NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Survey of DER Modeling Practices

NERC System Planning Impacts from Distributed Energy Resources Working Group (SPIDERWG) - White Paper

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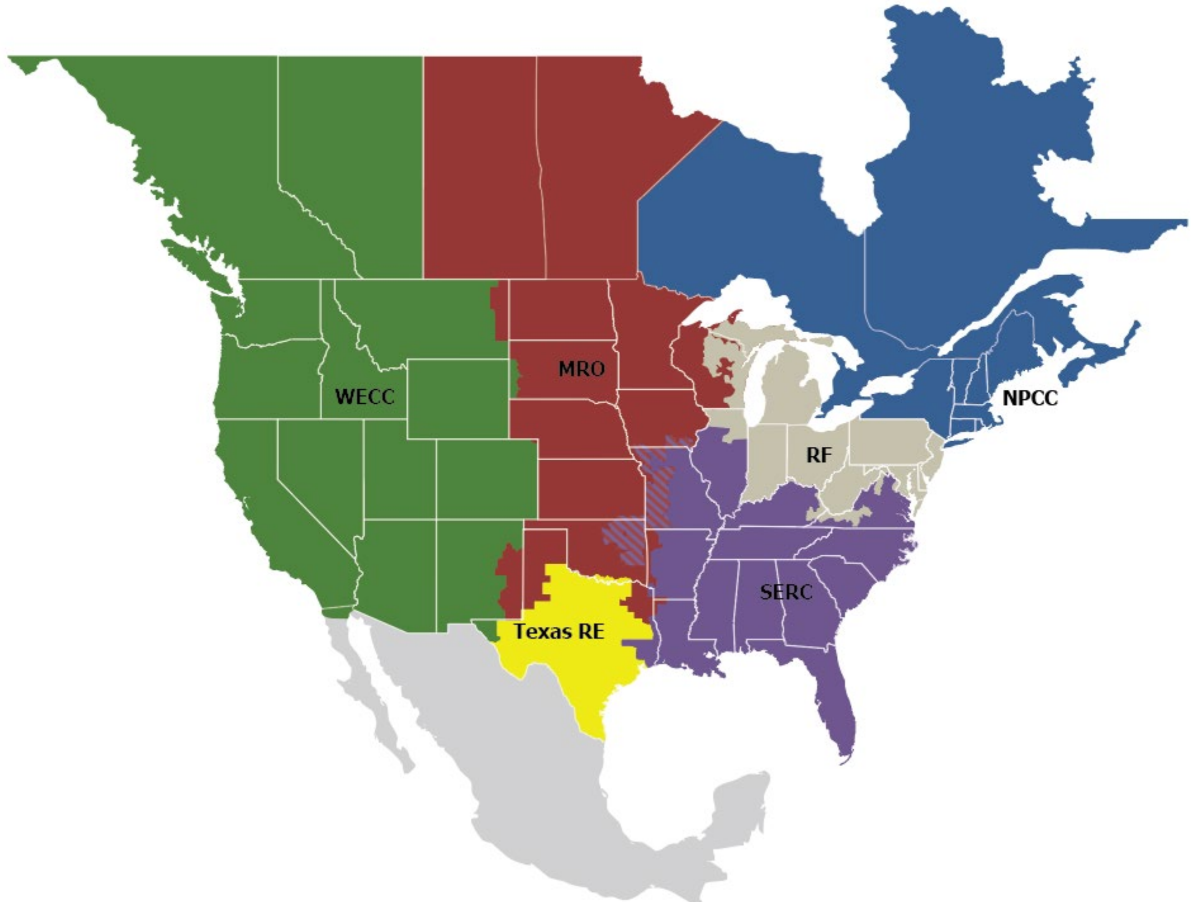
Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of the North American Electric Reliability Corporation (NERC) and the six Regional Entities, is a highly reliable and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entity boundaries as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners (TOs)/Operators (TOPs) participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Executive Summary

The NERC SPIDERWG performed an informal survey of its membership regarding distributed energy resource (DER) modeling practices.[1] SPIDERWG consists of a wide range of industry experts and a cross-section of industry representation, and 45 entities participated in the survey. The survey was primarily geared towards understanding DER modeling practices of Transmission Planners (TPs) and Planning Coordinators (PCs), which are well-represented on SPIDERWG. Results from the survey were analyzed to identify any major trends in DER modeling practices, to characterize the level of detail that TPs and PCs are using for DER modeling, and to identify any potential gaps in these practices that should lead future efforts for SPIDERWG and industry.

Key Findings

The following key findings were identified from this survey:

- **Questions 2 and 3:** Responding entities ranged in their peak gross load from over 20,000 MW to less than 500 MW. However, only 18% of respondents have a minimum load over 10,000 MW, and 50% of respondents have a minimum load less than 1,000 MW.
- **Question 5:** 31% of respondents reported having over 1,000 MW of installed DERs in their footprint, 60% reported having more than 100 MW, and 40% reported having less than 100 MW.
- **Question 6:** Forecasted DER penetration levels are likely to increase in the coming years, particularly in the planning horizon. Responses shifted towards increased penetration levels by 2024. However, about 15% of respondents did not have a DER forecast out to 2024.
- **Question 7:** 40% of respondents reported observing DER tripping during fault events on the electrical grid. A few entities were able to report a quantitative amount of DER tripping due to limited data available.
- **Question 8:** 40% of respondents reported a shift in peak or light net load hours due to the increased penetration of DERs in the planning time frame or real-time horizon. Shifts in peak or light net load hours had an impact on the planning assumptions used for BPS reliability assessments, impacting how NERC TPL-001 reliability studies are executed.
- **Question 9:** 50% of respondents reported that they receive operational DER information (i.e., DER output) for individual DERs above a size threshold. The majority of remaining respondents do not receive any operational data regarding DERs in their system, not even in an aggregated manner.
- **Question 10:** 45% of respondents model DERs explicitly with some representation of the aggregate level of DERs in their system. Most of those respondents model the aggregate DERs by using a generator record in the simulation tools. 40% of respondents use a negative load or embed DERs into load forecasts (i.e., no explicit dynamic behavior representation of DERs in study). 15% use a mix of explicit representation and net load reduction. Entities responding that they use negative load or embed DER in their load forecasts stated that they do not have tools to represent DERs, do not have enough data to represent DERs in study, or have DER capacity too small to make an impact on the BPS.
- **Question 11:** 50% of respondents do not have a threshold for modeling utility-scale DERs (U-DERs) (i.e., larger DERs that are three-phase installations and do not model U-DERs in their studies). The remaining respondents use some threshold that ranges from less than 1 MW to above 10 MW.
- **Question 12:** 62% of respondents stated that they do not model retail-scale DERs (R-DERs) to represent aggregate levels of DERs. 20% use a threshold less than 1 MW and 16% use a threshold between 1–5 MW.

[1] For this survey and its results, distributed energy resources are defined as "any source of electric power located on the distribution system," as defined in the NERC SPIDERWG Terms and Definitions Working Document: https://www.nerc.com/comm/PC/System%20Planning%20Impacts%20from%20Distributed%20Energy%20Re/SPIDERWG%20Terms%20and%20Definitions%20Working%20Document%20rev%201.docx.pdf

- **Question 13:** 53% of respondents stated that they are not modeling DERs in any aggregated manner in their studies, 22% of the respondents have aggregate based on connection point only (i.e., T-D substation), and 16% have aggregate based on size, fuel type, and connection point.
- **Question 14:** 73% of respondents stated that they do not model DERs in dynamic studies in any fashion and 27% reported that they do model DERs in dynamic studies. Reasons for not modeling DERs in dynamic studies were low amounts of DERs in their footprint, unavailability of DER models or tools, and a lack of DER information to populate the dynamic models in a meaningful way.
- **Question 15:** Those that are modeling DERs in dynamic studies are using primarily either the DER_A dynamic model or the more detailed second-generation renewable energy system models. No entities reported using the obsolete PV1 or PVD1 models. One entity reported using their own in-house dynamic model.
- **Questions 16 and 17:** 70% of respondents stated they do not model distributed energy storage in their models and 30% reported that they do. For those that do model distributed energy storage, 70% stated that they model both full injection and full absorption scenarios, 23% reported modeling the distributed battery at maximum injection level only, and one entity reported modeling their distributed storage off-line in studies.

Recommendations and Next Steps

The survey among SPIDERWG members highlights that DER penetrations are rising, but DER data collection, modeling, and modeling practices need to improve across the industry. SPIDERWG will continue to support industry education of DER modeling and study aggregate DER impacts to BPS reliability through workshops, webinars, guidelines, and technical reports. Based on the results of the survey of its membership, of which a large plurality of the respondents were registered TPs or PCs,[2] SPIDERWG recommends the following to all TPs and PCs to improve DER modeling practices:

- **TPs and PCs with minimal DER penetration:** TPs and PCs with minimal levels of DERs should continue monitoring DER forecasts and be prepared to incorporate DER models explicitly into planning assessments to understand their potential impacts to BPS reliability for steady-state and dynamic studies. Regardless of DER penetration level, all entities should track its DER growth such that the penetration of DERs can be accounted for in studies and forecasts appropriately.
- **TPs and PCs with DER penetrations but lack of available DER modeling information:** TPs and PCs in this situation should incorporate the recommendation in NERC *Reliability Guideline: DER Data Collection for Modeling in Transmission Planning Studies*[3] and work with their respective distribution providers to collect appropriate aggregate DER data for the purposes of BPS reliability studies. Without sufficient information regarding DER penetration levels, TPs and PCs cannot execute accurate reliability assessments in the planning horizon. Distribution providers are strongly recommended to review NERC *Reliability Guideline: Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018*[4] and ensure DER data is being collected and provided to the TP and PC for the purposes of BPS planning assessments.
- **TPs and PCs seeking guidance for recommended DER modeling practices:** All TPs and PCs should review the recommendations provided in NERC reliability guidelines[5] that pertain to recommended DER modeling practices and improve their modeling capabilities for representing aggregate levels of DERs. Modeling of DERs is required prior to being able to identify any potential reliability issues that may be presented with increasing levels of DERs, so entities cannot assess impacts with DER information and models to study those impacts.

SPIDERWG will continue to monitor the current state[6] of DER modeling practices and ensure that any limitations to the collection of DER information are addressed, such as through a subsequent survey.

[2] However, each entity can be registered in a number of roles. This means that a plurality could in fact be a majority of the total entities, but not of the functional registration.
[3] This document is available here
[4] This document is available here
[5] This document is available here
[6] This white paper illustrates that DERs are having an impact on the BPS, particularly tripping during fault events and that entities are using limited or no DER modeling practices in some cases. Furthermore, the extent of DER modeling in dynamic studies is fairly minimal considering the current and projected forecasts of DERs in many footprints. Limitations to DER modeling include lack of information regarding DER installations and limited DER modeling capability.

Introduction

Many areas of the North American BPS are experiencing an increasing penetration of DERs, and this is already affecting TP and PC modeling practices and planning assessments. Representing DERs in planning assessments becomes increasingly important as the penetration of DERs rises across many TP and PC footprints. NERC SPIDERWG has developed reliability guidelines and recommendations for modeling DERs in planning assessments and continues to support industry awareness and voluntary adoption of these recommendations. Unlike BPS elements that are often modeled explicitly, DERs are usually represented in aggregate due to the small size of individual units. While these resources are located on the distribution system, their growing impact to the BPS cannot be neglected; this is especially true in BPS planning assessments. DER models are needed to perform steady-state power flow, dynamics, short-circuit, electromagnetic transient, and other types of planning studies. TPs and PCs may need information and data that enable them to develop models of aggregate DERs for planning purposes.

In addition to issuing recommendations and guidelines, SPIDERWG conducted an informal survey of its members to analyze the DER modeling practices of different entities.[7] Understanding the different modeling practices across entities helps identify any gaps and develop a strategy for DER modeling as part of the overall reliable integration of these resources. This white paper discusses the survey questions and the results of the survey.

DER Survey Setup

The Modeling Subgroup of the NERC SPIDERWG developed and executed an informal survey of its membership. The survey questions were developed by the subgroup and reviewed by SPIDERWG. The survey was specifically geared towards TPs and PCs regarding their modeling practices, and 63 entities within SPIDERWG were asked to participate. A total of 45 of those entities provided a response to the survey. At the time of the survey, the NERC Compliance Registry consisted of 75 entities registered as PCs and 206 entities as TPs.[8] Some respondents did not provide completed surveys or answers to specific questions (believed to be due to the lack of information). Detailed descriptions of the survey setup and questions are in **Appendix A**.

[7] Note that the definition of "DER" has been agreed upon by SPIDERWG members to mean the definition as posted on the SPIDERWG's definitions document here.

[8] Note that the registration criteria for these types of entities are not mutually exclusive.

Chapter 1: Review and Analysis of DER Survey Responses

This section briefly describes the key findings and takeaways from the analysis of the survey results. **Appendix B** provides a summary of the responses to the survey questions. Information regarding specific entities' responses are withheld for confidentiality reasons. Relevant key findings are summarized in **Table 1.1**

Table 1.1: Key Findings from Survey Questions		
#	**Related Questions**	**Key Finding**
1	Question 6	From responses to this question and from comparison of the existing and future amounts of DERs, some entities will have an increase in amount of DERs that will move them to a higher category in the future with the DER growth. For example, currently, there are eleven entities with the DER capacity between 1,000 and 5,000 MW, and in the future there will be nine entities in this category. This is because for two entities, the increase in DERs will move them to the category of entities with the DER capacity larger than 5,000 MW. The same is true for entities with other DER amounts.
2	Question 7	Five respondents observed widespread tripping of the DERs with faults;[9] none of them provided the amounts of the DERs that were tripped. Although not many of the respondents observed widespread DER tripping with faults, this may be due to lack of visibility on the distribution systems and thus insufficient data on the DER output and tripping. Other prevailing inferences could be that faults did not occur in their areas or that the DER penetration is so low that any DER trip is lost in the "noise" of the response. Any of these would result in no observed widespread DER tripping.
3	Questions 16 and 17	The reasons for not modeling energy storage explicitly[10] were absence of such storage, absence or lack of data on distribution-connected energy storage, or absence of appropriate tools. The largest category of "No" responses was due to the absence of distribution-connected energy storage and followed by the category of lack of data on distribution-connected energy storage.

Based on the results of the survey, there are still not many entities that model DERs, especially in dynamic stability studies. A significant number of entities model DERs netted with load even if the amount of DERs in the system is substantial and represents a noticeable percentage of the system load. This substantial amount of DERs would have impact on the system performance, but this impact is not considered if the DERs are not modeled explicitly in the studies undertaken by TPs, PCs, and other transmission entities. With the growing penetrations of renewable resources on distribution-connected circuits, modeling DERs is becoming more important. Based on the attention to growing penetrations of DERs, the SPIDERWG modeling subgroup identified categories of the percentage of DER penetration of system peak load (non-coincident) based on the responses to Questions 2, 5, and 6. These can be found in **Table 1.2.**[11] The prominent modeling practices, along with the number of entities that fall into this category, are also provided in **Table 1.2**.

[9] As this question was put generally, the five responses could indicate either five different faults seen by the different survey responders, or it could be a single fault seen by the five different entities.

[10] Responses to the survey varied between assuming an implicit or explicit representation based on inference between the questions. Most assumed explicit representation from the survey question.

[11] One survey result did not have both questions 5 and 6 completed, which may skew this data slightly.

Table 1.2: DER Penetration based on Questions 2, 5, and 6		
Penetration Percentage	**Number of Entities**	**Prominent Modeling Practices**
Over 100%	1	In this entity, DERs were modeled as generators both in power flow and in dynamic simulations.
Between 50 percent and 100 percent	1	DERs were modeled as negative load due to lack of appropriate modeling tools.
Between 20% and 50%	2	One entity modeled DERs as negative load due to lack of modeling tools. The other modeled DERs as a generator as part of the composite load. DERs were modeled with second generation renewable dynamic models.
Between 10% and 20%	11	Out of these 11 entities, 3 modeled all DERs in power flow regardless of size, 3 others modeled only DERs that were larger than 1 MW, 2 entities modeled in power flow only DERs that were larger than 5 MW, 1 entity modeled DERs as larger than 10 MW, and 2 modeled all DERs as negative load. As for dynamic simulations, 5 entities out of these 11 didn't model DERs due of absence of data or lack of tools, and 6 entities modeled DERs. Out of these 6, 5 modeled DERs as generators with renewable models and 1 modeled DERs some as generators and some as a part of composite load model.
Between 5% and 10%	20	In power flow, 2 entities modeled all DERs regardless of size, 1 modeled only DERs that are larger than 1 MW, and 5 modeled them as negative load. In dynamic stability, 8 entities modeled DERs. The explanations of that were absence of tools and absence of DER data and for some entities, that they haven't observed visible impact of the DERs on transmission system that would justify modeling DERs in dynamic stability. Out of these entities, 2 modeled DERs in power flow as generators or as a part of composite load model and the 10 modeled DERs as negative load. In dynamic stability, 10 entities did not model DERs, and the other 2 modeled DERs with the DER_A model. Not modeling DERs was explained by the absence of tools, absence of DER data, and negligible impact of the DERs on transmission system.
Less than 1%	9	Out of these 9 entities, 7 did not model DERs and 2 modeled DERs in power flow and stability as generators with DER_A model. The survey respondents provided the following reasons for not modeling DERs: • Low amount of DERs in the system • Lack of data on the DER locations and their output • Lack of tools to model DERs • Lack of knowledge of the models

A significant amount of entities reported that they observed shifting of the system peak because of the DER output. Peak shifting causes TPs and PCs to study more system conditions than the ones that were studied before, and it creates a need for DER models of high quality and fidelity as the current dominant DER technology is solar photovoltaic (PV).[12] In addition to the system peak and off-peak conditions, such conditions as net system peak when DER output is low and the system load is still high will also need to be studied.[13] These cases may represent the hours on summer weekdays when sun goes down, but the load is high due to air-conditioners. Off-peak system conditions with high DER output and low load, which represent spring weekend afternoons, may also appear to be critical. System conditions with high gross load and high DER output (when these conditions are coincident) may be a challenge for dynamic stability system performance because of stalling of single-phase induction motor load with faults and possible tripping of DERs because of low voltages. In all of these cases, adequate modeling of the DERs is becoming more and more important.

This shifting of system peak because of DER output should be taken into account when attempting to correlate the responses related to Question 3 (minimum gross load) and Question 5 (DER capacity) as shown below in **Figure 1.1**. Nevertheless, it is significant and important to recognize that there are many jurisdictions where the ratio of maximum DER capacity to minimum gross load is above 20%.

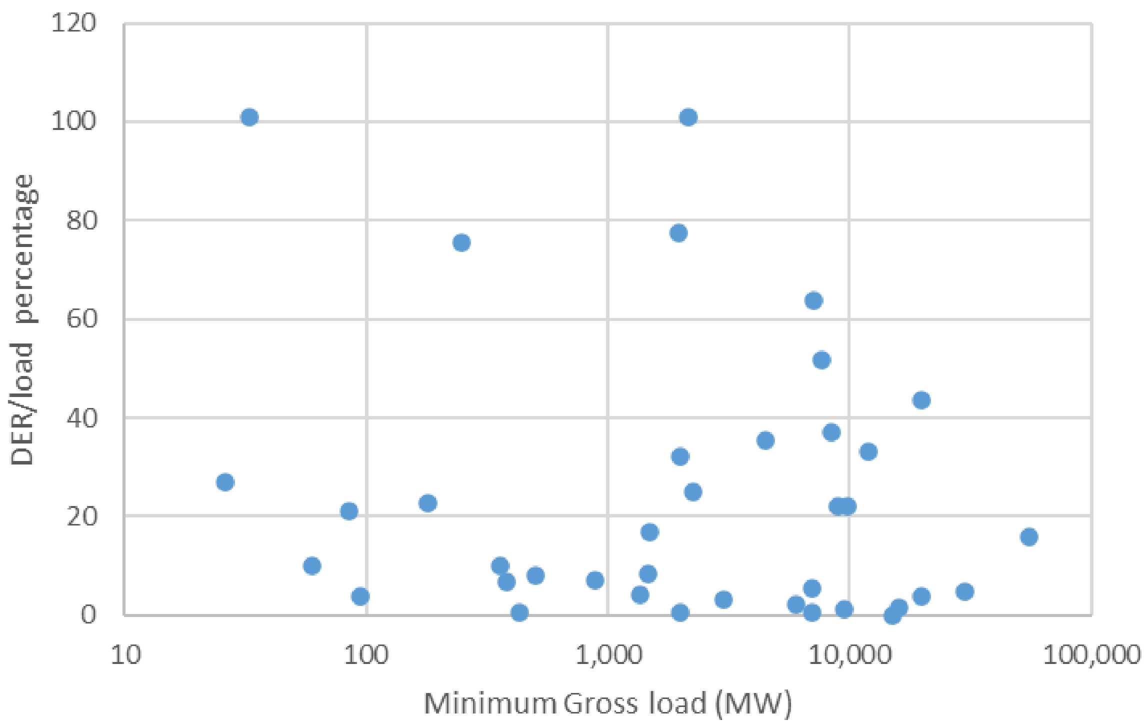
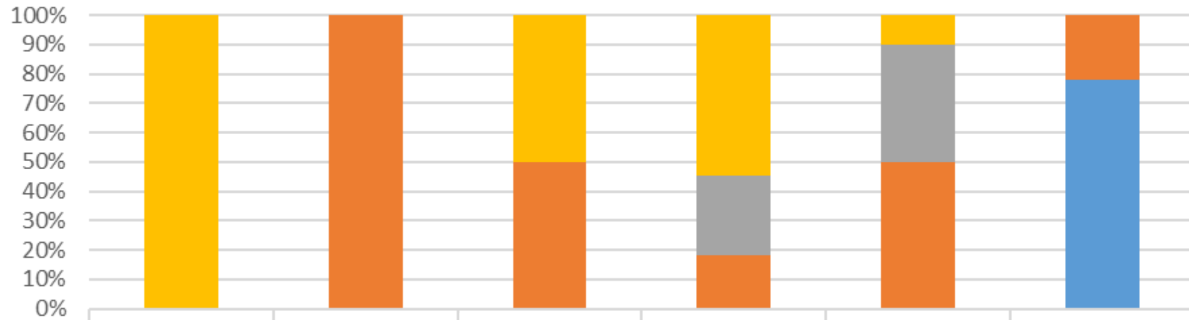


Figure 1.1: Ratio of Maximum DER capacity to Gross Minimum Load

From the results in the survey, the SPIDERWG categorized the number of entities by their modeling practices based on their penetration level in **Figure 1.2**. Entities that did not model in power flow or dynamics were recorded as "no modeling," entities that had power flow models but no dynamic models or were modeled as negative load were recorded as "limited modeling," entities that had a dynamic record associated with the DERs were recorded with "moderate modeling," and entities that used a dynamic record modeled according to latest guidance available were recorded as "exceptional modeling."

[12] This also applies to BPS-connected solar PV models. To reiterate, all solar PV models will need to modify their available power output based on the time of day selected for the study.

[13] This point is emphasized in "Verification Process for DER Modeling in Interconnection-wide Base Case Creation," published in the June 2020 CIGRE journal: https://e-cigre.org/publication/CSE018-cse-018.



	Over 100%	Between 50% and 100%	Between 20% and 50%	Between 10% and 20%	Between 5% and 10%	Less than 1%
Exceptional Modeling	1	0	1	6	2	0
Moderate Modeling	0	0	0	3	8	0
Limited Modeling	0	1	1	2	10	2
No modeling	0	0	0	0	0	7

Figure 1.2: Modeling Practice Percentage by DER Penetration

Although the respondents used their best knowledge in responses to the survey questions, the responses to the question regarding total amount of the DERs in the system may make survey conclusions less accurate. Since different entities included different types of technologies in the DER definition, the amount of the DERs reported to answer this question may not reflect the actual amount of the DERs in the system. These DERs were counted differently in different entities. Some included only solar PV, some also included energy storage, and some entities included all kinds of generation as well as demand response.

Appendix A: Detailed Survey Process with Questions

SPIDERWG determined that the best approach would be to conduct the DER survey in several phases with the first phase containing general questions regarding DER penetrations and basic modeling practices for each entity. The first phase did not include questions about the DER model parameterization or forecasting; it only included data sources in a cursory manner. SPIDERWG recommends conducting a more detailed follow-up survey of modeling practice upon completion and findings from the phase-one survey.[14] The following questions were asked in this phase-one survey:

1. What is your company's function(s)?[15]
2. What is the peak gross load of your area [MW]?
3. What is the minimum gross load of your area [MW]?
4. What technologies are included in the DER definition used when answering this survey?
5. What is the total capacity of DERs connected to your system [MW]?
6. What is the 5-year forecast for DER capacity to be connected to your system in 2024 [MW]?
7. Have you observed widespread tripping of DERs due to faults in operations? If yes, how many DERs tripped? (can be estimated from change in net load if detailed data is not available)
8. Have you observed shifting peak or light hours of net load due to increasing DER penetration level in planning time frames or real-time/historical for any sub-set of the system you are responsible for?
9. Do you receive any DER operational data (e.g., output of DERs)? On what level?
10. How do you model DERs in load flow studies?
11. What is the MW threshold to explicitly model individual (or multiple) U-DERs in the base case?
12. What is the MW threshold to explicitly model aggregate R-DERs in load flow studies?
13. How are DERs being aggregated in your system?
14. Do you model DERs in dynamic studies?
15. Which DER model do you use in your dynamic studies?
16. Do you model distribution-connected energy storage in your system?
17. How do you model energy storage in your system?

[14] Such questions include DER forecasting methods, sources of DER data, impacts of DERs on base case creation, considerations of DERs in special studies, and study impacts of DERs.
[15] Based on the entity's NERC Registration: https://www.nerc.com/pa/comp/Pages/Registration.aspx.

Appendix B: DER Survey Responses

This appendix provides the aggregated responses from the survey as well as the key takeaways for each question asked. The values in the charts that follow show the number of respondents and the percentage of total respondents, respectively for each question.

Question 1

"What is your company function?"[16]

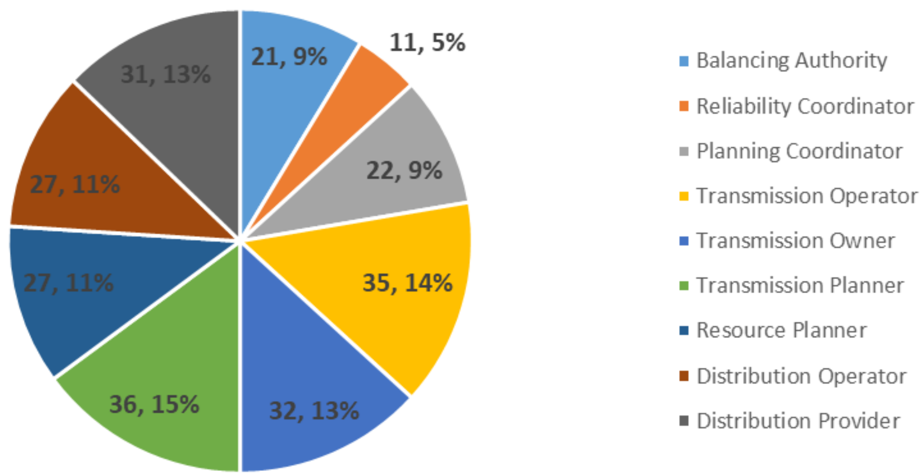


Figure B.1: Responses to Question 1

Key Takeaway: Question 1
A wide array of SPIDERWG members responded to this survey with 36 and 22 entities identifying as TPs and PCs, respectively (not mutually exclusive).

[16] Respondents were requested to mark all that apply, so there is a higher response count. A total of 45 entities responded to the survey.

Question 2

"What is the peak gross load of your area [MW]?"

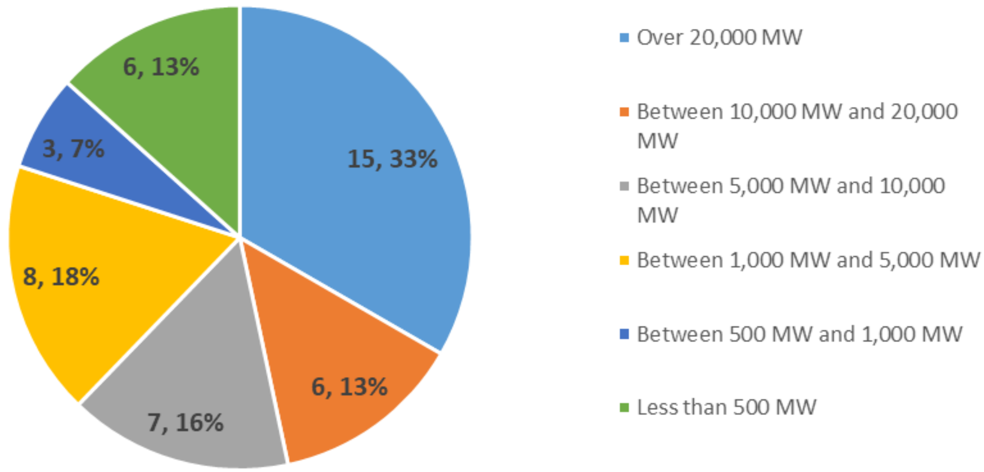


Figure B.2: Responses to Question 2.

Key Takeaway: Question 2
Entities ranged in their peak gross load from over 20,000 MW to less than 500 MW.

Question 3

"What is the minimum gross load of your area [MW]?"

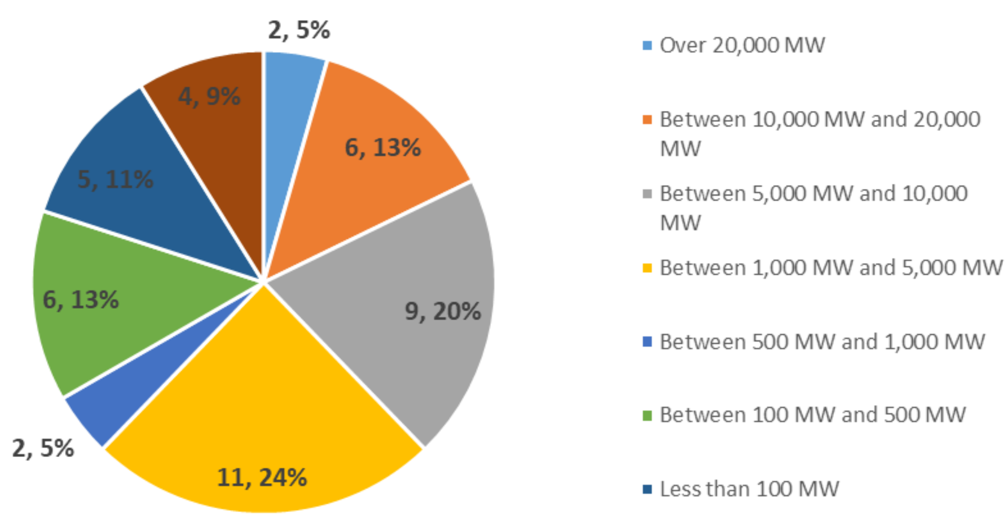


Figure B.3: Responses to Question 3

Key Takeaway: Question 3
Entities also ranged in their minimum gross load. However, only 18% of respondents have a minimum load over 10,000 MW, and slightly over 50% of respondents have a minimum load less than 1,000 MW.

Question 4

"What technologies are included in the DER definition used when answering this survey?"

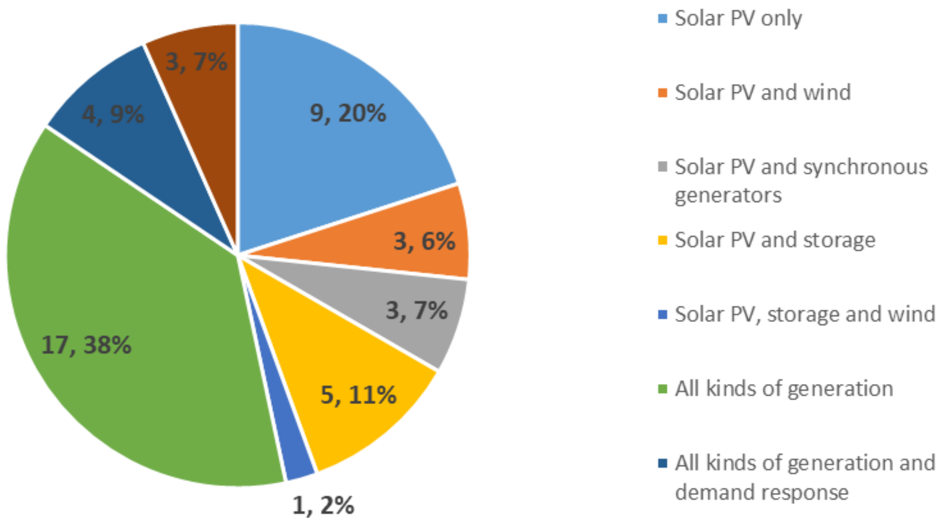


Figure B.4: Responses to Question 4

Key Takeaway: Question 4
Some entities included demand response in their DER definitions; however, the majority of respondents focused on "sources of electric power" with most focusing specifically on inverter-based DERs, such as solar PV, wind, and battery energy storage.

Question 5

"What is the total capacity of DERs connected to your system [MW]?" [17]

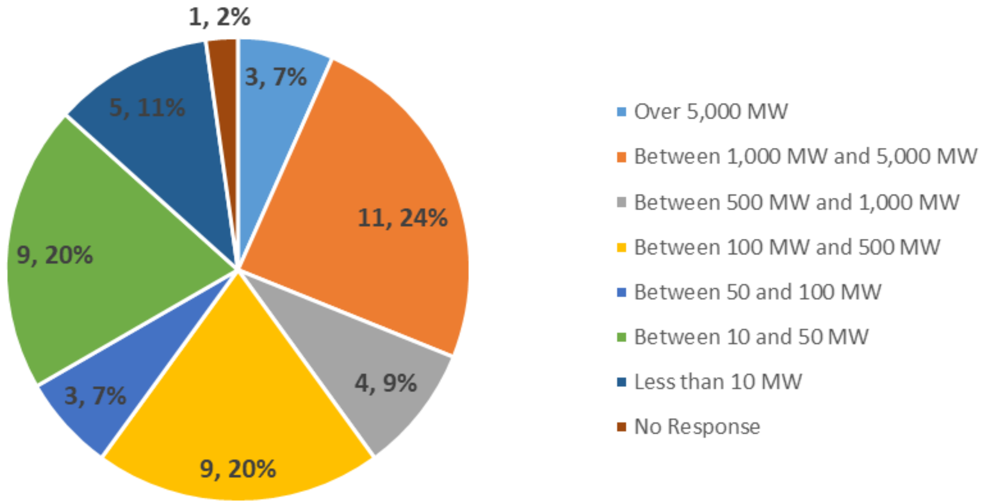


Figure B.5: Responses to Question 5

Key Takeaway: Question 5
31% of respondents reported having over 1,000 MW of installed DER in their footprint, 60% reported having more than 100 MW, and about 40% reported having less than 100 MW.

[17] Regarding this question, since different entities include different types of technologies in the DER definition (as seen from the responses to the previous question), the amount of the DER reported answering this question may not reflect actual amount of DERs in the system based on the SPIDERWG definition.

Question 6

"What is the 5-year forecast for DER capacity to be connected to your system in 2024 [MW]?"[18]

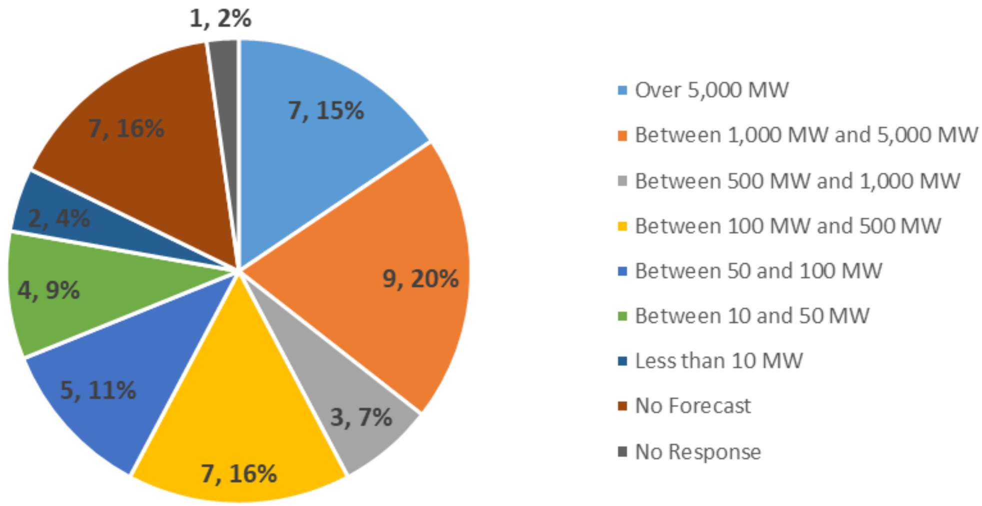


Figure B.6: Responses to Question 6

Key Takeaway: Question 6
In 2024, over 35% of respondents reported that they will have over 1,000 MW of installed DERs in their footprint, about 58% reported more than 100 MW, and about 24% reported less than 100 MW. About 15% of respondents reported no DER forecast out to 2024. One response (equal to about 2% of the survey) was left blank for this question.

[18] In summarizing the responses to this question, the DER forecast was compared with the existing amount of DERs.

Question 7

"Have you observed widespread tripping of DERs due to faults in operations? If yes, how many DERs tripped?"[19]

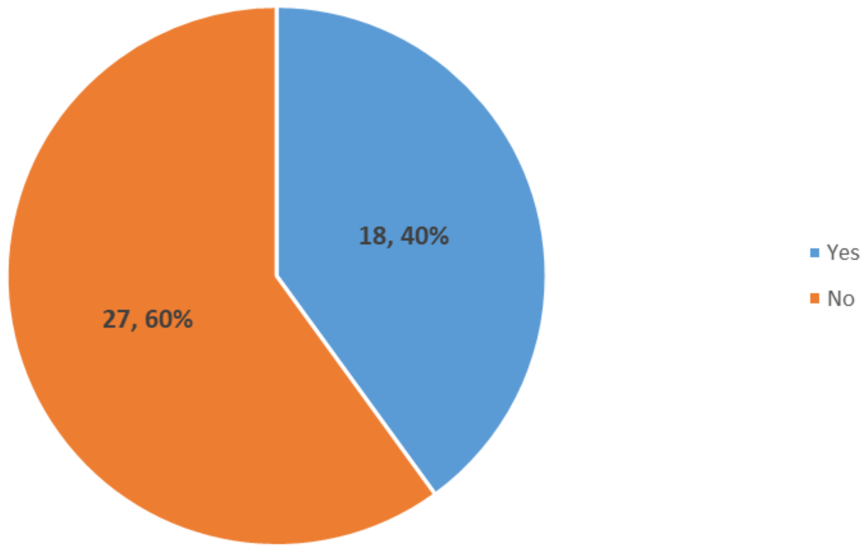


Figure B.7: Responses to Question 7

Key Takeaway: Question 7
40% of respondents reported observing widespread tripping of DERs during fault events in their footprint; the remaining 60% had not observed any DER-related tripping events.

[19] Note that the response to this question can be estimated from the change in net load if detailed data is not available.

Question 8

"Have you observed shifting peak or light hours of net load due to increasing DER penetration level in planning time frames or real-time/historical for any sub-set of the system you are responsible for?"

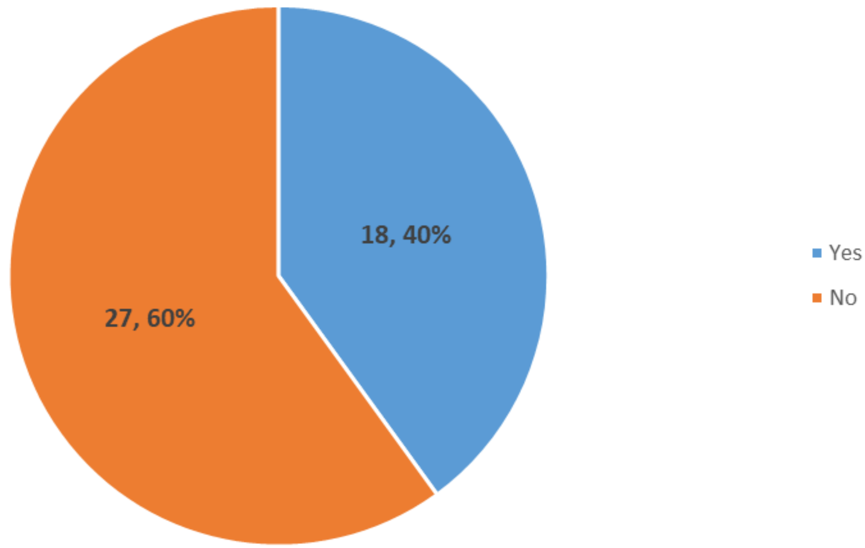


Figure B.8: Responses to Question 8

Key Takeaway: Question 8
40% of respondents reported a shift in peak or light net load hours due to the increased penetration of DERs in the planning time frame or real-time horizon; the remaining 60% had not observed any shift in net loading on their system.

Question 9

"Do you receive any DER operational data (e.g., output of DERs)?"

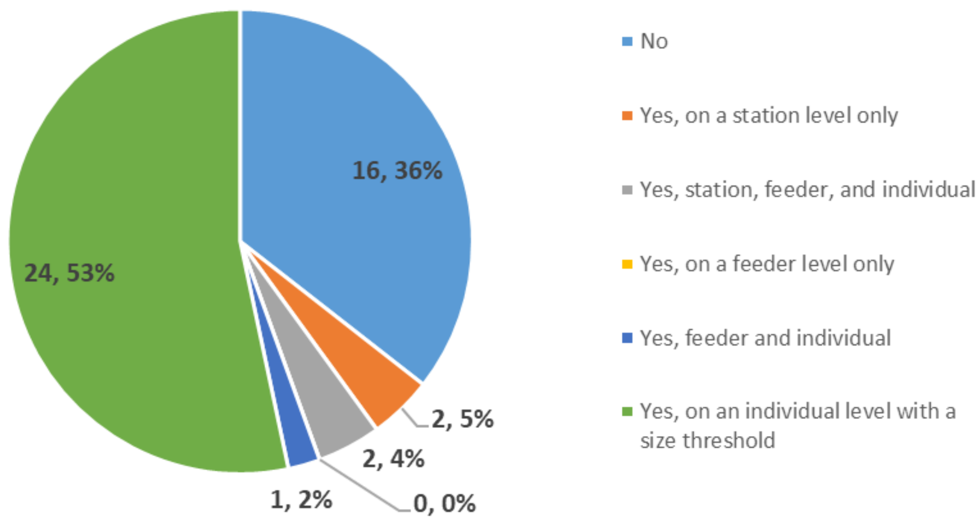


Figure B.9: Responses to Question 9

Key Takeaway: Question 9

50% of respondents reported that they receive operational DER information (i.e., DER output) for individual DERs above a size threshold. The majority of remaining respondents did not receive any operational data regarding DERs in their system nor in an aggregated manner. Some respondents receive limited DER information on a station- or feeder-level.

Question 10

"How do you model DERs in load flow studies?"[20]

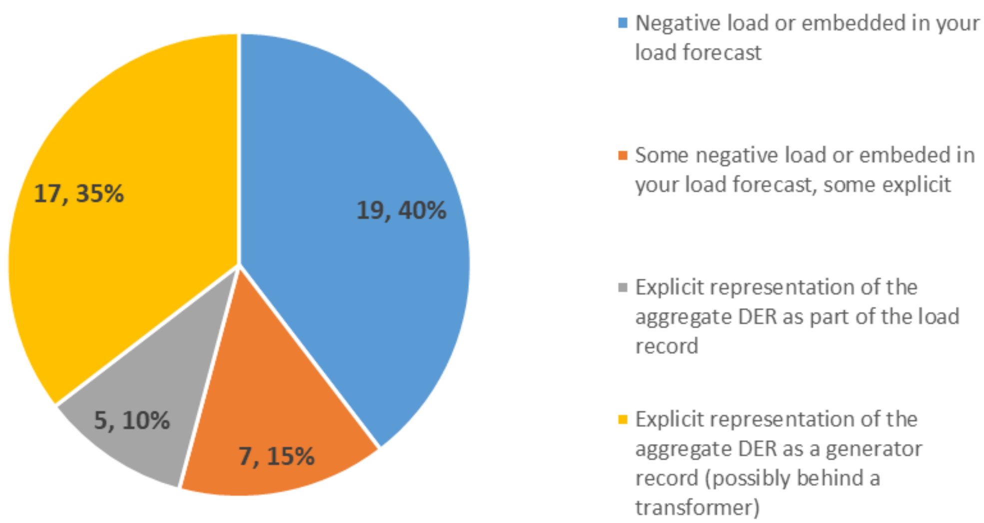


Figure B.10: Responses to Question 10

Key Takeaway: Question 9

45% of respondents model DERs explicitly with some representation of the aggregate level of DERs in their system. Most of those respondents model aggregate DERs by using a generator record in the simulation tools. 40% of respondents use a negative load or embed DERs into load forecasts (i.e., no DER representation in study). 15% use a mix of explicit representation and net load reduction. Entities that responded that they use negative load or embedded in the load forecasts stated that they do not have tools to represent DERs, do not have enough data to represent DERs in study, or have DER capacity too small to make an impact on the BPS.

[20] Note that the response to this question include some overlap as respondents reported more than one option.

Question 11

"What is the MW threshold to explicitly model individual (or multiple) utility-scale (U-DERs) in the base case?" [21]

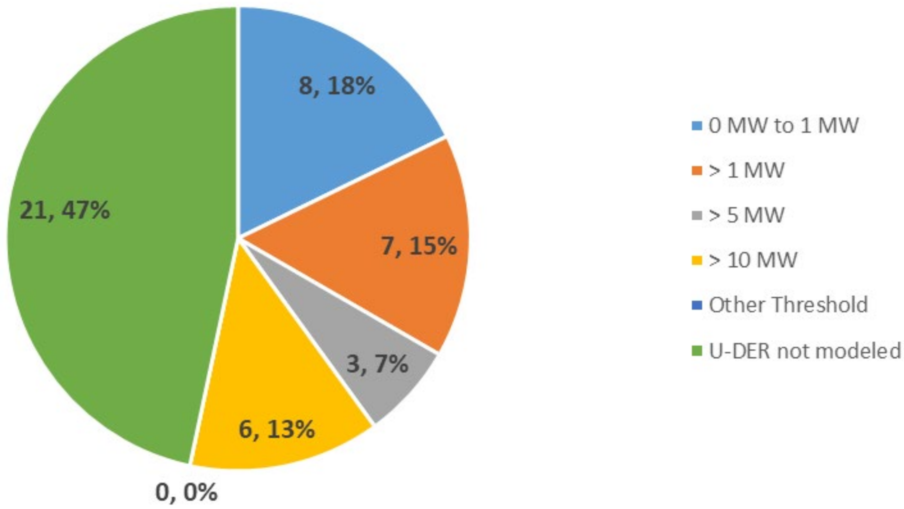


Figure B.11: Responses to Question 11

Key Takeaway: Question 11

50% of respondents do not have a threshold for modeling utility-scale DERs (i.e., larger DERs that are often three-phase installations) and do not model U-DERs in their studies. 13% use a threshold over 10 MW, 7% use a threshold between 5–10 MW, 15% use a threshold between 1–5 MW, and 18% use a threshold less than 1 MW.

Question 12

"What is the MW threshold to explicitly model aggregate retail-scale (R-DERs) in load flow studies?"

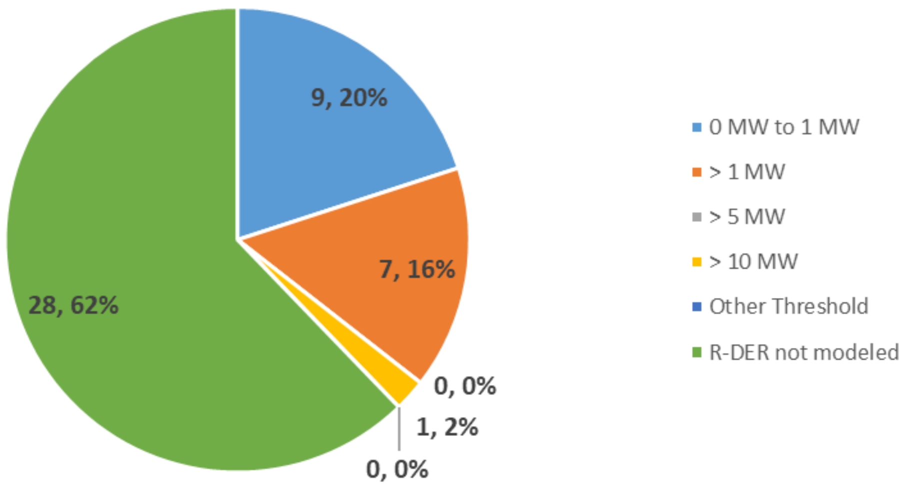


Figure B.12: Responses to Question 12

Key Takeaway: Question 12
62% of respondents stated that they do not model R-DER to represent aggregate levels of DER, 20% use a threshold less than 1 MW, and 16% use a threshold between 1–5 MW.

Question 13

"How are DERs being aggregated in your system?"

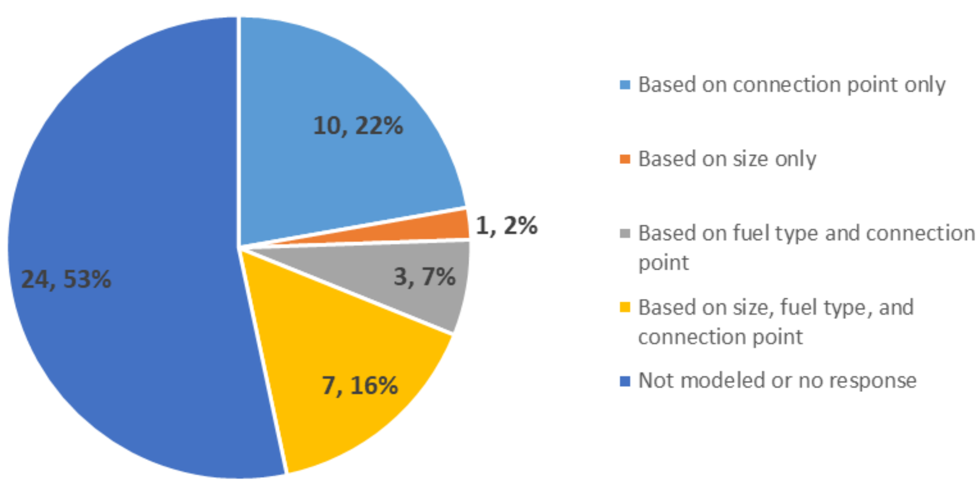


Figure B.13: Responses to Question 13

Key Takeaway: Question 13
53% of respondents stated that they are not modeling DERs in any aggregated manner in their studies; 22% aggregate based on connection point (i.e., T-D substation); and 16% aggregate based on size, fuel type, and connection point.

Question 14

"Do you model DERs in dynamic studies?"

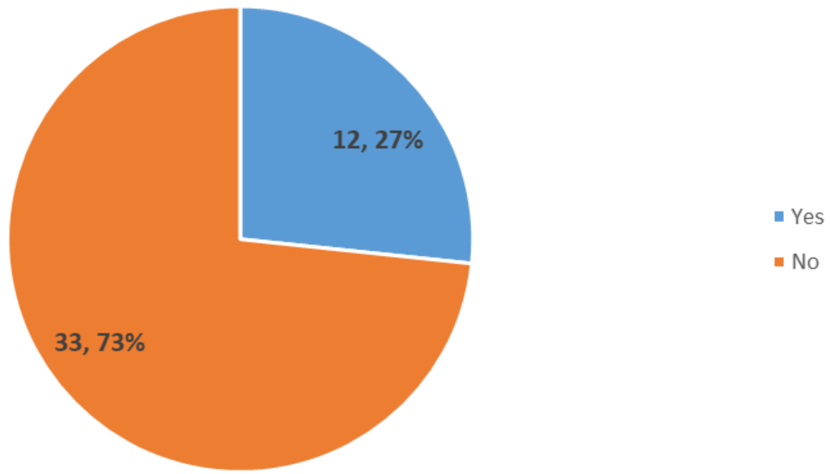


Figure B.14: Responses to Question 14

Key Takeaway: Question 14
73% of respondents stated that they do not model DERs in dynamic studies in any fashion, and 27% reported that they do model DERs in dynamic studies. Reasons for not modeling DERs in dynamic studies were low amounts of DERs in their footprint, unavailability of DER models or tools, and a lack of DER information to populate the dynamic models in a meaningful way.

Question 15

"Which DER model do you use in your dynamic studies?"

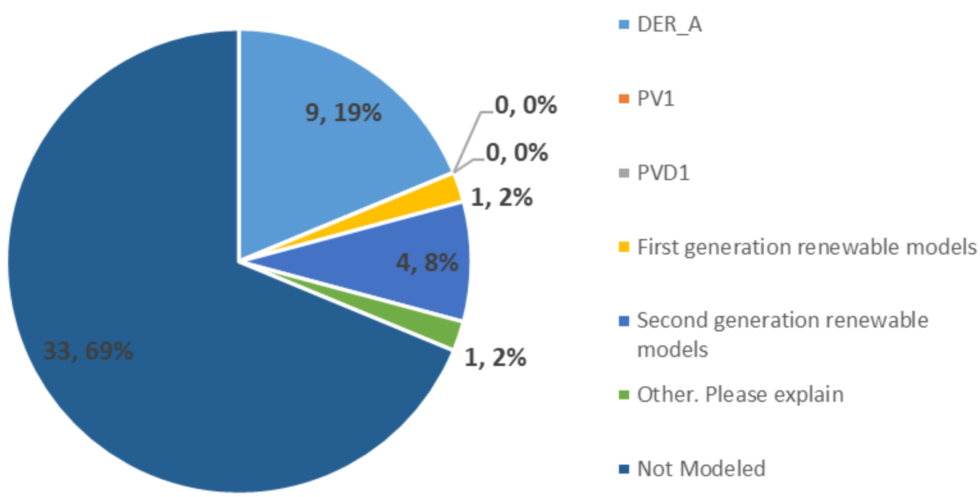


Figure B.15: Responses to Question 15

Key Takeaway: Question 15
Most respondents reported not modeling DERs in dynamic studies. Those that are modeling DERs in dynamic studies are using primarily either the DER_A dynamic model or the more detailed second-generation renewable energy system models. No entities reported using the obsolete PV1 or PVD1 models. One entity reported using their own in-house dynamic model.

Question 16

"Do you model distribution-connected energy storage in your system?"

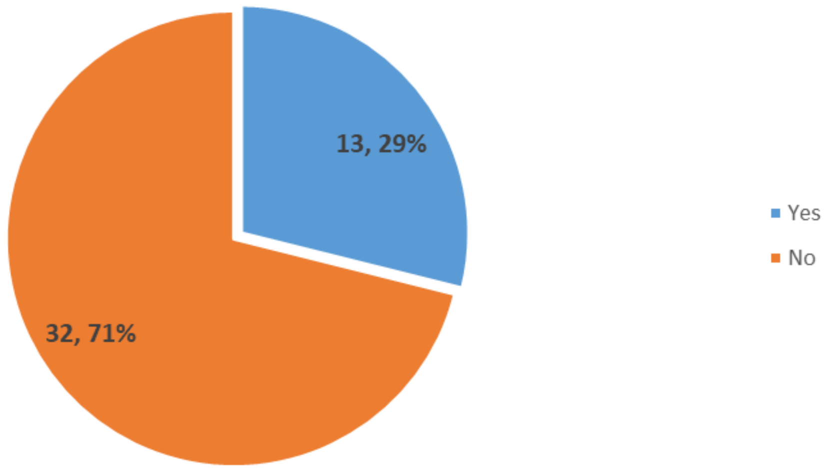


Figure B.16: Responses to Question 16

Key Takeaway: Question 16
70% of respondents stated they do not model distributed energy storage in their models, and 30% reported that they do model distributed energy storage.

Question 17

"How do you model energy storage in your system?"

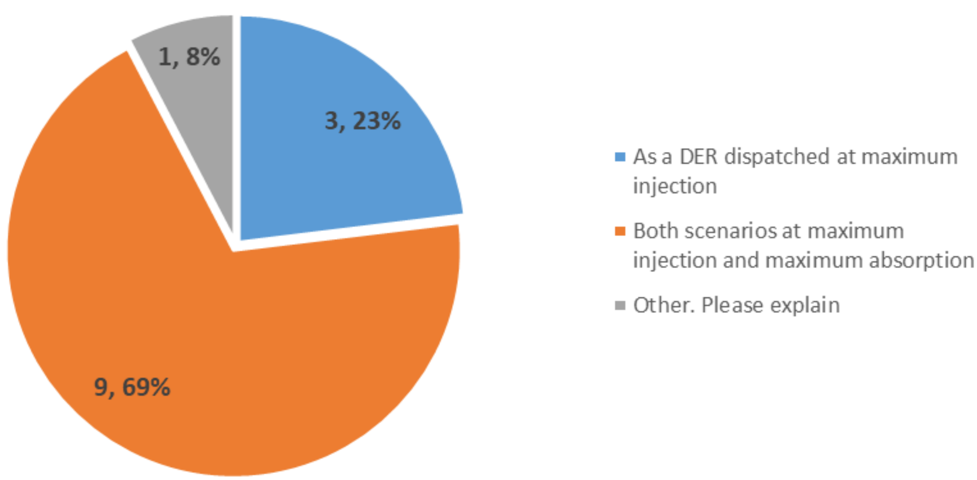


Figure B.17: Responses to Question 17

Key Takeaway: Question 17
70% of respondents stated that they model both scenarios for full injection and full absorption for the distributed battery output, and 23% reported modeling the distributed battery at maximum injection level only. one entity reported modeling their distributed storage off-line in studies presently.