



Distribution System Operator (DSO) Models for Utility Stakeholders

Organizational Models for a Digital, Distributed Modern Grid

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TABLE OF CONTENTS

3	Background
6	Executive Summary
8	DSO Current Industry Perspectives
10	Role Definitions
14	Key Assumptions
16	Spectrum of DSO Models
18	Highly Centralized Transmission Level Wholesale DSO Models
23	Local Distribution Area Nodal DSO Models
28	Highly Distributed Peer-to-Peer DSO Models
34	Conclusion

LIST OF FIGURES

5	Figure 1-1: The establishment of new DSO functions leads to new opportunities and new benefits
17	Figure 6-1: Spectrum of DSO models - highly centralized to highly distributed
20	Figure 7-1: Model 1 - Total TSO roles and responsibilities
21	Figure 7-2: Model 2 - Minimal TSO roles and responsibilities
22	Figure 7-3: Key differences between model 1 and model 2
25	Figure 8-1: Model 3 - Utility LDA Node roles and responsibilities
26	Figure 8-2: Model 4 - Independent DSO LDA Node roles and responsibilities
27	Figure 8-3: Key differences between model 3 and model 4
30	Figure 9-1: Model 5 - Utility DMO peer-to-peer roles and responsibilities
32	Figure 9-2: Model 6 - Independent DMO peer-to-peer roles and responsibilities
33	Figure 9-3: Key differences between model 5 and model 6

LIST OF TABLES

11	Table 4-1: DSO roles, what they resemble today, and key assumptions
13	Table 4-2: Other DSO stakeholder roles, what they resemble today, and key assumptions

SECTION 1

BACKGROUND

The purpose of this document is to introduce the spectrum of Distribution System Operator (DSO) organizational models, DSO model examples, roles and responsibilities and key assumptions and questions on the different examples.

The legacy electricity wholesale market system has enabled utilities, Independent Power Producers (IPPs), and now “qualified” third-party aggregators to trade and profit from the bulk energy and ancillary services markets. It is a closed market in which the Independent System Operator (ISO) determines who can play and who cannot. This scenario makes sense in a highly centralized, bulk power, transmission paradigm as it relates to high-voltage, high-amperage, high-volume generation meant to travel long distances that requires large investments and power delivery reliability.

The result of having wholesale markets and creating a competitive landscape has had numerous benefits, including lower energy costs to end consumers and more reliable energy delivery. The other, equally important effect, is the innovation that is fostered by having a market in which to compete. These dynamics have resulted in more efficient and cleaner power plants, new software applications, better control systems and new optimization solutions.

We have now reached a point where Distributed Energy Resources (DER) can be purchased by businesses and homeowners at prices that have a justifiable return on investment (ROI). This is especially true as energy prices increase and the price of DER decreases. This has created a conundrum where utilities are selling less power to end consumers that are reducing their loads which further requires them to raise prices, making it even more compelling for customers to purchase DER to offset higher utility prices. This market environment is pushing utilities to completely rethink their business models.

Regulators, ISOs and utilities are studying the concept of creating a Distribution System Operator (DSO) that would stimulate new distribution markets and engage DER owners. Imagine what a transparent, open, inclusive market would do for the electric power industry-would accelerate the adoption of DER, create opportunities for innovation and new businesses and completely change the way the grid operates and the way that consumers, producers and machines interact with it.

We have now reached a point where Distributed Energy Resources (DER) can be purchased by businesses and homeowners at prices that have a justifiable return on investment (ROI).

Figure 1-1: The establishment of new DSO functions leads to new opportunities and new benefits



Establishing new DSO functions that include an open and transparent distribution market is the next evolutionary step required to enable a “[New Energy Economy](#)” that empowers utilities, consumers, producers, third-party aggregators, technologists, and new business model operators to create more efficiencies, cleaner and more economical power, better reliability and more resilience. The DSO functions and different models described in this document lay the foundation for considering how to enable this New Energy Economy ecosystem from an organizational standpoint based on local politics, regulations, grid constraints and community-specific factors.

DISCLAIMERS

1. There is confusion around the term “DSO.” Most stakeholders associate it with an organization. However, the author of this document uses the term to describe a set of roles and responsibilities. These roles are described in [subsequent sections](#). The key point to understand is that DSO roles may be assumed by a single independent or utility-owned “DSO” entity or the roles could be distributed across multiple organizations.
2. The six DSO models described in this document are illustrative. They are not the only possibilities but are rather parts of a spectrum of different organizational and market structures.
3. The assumptions described in [Section 4, Assumptions](#), were used to “bound” the solution possibilities used in this paper. These assumptions may be different for your individual local conditions.
4. The model names used in this document were based on existing language used by the U.S. Department of Energy and other DSO reference material authors. The author of this paper is open to other naming conventions for the models described herein.

SECTION 2

**EXECUTIVE
SUMMARY**

This paper introduces six DSO models based on current industry perspectives and provides explanations of the roles and responsibilities for each actor in the models. The models presented are meant to be representative of a spectrum of market and ownership types ranging from highly centralized wholesale markets to highly decentralized peer-to-peer markets – with some models in between. They are not meant to be only possible models, but rather to provide starting points based on the closest one(s) to what is “viable” based on local conditions, politics, regulatory environments, grid situations, and other specific community considerations.

The stakeholders include the ISO, the utility, the Distribution Grid Operator (DGO), the Distribution Market Operator (DMO), the Distributed Energy Resource Manager (DERM), and consumers/producers/aggregators. Underlying assumptions include the concepts that the DMO cannot also participate in the market(s) it operates; the utility will continue to own the distribution grid assets and networks; and the utility will remain responsible for safety and reliability of the distribution networks.

Model 1 – Total Transmission System Operator (TSO)

A highly centralized model where the ISO/TSO is responsible for the DMO and DERM under its jurisdiction, including the DER on the Utility’s distribution networks.

Model 2 – Minimal TSO

A highly centralized model where the DMO is managed by the ISO, but the DERM is managed and coordinated by the Utility.

Model 3 – Utility Local Distribution Area (LDA) Node

A nodal model that uses Locational Marginal Pricing (LMP) at a physical Local Distribution Area (LDA) such as a substation or feeder. The Utility is responsible for both the DMO and DERM.

Model 4 – Independent Entity LDA Node

A nodal model that uses LMP at a LDA, where an independent organization operates the DMO and the DERM on the distribution grid.

Model 5 – Utility Peer-to-Peer (PtP)

A highly distributed PtP market where the DMO role is owned by the Utility. DER dispatch is performed automatically (by customer and third-party traders) based on market activity.

Model 6 – Independent Entity Peer-to-Peer

A highly distributed PtP market where the DMO is managed by an independent organization, and DER dispatch is performed automatically based on market activity.

SECTION 3

DSO CURRENT INDUSTRY PERSPECTIVES

A handful of thought leadership documents have been published over the past two years that discuss a “platform” provider (Distributed System Platform Provider or DSPP) and the DSO organization. Depending on which DSO model is implemented, this may be one and the same organization or separate. The main difference between a DSO and a DSPP is that the DSPP provides the underlying technology that enables the DMO market and DER management systems. The platform enables system actors (ISO, Utility, third parties, and customers) to interact in a distributed operation and market structure. For the purposes of this project (and as a practical approach), the DSO organizational model and the roles of the different actors is our focus – and you need to first establish the “what it looks like” before discussing the “how to enable it” with the platform requirements necessary to support the DMO role.

During the research performed for this paper, one very clear theme emerged from all the references. There are two extremely different, opposite modeling approaches that create a spectrum of model designs starting with highly centralized transmission-based models and ending with highly distributed peer-to-peer based models. Over this spectrum, there are other models that fall in between. The author of this paper has digested these reference sources and created models that consolidate the thinking from these authors.



SECTION 4

ROLE DEFINITIONS

This section provides working definitions for key roles that would likely exist in the future ecosystem in which a DSO capability exists. The DSO ecosystem roles reveal an “unbundling” of the traditional utility distribution business and enable the evaluation of different DSO model designs. When designing a DSO model, these roles should be the starting point to accelerate the design process and enable easier comparisons between models.

There are ten general roles identified as part of the framework. Seven of the roles are related to functions, or activities, that a traditional Utility might be expected to play in a high-penetration DER future. The roles include:

- ISO/TSO
- Utility
- Distribution Grid Operator
- DERM
- Distribution Market Operator
- Short-term Planner
- Long-term Planner

Three additional roles are identified to represent other parties that may interact with the DSO. These are:

- Customer
- Producer
- Aggregator

Each role provides functionality that may be necessary in a high-DER scenario. The role descriptions include:

- What it does
- What it resembles today
- Key assumptions

DSO ROLES

Table 4-1: DSO roles, what they resemble today, and key assumptions

DSO Role	What it does	What it resembles today	Key assumptions
ISO/TSO	Responsible for real-time operations of the bulk transmission system and operation of a competitive wholesale power market within its jurisdiction. Also responsible for long-term transmission planning.	This role resembles the regional ISO's today (e.g. ISO-NE, NYISO, PJM, MISO, SPP, CAISO, ERCOT).	• The ISO will be responsible for transmission markets and operations • The ISO will be the balance authority for transmission
Utility	Responsible for the ownership, field operation and maintenance of the infrastructure and equipment of the Electric Distribution System.	This role resembles traditional Utility businesses – Investor Owned Utilities (IOUs), Municipal Utilities (Muni's), and Electric Cooperatives (Co-op's) that are responsible for distribution reliability and safety, and distribution power delivery.	• The Utility will own distribution assets • The Utility will be responsible for distribution reliability and safety

Distribution System Operator Models

DSO Role	What it does	What it resembles today	Key assumptions
Distribution Grid Operator (DGO)	Responsible for the real-time operations of the electric distribution system within its jurisdiction.	This role resembles the Electric Distribution Operations group at the Utility.	- The DGO may be subject to rules that prevent its employees from sharing non-public information with employees of certain other roles, including the DMO or DER owner/operators. These rules could be similar to current Standards of Conduct rules imposed on Transmission Providers by the FERC. - Since the DGO operates the distribution grid, it is also responsible for distribution reliability and safety.
Distributed Energy Resource Manager (DERM)	Responsible for the monitoring, management, coordination and optimization of numerous DERs owned and operated by the Utility, Producers, or third-party Aggregators.	No such role exists today in the form that we envision. However, utilities and third parties have begun developing requirements or (in a few cases) have begun implementing a DER Management System (DERMS).	In certain market configurations (peer-to-peer), there is no central management and coordination of DERs, so there is no need for a central DERM.

DSO Role	What it does	What it resembles today	Key assumptions
Distribution Market Operator (DMO)	Responsible for managing a platform for Utility and third-party bids, offers, and bilateral transactions for distribution services, as well as transaction clearing and settlement.	No such role exists today in the form that we envision.	The DMO may not be a market participant in the market(s) it operates.
Long-term Distribution Planner (LDP)	Analysis and planning of the Electric Distribution System with the primary objective of ensuring that distribution infrastructure can support future grid services for load and distributed generation.	This role resembles the Utility's Distribution Planning group.	The LDP planning horizon is greater than 30 days
Short-term Distribution Planner (SDP)	Responsible for the analysis and planning of the Electric Distribution System with the primary objective of supporting Distribution Grid Operator in providing week-ahead, day-ahead, hour-ahead, and/or real-time grid services for existing load and distributed generation.	This role resembles the real-time, or operational, planning function of an electric transmission system operator (ISO/TSO), only focused on the Electric Distribution System. Today no such role exists today in the form that we envision.	- The SDP planning horizon is less than 30 days - The SDP would work closely with the DGO and have access to real-time system information

OTHER ROLES

Table 4-2: Other DSO stakeholder roles, what they resemble today, and key assumptions

Other Role	What it does	What it resembles today	Key assumptions
Consumer	Purchases energy services to serve grid connected equipment and appliances (load)	This role resembles retail electricity customers served by the Utility.	Physically connected to the Electric Distribution System owned by the Utility
Producer	Provides energy services from grid connected distributed energy resources and related equipment	This role resembles entities with distributed energy resources such as rooftop PV, electricity storage, or demand response equipment, who are connected to the utility's distribution system (primary or secondary).	Physically connected to the Electric Distribution System owned by the Utility
Aggregator	Transacts with multiple Consumers and/or Producers to aggregate and transact bundled energy services for delivery to the DSO, Utility, or ISO/TSO	This role resembles entities such as demand response providers, Community Choice Aggregation organizations, or other groups who deal collectively with the Utility or the ISO.	Conform to the business requirements and qualifications necessary to be an aggregator

SECTION 5

KEY ASSUMPTIONS

The following assumptions apply to all the models described in this document. These assumptions were developed to help “bound” the development of the sample models provided and may not apply, be different, or incomplete in your circumstance. Establishing and agreeing on bounding assumptions early will greatly simplify your modeling efforts and reduce the “what-if” scenarios and the amount of time spent when working in groups. The bounding assumptions for the six DSO models discussed in this paper include:

1. **The Public Utility Commission (PUC) will make decisions in the interests of the rate payers:** Although the PUCs will take input from the utilities in their jurisdiction, ultimately the PUC will make decisions in the public interest that manifest themselves around safety, reliability and end consumer costs of electricity.
2. **The Distribution Market Operator (DMO) cannot also participate in the market:** Whether it is the ISO/TSO, the utility, or an independent DSO entity, the organization operating the market cannot bid its own DER assets into that market. The opportunity for market manipulation and increased costs to the consumer exist, and at the very least, the public’s perception must be properly managed. This conclusion is common sense and it is unlikely the PUC will allow this to occur.
3. **The Utility will continue to own the distribution network and its assets:** Utility companies have invested the resources, time, and (in some cases)

their own money to develop safe and reliable distribution systems for its customers. The distribution networks the utility operates have value, and that value logically belongs to the utility. It is unlikely that any government legislating agency (state or national) will challenge this ownership and have to deal with lobbyists, lawyers and investors who have vested interests in maintaining that ownership claim.

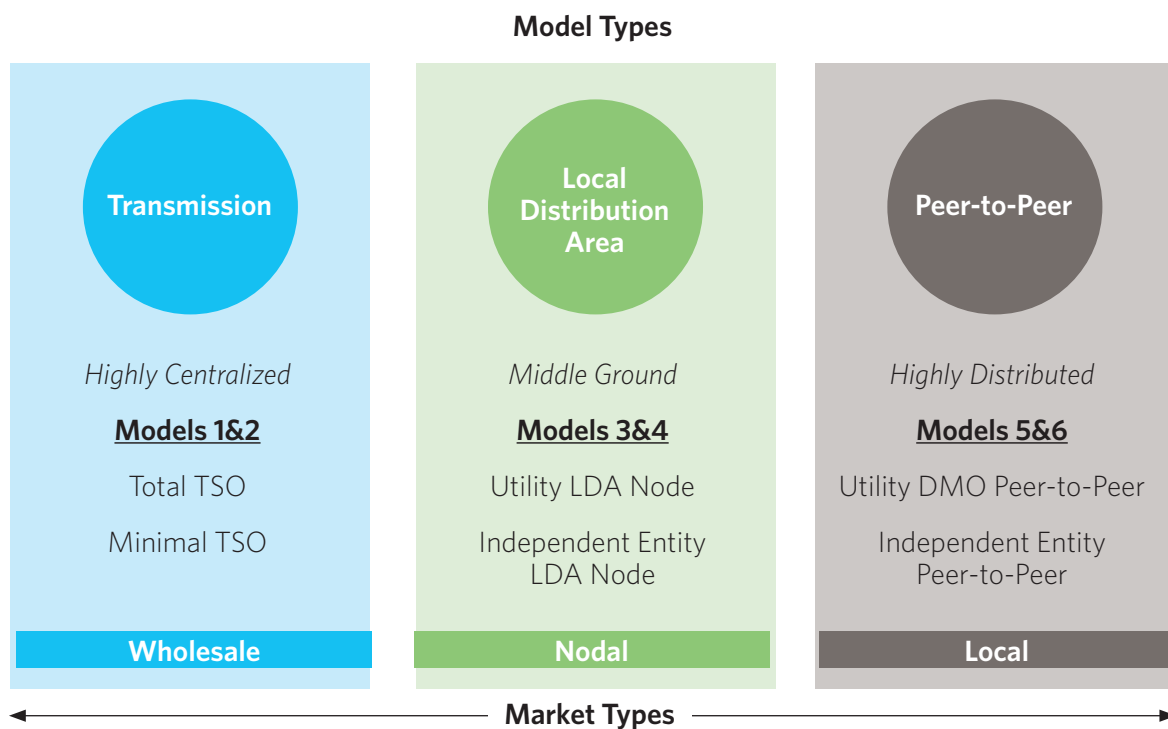
4. **The utility will remain responsible for the safety and reliability of its distribution networks:** This is an important consideration and simplifies the conversation around several of the DSO models that will be discussed later in this document. As the owner of the assets, the Utility will want to protect those assets. It is also in the best interests of the public for the Utility to remain the responsible party for distribution safety and reliability. They are the best qualified, most experienced organization to protect the system and the public. This means that no matter which organization is responsible for DER management, the utility will remain responsible for switches and protection asset operation and maintenance.

SECTION 6

SPECTRUM OF DSO MODELS

The spectrum of DSO models ranges from highly centralized transmission-level models to highly decentralized peer-to-peer models. In-between those two extremes, exist models that we will call “nodal” models. In some DSO papers, these are also referred to as LDA models and represent a physical location on the distribution network such as a T&D substation or a feeder, which becomes a separate nodal market instance for the actors on that LDA node.

Figure 6-1: Spectrum of DSO models - highly centralized to highly distributed



This document describes six different DSO models based on current industry thinking and the spectrum of modeling and market types shown in Figure 6-1, above. The models presented are meant to be representative and are not meant to be the only models, but rather to provide starting points based on the closest one(s) to what is “viable” based on local conditions, politics, regulatory environments, grid situations and other local considerations.

SECTION 7

HIGHLY CENTRALIZED TRANSMISSION-LEVEL WHOLESALE DSO MODELS

Transmission-level DSO models are highly centralized organizational structures primarily operated by the ISO/TSO. In fact, the DMO role in both of the examples in this section are owned by the ISO. With transmission-level DSO models, the intent is to leverage the existing wholesale markets and create an open and transparent mechanism that animates participation from distribution system DER owners. The primary issue becomes one of scalability – specifically, the ability of the ISO to fully model both the transmission and each distribution network within the ISO territory, which is necessary to accurately plan and forecast. This capability requires significant computing power, detailed power flow models, and accurate/current representations of all grid assets, including those behind the meter. These types of market models are discussed in the U.S. Department of Energy (DOE) paper, “Two Visions of a Transactive Energy System” by De Martini, Kristov and Taft.

Key questions to consider include:

- Can transmission level DSO models scale?
- Does the ISO want to assume the additional market and operations responsibilities?
- What could go wrong? Would the grid be more susceptible to cascading events or cybersecurity vulnerabilities?
- What is the frequency and in what form does the ISO receive interconnect data from distribution grid operators?
- What technology, systems and devices are required for actors to participate in the market?
- What are the minimum requirements for distribution DER owners to qualify for market participation?
- How does the Distribution Market Operator make money?

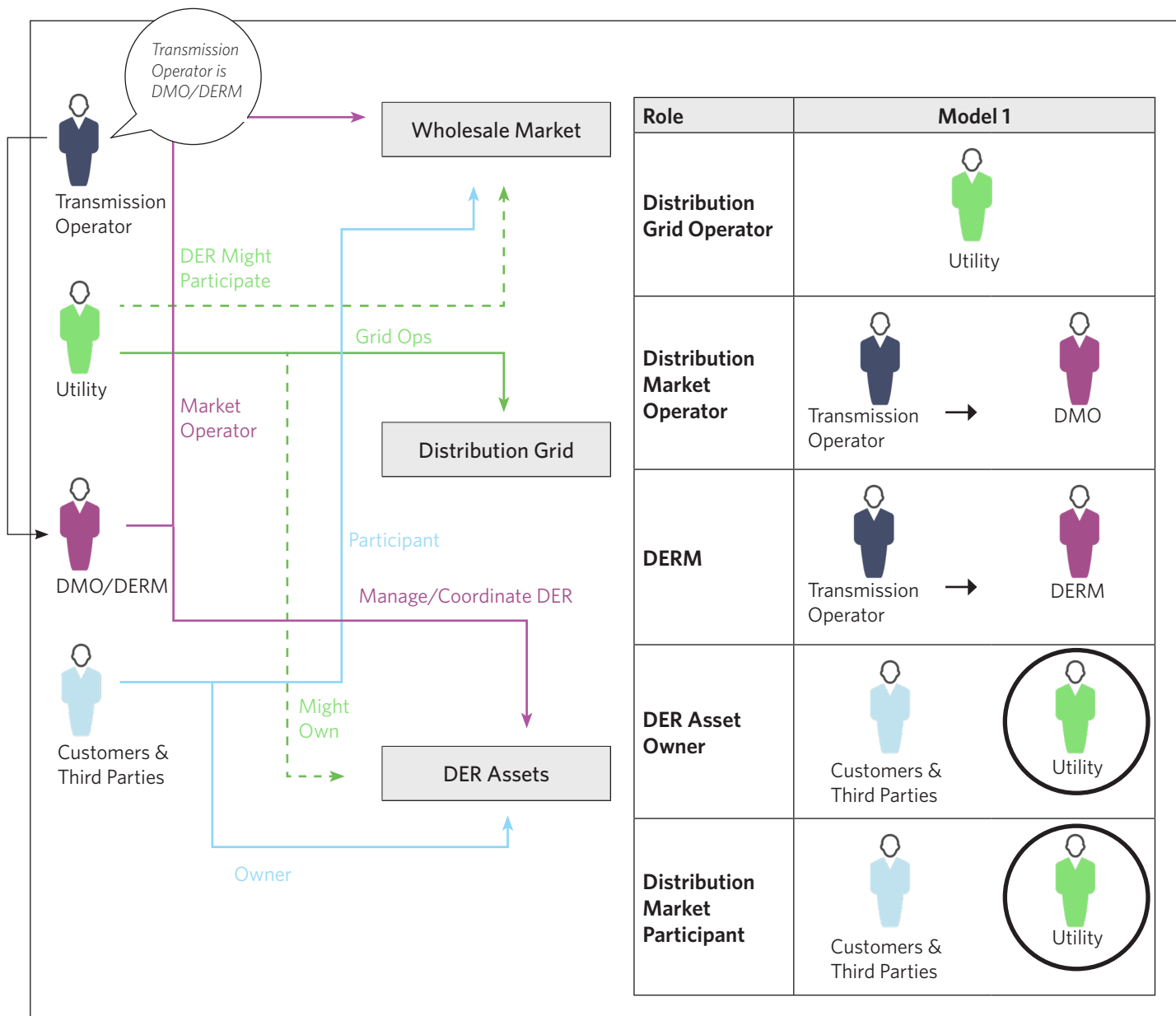
MODEL 1 – TOTAL TRANSMISSION SYSTEM OPERATOR (TSO)¹

The Total Transmission System Operator (TSO) model is what DOE calls the “Grand Central Optimization TSO”.² Under this model, the ISO/TSO owns the market operator functions and manages/coordinates all DER on the system. In other words, the ISO/TSO organization is both the DMO AND the DERM. The Utility is the distribution grid owner/operator (the DGO) and is responsible for traditional grid asset operations.

¹Total TSO is a term defined by DOE in their paper, “Two Visions of a Transactive Electric System”, 2016

²Grand Central Optimization TSO is a term defined by DOE in their paper, “Two Visions of a Transactive Electric System”, 2016

Figure 7-1: Model 1 - Total TSO roles and responsibilities



Comments/Points to Consider:

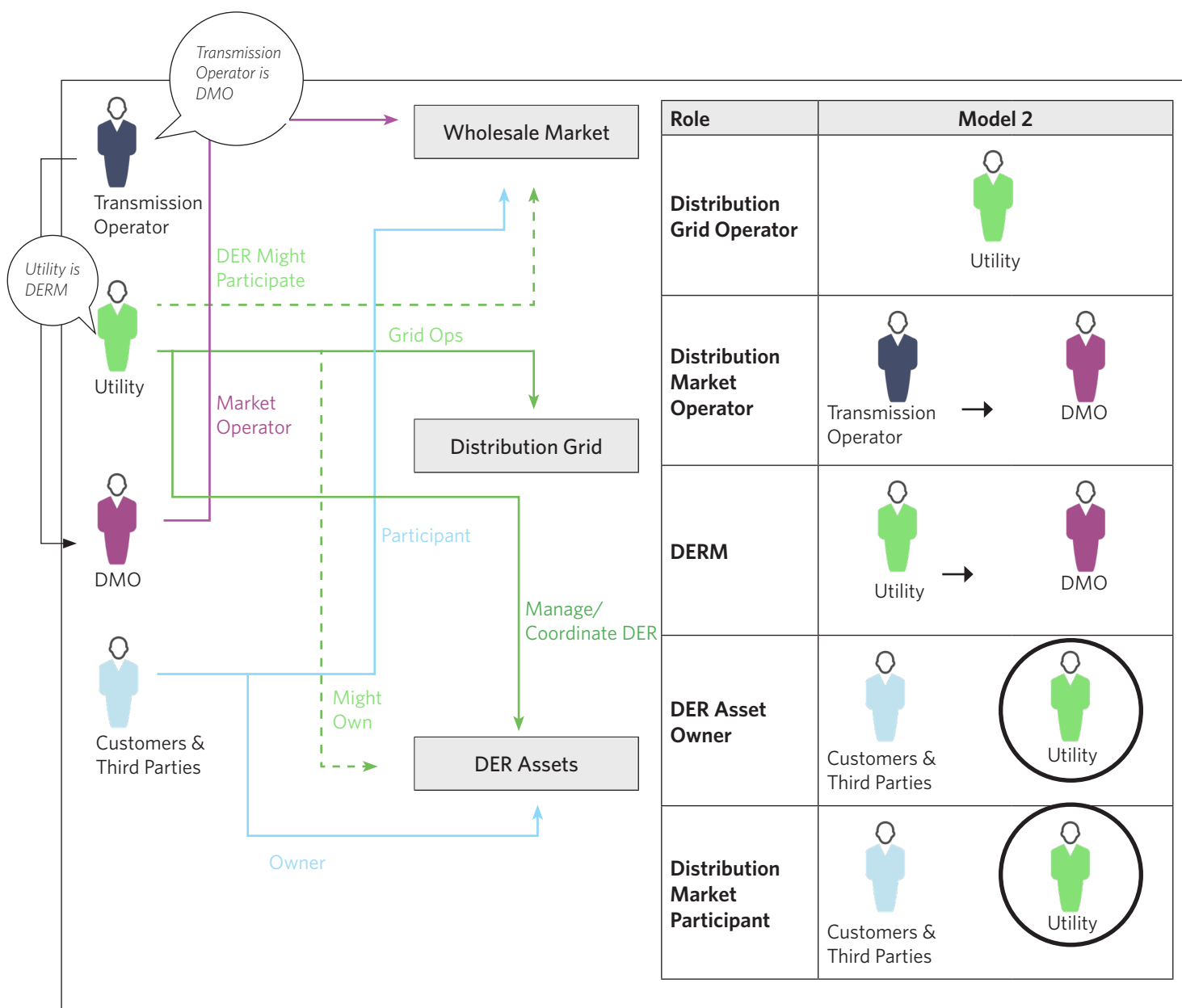
Conceptually, Model 1 is perhaps the simplest of all six models. However, in practice it would be highly complex to implement and keep current. The key takeaways in this model are that the ISO is responsible for the DMO and the DERM. The Utility remains responsible for distribution safety and reliability and

is the DGO. In this model configuration, whether the Utility can own and/or participate in the market with its own DER assets is unknown and would have to be defined by local rules. In California, the CAISO has indicated it is not interested in assuming this level of responsibility for both DMO and DERM.

MODEL 2 - MINIMAL TSO

The Minimal TSO model is a hybrid centralized model that the DOE calls the “Grand Central Optimization Minimal TSO”. Under this model, the ISO is responsible for the DMO. However, the Utility has the role of the DERM.

Figure 7-2: Model 2 - Minimal TSO roles and responsibilities



Comments/Points to Consider:

DOE believes that Model 2 is viable and a likely choice for some states. The reality is that from a Utility point of view, Model 2 is not much different than today's standard method of operation:

1. Wholesale market system operated by ISO/TSO
2. Utility is DGO and includes DERM as part of its DGO role

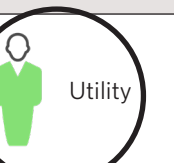
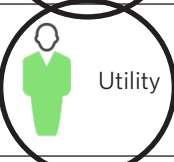
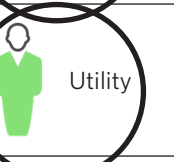
This model could act as a transitional model to a less centralized, distribution-level market system in the future. The primary issue of either of the highly centralized models is that market participants must be a certain scale in order to be qualified to participate. This caveat limits opportunities for individual smaller DER asset owners with their only real opportunity to play in the market through an aggregator.

KEY DIFFERENCES BETWEEN MODEL 1 AND MODEL 2

There is one key difference between Model 1 and Model 2:

- Model 1 – the ISO/TSO is responsible for DMO and DERM.
- Model 2 – the ISO/TSO is responsible for DMO. The Utility is responsible for DERM.

Figure 7-3: Key differences between model 1 and model 2

Role	Model 1	Model 2
Distribution Grid Operator	 Utility	 Utility
Distribution Market Operator	 Transmission Operator →  DMO/DERM	 Transmission Operator →  DMO
DERM	 Transmission Operator →  DMO/DERM	 Utility →  DERM
DER Asset Owner	 Customers & Third Parties  Utility	 Customers & Third Parties  Utility
Distribution Market Participant	 Customers & Third Parties  Utility	 Customers & Third Parties  Utility

SECTION 8

LOCAL DISTRIBUTION AREA NODAL DSO MODELS

LDA Nodal Models represent a compromise and middle ground between highly centralized and highly distributed DSO models. The DMO market operations are logically tied to a physical location (which could be an interconnection location or an area that consists of several interconnections) on the distribution network such as a substation or feeder. These markets either act independently or behave as points of bidder aggregation and might have a logical relationship to the ISO wholesale markets – or not. Nodal prices were defined by FERC in its Standard Market Design as Locational Marginal Price (LMP). The concept of nodal markets is not new and has been used in transmission markets like CAISO and ERCOT for many years using standard calculations to establish LMP market-based prices to manage congestion locally. A similar approach could be used with the LDA Nodal Models, but “all markets not being equal”, there could be the perception of market inequity by customers/third parties that receive higher payments for DER market participation than their neighbors simply because they are on a more congested substation or feeder.

Another consideration for these models is that if the DER assets do not provide the proper voltage or power quality needs for a market area, it would logically fall upon the Utility to be the “provider of last resort” to ensure reliability. This is not unmanageable but will require better bottoms-up long-term and short-term forecasting tools to properly plan for DER capacities on the network.

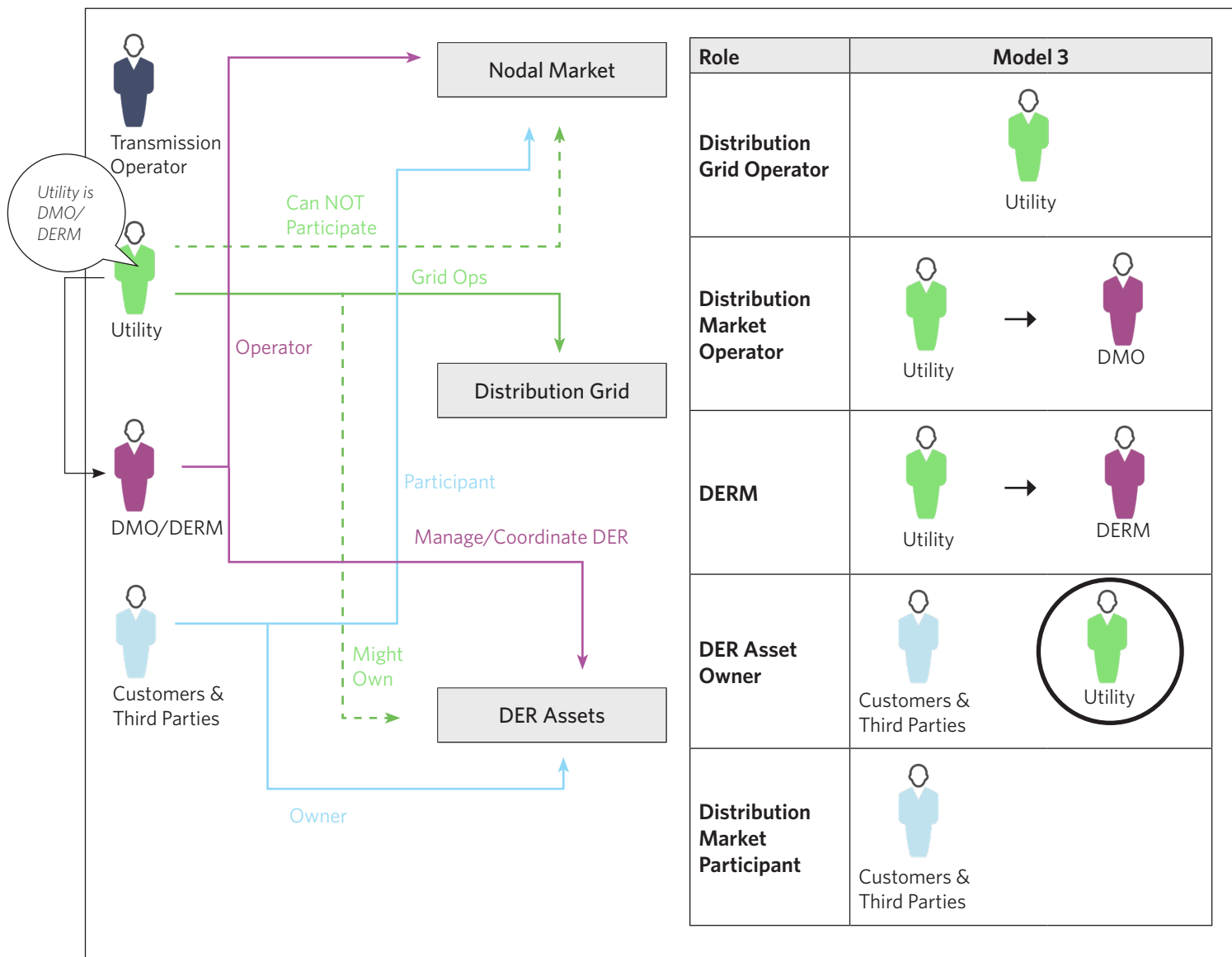
Key questions include:

- How are LDA Nodal LMP prices set? Who sets them? What is the relationship of LDA Nodal prices to ISO wholesale market prices?
- Where is the optimal location to set the LDA markets? Substation? Feeder? Neighborhood? Meter?
- What technology, systems and devices are required for stakeholders to participate in the market?
- How does the Distribution Market Operator make money?

MODEL 3 – UTILITY LDA NODE

The utility LDA Node model uses LMP at a physical LDA interconnection location such as a substation or feeder. Under this model, the Utility is the DMO and the DERM in addition to its DGO duties. Because the Utility has responsibility for operating the Nodal Market under the DMO, it would not be allowed to participate in that market with its own DER distribution assets.

Figure 8-1: Model 3 - Utility LDA Node roles and responsibilities



Comments/Points to Consider:

In Model 3, the Utility operates in “business as usual” with the additional role of DMO. As the DMO, there are numerous revenue models that might include a “pay to play subscription” model, a “grid network usage fee” model, or a “transaction fee” model. The Utility is in a familiar role as the DGO and remains responsible for safety and reliability. It also continues to operate

the business using the standard rate-based recovery methods, including approved DER assets as Non-Wires Alternatives (NWA) for safety and reliability reasons. However, there may be additional steps or rules associated with grid upgrades since DER producers and third-party aggregators could also potentially offer NWA solutions at no capex cost to rate payers. The circled Utility icon in the DER Asset Owner row indicates that this is a question that will need to be explored.

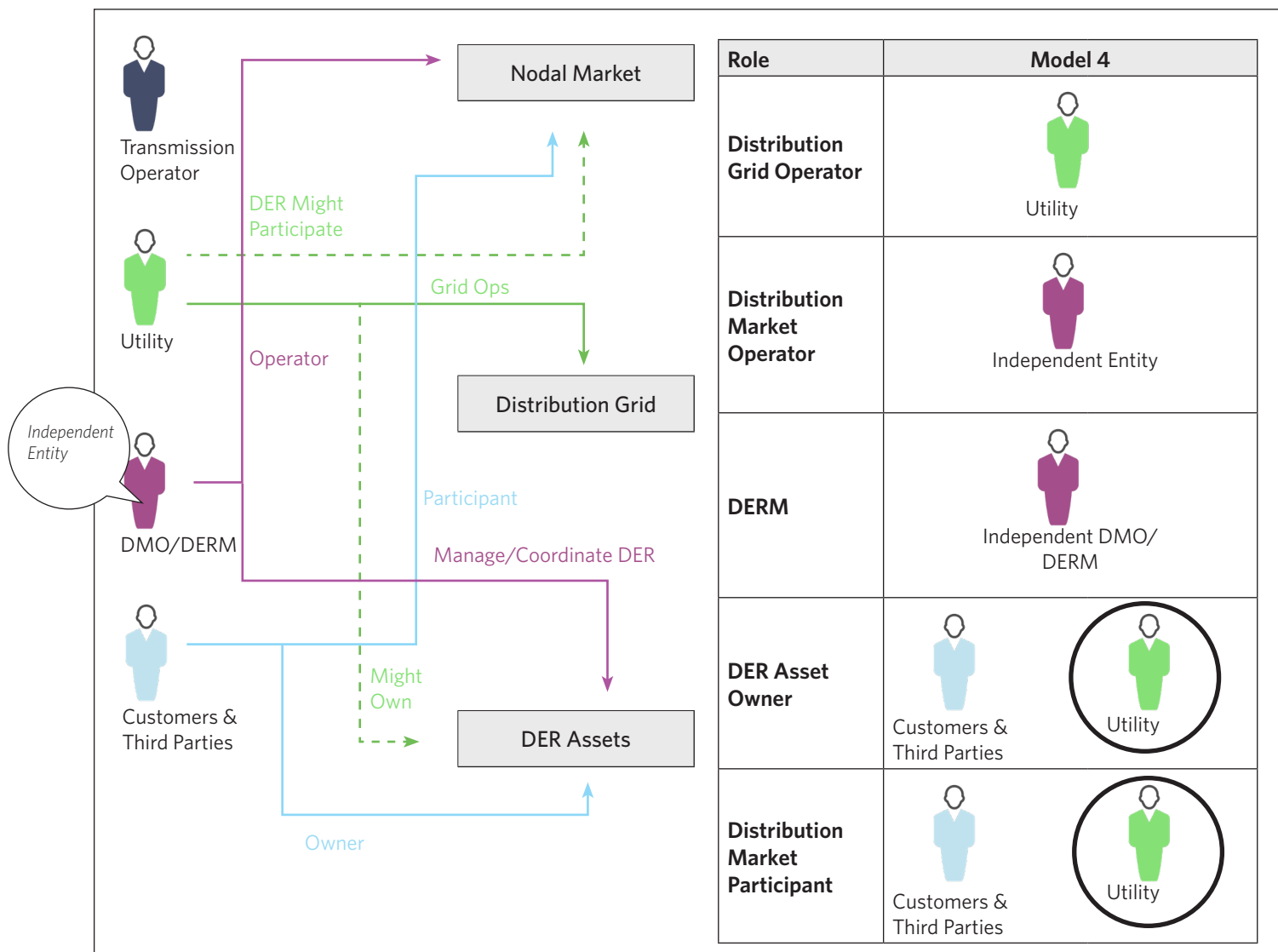
MODEL 4 - INDEPENDENT ENTITY LDA NODE

Model 4, Independent Entity LDA Node, uses LMP at a physical LDA interconnection – the same market configuration as Model 3. Under Model 4, however, the DSO is a separate independent organizational entity that is responsible for DMO and DERM roles. Because the independent organization has responsibility for operating the DMO's Nodal Market, the Utility might be allowed to participate in the LDA Nodal Market with its distribution DER assets.

Figure 8-2: Model 4 - Independent DSO LDA Node roles and responsibilities

Comments/Points to Consider:

As a separate entity, the independent organization would have a far larger role as the DMO and DERM. It might also assume the customers of the Utility to include billing operations alongside the measurement and verification services. Metering services might fall under the Utility or the DSO, but both organizations will need metering data for planning and settlement purposes. The positive aspect of this model for the Utility is a very justifiable case to participate in the DMO distribution market. The circled Utility icons in the DER Asset Owner and Distribution Market Participant indicate that these are questions that require discussion. The Utility would also continue to



use a rate-based reimbursement business model for grid asset investments to support safety and reliability. The circled utility icons in the DER asset owner and Distribution Market Participant rows indicates that there is a question of whether the utility can own and participate in the distribution market with its own DER assets.

KEY DIFFERENCES BETWEEN MODEL 3 AND MODEL 4

There is one key difference between Model 3 and Model 4:

- Model 3 – the Utility is responsible for DMO and DERM.
- Model 4 – an Independent DSO organization is responsible for DMO and DERM.

The implications of an Independent organization in Model 4 create an interesting opportunity for the Utility to potentially own DER assets on the distribution grid and to be allowed to bid those assets into the DMO distribution market. This obviously would require PUC approval, and there are likely to be special rules on how the Utility could participate in the market.

Figure 8-3: Key differences between model 3 and model 4

Role	Model 3		Model 4	
Distribution Grid Operator	 Utility		 Utility	
Distribution Market Operator	 Utility → →  DMO		 Independent Entity	
DERM	 Utility → →  DERM		 Independent Entity	
DER Asset Owner	 Customers & Third Parties	 Utility	 Customers & Third Parties	 Utility
Distribution Market Participant	 Customers & Third Parties		 Customers & Third Parties	 Utility

SECTION 9

HIGHLY DISTRIBUTED PEER-TO-PEER DSO MODELS

Peer-to-Peer (PtP) are the popular transactive energy models that you hear blockchain enthusiasts pontificate about the idea of neighbors selling electricity to neighbors. However, the devil is in the details on how this would be accomplished. The PtP markets could theoretically support a wide variety of granularity – from a single meter entity, to neighborhoods, to a LDA, to a Utility territory, or an ISO LMP market. The DMO organization would have to be somewhat “virtual”, spinning up (or combining) new markets as the marketplace evolves and creates more (or less) granular distribution markets. The point is that this type of marketplace allows individuals/organizations to purchase power directly from other individuals/organizations in whatever “local” market territory they live within whenever they want.

Another key point – and one that could introduce real chaos on a scaled system – is the concept that DER assets self-dispatch. The peer-to-peer contracts determine when and how much to dispatch, and there is no brokered dispatch system to manage it at a system level. The concept of peer-to-peer self-dispatching assets is discussed in E3R Consulting’s, “Market Architectures for Managing Distributed Energy Resources,” and is what they call the “Blockchain Model”.

Peer-to-peer market technology is nascent, but there are active pilots going on in New York, Australia and Asia. These models are typically the ones that customers believe are the most transparent and beneficial, although that is not necessarily true. How this might scale and how many stakeholders would participate is extremely questionable, especially since there would be investment costs, new technology and time involved in being a market participant. There is a rational argument that because of the expense and time investment requirements for participation, these models are unfair to less fortunate populations. Regardless, they are likely to be considered by PUC in support of the rate-payers’ and third-party participants’ wishes. Markets of this type would likely require new,

innovative solutions that include Artificial Intelligence (AI) to automate and optimize participation and distribution grid operations to reduce or eliminate human interaction with the DMO distribution market. Viability of these markets on a scaled deployment are untested and unknown at this time.

As with the two LDA Nodal models, the PtP models require a “provider of last resort” to ensure reliability when voltage and power quality requirements are unmet by the local PtP market assets. This responsibility would fall upon the Utility for that marketplace since there is no centralized DERM to help. The utility will require compensation for providing this service, perhaps even as a monthly service fee - like cable or internet services.

PtP models are the most complex and inspire many questions that include:

- Is the market transparent, open and fair? What are the costs to participate?
- How are market prices set? Who sets them? Or, is it a truly free market where prices are determined by the participants themselves? If so, what happens when market prices get very high or go negative?
- What are the potential consequences of allowing DER assets to self-dispatch? How is reliability affected? Who is responsible for reliability? How are they compensated?
- What technology, systems, devices and training are required for actors to participate in the market? What technology is needed to reduce or eliminate the need for human interaction with the DMO distribution market system?
- What rules are required to establish market territories? What territory is a market tied to? What (if any) is the relationship of PtP markets to ISO markets?
- What additional revenue models might be available

for the Utility or the DMO? Are there new services that could be created to bring new value to the customer base?

- How does the DMO make money?

MODEL 5 - UTILITY DMO PEER-TO-PEER

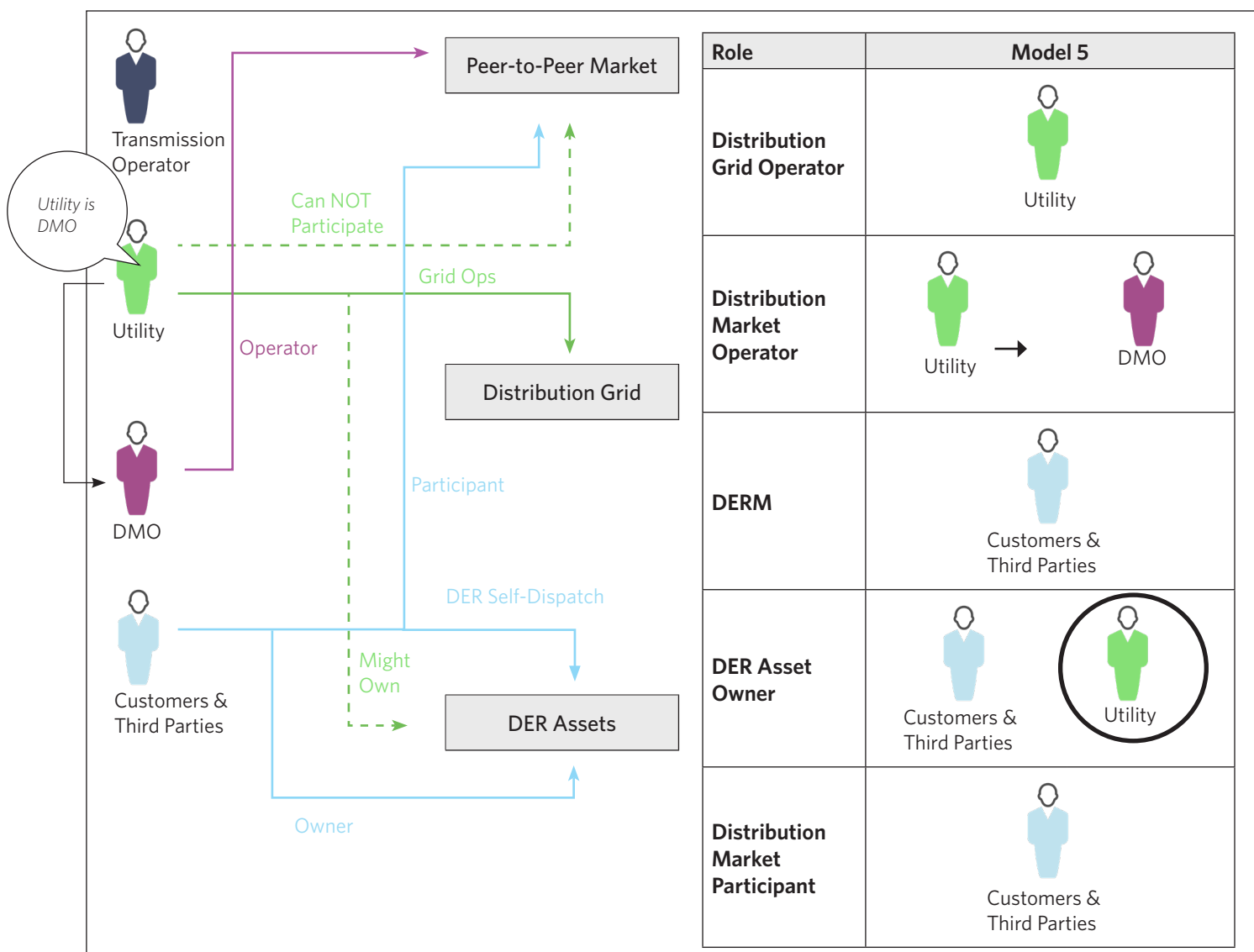
Model 5, the utility DMO PtP model, combines the DMO as a utility role, with market operation and traditional DGO responsibilities being owned by the utility. Because the Utility has responsibility for operating the PtP Market under the DMO role, it would not be allowed to participate in the distribution market with its own distribution DER assets.

Comments/Points to Consider:

The key point to recognize in both PtP models is that there is no DERM – DER self-dispatch. The utility's role under this model is the same as the utility LDA Nodal model, except that the market must support direct financial interactions between individual participants within the market jurisdiction. Like the Utility LDA Nodal model, there are numerous potential revenue models for the utility that include “pay to play subscription fee”, “transactional fee”, or a “monthly grid asset usage fee” model.

The utility remains responsible for safety and reliability

Figure 9-1: Model 5 - Utility DMO peer-to-peer roles and responsibilities

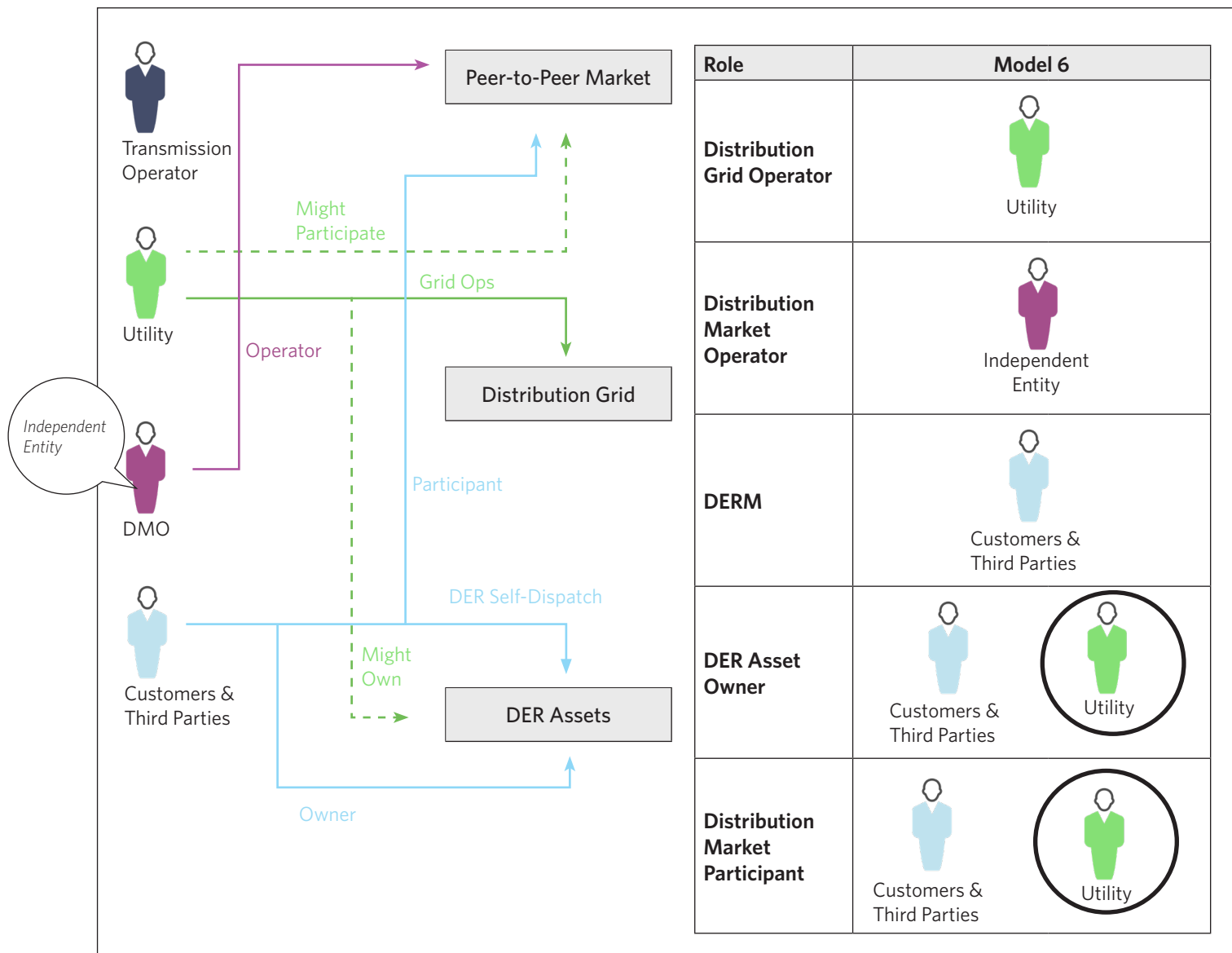


and the traditional operation of the distribution grid as the DGO. There is no DERM, so the grid could look quite different and require utility-owned DER (especially energy storage) to manage power perturbances on the grid due to uncontrolled DER market activities. Utilities could continue to use the familiar rate-based recovery business models. There are likely to be significant grid and IT investments needed to support this type of model (more granular sensing/situational awareness technology, upgrades, NWA options, forecasting and planning tools, etc.), creating near term rate-based revenue opportunities for the Utility. Since the utility may not participate in the PtP markets, they might own DER (or non-wires alternatives – NWA) to support reliability and safety needs using rate recovery methods. The circled Utility icon indicates that this is an area for discussion. If the utility is allowed to own distribution DER, there may be additional steps or rules associated with grid upgrades since customer and third-party aggregators could also potentially offer NWA solutions at no cost to rate payers.

MODEL 6 - INDEPENDENT ENTITY PEER-TO-PEER

In Model 6, Independent Entity PtP, the DMO is an independent entity that is responsible for market operations and provides the market platform. Because the independent entity has responsibility for operating the PtP market, the utility might be allowed to participate in the PtP Market as both a seller and a buyer with its distribution assets.

Figure 9-2: Model 6 - Independent DMO peer-to-peer roles and responsibilities



Comments/Points to Consider:

In Model 6, the utility is the DGO and performs traditional grid operations, probably with the addition of utility-owned (or third-party contracted) DER assets, such as grid-scale energy storage. The utility would continue to use a rate-based reimbursement business model for grid assets and has the potential opportunity to participate in the PtP market. The circled utility

icons in the DER Asset Owner and Distribution Market Participant rows indicate there is discussion necessary. In addition, many new grid assets (sensors, upgrades, NWA options) will be required to support this type of model, which creates near-term revenue opportunities for the utility.

KEY DIFFERENCES BETWEEN MODEL 5 AND MODEL 6

Figure 9-3: Key differences between model 5 and model 6

Role	Model 5	Model 6
Distribution Grid Operator	 Utility	 Utility
Distribution Market Operator	 Utility →  DMO	 Independent Entity
DERM	 Customers & Third Parties	 Customers & Third Parties
DER Asset Owner	 Customers & Third Parties  Utility	 Customers & Third Parties  Utility
Distribution Market Participant	 Customers & Third Parties	 Customers & Third Parties  Utility

There is one key difference between Model 5 and Model 6:

- Model 5 – the utility is responsible for DMO.
- Model 6 – an Independent organization is responsible for DMO.

As with the independent organization in Model 4, Model 6 also creates an interesting opportunity for the utility to potentially own DER assets on the distribution grid and to be allowed to bid those assets into the distribution market. As mentioned previously, this would require PUC approval, and special rules for utility participation are likely to apply.

SECTION 10

CONCLUSION

The key take-away from this document is that there is a spectrum of DSO models that range from highly centralized to highly distributed. It is also important to understand that most people recognize that a DSO includes the roles of the DMO and the DERM. However, not everyone recognizes that these roles can be separated between organizations that include the ISO/TSO, the utility, and an Independent organization.

The models represented here are illustrative and are based on the [assumptions discussed in Chapter 5](#). These assumptions may not apply to your situation. Before developing a DSO model for your situation, consider your local politics, regulatory environment, grid constraints, and other local conditions. This will help bound the discussion and simplify/shorten “what-if” debates on which model(s) are most beneficial.



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