



ROBINSON BOWMAKER PAUL



THE FUTURE POWER MARKET OPERATOR

In 1882, the Pearl Street Station, the first central power plant in the United States, began producing electricity serving 85 customers providing electricity to 400 lamps.

The set up was simple: generator produces power; wires and poles carry power to end-user; end-user consumes power and pays the utility for the privilege of having power.

And for 130 years this basic paradigm remained largely unchanged. But no more.

The global electricity sector is on the precipice of unprecedented change. Technological developments, changing consumer attitudes and regulatory innovation are driving trends that have the potential to profoundly change the nature of electricity markets of the future, including automation, widespread adoption of distributed generation, increased reliance on electricity for vehicle charging, load smoothing through battery storage, and increasing consumer resilience to network outages.

Yet despite the abundance of opinions on the implications of change, there is no consensus on what the future will actually look like.

This is no surprise: thinking about the future is inherently difficult. Human brains struggle to cope with problems that have multiple dimensions of uncertainty. Even the best of us can struggle to imagine revolutionary developments, even ones that aren't very far away.

"There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will" - Albert Einstein, 1932

Thinking about the future is hard

Prediction of the evolution of and impacts of industry trends can be fraught with error because we tend to:

- Gravitate towards a single most probable future scenario which is often coloured by our unconscious biases
- Predict linear progression as opposed to exponential change
- Ignore unfavourable scenarios.

So how does one plan for an uncertain future?

Planning for multiple possible futures helps mitigate risks associated with uncertainty

Structured thinking about the future is less about prediction and more about rigorously challenging and testing our assumptions so the decisions we make today will position us well whatever the future brings. To do this, it is important to plan for not one, but multiple futures as that enables the creation of least regrets strategies that can be effective however the uncertainty is resolved.

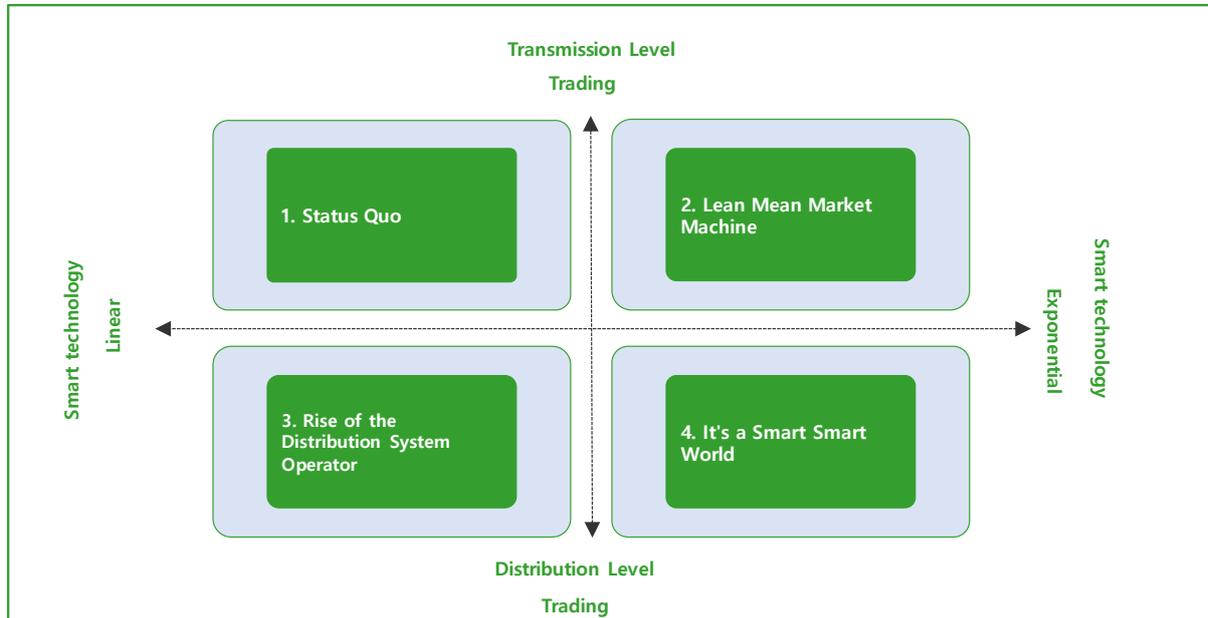
But how do we know what these possible futures might look like?

To properly consider potential futures, we must first consider the key drivers of uncertainty and risk

By way of example, we can use two key drivers of uncertainty in the future of power markets to identify four potential power market futures, and think about how market operators would be affected (Figure 1).



Figure 1: Four potential power market futures



The first driver of uncertainty appears on the *y-axis* in Figure 1 and is the *level of disaggregation in market trading*. It can range from:

- Trading occurring predominantly at the transmission connected level (the status quo in most power markets today); to
- A combination of transmission connected and highly disaggregated trading at the distribution connected level; here small businesses and residential consumers can play in the market also.

The second driver of uncertainty appears on the *x-axis* in Figure 1 and is the *evolution of smart technologies such as automation, artificial intelligence and connectivity of devices in the Internet of Things (IOT)*. This can range from

- Linear evolution; to
- Exponential (or very rapid) revolution.

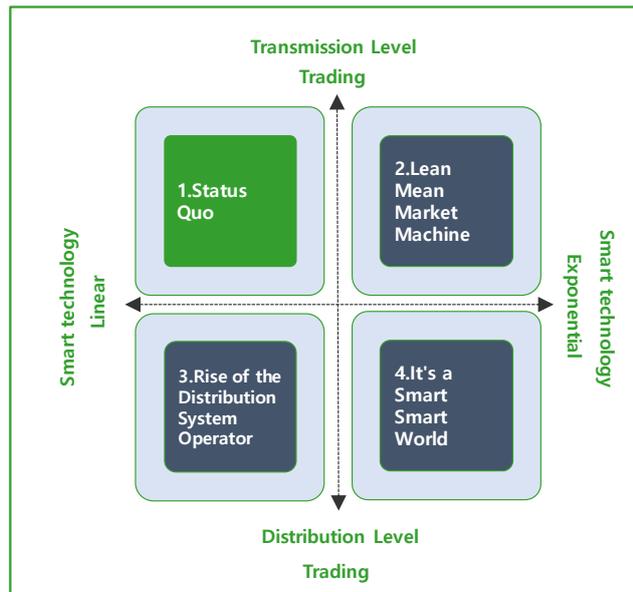
In this analysis, we treat the increasing penetration of grid-edge technologies such as solar and battery storage as a given. The current downward price trajectory of these technologies means that over time, their widespread adoption is inevitable. The pace of penetration will vary from market to market; however, it is reasonable to assume that we will continue to see increasing adoption of solar and battery storage technologies globally.

Looking out ten years from now, what might the future hold for power market operators?

Future 1: The Status Quo

Ten years from now an increasing number of residential and commercial producer-consumers (prosumers) are adopting solar and battery storage technologies. For the residential consumer, these grid edge technologies are a lifestyle product; the non-market value exceeding the market value of the asset.

Distribution network utilities are also installing batteries to defer network investment by smoothing peak load.

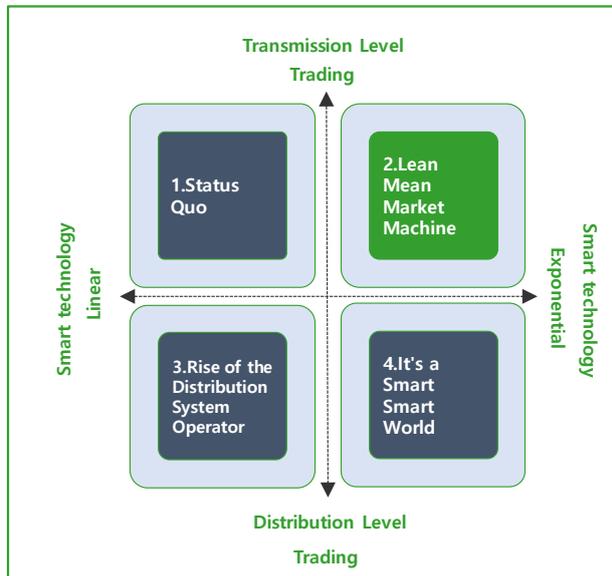


Despite the increasing number of embedded players with Distributed Energy Resources (DERs), they all make decisions based on the value to them alone, and have limited appetite and ability to tap multiple value streams. There has been no regulatory intervention, and no market maker in the form of an aggregator or platform provider has emerged.

Implications for power market operators

In this future, the market operator's participant base remains largely unchanged (predominantly comprising large generators and off-takers). Some minor changes to market system are made to accommodate grid-connected batteries and increasing levels of intermittent generation, but there are no large scale changes. Likewise, the market operator's workforce requirements also remain unchanged, driven by the need for expert human discretion in power market and system operations.

Future 2: Lean Mean Market Machine



Like the Status Quo, this future also has an increased number of embedded prosumers. However, the exponential development of smart technology means that these embedded prosumers live in smart-connected homes with intelligent energy management systems to control self-generation and consumption. Detailed, timely data is available and used in power system operations. Machine learning technologies allow market and system

operators to run the power system more efficiently and at lower cost.

Still, despite the tremendous advances in technology, there is still limited opportunity for embedded prosumers to play in the market. Many Peer-to-Peer (P2P) energy trading pilots are taking place, but there has been no large-scale rollout: the right business model is yet to emerge.

Implications for power market operators

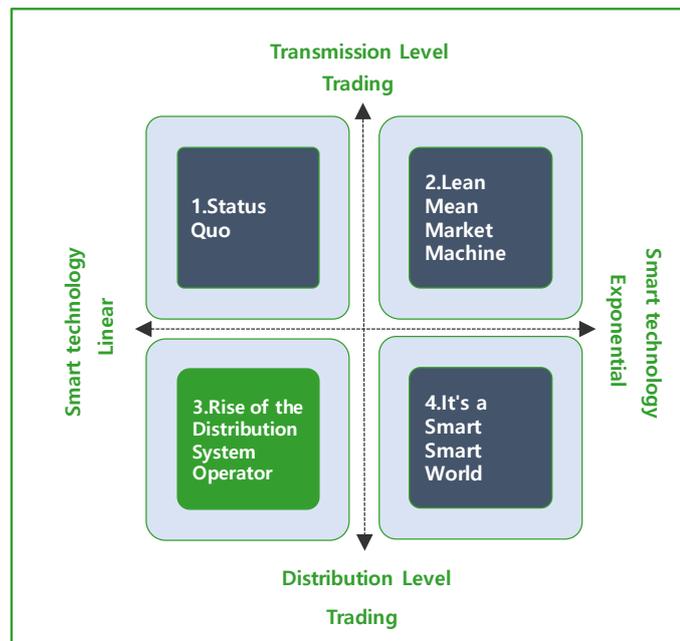
In this future, the market operator has highly intelligent and automated market systems. Highly accurate forecasting algorithms provide visibility of activity in embedded networks while many tasks which previously required human intervention (e.g. control room operations, power system planning, settlement and validation, etc.) are now performed by intelligent machines. As a result, market operators now run lean organisations with low headcounts. In terms of workforce requirements, the market operator notice a shift away from requiring expert human controllers and operators to requiring expertise to keep the systems tuned and protected: cybersecurity, IT/OT and platform development.

Future 3: Rise of the Distribution System Operator

In this future, prosumers can and do participate in the market.

Perhaps government has intervened in the manner we have seen in New York or California, or perhaps a market maker has emerged.

However, the technology is not advanced enough for the market operator to directly include these new embedded participants in their markets. DERs can only be included through a collection of intermediaries: Distribution System Operators (DSOs), aggregators or platform providers.

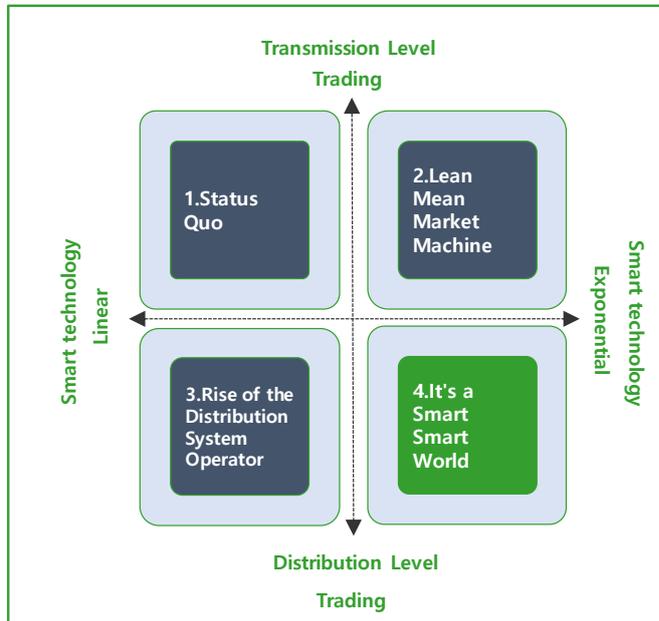


Implications for power market operators

In this future, the market operator’s systems must undergo significant change to interface with the systems of and to accommodate new pricing instruments to reflect distribution level pricing. Over time, market operators find that less energy is cleared through their markets as the distribution markets become increasingly self-sufficient. As a result, market operators find themselves coming under increasing pressure from regulators to cut costs, even though their fixed cost base is not changing.



Future 4: It's a Smart Smart World



In this future technology has advanced to the point where the market operator can include embedded prosumers in their markets directly without requiring an intermediary. IOT advances and automation technologies mean that the market operator can include not only a prosumer's solar and battery storage assets, but their electric vehicles and energy management systems. Each neighbourhood is now a potential virtual power plant.

Furthermore, the combination of technological, regulatory and entrepreneurial innovation means that multiple value streams can be unlocked for DERs. The prosumer has choice on how to commercialise their DER assets: they can play in the market operator's market; they can sign up to one of many P2P energy trading programs; or they can enrol online with one of the myriad set-and-forget demand side aggregation programs.

Implications for power market operators

In this future, the market operator has potentially millions of participants. These participants have a different level of market knowledge and completely separate set of expectations of the market operator as a service provider. Moreover, these new participants can switch "providers" if they are displeased with the level of service provided. In terms of workforce requirements, in addition to requiring the technological expertise noted in Future 2, the market operator will also require customer advisory and analytics skills to retain the challenging participant base they have acquired. Finally, despite the exponential increase in the market operator's participant base, the automation and intelligence of market systems in this future means that in terms of headcount, the market operator remains approximately the same size as under the Status Quo.

Multiple futures can be used to create least-regrets strategies

The futures envisioned above can be used as inputs to your strategic planning process by:

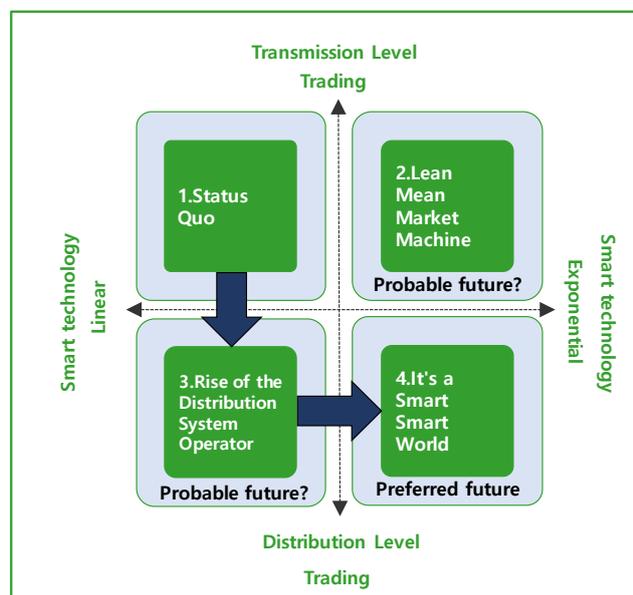
- Forming a view about where the you sit currently, where you are likely headed (“Probable Future”) and where you would like to be headed (“Preferred Future”)
- Planning strategic initiatives to transition to a Preferred Future
- Putting in place least-regrets measures that work out in a range of potential futures.

The journey is an important consideration – what happens if one or other driver tips first?

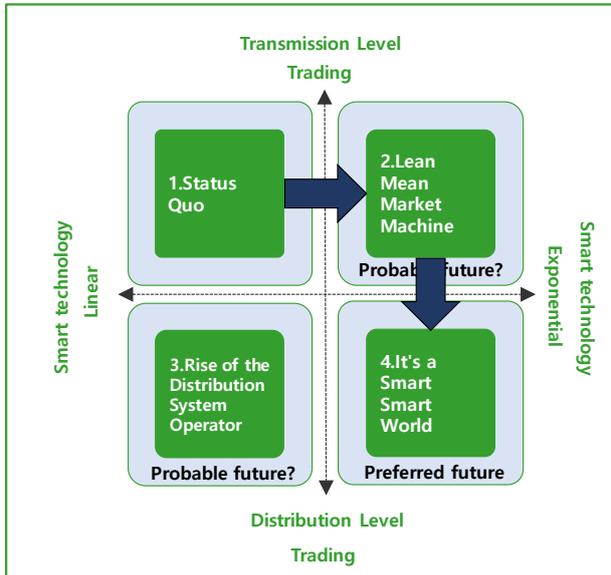
For example, what if Future 4 (It’s a Smart Smart World) is your Preferred Future, but Future 2 (Lean Mean Market Machine) and Future 3 (Rise of the DSO) are equally probable. It’s possible that we could move directly to Future 4, but also very likely that we could pass through future 2 or 3 on the way there.

What does a transition path through Future 2 (Lean Mean Market Machine) mean?

If the technology to plug and play directly with the market operator develops before trading develops at the distribution level (Future 2), the market operator is placed ideally to pick up the new embedded participants. In order to facilitate this transition, you could decide to aggressively invest in automation technology, and pilot platforms that allow the inclusion of embedded prosumers as direct market participants.



What does a transition path through Future 3 (Rise of the DSO) mean?



If the ability of embedded prosumers to trade and commercialise their DERs develops first, the market operator will face stiff competition for the role of managing embedded prosumers. This is because a transition path through Future 3 will see the likes of DSOs and other intermediaries establish themselves as first movers. By the time technology is sufficiently advanced it may be too late to become a part of the distribution level markets and you may find

yourself limited to an interface role.

All is not lost – positive outcomes can be achieved despite uncertainty around transition paths and potential futures

While a transition path through Future 3 may limit severely a market operator’s future role, there are strategies to mitigate this risk. For example, you could take the lead in technological projects trialling distribution market platforms and position yourself to the regulator as the natural distribution market operator or distribution system platform provider; a specialty in market operation is the ideal qualification for such a role.



Where to from here?

We have three concluding thoughts based on the above hypothetical futures and their implications.

- **Be proactive in shaping your transition path.** This means developing indicators that can measure your status and which future you are likely headed towards so that you can facilitate a transition to your preferred future.
- **Be nimble.** No matter how much you prepare, new technologies and changing consumer preferences will always result in surprises. Ensure your organisation is nimble enough to respond to such changes quickly and effectively.
- **Be adaptable with workforce planning.** In the future, you may find yourself moving away from a market where engineering is a hot skill to one where IT/OT and customer advisory skills become increasingly important. Monitor changing workforce requirements and adapt your talent strategy so you can attract and retain the best people.

If you need an independent, expert view on possible futures and their implications for your operations, we'd be happy to help. Please get in touch.

Sue Paul

 sue.paul@robinsonbowmakerpaul.com

 +64 4 4965636

 +64 21 2047369

Tim Robinson

 tim.robinson@robinsonbowmakerpaul.com

 +64 4 4965619

 +64 21 576483

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ROBINSON BOWMAKER PAUL
Level 8
104 The Terrace
Wellington 6011
NEW ZEALAND

 @RBPEnergy
 robinsonbowmakerpaul.com