security of supply. Utilities may have the option to participate freely, or they may be constrained in their freedom to be active, competitive participants.

- **Technology and system innovation**: Innovation addresses the adoption of new technologies and approaches to support and enable transformation. It spans strategic and operational planning as well as network and system operations matters. Integration is a key aspect, moving from networks-based perspectives to systems-based ones. Pace of adoption is also a key consideration.

  Reactive technology and system innovation will respond to specific requirements but is unlikely to be enthusiastic in introducing new technologies or methods. Interventions will be incremental, not transformative. There is inherent risk aversion, so the pace will be slow. Networks will continue to function as needed but will offer primarily standard services.

  Proactive technology and system innovation actively seeks to collaborate with other industry players and engage with and adopt new capabilities. It is motivated by continuous improvement and extracts the benefits that arise. This implies a willingness to take some risk but, in addition, to employ new techniques for mitigating that risk. The result is a modern evolving network that forms part of a system that addresses replacement of aging infrastructure and builds platforms for better performance and optimized offerings.

In both axes is an assumption that there will be sustained intensity of effort on decarbonization across all stakeholders.

The matrix consists of four quadrants, each of which describes how a utility might engage with the energy opportunity:

- **Utilities follow**. Utilities respond to specific drivers and mandates but largely continue to evolve organically with incremental growth and tempered adaptation. The business environment is supportive of this, and potentially reinforces this response. Regulation retains or possibly strengthens a traditional view of the utility, protecting or extending its monopoly. Utilities remain the bedrock of energy delivery, holding the primary customer relationship. The business model is sustainable but with a constrained growth opportunity and that opportunity derived mainly from the volumetric supply of energy. The change could be described as centered on substituting fossil fuel energy with low-carbon energy but otherwise retaining many familiar structures and behaviors. Utilities closely follow government and regulatory direction and continue to deliver decarbonization efforts. However, innovation is focused on building on existing networks and evolution: replacement of aging infrastructure, asset management, and scaling. The perspective is more to assets than systems. Sector change is guided by necessity, not opportunity. The utility retains a more traditional role, potentially relying on partners or third parties when distinctly new capabilities are required.
- **Utilities retreat**. To deliver decarbonization commitments and give customers choices, policymakers and regulators open up new markets and introduce competition. Utilities respond in a relatively traditional way, either by preference or because of regulatory constraints. Some freedom from certain aspects of their obligations may be opened, but there is little enthusiasm for pursuing them aggressively. The environment is more dynamic; utilities will rely on their strengths to pursue opportunity where possible, but the scale of opportunity will be constrained by competition. They may strengthen or scale their businesses, but not increase in scope. Consumer behavior could change significantly with increases in self-generation and consumption and more commitment to demand reduction and efficiency. This could be material to volumetric sales of energy with impact on business models. Utilities are likely to remain the entity that must ensure security of supply, which means carrying costs associated with less profitable activities and with obligations; this requires suitable financial arrangements to be in place. Utilities will build on existing network and evolve to decarbonize in keeping with political and regulatory requirements. The network could be seen as a platform that provides certain core services with other services and possibly competing services being provided by others in a relatively open market. Innovation by utilities will be evolutionary; innovation by others could be substantial.
- **Utilities lead**. Utilities embrace innovation: technology development continues at pace, system approaches become increasingly embedded, ways are found to deliver new services. Policymakers and regulators look to build on the strengths of utilities to deliver decarbonization and other ambitions. The role of utilities is enhanced because they are positioned to be the leaders on delivering sector transformation. Utilities see this opportunity and respond to sector drivers and mandates in a transformative way and assume leadership. Innovation across the utility business will be actively pursued, and adoption will be encouraged. Risk management mechanisms will be established accordingly. The consumer will look to the utility for modern services—a decarbonized grid, standard offerings, new services, and support with efficiency measures. The utility might choose to work with partners to deliver these services. The business opportunity is significant and sustainable but requires

creative development and execution. Regulators will act in a largely traditional way to ensure that consumers are protected and a fair transition happens but will provide relaxations to enable utilities to make investments based on innovation.

- **Utilities disrupt**. All parties, including utilities, see the opportunities in transformation and actively seek to achieve value and benefit. Substantial innovation and new market entrants drive meaningful change enabled by policymakers and regulators taking more radical positions: they set the high-level trajectory and leave the rest to natural market forces, customer choice, and technology deployment. The classic utility model falls by the wayside but is replaced by other new models. The result is a dynamic, vibrant, competitive sector with many participants. This creates strong potential for utilities with appetite for a competitive, fast-changing environment and offers a sustainable, growing business environment for the agile provider of good-value products and services. The consumer plays an active role in both the supply side and demand side; they may join community groups to support sharing services. Utilities have the freedom to operate and compete in the solution provision market but retain obligations to provide supply insurance. Innovation occurs across the whole landscape.

Utilities will find themselves in one of these quadrants or on a journey across them over time. A utility can succeed in any of the quadrants, but by design, not by accident; success in any quadrant will not happen without proactive intervention. Similarly, a utility can fail in any of these scenarios, either in steady state or in transition.

7. USING THE SCENARIOS

The scenarios are intended to be used informally to enable discussion and frame thinking about possible futures. This can take the following forms:

- Allowing a utility to see where they sit in the landscape today
- Identifying possible responses to changes that are happening or could happen in the landscape
- Considering the perspectives of other stakeholders and how they might align or conflict with those of the utility
- Tracing possible journeys across the landscape that could inform strategic options
- Helping to think through where a good destination might be in transformation

The scenarios can help utilities and their partners consider the decisions that might need to be made and the factors on which they depend. Table 3 lists example questions.

One approach to using the scenarios is as a way of supporting a "future-back" review of the utility's strategy and direction. The scenarios provide a way of perceiving possible futures at a very high level; the questions in Table 3 then allow the various aspects of change to be explored that relate to what is required to achieve that position and whether the enabling conditions are in place or could be built that would allow such a direction of travel. The scenarios can also reveal how it might be possible to move from one position to another over time, based on change in circumstances or in response to threat or opportunities. Other approaches are possible; however, in all cases, the objective is to organize the complexity of potential change and enable stakeholders to have meaningful discussion using common language and a shared reference point.

The scenarios could help to build an understanding of the relevance of some of these questions and how to answer them. Conversely, the questions can act as a guide to potential journeys around the scenarios. In the first instance, the discussion that unfolds could be more valuable than a clear statement of the path to be followed.

Table 3. *Decisions and dependencies*

Aspect	Decision	Dependencies
STRATEGY: Focus on markets and customers where competitive advantage can be sustained, and do so in what is an uncertain and unpredictable environment.	▪ What role for the utility? ▪ Which markets to pursue? ▪ Where to position on the value chain? ▪ Energy only? ▪ Options that are realistically available? ▪ Positioning against competing demands? ▪ How to play: individual player or with partners? ▪ Measuring success: what success factors will be measured? How and why? ▪ What mergers, acquisitions, and partnerships could be needed or beneficial? ▪ Restructuring to enable participation in unregulated markets?	▪ Completion of a "no holds barred" assessment of the current business and its ambitions and aspirations, strengths, and weaknesses ▪ Identification of the credible and viable options and undertaking analysis of them ▪ Navigating policy and regulatory uncertainty and change, technology readiness and consumer intent, engagement, and acceptance ▪ Competitive landscape ▪ Supply chain readiness and resources availability ▪ Commitment to change and ability to execute
CARBON: Commit to delivery of decarbonized energy and to decarbonizing their businesses.	▪ Can required decarbonization be provided inside a viable business model and financial constraints? ▪ What offering can be made that aligns? ▪ Desired customer/community perception of the organization?	▪ Corporate strategy ▪ Ability to measure progress
RESILIENCE: Satisfy economic and social needs for reliable and resilient sources of energy.	▪ Can required resilience be provided inside a viable business model and financial constraints? ▪ What level of resilience and what kind do you want to offer (aligned with service offering)?	▪ Corporate strategy ▪ Policy and regulatory requirements/obligations
REPUTATION: Respond to consumers' and citizens' needs. Act in a way that builds positive, trust-based relationships and respect in the community.	▪ Which customers? ▪ Where to position in the market (in terms of offering and quality)?	▪ Careful segmentation of customers and offers that responds to the needs of target markets ▪ Excellent delivery ▪ Agility, iteration, and adaptation
RISK: Identify, evaluate, mitigate, and manage the interdependent technical, operational, and commercial risks that arise with change.	▪ Risk appetite?	▪ Corporate strategy ▪ Stakeholder strategy ▪ Excellent delivery ▪ Agility, iteration, and adaptation
FINANCIAL: Be financially robust and sustainable, following best corporate practice.	▪ Which business model? ▪ What are the costs of implementation/change? Can this be afforded? ▪ Is the new business model sustainable?	▪ Markets that enable sensible costs and viable prices ▪ Access to finance and investment at viable rates and terms ▪ Compelling case for the new business model ▪ Convincing risk management
INNOVATION: Be innovative, drawing on the best that technology has to offer and applying it in the most effective and efficient ways.	▪ Leverage existing strengths and optimize or embrace innovation? ▪ Focus and priorities if innovation is to be key? ▪ How to address the risk of stranded assets?	▪ Ability and willingness to engage with the innovation agenda ▪ Funding ▪ Ways to test and validate ▪ Excellent execution ▪ Agility, iteration, and adaptation
POLICY: Operate within the policy structures and engage positively with policymakers.	▪ How active to be in trying to drive change? ▪ Knowing what you want— which changes and which priorities? ▪ Align the business with the desired policies?	▪ Relationships and approaches for engaging on a new footing ▪ Collaborative/cooperative relationships with others in the value chain to set direction/ create critical mass ▪ Time to enable change to be affected
REGULATION: Maintain constructive relationships with regulatory bodies and comply with the spirit and rule of regulation.	▪ How active to be in trying to drive change? ▪ Knowing what you want— which changes and which priorities? ▪ Align the business with the desired policies?	▪ Relationships and approaches for engaging on a new footing ▪ Collaborative/cooperative relationships with others in the value chain to set direction/ create critical mass ▪ Time to enable change to be affected

8. BUSINESS MODEL OPPORTUNITIES FOR UTILITIES

The future utility scenarios provide context for considering emerging business models.

Evolution of Existing Business Models

Traditional utility business models will evolve or be displaced, as suggested in Table 4 (next page). These business models would be relevant to utilities in all scenarios, but there will be variation in interpretation.

Potential and Emerging Business Models

There are new business models that can be considered in the future energy system, including those described in The Utility Business Model (UBM) Working Group: 2021 Report (EPRI 3002023073). Their structure and viability will be influenced by several factors, including (but not limited to):

- Attractive service offerings rather than commodity offering (units of energy in kWh)
- The extent to which consumers become prosumers
- Success of demand reduction and efficiency measures
- The move to integration and delivery of a solution rather than transactional supply

All of these depend on the policy and regulatory environment and on innovation to create and deploy them successfully. These business models, described in Table 5 (page 20), would be particularly relevant to utilities in the Utilities Lead and Utilities Disrupt scenarios. Some interpretation might be possible in Utilities Retreat, but it would be limited. It is unlikely that these models would play a role in Utilities Follow. Note that these business models could be established by others and be competitive with utilities' offers.

Table 4. *Evolution of key existing business models*

Today	Description	Tomorrow	Description
Generator	▪ Centralized, large-scale generation; predominantly fossil fuels or nuclear ▪ Delivers to wholesale markets or other contractual arrangements ▪ Based on units of energy sold ▪ Competitive markets in some countries	**Generator** All scenarios	▪ Evolved and optimized version of today ▪ Renewables, nuclear, clean gas, hydro-based replacing fossil fuels over time ▪ Distributed with connection at all levels in the network hierarchy with opportunities at all levels
Transmission Operator	▪ High-voltage network for long-haul electricity transport ▪ Industrial customer connections ▪ Grid-level infrastructure and operations, including balancing ▪ Interconnectors ▪ Typically based on units of energy transported ▪ Not competitive	**Transmission Operator** All scenarios	▪ Potential for spectrum of platform/services, from connectivity to fully managed transmission grid ▪ Evolved and optimized version of today ▪ Onshore and offshore provision ▪ Grid-connected storage
Distribution Operator	▪ Medium- and low-voltage networks for transport serving regional and local areas and directly connected consumers ▪ Typically based on units of energy transported ▪ Typically not competitive	**Distribution Operator** All scenarios	▪ Potential for spectrum of platform/services, from basic connectivity to fully managed distribution network ▪ Inter- and intra-community connectivity services ▪ Evolved and optimized version of today ▪ Increased levels of digitalization to enable services and operations ▪ Network-connected storage
Retailer	▪ Buys energy from generators through the markets or other contractual arrangements and sells to consumers ▪ Delivers to consumers using distribution infrastructure and services ▪ Owns customer relationship ▪ Competitive in some markets ▪ Based on units of energy sold	**Retailer** Different across scenarios At risk in its current form	▪ Retained single ownership of generation and retail functions ▪ Optimized version of today where optimization arises from the combination of the two roles ▪ Potential for imaginative tariffs
Generator-Retailer	▪ Single ownership of generation and retail functions ▪ Pay charges to networks ▪ Competitive in some markets ▪ Based on units of energy sold	**Generator-Retailer** All scenarios	▪ Single ownership of generation and retail functions ▪ Sells energy to retail consumers ▪ Optimized version of today ▪ Potential to use skills to pursue industrial or domestic generation solutions (solar packages, for example) ▪ Based on units of energy sold but potential for imaginative tariffs ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use and flexibility shaping the demand curve ▪ Competitive in some markets ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs
Network Provider	▪ Combined transmission and distribution network provision	**Network Provider** All scenarios	▪ Potential for spectrum of transmission/distribution services; from connectivity to fully managed networks ▪ Integrated and optimized version of today ▪ Inter- and intra-community connectivity ▪ Onshore and offshore ▪ Network-connected storage
Fully Integrated	▪ Integrated value chain from generation through to retail supply to consumers ▪ Based on units of energy sold	**Fully Integrated** Different across scenarios	▪ Reshaped, optimized, and decarbonized version of today: renewables-based generation, distributed resources, storage, and new services, such as flexibility ▪ Includes spectrum of offers from commodity to services ▪ Potential to extend retail into service models

Table 5. *Potential and emerging business models*

Tomorrow	Description
Energy Service Provider	▪ Consumer subscribes to an energy service such as Comfort as a Service or Energy as a Service. ▪ Outcomes rather than kWh-based purchase. ▪ Energy service provider supplies the equipment necessary to enable the service offered to function. ▪ Could include efficiency measures. ▪ Potential to work with partners. ▪ Buys energy from generators and uses network platform services. ▪ Could be an evolution of a retailer. ▪ Variations on who provides the consumer premise equipment needed to provide the service: could be consumer-provided or provided by the service provider as an integrated package. ▪ Arrangements for financing the equipment also a point of flexibility in the offer. ▪ Margin, not return on assets. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use.
Energy Solution Integrator	▪ Consumer engages the solution integrator to undertake implementation of a solution that will enable varying degrees of prosumer participation. Services drawn from consulting, providing, installing, integrating, and bringing into operation. ▪ Could include efficiency measures. ▪ Finance and maintenance options. ▪ Potential to work with partners. ▪ Outcomes, not units. ▪ Margin, not return on assets.
Full Energy Service	▪ Combined energy service integrator with network services provision. ▪ Purchase of exported energy. ▪ Provision of security of service provision. ▪ Potential to work with partners. ▪ Outcomes based. ▪ Margin, not return on assets.
Beyond Energy	▪ Services provided go beyond energy to include security, communications, entertainment—fully connected home. ▪ Leverage data to provide tailored value-added services. ▪ Potential to work with partners. ▪ Outcomes based. ▪ Margin, not return on assets.
System Optimization	▪ Digitally enabled service provider. ▪ Aggregates flexibility and other consumer-provided services and offers these as system services. ▪ Provides network mediation and connection services. ▪ Provision or outcomes based. ▪ Margin, not return on assets.

9. SIGNPOSTS

The energy sector is gathering pace in its transformation. The future utility scenarios seek to describe a view of how this might evolve for key stakeholders in the sector, to a level that might help frame discussion. Business models that might emerge can also be postulated.

It is valuable to look at how the drivers and influences are being exerted and how that might be interpreted using the scenarios. A suggested approach is to look at "signposts" that align with the aspects of transformation given in Table 6 (next page). These signposts are expressed in terms of the axes of the scenarios and suggest measures to assist in assessing the utility's position in the scenario landscape and give insight into how this position might be expected or enabled to change.

Some signposts will naturally occur together and indicate a particular pathway; for example, technology breakthroughs tend to create new business opportunities that utilities and others will exploit. Conversely, stronger regulation, stressed financial markets, and weak policy support might see utilities take more of a "follow" and "retreat" approach. Some high-level signposts and how they align to scenarios are illustrated in Figure 3.

TECHNOLOGY and SYSTEM INNOVATION	CLOSED	OPEN
PROACTIVE	**Utilities Lead** ▪ Technology progress ▪ supportive regulation, ▪ limited competition, ▪ clear policy commitments, ▪ aggressive growth-focused corporate strategies.	**Utilities Disrupt** ▪ Significant technology development, ▪ open and liberal markets, ▪ growth in commercial arms of utilities, ▪ investment in brand and marketing.
REACTIVE	**Utilities Follow** ▪ Constrained financial markets, ▪ tight regulation, ▪ measured carbon commitments, ▪ safe and risk-adverse strategies.	**Utilities Retreat** ▪ Market liberalization, ▪ many new market entrants, ▪ utility 'retrench' focused strategy to platform or backbone, infra-structure role. ▪ Risk-adverse approach.
	BUSINESS ENVIRONMENT	

Figure 3. *Signposts and scenarios*

Table 6. *Signposts*

Aspect	Signpost
STRATEGY: Focus on markets and customers where competitive advantage can be sustained, and do so in what is an uncertain and unpredictable environment.	*Business Environment* ▪ Corporate financial and market share positions and their trajectories ▪ Emerging demand in terms of scale (kWh, for example) and the degree of success in serving it ▪ Emerging demand in terms of how it is being supplied (units of energy versus services, for example) and the degree of success in serving it ▪ Number and type of new players being attracted to the sector and offering direct and indirect competition ▪ Partnership/ecosystem potential and opportunities identified or offered ▪ Degree of alignment or conflict with prevailing policy and regulatory environment *Technology and System Innovation* ▪ Stated and real corporate commitment to innovation ▪ Ability to service capital and operational costs for planning, building, and operating assets and systems ▪ Number of asset failures and system stress events ▪ Use of point solutions to deliver services where strategic investments might be beneficial ▪ Number and types of services that cannot be offered ▪ Time to build or reinforce networks and systems ▪ Level of investment in innovation ▪ Level of investment in people and skills ▪ Technical, financial, and intellectual capacity to innovate at pace
CARBON: Commit to delivery of decarbonized energy and to decarbonizing their businesses.	*Business Environment* ▪ Demonstrable support to international, national, and local decarbonization commitments ▪ Financially successful value propositions for low-carbon energy being delivered ▪ Differentiated carbon position in the landscape ▪ Access gained to relevant carbon incentives ▪ No policy or regulator penalties or restrictions arising because of carbon performance ▪ No carbon-based restrictions on finance or insurance ▪ Satisfaction of corporate measures (Scope 1, 2, 3) ▪ Perception as a low-carbon provider and business *Technology and System Innovation* ▪ Extent of supply of low-carbon energy ▪ Demonstrable progress on a plan to be a provider of low-carbon energy and net-zero utility ▪ Well-progressed suitable adaptation mechanisms established (such as those described by the EPRI READi initiative[8])
RESILIENCE: Satisfy economic and social needs for reliable and resilient sources of energy.	*Business Environment* ▪ Active engagement with policy and regulatory change initiatives ▪ Monitoring and response to relevant aspects of the geopolitical environment (the price of methane, for example) ▪ Financial and business model adaptability (hedging measures, for example) ▪ Agility a recognized and applied attribute of value propositions ▪ Explicit arrangements for supply chain stability in place ▪ Approaches established for people and skills availability, development, and retention *Technology and System Innovation* ▪ Mitigation and continuity plans established and practiced (against cyber risks, for example) ▪ Identification and understanding of key dependencies (between energy and telecommunications, for example) ▪ Fall-back approaches (in addition to "strengthening") in place and practiced to protect against asset and system failures ▪ Extent of deployment of digitalization to support planning, build, and operations ▪ Well-established test and demonstration facilities and practices ▪ Design preparedness for "black swan" events ▪ Adaptation measures in place and an integral part of planning (such as those described by the EPRI READi initiative[9])

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[8] Climate READi (epri.com)

[9] Climate READi (epri.com)

Table 6. Signposts (continued)

Aspect	Signpost
REPUTATION: Respond to consumers' and individuals' needs, and act in a way that builds positive, trust-based relationships and respect in the community.	*Business Environment* ▪ Customer acquisition success and costs ▪ Customer retention and satisfaction measures ▪ Public perception as a corporate citizen (as reflected in the press or social media, for example) ▪ Public perception as low-carbon organization (as reflected in the press or social media, for example) ▪ Public reaction to measures to address emerging issues (such as the cost of energy) ▪ Partnership opportunities identified or offered ▪ Ease of recruitment and retention of people *Technology and System Innovation* ▪ Perception as an innovation leader ▪ Quality and assurance of supply measures ▪ Impact of approach on amenity and willingness to engage and listen to individuals and communities ▪ Support for consumer participation where consumers are actively trying to take advantage of new technologies to address their energy needs (self-generation, for example)
RISK: Identify, evaluate, mitigate, and manage the interdependent technical, operational, and commercial risks that arise with change.	*Business Environment* ▪ Sound risk management approach in place and demonstrated to be effective ▪ Cultural alignment with an ability to respond to unforeseen risks ▪ Extent of diversity in value propositions and business models ▪ Support for explicit decision making in uncertainty approaches *Technology and System Innovation* ▪ Adoption of systems approaches to reveal interactions, interdependencies, and trade-offs ▪ Application of and adherence to best practices and codes in planning, building, and operating assets and systems ▪ Attention on intercepting innovation when it is adequately proven yet offering competitive advantage in its application
FINANCIAL: Be financially robust and sustainable, following best corporate practice.	*Business Environment* ▪ Corporate financial and market share positions and their trajectories ▪ Forecast and market analysis approaches well-established in the context of uncertainty and change ▪ Diversity in revenue streams ▪ Agility on competitive position (avoiding purely price-based competition, for example) ▪ Continuous review of competitive position and awareness of political context ▪ Policy and regulation change tracking to provide early insight into financial impacts ▪ Move from an asset to a system-based investment approach ▪ Commitment to decarbonization to ensure alignment with growing requirements from finance and insurance communities *Technology and System Innovation* ▪ Adoption of systems approaches to avoid false starts and mitigate the impacts of stranded assets ▪ Adoption of strategic solutions where feasible to build platforms for change rather than point solutions that are likely to be more expensive in aggregate ▪ Mitigation of financial risks by test and demonstration ▪ Attention on intercepting innovation when it is adequately proven yet offering competitive advantage in its application ▪ Access of innovation incentives and support mechanisms

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Table 6. Signposts (continued)

Aspect	Signpost
INNOVATION: Be innovative, drawing on the best that technology has to offer and applying it in the most effective and efficient ways.	*Business Environment* ▪ Active pursuit of access to new opportunities or markets ▪ Extent of diversity in value propositions and business models ▪ Agility of business models ▪ Extent of the move to services from commodity supply where beneficial ▪ Integration with non-energy services to create new value propositions ▪ Digitalization to improve customer interaction *Technology and System Innovation* ▪ Adoption of systems approaches to reveal interactions, interdependencies, and trade-offs ▪ Uptake of low-carbon technologies (LCTs) ▪ Adoption of new system technologies (storage, for example) ▪ Extent of digitalization (use of data to support operation of renewables-biased networks, for example) ▪ Automation in operations processes to reduce cost and improve services ▪ Support for consumer participation where consumers are actively trying to take advantage of new technologies to address their energy needs (self-generation, for example) ▪ Application of new methods of building skills and retaining people
POLICY: Operate within the policy structures and engage positively with policymakers.	*Business Environment* ▪ Extent and quality of relationships with policymakers and policy influencers ▪ Clarity of messages regarding corporate position and role in energy supply ▪ Degree of alignment with best view of policy direction ▪ Perceived degree of support provided to policy initiatives ▪ Level of creative input offered to the sector and clarity regarding the policy environment *Technology and System Innovation* ▪ Degree of agility to respond to policy change ▪ Clarity regarding the dynamics between policy and the ability of the system to respond at reasonable cost and in feasible timescales ▪ Communication of opportunities for policy change that innovation can enable
REGULATION: Maintain constructive relationships with regulatory bodies and comply with the spirit and rule of regulation.	*Business Environment* ▪ Relationships with regulation makers and regulation influencers ▪ Clarity of messages regarding corporate position and role in energy supply ▪ Degree of alignment with best view of regulation direction ▪ Perceived degree of support provided to regulatory initiatives ▪ Level of creative input offered to the sector and clarity regarding the regulatory environment *Technology and System Innovation* ▪ Degree of agility to respond to regulatory change ▪ Clarity regarding the dynamics between regulation and the ability of the system to respond at reasonable cost and in feasible time scales ▪ Communication of opportunities for regulatory change that innovation can enable

10. RECOMMENDATIONS

Utilities are at the center of transformative change in the energy sector. This presents threats but also huge opportunities for those willing to pursue them. These opportunities come in multiple forms; some will emerge over time. The scenarios offered in this report provide a way to frame thinking about possible futures.

Review of the changing landscape leads to recommendations for utilities as they consider the steps required to ensure their sustainability and ongoing contribution to the communities they serve:

- Utilities should undertake deep review of their strategic purpose, direction and aspirations, their resources to deliver their preferred strategy, the environment in which they operate, and their ability to effect change. Current offerings might be sustainable, but they need to be placed in the context of the changing environment. Utilities must decide what role they want to play and what markets they want to focus on and, if appropriate, develop new offerings that could displace or enhance existing ones.
- Utilities should plan their strategy backward from the future and should not seek the perfect business model before acting. There should be an approach that develops a "living roadmap," one that implements and then actively monitors measures to drive learning and adaptation. Iteration and agility will be key success factors.
- Utilities should take a systems-oriented approach both in considering evolution or change pathways and in executing the chosen strategy. There is no room for siloed behaviors as the landscape of interactions and dependencies that will affect decision making become more complex and the stakes become higher. The decision on which path to follow will depend on the appetite and ability to compete with a variety of other players and the appetite and ability to develop and deliver compelling offers.
- Utilities should explore new techniques for decision making under uncertainty, such as artificial intelligence as applied by organizations such as Faculty AI[10] and new approaches—for example, those espoused in the Utility 2050 thinking.[11]
- Utilities should be open to relationships with partners and partner ecosystems to provide needed capabilities; enable interesting, differentiated offerings; and support sustained competitive advantage.

These recommendations are served by the scenarios. The process of drawing together the right stakeholders to engage in discussion using the scenarios as a shared reference point to facilitate understanding is a valuable step in the transformation journey.

[10] https://faculty.ai/ai-for-energy-transition-and-environment/

[11] https://foresighttransitions.co.uk/energy-transitions-and-futures/

APPENDIX A: Electricity Utility Evolution

Table 7. *Electric utilities today*

Aspect	How It Works Today
Generation	▪ Fleets of relatively few centralized, large-scale generators. Led predominantly by fossil fuel, but also significant nuclear and hydro. ▪ Dispatched under the control of the system operator function to maintain supply and network stability. ▪ Large-scale capital to construct. Long-duration projects to build. ▪ Costs of energy linked to costs of fuel. ▪ Capacity margin maintained as a matter of policy and regulation.
Transmission	▪ Large-scale high-voltage networks used to transport electricity over long distances. ▪ High levels of reliability and resilience. ▪ Typically a high degree of monitoring and digital control. ▪ Capacity and structure a function of the relationship between generation location and large centers of demand. ▪ Frequently coupled with the system operation function.
Distribution	▪ Small to large-scale, medium- and low-voltage networks used to transport electricity in regions and local areas to consumers. ▪ Varying levels of reliability and resilience. ▪ Typically, some monitoring at medium voltage levels and little if any at low voltages. ▪ Capacity and structure are functions of the particular needs of the region or local area (urban, rural, for example). ▪ May be coupled with a system operation function that is subordinate to that provided by the transmission-level system operator.
Retail	▪ Buys units of electricity from generators and sells them to consumers with delivery over transmission and distribution networks. ▪ Consumers span industrial, commercial, and residential users. ▪ Industrial and commercial users may be engaged; residential consumers are typically passive. ▪ Competition often on a price-only basis.
System Operation	▪ Operation of the system where the system in bounded by the meter on the customer premise. ▪ Coordination of the parties to ensure system and operational integrity. ▪ Balancing, frequency, voltage, thermal, fault management. ▪ Disinterested in the consumer side of the meter, except in terms of the level and timing of demand being presented. ▪ Often within the transmission network provider but might be separate and independent. ▪ Complex restart mechanism for recovering from extreme circumstances.
Use	▪ Purchase and use of units of energy. ▪ Pays bills that typically represent charges for network use and for energy units and may include other social levies. ▪ Usually passive and often mistrusting in the relationship with the energy system and utility. ▪ Perceives energy as a basic need (and, therefore, a right). ▪ Price-sensitive. ▪ Level of awareness means that supply of energy is taken for granted; highly reliable, relatively cheap.

Table 8. *Electric utilities tomorrow*

Aspect	How It Might Work Tomorrow
Generation	▪ Transition from fossil fuels over time. ▪ New sources of generation deployed: wind, solar, clean gases. ▪ Nuclear and hydro retained and potentially grow. ▪ Gas coupled with carbon capture use and storage might have a role. ▪ Hydrogen could have a role both as a generation fuel and an alternative vector. ▪ Bias to renewables means that generation becomes weather-dependent and intermittent. ▪ Implications for capacity, networks, operability, and resilience, among other factors. ▪ Likely to be a requirement for some fossil fuel–based plants, at least in the medium term during transition and until security of supply can be ensured. ▪ Not yet fully known how network services will be addressed in renewables-based systems. ▪ Deployed at a spectrum of scales and at all levels of the network and in customer and community structures. ▪ Dispatched by system operator functions operating at several levels. ▪ Costs of energy under debate: linked to marginal costs, linked to system costs, other options to be considered in market reform. Renewables carry and imply systems costs, such as the measures that must be put in place to address intermittency. ▪ Capacity margin maintained as a matter of policy and regulation, but the meaning of this is not yet clear in the new context.

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Table 8. Electric utilities tomorrow (continued)

Aspect	How It Might Work Tomorrow
Transmission	▪ Increased capacity to support growth in energy demand. ▪ New coverage and structure requirements to reflect changing generation locations and centers of demand, including offshore. ▪ High levels of reliability and resilience. ▪ High degree of monitoring and digital control and increased degree of integration. ▪ Potential need for offshore grids.
Distribution	▪ Increased capacity to support growth in demand. ▪ New coverage and structure requirements to reflect changing network architecture: connection of distributed generation, storage, communities. ▪ High levels of reliability and resilience. ▪ Deployment of more dense monitoring at all voltage levels. ▪ Increased focus on specific and regional assets and characteristics. ▪ May be coupled with a system operation function that is subordinate to that provided by the transmission-level system operator. ▪ Connectivity platform applications for support of community systems. ▪ Significantly increased levels of digitalization. ▪ Significant dependence on flexibility of demand to avoid or defer reinforcement needed to respond to increasing demand.
Retail	▪ Significantly transformed and will be required to offer a spectrum of options, from buying units of electricity in the traditional way to supplying products and services to providing combinations of commodities and products. ▪ Consumers span industrial, commercial, and residential users with needs that will change over time as they themselves transform. ▪ Industrial and commercial users may be engaged; residential consumers will assume a broad spectrum of relationships: full consumer, prosumer, or semi-off-grid with insurance. ▪ Competition based on price, service, new offerings, and possibly other metrics.
System Operation	▪ Operation of the system where the system is no longer bounded by the meter on the customer premise. ▪ Coordination of the parties to ensure system and operational integrity. ▪ Balancing, frequency, voltage. ▪ Active interest in the consumer side of the meter, specifically, for flexibility services. ▪ Implemented at various levels in the system hierarchy.
Storage	▪ Could be the most impactful technology in energy system transformation. ▪ Fossil fuels provide vast amounts of storage to address extreme events; it is not clear how this will be replaced. ▪ Needs to address all scales and for all durations. ▪ Deployed at all levels in the system hierarchy. ▪ Heat and hot water storage need to be considered in addition to electrical storage as forming part of the needed solution set.
Flexibility	▪ Flexibility (in both demand and supply) a key contributor to avoid (or delay) massive cost in network reinforcement. ▪ Helps address intermittency of renewables-based generation. ▪ Time needed to achieve aspects of transformation reduced because flexibility enables faster action. ▪ Prospect to provide flexibility/network services by consumers; values demand in a manner similar to supply and allows suppliers of flexibility to be financially rewarded.
Use	▪ Substantial emphasis being placed on the fact that the energy system must be consumer-centric. ▪ Significantly reshaped demand in terms of type, nature, and scale. ▪ Assumption that consumers will remain passive takers of units of energy is no longer reliable. ▪ Not all consumers will be able or willing to engage in supply or demand for reasons of circumstances or preference. Utilities are likely to remain obliged to provide energy to all segments and types of consumers. ▪ Some consumers will continue to behave traditionally. ▪ Options for participation can include the provision of flexibility directly or through a third party (an aggregator, for example), acting as a prosumer, generating electricity, exporting excess and importing when needed to satisfy demand, taking part in community schemes and/or becoming truly self-sufficient and disconnecting from the network. ▪ Different interpretations of what reliability and resilience mean, and therefore how they should be provided, will emerge. ▪ Although consumers may choose to engage in both supply and demand, they are likely to expect the same level of service. This means that the utility will be expected to guarantee supply that might never be called on. ▪ Measures deployed to ensure that the transition is fair and equitable. ▪ Increasingly expected to want choice and to demand high-quality customer service. ▪ Efficiency and modal change measures will reduce demand. ▪ Consumer export from self-generation will provide an unreliable source of energy for the utility. ▪ Many new parties emerging to serve needs, creating a competitive environment. ▪ Diversity of consumers and needs enables propositions that do not rely on selling units of energy; changes the basic premise of the prevailing utility proposition. ▪ Perceives energy as a basic need (and, therefore, a right). ▪ Price-sensitive.

APPENDIX B: Stakeholder Outcomes

Business model change enabled by energy system transformation should be informed and guided by the outcomes that these key stakeholder groups are seeking and that respond to the key drivers of transformation. Considering the implications of each of the drivers on each stakeholder group enables the overarching outcomes to be summarized in a way that reflects a whole-systems view. Tables 9–14 describe the various outcomes sought by consumers and citizens, utilities, government, innovators, and investors in energy transformation.

Table 9. *Decarbonization*

(To contribute to the deep reduction of greenhouse gas emissions as expressed in political and social commitments, not only in the energy system but in sectors coupled to it, such as heating and transport.)

Stakeholder	Outcome Sought
Consumers and citizens	▪ Access to energy in a way that does not disrupt the high level of service that they have come to expect and at a price that they consider affordable ▪ Clarity and choice in how they participate in decarbonization ▪ A spectrum of opportunities to engage actively, including being a prosumer ▪ Little if any loss of amenity
Utilities	▪ Generation, delivery, and supply of safe, sustainable energy in satisfaction of political, regulatory, and social demands ▪ Corporate and operational satisfaction of decarbonization requirements ▪ Sustainable businesses amid the uncertainty that accompanies transition ▪ Supportive of dependent sectors in achieving their decarbonization goals
Government (at all levels) and regulators	▪ Net-zero future ▪ Satisfaction of carbon, economic, and societal demands, balancing the need to deliver within the complexities of politics, including affordability and security of supply ▪ Balance of individual, community, local, regional, national, and international needs
Innovators	▪ Provision of viable solutions to complex decarbonization problems that support sustainable businesses ▪ Commercially successful exploration and application of new areas of technology, social science, economics, and integration to satisfy the complex and sometimes conflicting needs of stakeholders
Financiers and investors	▪ Opportunities to make sustainable returns in decarbonized energy, either directly (in utilities) or indirectly (emerging supply chains, for example) ▪ Sufficient clarity and certainty to be able to identify and price risk ▪ Adherence to the requirements of green finance and insurance

Table 10. *Reliability and resilience of energy supply*

(In the face of increased economic and societal dependence on energy and the mounting risks arising from climate change.)

Stakeholder	Outcome Sought
Consumers and citizens	▪ Assurance that energy will be available when it is needed and in the amount needed to support increasing energy demands and dependence ▪ Clarity and choice in how they can participate in ensuring reliability and resilience ▪ Opportunity to take an active role in ensuring supply for themselves and their communities
Utilities	▪ Satisfaction of the demands of consumers, governments, and regulators that energy be delivered to sustain economic and social well-being ▪ A fair balance of the costs of reliability and resilience against the financial and operational realities of delivery ▪ Optimization across energy vectors
Government (at all levels) and regulators	▪ Satisfaction of demands for the availability of energy in the face of economic and societal dependence ▪ Satisfaction of the balance of risks to ensure security of supply
Innovators	▪ Opportunities for creative application of technology and other techniques to provide high-value approaches to ensured provision of energy (exploiting flexibility options, for example)
Financiers and investors	▪ Protection from the risks that compromise reliability and resilience and the liabilities that arise ▪ Balance between the costs of mitigating risk and the liabilities that could arise

Table 11. *Technology*

(Technology-enabled opportunities to provide new services and reduce costs, particularly opportunities arising from digitalization.)

Stakeholder	Outcome Sought
Consumers and citizens	▪ Alignment of energy with increased use of technology and digitalization in work and daily life ▪ Opportunity to participate actively in energy system transition and achieve cost savings and security of supply ▪ Insulation from unwanted technology complexity
Utilities	▪ Modernization of aging networks ▪ Provision of new services ▪ Cost optimization ▪ Acquisition of services—flexibility, for example
Government (at all levels) and regulators	▪ Facilitation of energy outcomes ▪ Measurement, monitoring, and reporting of progress ▪ Compliance management ▪ Cost management ▪ Economic growth through new business development ▪ Social enhancement through new job opportunities and prospering communities
Innovators	▪ Business opportunities nationally and globally, leading to sustainable businesses and wealth ▪ Imaginative ways to deliver needed results
Financiers and investors	▪ New opportunities to make returns, potentially substantial ones ▪ Cost reduction in existing investments

Table 12. *Consumer and citizen expectations*

(Reflected in affordability and availability of energy and supported by desire for high-quality customer service.)

Stakeholder	Outcome Sought
Consumers and citizens	▪ Assurance that energy will be available when it is needed and in the amount needed to support increasing energy demands and dependence ▪ Active participation to achieve cost-effective results for them and their communities ▪ Achievement of co-benefits for communities and the people who live and work in them
Utilities	▪ Consumers are provided a good service, and utilities are being paid fairly for it ▪ Trust-based relationships established with customers ▪ Customer safety ensured ▪ Fair treatment by customers and citizens ▪ Supportive of economic growth and social development and enhancement ▪ Positive experience delivered for all citizens, not just consumers, with respect to amenity, for example
Government (at all levels) and regulators	▪ Interests of consumers protected in a complex, changing environment with new and unclear risks ▪ Fair and equitable transition of the energy system ▪ Affordable, easy access to needed energy
Innovators	▪ Direct markets for innovation ▪ Beneficiaries of innovation through direct and indirect means ▪ Active engagement with energy and the energy transition
Financiers and investors	▪ Consumption of energy continues at a scale and in a way that generates sustained, predictable returns.

Table 13. *Finance and investment requirements*	
(To achieve revenues and profits that will sustain viable returns in an uncertain and complex environment.)	
Stakeholder	**Outcome Sought**
Consumers and citizens	▪ Energy remains affordable. ▪ Participation is rewarded fairly.
Utilities	▪ The cost of transition can be financed in a way that presents reasonable risk. ▪ Finance can be obtained. ▪ Returns can be achieved. ▪ Sustained investment can be afforded.
Government (at all levels) and regulators	▪ Access to adequate finance and investment is provided. ▪ Fair returns are ensured. ▪ Returns are commensurate with the risks taken. ▪ Transparency of financial and investment arrangements.
Innovators	▪ Access to adequate funding to enable the innovation process through to commercialization. ▪ Access to the markets that their innovation genuinely serves.
Financiers and investors	▪ Visibility of opportunities. ▪ Ability to assess risks. ▪ Clarity and certainty in the transformation environment. ▪ Returns on money provided.

Table 14. *Policies and regulations*	
(Government bodies and regulators interpret global, national, and local interests; set the direction, framing, and rules that describe the transformation expected; and establish the context for change.)	
Stakeholder	**Outcome Sought**
Consumers and citizens	▪ Affordable energy is available. ▪ Fairness and equity are ensured. ▪ Good climate, economic, and social outcomes are delivered
Utilities	▪ Clear, certain, and consistent policies. ▪ Agile regulation that is consistent with policy. ▪ Fairness in the balance between demands and reward. ▪ Fairness in the balance between risk and reward. ▪ Sufficient certainty to enable finance to be obtained. ▪ Returns can be achieved.
Government (at all levels) and regulators	▪ Good climate, economic, and social outcomes are delivered. ▪ Political continuity. ▪ Regulatory compliance.
Innovators	▪ Vibrant innovation landscape. ▪ Successful investment of innovation funding.
Financiers and investors	▪ Clarity and certainty in the policy and regulatory environments with a clear line of sight on direction of travel. ▪ Ability to make adequate returns to reward risks taken.

APPENDIX C: Challenges and Opportunities

Table 15. *Challenges and opportunities for utilities*

Aspect	Challenges for Utilities	Opportunities for Utilities
STRATEGY: Focus on markets and customers where competitive advantage can be sustained, and do so in what is an uncertain and unpredictable environment.	▪ Maintaining a viable business will become more difficult in a changing and increasingly competitive environment. ▪ It is difficult to make decisions given the high degree of uncertainty in the energy landscape. ▪ New markets are emerging; they are likely to disrupt existing ones. ▪ Technology change is rapid, and the risk of stranded assets is material. ▪ Consumers are expected to become more engaged in energy and may become prosumers or go off-grid. ▪ Too much choice can lead to confusion and paralysis in decision making. ▪ There is a need for more agile, iterative adaptive planning and implementation. ▪ The restrictions and obligations of being regulated entities may constrain timely response to change. ▪ Skills and literacy in the broad set of areas that will be needed and, in the quantity required, may be beyond those established in the utility and may be difficult to acquire. ▪ The supply chain may not have the capacity or readiness to respond.	▪ Business agility will be essential and could provide opportunity for corporate reassessment and refresh. ▪ Radical change could be required and should be on the spectrum of options considered. ▪ Vibrant markets for new services may emerge. ▪ Early engagement could allow the shaping of market opportunities. ▪ Clear focus on the markets and consumers to be served is essential, acknowledging the immature state of both. ▪ Create new markets, new value propositions, new business models, operational improvements, cost reductions, premium products, services bundling, leverage of existing assets and business models. ▪ Restructure to enable participation in unregulated markets. ▪ Look across energy vectors and focus on service provision, not units of energy. ▪ Respond to decision-making uncertainty by acknowledging it is impossible to have a definitive plan; build credible, viable plans that are adaptive. ▪ Pursue mergers, acquisitions, and partnerships where these build competitive strength or generate pace. ▪ Align transformation with addressing aging infrastructure replacement—clever migration can offer efficiencies and open doors for new services.
CARBON: Commit to delivery of decarbonized energy and to decarbonizing their businesses.	▪ Substantial changes to generation will be deployed with new intermittency and weather dependence. ▪ Associated restructuring of network architectures will be required. ▪ Significant change in the nature and role of demand is emerging quickly. ▪ Dependent sectors will be relying on utilities to support them in achieving their carbon obligations. ▪ Operations must be decarbonized. ▪ The cost of decarbonization is high and potentially difficult to finance. ▪ There is a requirement to ensure decarbonized supply chains and address embedded carbon. ▪ Consistent measurement of achievement and compliance with evolving requirements, potentially arising from multiple sources, will be needed to satisfy customer, corporate, finance, policy, and regulatory demands.	▪ Embrace and lead the transition to clean energy. ▪ Position as a decarbonization leader. ▪ Commit to corporate decarbonization, applying best practice, and communicate to all stakeholders. ▪ Apply digitalization to achieve carbon reductions. ▪ Leverage position to achieve results in supply chain decarbonization.
RESILIENCE: Satisfy economic and social needs for reliable and resilient sources of energy.	▪ System reliability and resilience and thus security of service to consumers is critical in the face of increased economic and societal dependence on energy and the increased risks arising from climate change. ▪ The new energy system architecture will require new approaches to ensuring reliability and resilience. ▪ The energy system now explicitly extends into the consumer domain give n the significant and active role for demand and potentially for supply. ▪ Operability of renewables- biased networks is not yet fully explored. ▪ Reliance on renewables will lead to a dependence on weather. ▪ Fossil fuels provide large amounts of storage that offer resilience; it is not clear how this will be replaced. ▪ Transformation assumes a high degree of customer behavior change; this could happen in an unhelpful way. ▪ The involvement of many new players makes reliability and resilience harder to ensure, with key elements outside utility control. ▪ More extreme weather events will make it harder to ensure service and restoration. ▪ Obligations may remain to provide insurance services. ▪ It is not clear how to restore services in extreme circumstances such as black start in renewables-biased systems.	▪ Distributed architectures may offer higher system reliability and resilience. ▪ Autonomous control mechanisms could support more resilient architectures. ▪ Advanced use of data could support more probabilistic operations. ▪ Adaptation efforts will be increased. ▪ Roles and responsibilities in the transformed energy system will require redefinition or confirmation. ▪ Codes and standards will be needed to enable operation in a disaggregated, highly distributed system with many participants, devices, and potentially competing services. ▪ Coordination of the parties to ensure that system and operational integrity will be required and a hierarchy of control established between individual, community, local, regional, and national interests.

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Table 15. Challenges and opportunities for utilities (continued)

Aspect	Challenges for Utilities	Opportunities for Utilities
REPUTATION: respond to consumers and citizens needs and act in a way that builds positive, trust-based relationships and respect in the community.	▪ Consumers are changing and will have choice about how they interact with utilities, if at all. ▪ Too much choice can lead to confusion and withdrawal from engagement. ▪ Existing relationships are often not based on trust and tend to be diminished to one driven by price and loss of service impacts. ▪ The cost of customer acquisition will be high.	▪ Carefully segment customers and focus offers that respond to the needs of target markets. ▪ Look outside traditional customer sets and offerings, acknowledging that customers are likely to become much more heterogeneous. ▪ Establish partnerships. ▪ Traditional utility energy offerings could be bundled with other consumer services. This could dramatically alter the visibility of energy in the eyes of consumers and certainly would alter the relationship between utility and consumer. ▪ The competitive landscape will encompass offerings from more than one vector for delivery of certain outcomes. Consumer choices will influence the position of the utility in terms of which offerings from which vectors will be sustainable. ▪ Transition must be just and fair. ▪ Differentiation on customer care.
RISK: identify, evaluate, mitigate, and manage the interdependent technical, operational, and commercial risks that arise with change.	▪ New risks will emerge from interactions, interdependencies, and trade-offs. ▪ Complexity will make risks hard to identify, analyze, and address. ▪ Traditional risk management methods may not be adequate and could be distracting or misleading. ▪ Uncertain, unpredictable change in the sector demands agility in risk management. ▪ New parties who perceive and act on risk differently will participate in the sector.	▪ Develop insights through application of systems approaches. ▪ Engage with stakeholders to identify shared strategies and direction. ▪ Use iterative measures to effect change. ▪ Adopt agility as a planning and operational principle.
FINANCIAL: Be financially robust and sustainable, following best corporate practice.	▪ Revenue streams may be eroded by virtue of lower demand (through demand reduction or efficiency measures) or competition. ▪ Costs to renew and digitalize could be high and may not be accommodated in applicable price control mechanisms. ▪ Circumstances could arise in which utilities are required to incur the costs of decarbonization and guarantee supply but be excluded from access to revenues and profits from other sources, such as the supply of value-added services to consumers. ▪ Marginal costs of a unit of energy do not reflect true system costs and distort debate on how to align price with cost. ▪ Investment requires that it be possible to price risk, which is challenging in an uncertain and rapidly changing environment. ▪ Financial matters are directly connected to the actions of policymakers and regulators who act in response to interests and stimuli beyond those of utilities.	▪ Transformation can create increased or new opportunities to generate revenue and profit, through new service offerings or partnership arrangements. ▪ Transformation may enable cost efficiencies through technology deployment. ▪ If there is a retained dependence on utilities to provide certain core services, mechanisms need to be found to pay for them. ▪ Attracting finance and investment, no matter the source, will be increasingly connected to being able to demonstrate commitment to and delivery of decarbonization. Financial institutions will demand that best practice be followed; governments will rely on utilities to support them in wider political commitments.
INNOVATION: Be innovative, drawing on the best that technology has to offer and applying it in the most effective and efficient ways.	▪ Utility infrastructure has long life cycles, and migration can be difficult and costly. ▪ Innovating or acquiring innovation too early can lead to stranded assets. ▪ New technology requires skills that may not be easily acquired and retained.	▪ Apply new technologies in conjunction with system approaches to replacing or updating aging infrastructure, making networks/systems more flexible and agile. ▪ Build multi-vector, multi-sector businesses that are enabled by innovative integrations. ▪ Achieve competitive advantage and pace by deployment of well-selected innovations; use trials and living labs effectively to mitigate risks. ▪ Flexibility (in both demand and supply) is seen as a key contributor to avoid (or delay) massive cost in network reinforcement. This is reflected also in the time needed to achieve aspects of transformation: flexibility enables faster action.
POLICY AND REGULATION: Operate within the policy structures and comply with the spirit and rule of regulation.	▪ Policy and regulation change arising from decarbonization is not clear or certain and can result in unintended consequences. ▪ Relationships cannot be assumed to be collaborative between utilities and policymakers and regulators. ▪ The pace of policy and regulatory change may be surpassed by the pace of change initiated or championed by other parties. ▪ Interdependencies between policymakers and regulators might not be understood or resolved. ▪ Obligations could be retained, but freedom to compete in emerging markets is limited. ▪ Planning regimes are not supportive of infrastructure building.	▪ Policy and regulation are also transforming. Utilities need to be a key stakeholder in this change. ▪ Utilities engage positively and continuously with policymakers and regulators and impress on them that transforming an energy system requires robust utilities (not all functions can or should be provided by other parties). ▪ Utilities will increasingly be the owners and operators of systems, not just assets. ▪ Conditions must be retained or created that enable needed functions to be performed/ services delivered for a fair and reasonable return. ▪ If utilities are to be obliged to provide security of supply services and the trend is to make other services competitive, they need to be recognized as providing a public good and funded in that way or be given the freedom to act in the competitive environment being created.

APPENDIX D: Stakeholder Possibilities

CONSUMERS and CITIZENS

- Disengaged. Deploy LCTs and efficiency measures only where these are the only options available. Access third party to help to do this.
- Takes from the utility.

- Deploy LCTs and efficiency measures. Access third party help to do this.
- Largely passive consumer.
- Takes from the utility.

- Little if any self-generation, but active on the demand side (V2G, LCTs). Deploys efficiency measures.
- Provides network services.

- Self-generating the electricity needed and using storage to be more or less self sufficient; subscribes to a community scheme for local sharing.
- Exports excess energy to the grid; occasionally imports.
- Provides network services (through an aggregator).
- Deploys efficiency measures, but not extreme.

- Self-generating all the electricity needed and using storage to be self-sufficient; subscribes to a community scheme for local sharing.
- Not connected to the grid.
- Deploys lots of efficiency measures.

GOVERNMENTS and REGULATORS

- Unwilling or unable to make adequate responses or decisions.
- Increasing diverge between policy and regulation and reality in the sector.
- Too slow to be relevant.
- Paralysed by uncertainty and conflicting pressures.

- Doubling down on the application of historically successful approaches in an attempt to create certainty.
- Rules driven.
- Slow to adapt and change.
- Perceived as protecting vested interests.

- Incremental approaches building on existing ones.
- Committed to Net Zero but distracted by other issues like geo-political concerns.
- Calls for market reform but the markets are heavily controlled.
- Continued commitment to RAB model.

- Evolution of current approaches with more disruptive interventions in some cases.
- Adaptive with elements of experimentation.
- Reform of markets with a focus on competition.
- Interactions between measures not always clear or fully functioning.
- Retained RAB model for public good.

- Active commitment of Net Zero strategies.
- Economic agenda coupled to Net Zero.
- Radical new thinking to accelerate change.
- Free markets. Open competition for all players.
- State support for limited and clearly defined public good services.
- Light principles based regulation to drive outcomes.

INNOVATORS

- Passive and limited.
- Unsupported by government and other sources of starter funding.
- Barren opportunity landscape.
- Unsupportive market conditions.
- Failure to identify gaps that exist and then exploit them.
- Dependent on traditional offers from traditional players.

- Reactive to specific calls ans sources of funding.
- Incremental developments.
- Uncertain and isolated.
- Specific market opportunities.
- Investment requires strong case and could appear reluctant.
- Reliance on traditional supply chains.

- Active innovation landscape but constrained by uncertainty and risk aversion.
- Directed funding available.
- Some private investment.
- Challenging linkage to BAU.

- Adaptive and responsive to emerging opportunities and requirements.
- Encouraging funding landscape.
- Active private investment in some domains.
- Commercialization capacity.
- Facilitated procurement processes.

- Active, vibrant innovation environment.
- Addresses technology, value propositions, business models, policy, regulation.
- Disruptive.
- Well supported by research and stimulus funding to drive creativity and pace.
- Private investment.
- Successful commercializations.
- Leading transformation.

FINANCIERS and INVESTORS

- Utilities lose their appeal given uncertainty and pace of change.
- Flight to other sectors.
- Constrains finance and investment and hence progress.
- Dependence on the state.

- Strong appetite for regulated returns but little interest in more innovative businesses.
- Encourage reshaping of utilities to protect traditional investments.

- Cautious.
- Hard to price risk, given uncertainties.
- Cornerstone funding available for some investments.
- Dynamic between asset and system finance not resolved.
- Comfort of regulated models strongly sought.

- Attractive opportunities and proof points emerging for success.
- Adapting to investing in systems rather than assets.
- Public cornerstone funding mechanisms established and functioning.
- Sight of revenue and profit.
- Growing portfolio of opportunities.

- Strong portfolio of opportunities that appeal to a spectrum of financial/investor types.
- Aggregation to achieve scale routine.
- Positive feedback loops from successful investments.
- Acceptable costs.
- Revenue growth. Sufficient profits.

UTILITIES

- Utility not required.
- Consumer self-sufficiency; local solutions.
- Market provision of services,
- Social acceptance of security of supply risks.

- Much diminished provider of basic services mainly to those that can't afford to self-generate or prefer not to.
- Reduced levels of volumetric sales.
- Tighlty regulated.
- Obligations to provide services.
- Insurance obligations.
- Taxpayer supported. (Nationalized?)

- Traditional.
- Optimization of existing business and its operations.
- Provider of services across a broad consumer base.
- Reduced levels of volumetric sales.
- Regulated.
- Obligations to provide services.
- Insurance obligations.
- Return to assets based businesses.

- Utility is systems integrator in addition to providing a core/ traditional role.
- Actively competes to provide consumer solutions.
- Provider of core services mainly to those that can't afford to self-generate or prefer not to.
- Aspects are regulated.
- Some obligations to provide services.
- Insurance policy obligations.

- Utility is systems integrator and provider of services.
- Active competitor to provide consumer solutions.
- Works extensively with partners.
- Offers services in addition to energy.
- Provider of core services mainly to those they are obliged to serve.
- Aspects are regulated. Principles based.
- Limited obligations to provide services.
- Insurance policy obligations.

APPENDIX E: Scenarios Detail

Table 16. *Detailed scenarios based on how utilities engage with the energy opportunity*

Utilities Lead	Utilities Disrupt
▪ Utilities see the opportunity to respond to sector drivers and mandates in a transformative way and assume a leadership role. Consumers and the market act in a more incremental way, responding to utility initiatives but preferring to avoid disruption. ▪ Modern, revitalized sector with competition in some parts and a significant utility role in effecting change. ▪ Strong potential for utilities with medium risk. Builds on today's infrastructure and know-how but with strong openness to innovate. ▪ Sustainable business environment with growth opportunity but requiring creative development and execution. ▪ Opportunities to build better relationships with consumers and ensure position. ▪ Consumers receive decarbonized energy and good service with acceptable levels of engagement and change. ▪ Approaches are found to make prices affordable. ▪ Consumers look to the utility to provide them a modern service—a decarbonized grid, standard offerings, service-based offerings (where permitted), and efficiency measures support. The utility may choose to work with partners to deliver these services. ▪ Consumers might have some generation and storage participation, but their active involvement in more likely to be demand side, using LCTs. ▪ Consumers provide network services directly to the utility or through aggregators or other players. ▪ Utilities are required to provide supply insurance. ▪ Regulators provide utility regulation updated to reflect decarbonization mandates. ▪ Innovation focused on enablement of utility offerings and demand side solutions such as connected home, heating, EVs.	▪ All parties including utilities see the opportunities in transformation and actively seek to achieve value and benefit. ▪ Dynamic vibrant, competitive sector with many participants. ▪ Very high potential for utilities with high risk given a competitive, fast changing environment. Sustainable growing business environment for the agile provider of good value products and services. ▪ Consumer plays an active role in both supply side and demand side, with self-generation satisfying much and possibly all of their energy needs. Careful demand management and use of storage. Committed to LCTs and energy efficiency measures. ▪ May join community groups to support sharing services. ▪ Consumer looks to third parties to support design and implementation of energy solutions and to support them in operation. Seeks this support from an active market. Some will self-integrate, others will seek integrated solutions. ▪ Consumers may export and/or provide network services through aggregators or other players. ▪ The impact on the utility is not clear when measured in terms of demand for units of energy, but there is an impact in that the customer relationship is no longer necessarily with the utility, implying a move from B2C to B2B operations. ▪ Consumers may subscribe to services provided by others. ▪ Relies on the grid for insurance services but will seek to minimise use of import. ▪ Utilities have freedom to operate and compete in the solution provision market but retain obligations to provide supply insurance. ▪ Pricing highly competitive with strong dependency on perceived value. ▪ Regulators provide utilities the ability to participate actively across the sector and regulate on outcomes. ▪ Innovation across the whole landscape.
Utilities Follow	**Utilities Retreat**
▪ Consumers and utilities respond to specific drivers and mandates but largely act in an incremental way, with a preference for minimal disruption, maintaining a steady trajectory ▪ Sector change is guided by necessity not opportunity. Utility retains a more traditional role, potentially relying on partners or third parties for new capabilities ▪ Some potential for utilities but with relatively low risk as this relies on relatively familiar approaches. Potential limited by subdued market interest and behaviour and carries with the need to satisfy decarbonization mandates. ▪ Sustainable business model but with constrained growth opportunity and that opportunity derived mainly from the volumetric supply of energy. Basically, fossil fuel derived energy substituted by green energy. ▪ Build on existing network and evolve to decarbonize in keeping with political and regulatory requirements. ▪ Consumers adopt a relatively passive role and look to the utility to provide them a reliable service with minimized disruption to themselves. ▪ Consumers acquire and use LCTs but only to the extent other viable options do not exist. ▪ LCT usage contributes to decarbonization on the demand side but relatively limited supply-side engagement from consumers. ▪ Consumers may respond to requests to provide network services (flexibility) either directly or through third parties, such as aggregators. ▪ May deploy some efficiency measures. ▪ Possibly some service-based offerings from third parties, but consumers remain largely committed to traditional supply. ▪ LCT uptake will be largely addressed by classic approaches (capacity) and some flexibility services provided. ▪ Networks provide supply insurance as part of BAU. ▪ Regulators adopt a conservative but robust approach. ▪ Innovation focused on evolution: improvement and scaling, and probably technology-oriented.	▪ Consumers see the benefits of active engagement and participation in energy supply and use and do so. Utilities act in a more traditional way, either by preference or because of regulatory constraints. ▪ Competitive sector with utilities at risk of carrying costs associated with less profitable activities and with obligations. ▪ Sustainable business for utilities but with limits on growth potential from incremental development. ▪ Build on existing network and evolve to decarbonize in keeping with political and regulatory requirements. ▪ The network functions as a platform to provide certain core services; these could be basic or incorporate enabling features for consumers and markets. ▪ Consumers may operate highly independently or may look to the utility to provide them capabilities that will enable them to build and use supply-side and demand products and services. ▪ Consumer plays an active role in both supply side and demand side, with self-generation satisfying much and possibly all of their energy needs. Careful demand management and use of storage. Committed to LCTs and energy efficiency measures. ▪ May join community groups to support sharing services. ▪ Looks to third parties to support design and implementation of energy solutions and to support them in operation. Seeks this support from an active market. Some will self-integrate; others will seek integrated solutions. ▪ Consumers may export and/or provide network services through aggregators or other players. ▪ Consumers may subscribe to services provided by others. ▪ Relies on the grid for insurance services but will seek to minimize use of import. ▪ Consumers may export and/or provide network services through aggregators or other players. ▪ Networks provide supply assurance as part of regulatory requirement. ▪ Innovation focused on enablement of consumer side and markets for consumer-side solutions, some of which could impinge on network services.

APPENDIX F: Business Model Options

Table 17. *Evolution of key existing business models: current state*

Today	Description	Tomorrow	Description
Generator	▪ Centralized, large-scale generation; predominantly fossil fuels or nuclear. ▪ Delivers to wholesale markets or other contractual arrangements. ▪ Based on units of energy sold. ▪ Competitive markets in some countries.	**Generator**	▪ Renewables, nuclear, clean gas based; large-scale, centralized (offshore wind farms); optimized evolution of today. Baseload provision and peaking, acknowledging that demands curves are likely to be flatter. ▪ Potential for smaller-scale distributed generation (distribution connected). ▪ Potential to use skills to pursue industrial or domestic generation solutions (solar packages for example), but unlikely to appeal. ▪ Potential for some remaining fossil fuel-based provision for security of supply reasons particularly in a transition period. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use and flexibility shaping the demand curve. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.
Transmission Operator	▪ High-voltage network for long-haul electricity transport. ▪ Industrial customer connections. ▪ Grid-level infrastructure and operations, including balancing. ▪ Interconnectors. ▪ Typically based on units of energy transported. ▪ Not competitive.	**Transmission Operator**	▪ Large-scale provider of transmission platform/services including infrastructure and operations (TNO, TSO). Optimized version of today. Onshore and offshore. Interconnectors. ▪ Potential for spectrum of platform/services; from connectivity to fully managed transmission grid. ▪ Size and nature of the opportunity could be influenced by materiality of efficiency measures, consumer self-generation/storage/use, and flexibility shaping the demand curve. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.
Distribution Operator	▪ Medium- and low-voltage networks for transport serving regional and local areas and directly connected consumers. ▪ Typically based on units of energy transported. ▪ Not competitive.	**Distribution Operator**	▪ Provider of regional and local distribution platform/services including infrastructure and operations (DNO, DSO). Inter- and intra-community connectivity services. Optimized version of today. ▪ Increased levels of digitalization to enable services and operations. ▪ Potential for spectrum of services from basic connectivity to fully managed distribution network. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use and flexibility shaping the demand curve. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.
Retailer	▪ Buys energy from generators through the markets or other contractual arrangements and sells to consumers. ▪ Delivers to consumers using distribution infrastructure and services. ▪ Owns customer relationship. ▪ Competitive in some markets. ▪ Based on units of energy sold.	**Retailer**	▪ Buys energy from generators through the markets or other contractual arrangements and sells to consumers. Competitive in some markets. ▪ Some potential to optimize, but difficult if competition is purely price-driven. ▪ Clarity of value-add will be needed. ▪ Some requirement, but expected to be transformed by energy service provision-based offers.
Generator-Retailer	▪ Single ownership of generation and retail functions. ▪ Pay charges to networks. ▪ Competitive in some markets. ▪ Based on units of energy sold.	**Generator-Retailer**	▪ Single ownership of generation and retail functions. ▪ Sells energy to retail consumers. ▪ Optimized version of today. ▪ Potential to use skills to pursue industrial or domestic generation solutions (solar packages, for example). ▪ Based on units of energy sold but potential for imaginative tariffs. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use and flexibility shaping the demand curve. ▪ Competitive in some markets. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.

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Table 17. Evolution of key existing business models: current state (continued)

Today	Description	Tomorrow	Description
Network Provider	▪ Combined transmission and distribution network provision.	**Network Provider**	▪ Provider of transmission and distribution platform/services including infrastructure and operations (NO, SO), onshore and offshore. Interconnectors. Integrated and optimized version of today. ▪ Potential for spectrum of services, from connectivity to fully managed networks. Inter- and intra-community connectivity. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use, and flexibility shaping the demand curve. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.
Fully Integrated	▪ Integrated value chain from generation through to retail supply to consumers. ▪ Based on units of energy sold.	**Fully Integrated**	▪ Integrated value chain from generation through to retail supply to consumers. Reshaped infrastructure including renewables-based generation, distributed resources, storage, and new services, such as flexibility. ▪ Optimized and decarbonized version of today. ▪ Potential to extend retail into service models. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use, and flexibility shaping the demand curve. ▪ Policy and regulation decision on obligations to provide capacity to serve security of supply/peaking needs.

Table 18. *Potential and emerging business models*

Tomorrow	Description
Energy Service Provider	▪ Consumer subscribes to an energy service such as Comfort as a Service or Energy as a Service. Outcomes rather than kWh-based purchase. Energy service provider provides the kit necessary to enable the service offered to function and may also offer efficiency measures. ▪ Potential to work with partners. Buys energy from generators and uses network platform services. Could be an evolution of a retailer. ▪ Variations on who provides the consumer premise equipment needed to provide the service: could be consumer-provided or provided by the service provider as an integrated package. Arrangements for financing the equipment are another point of flexibility in the offer. ▪ Margin, not return on assets. ▪ Competitive. ▪ Size and nature of the opportunity could be driven by materiality of efficiency measures, consumer self-generation/storage/use.
Energy Solution Integrator	▪ Consumer engages the solution integrator to undertake implementation of a solution that will enable varying degrees of prosumer participation. Services drawn from consulting, providing, installing, integrating, and bringing into operation. Efficiency measures. ▪ Finance and maintenance options. ▪ Potential to work with partners. ▪ Competitive. ▪ Outcomes not units. ▪ Margin, not return on assets.
Full Energy Service	▪ Combined energy service integrator with network services provision. ▪ Export purchase. ▪ Security of service provision. ▪ Competitive. ▪ Potential to work with partners. ▪ Outcomes, not units. ▪ Margin, not return on assets.
Beyond Energy	▪ Services provided go beyond energy to include security, communications, entertainment; fully connected home. ▪ Leverage data to provide tailored value-added services. ▪ Potential to work with partners. ▪ Outcomes, not units. ▪ Margin, not return on assets.
System Optimization	▪ Digitally enabled service provider. ▪ Aggregates flexibility and other consumer-provided services and offers these as system services. ▪ Provides network mediation and connection services.

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