



*Pacific Gas and
Electric Company®*



Supply Side II DR Pilot 2019 Summary and Findings (Public Version)

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1 Acknowledgements

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2 Executive Summary

This report summarizes the market context, project objectives, technical results and lessons learned for the Supply Side II Demand Response Pilot (SSP II) for 2018 and 2019.

Background

Current California policies and the establishment of other state goals along with the penetration of new end-use technologies continuously adds complexity to future grid needs. Furthermore, the California Independent System Operator (CAISO) identified that with a 33% penetration of renewables, net load to be served will have steep ramps during both winter and spring. These changes in net load, policy and technology, require California to evaluate the various characteristics resources might require to address future grid needs. With a focus placed on the importance of wholesale integration of demand resources by the CAISO and subsequently the CPUC¹, the Supply Side Pilot II (SSP II) is designed to test various program structures to ensure a successful path forward to meet California's policy goals.

In the SSP II, responsive loads are being considered as one of the many resources that can support economic and reliability needs of the future grid. In addition to traditional demand response that addresses summer peak shaving, new demand response offerings must be considered in order to meet other future grid needs (transmission and distribution). This pilot program was developed by PG&E and Olivine to facilitate demand response on the commercial and residential side of the grid. This pilot is in its fourth phase (i.e., the SSP Phase 2 or SSP II), and builds upon earlier pilots.

In 2010, the Intermittent Renewable Resources Pilot (IRR) integrated demand response with the CAISO as Participating Load. This project predates the modern CAISO demand response resource types and provided inputs into the design of PDR. The subsequent 2013 Intermittent Renewable Management Pilot Phase 2 (IRM2) extended the learnings by demonstrating with third-party aggregators and large commercial and industrial customers that DR resources can participate in the CAISO wholesale market and provide flexible resources with the then-new Proxy Demand Resource (PDR) resource type. The Pilot continued in 2015 renamed as the Supply Side Pilot with an expansion into residential customers and closer alignment to the CPUCs Resource Adequacy policies. Finally, in 2017 the Supply Side Pilot went into its current phase with the addition of distribution-service (capacity deferral) to the existing wholesale market integration framework.

Key Accomplishments and Lessons Learned:

The following are key accomplishments and lessons learned from the pre-operational and operational phases of this pilot:

Pre-Operations

- **Enrollment:** Through the pilot's enrollment process, administrators gained insights into why there was greater interest up front versus actual enrollment. Reasons for decreased enrollment versus interest may be attributable to: education, ability to provide load increase, alternatives which would prohibit participation due to dual participation rules,

¹ Order Instituting Rulemaking to Enhance the Role of Demand Response in Meeting the State's Resource Planning Needs and Operational Requirements ("Bifurcation Decision") D.14-03-026.

and the short-term nature of the pilot. In addition, some interested providers had enabling technology, but not a pathway to customers for enrollment.

- Residential is uniquely challenging: Customer authorizations, CAISO registration process and meter data requirements become more challenging at scale for aggregators and the demand response provider, reducing the value proposition of pursuing residential customers as oppose to commercial and industrial customers.

Operations

- First year-round PDRs: Back to the inception of the pilot, the pilot successfully bid Proxy Demand Resource (PDR) resources in the CAISO market year-round.
- First battery storage: The first battery storage deployed in the CAISO markets was within the pilot. As part of integrating the battery storage system into the CAISO, challenges with sub-metering were uncovered. These learnings were ultimately informative to the development of the CAISO Meter Generation Output (MGO) baseline methodology.
- First electric vehicles: The first electric vehicle charging in the CAISO markets was within the pilot in a work-place charging application.
- Automation is not always required: Several participants were able to participate as day-ahead resources without IT integration. As a result, cost reductions could be achieved for providers by omitting any hardware upgrades and additional time that would have been spent completing the integration.
- Key input into the design of the latest PG&E CBP: The 2018 Capacity Bidding Program (CBP) introduced Elect and Elect+ options, both of which were influenced directly by the SSP.

Recommendations

Product Recommendations:

- Grid Needs: Any products should serve grid needs associated specifically with renewable integration challenges. Needs should also be examined outside of the resource adequacy periods to ensure that demand response is not only utilized as a ramping or peaking product. Such needs include resource-level response at other times of the day, but also localized needs that have specific value to the distribution utility.
- Technology Neutral: Demand response programs should generally be technology agnostic to enable any end use to provide reduction. We acknowledge that some technologies may thrive under demand response paradigms where others may not but being technology neutral allows technology providers to best determine how to make their solutions viable and competitive.
- Participation payments are a requirement: The SSP II has provided clear data on the relatively low revenues to be achieved from CAISO market participation through the energy market. Without the SSP II capacity payment, and participation payments more broadly, demand response cannot be incentivized sufficiently from wholesale energy only incentives. Capacity incentive is a key element for participants to engage. However, in order to achieve cost-effective results, any incentives, including capacity, should be correlated to actual grid needs.

Operational Recommendations:

- Availability: Periods of availability should be based on grid needs with flexibility to reflect participants' abilities to respond. As part of this, participants should be allowed to specify their availability to provide load decrease at any hours, noting that incentive payments should be adjusted accordingly.
- Frequency: Frequency of dispatch should be based on the resource's capabilities, which is driven by the underlying customer abilities, but also needs to be tied into incentives payments. The SSP II protects against participants avoiding dispatches through high market bidding by implementing a day-ahead price cap, but in general any capacity program that incentivizes customers to bid into the wholesale market should ensure that dispatches are feasible in the market. Distribution-related dispatch frequency must also be considered, noting that if the distribution need requires very frequent dispatch, then new performance standards may be necessary to better reflect reasonable resource expectations.
- Performance Methodology: The performance methodology that is used to determine the performance of a resource or to determine the available capacity of a resource should be consistent across the multiple services that the resource provides. This creates a common language that distribution operators, wholesale operators and grid planners can use to understand what a resource may deliver. Dependent on program design, a consistent performance methodology will also simplify settlement processes for the customer.
- Distribution Planning and Operations: The potential impacts that exists as a result of responding to both wholesale and distribution-related events has ramifications on how distribution planning and operations is conducted—particularly in the delaying of distribution upgrades. It is imperative that development and operation of this type of product/program be integrated with distribution planning and operations groups; otherwise, the distribution value will not be realized.

Conclusion and Next Steps

The SSP II extension has been underway since 2018 and is scheduled to continue through 2020. While continuing to support the existing participation models, the following items are being addressed beginning in 2020:

- Development of new materials to focus on the distribution aspects of the SSP II.
- Enable the partial dispatch of resources for distribution need, enabling resources to be partially dispatchable by location.
 - These dispatches will target distribution feeders and possibly other artificial distinctions to test out the flexibility of sub-dispatch.
 - In conjunction with sub-dispatch, the SSP II will also evaluate various performance-measurement methodologies to ensure fairly compensating participants for providing such flexibility.

The SSP II and its precursors have been on the cutting edge of retail / wholesale integration issues since their inception, heavily influencing the development of other programs and concepts. A

missing element has been how to integrate distribution need, particularly from the perspective of renewable impact on distribution circuits. The central focus for the SSP II in 2020 will be on how to integrate participants providing multiple grid services (distribution services into the existing wholesale market services) that are dispatched by multiple operators and evaluate whether participant resources are capable of meeting both grid services in a reliable way.

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3 Introduction

3.1 Regulatory Background

California policies in addition to the establishment of other state goals along with the penetration of new end use technologies continuously adds complexity to future grid needs. Furthermore, the California Independent System Operator (CAISO) identified that with a 33% penetration of renewables, net load to be served will have steep ramps during both winter and spring. These changes in net load, policy and technology, require California to evaluate which resources can address future grid needs. In this project, responsive loads are being considered as one of the many resources that can support economic and reliability needs of the future grid. In addition to traditional demand response that addresses summer peak shaving, new demand response offerings should be demonstrated to understand the efficacy of these DR resources in meeting future grid needs. This pilot program was developed by PG&E and Olivine to facilitate demand response on the commercial and residential side of the grid. This pilot – the Supply Side II DR Pilot (SSP II) – stems from earlier pilots, described in the following sections.

3.1.1 The First Two Phases of the Demand Response Pilot (2011-2014)

The current implementation of the SSP II is rooted from past iterations of the pilot, each with a slightly different name and objectives. The first phase was called the Intermittent Renewable Resources (IRR) pilot. During this phase, two commercial buildings and one industrial facility were equipped with automated demand response and telemetry equipment to demonstrate their ability to provide ancillary services – frequency regulation up/down. Each facility was tested for response time, duration and latencies (Kiliccote et al. 2010). The next phase of the pilot was approved on April 2, 2013 by the California Public Utilities Commission (CPUC) as filed in PG&E's Advice Letter 4077-E-B. This filing included the next phase, known as the Intermittent Renewable Management Pilot Phase 2 (IRM2). The objective for this second phase was to demonstrate with third-party aggregators and large commercial and industrial customers that DR resources can participate in the CAISO wholesale market and provide flexible resources. With the introduction of the CAISO Proxy Demand Resource (PDR), the IRM2 was designed so resources could bid into the CAISO wholesale day-ahead energy market as this new resource type. The SSP included a monthly participation commitment with CAISO bidding requirements. Each participant had the option of committing to either contiguous three-hour blocks for 24 days per month or six-hours for 12 days per month with day-ahead notification that aligned with the CAISO integrated forward market (IFM). In recognition of their availability and by meeting all requirements, the customer was paid \$10/kilowatt (kW)-month for capacity. Olivine, Inc. served as the program administrator and took on scheduling coordination for third party and customer resources. For initial participation, prospective participants were required to commit their resources for six months and the minimum resource size was 100 kW. The pilot concentrated on understanding issues related to direct participation of third-parties and customers including the following:

- Customer and third-party aggregator acceptance;
- Market transformation challenges (wholesale market, technology);
- Technical and operational feasibility; and

- Value to the DR resource owners and the utility on providing an enabling mechanism for DR resources into the wholesale markets.

3.1.2 The Supply Side Pilot: The Third Phase (2015-2016)

As part of the 2015-2016 DR bridge funding Decision, the Commission approved a continuation and expansion of the IRM2 in D.14-05-025. This next phase, known as the Supply Side DR Pilot (SSP), continued with the objective of engaging participants in a third-party wholesale integrated capacity program. This phase was designed to facilitate daily energy bids into the wholesale market in usable blocks. Retail capacity incentives were provided from the utility so as to understand the following:

1. Whether DR is able to provide valuable capacity through utility agreements;
2. The process of enablement of resources to bid directly into the wholesale market

Better understanding of these mechanisms would enable the provision of support for the integration of intermittent renewables into the grid and subsequently be valued as a supply resource.

The SSP moved beyond day-ahead energy provided by C&I customers in the IRM2, enabling:

- Participation by residential customers
- Participation in real-time energy and non-spinning reserves (for non-residential participants)
- A simplified program design, particularly around the wholesale market pricing rules
- A program design that is more closely tied to resource-adequacy must-offer-obligations. For example, this results in a single 4-hour contiguous block instead of the 3 and 6-hour block options in IRM2.

Figure 1 displays the concept for integration of the retail resources with wholesale PDR model.

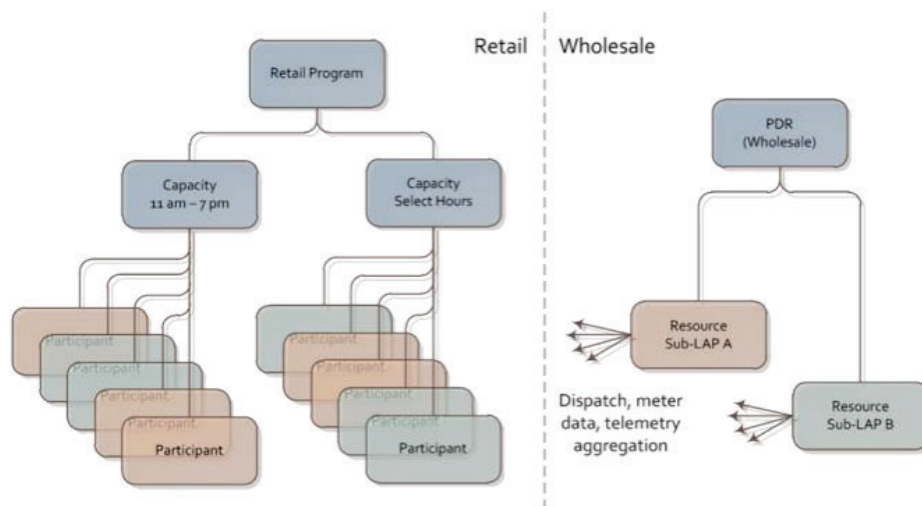


Figure 1: Concept for Integration of Retail and Wholesale DR. Courtesy of Olivine, Inc.

The pilot team roles and responsibilities are identified in Figure 2. Both large single customers and aggregators can participate in the SSP. Olivine serves as a scheduling coordinator (SC) and wholesale market demand response provider (DRP). It provides the sole interface between participant and pilot, including the CAISO market, and handles recruitment, enrollment and registration; nominations and bidding; award and dispatch notifications; meter data aggregation and submissions; resource certification; credit and collateral; and settlements and payments.

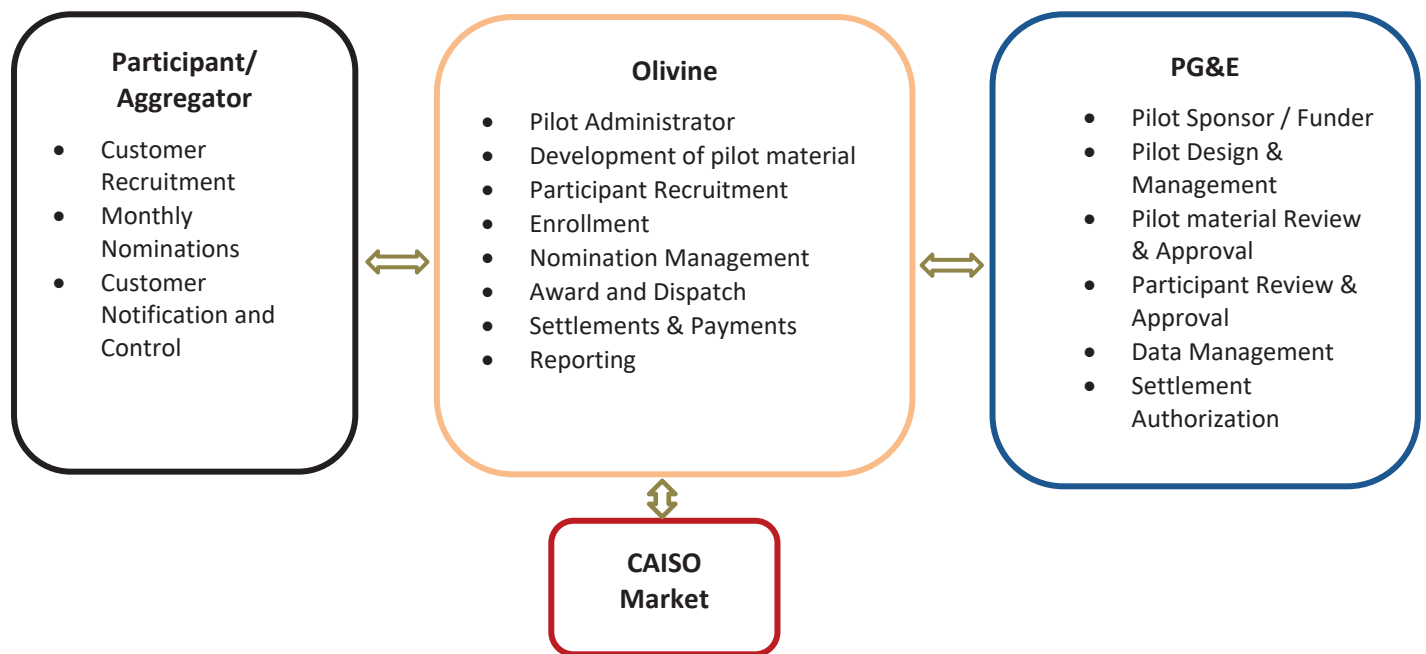


Figure 2: Entities Involved in the SSP II and their Roles

3.1.3 The Supply Side Pilot 2: The Fourth Phase (2017 to present)

The SSP was initially scheduled to run from 2015 through 2016. However, PG&E received approval from the Commission to continue the pilot through 2017 in D.16-06-029 and then from 2018 – 2020 in D.17-12-003. In addition to providing CAISO market-based services, this extension, known as the Supply Side II DR Pilot (SSP II) is looking into how to enable the option for DR resources to be called to address local distribution reliability issues for the distribution grid.

The SSP II is meant to augment the Distribution Resources Plan (DRP) and integrated Distributed Energy Resources (IDER) proceedings: whereas the DRP and IDER proceedings are focused on determining where Distributed Energy Resources (DER) can meet distribution system needs and the associated value, the SSP II is investigating the operational feasibility of utilizing DR resources that are integrated in the wholesale energy market and provide Resource Adequacy (RA) to also address local distribution needs.

3.2 Program Objectives & Progress

As stated in PG&E's 2018 – 2022 2020 DR Application Supplemental Testimony, the primary objectives of the SSP II, and current progress, are to:

1. Determine whether customers are willing to be dispatched frequently enough and over the range of hours necessary to meet both local distribution system needs and the Commission and CAISO requirements for DR RA resources.

The willingness of Participant's to be dispatched on a frequent basis is highly dependent on the underlying technology and the other scheduled services that technology is required to provide (e.g. HVAC, demand charge management) as part of its typical use outside of the SSP II. The concern of exhausting available capacity becomes forefront when more frequent dispatches arise. The ability to respond to long-duration events or start-up multiple times per day is prohibitive depending on the underlying DR technology. Initial discussions with participants have shown the same concern on their end regarding the uncertainty of whether their resource will have enough capacity to meet potentially concurrent needs. The level of communications integration that a resource has also affects the sensitivity to the number of dispatches. Resources that have no integration or limited integration have a larger operational effort to set the resource up.

2. Determine whether it is technically feasible to dispatch DR resources pursuant to requirements for DR RA resources and the CAISO must-offer obligation, while also being dispatched to meet local distribution system needs.

As part of the SSP II design updates for 2020, bidding requirements will be updated such that they are more conducive for testing the feasibility of meeting RA requirements while being dispatched to meet local distribution needs. A significant learning that will come from this implementation is the ability to ensure a resource is not over committed if a wholesale and distribution need were to

exist at the same time. The interactions between wholesale market bids and distribution needs will have to account any changes to available capacity as the resource is being committed.

3. Investigate how to operationalize and automate the interactions between wholesale market availability and distribution services availability, including how to make this information more readily available to distribution operations personnel.

The investigation into the interactions between wholesale market availability and distribution service availability is in development and set for implementation in 2020. The following three high level use-cases for a resource providing both wholesale and distribution services have been developed and inform the type of necessary interactions:

- Distribution Event Only
- Wholesale Event Only
- Distribution & Wholesale Event

As a first step, much of the interaction will rely on manual communication channels between distribution operations, Olivine, and the Participant. As operational experience is gained, streamlining communications or implementing automation will be explored.

4. Develop a method for dispatching available DR resources based on distribution operational needs.

The geographical granularity of wholesale market resources is at the Sub-LAP level. Sub-LAPs are fairly large regional definitions and resources segregated as such can lack the precision to resolve distribution needs. Therefore, the SSP II has implemented sub-aggregations at a distribution feeder level as a means of more effectively targeting specific locational distribution needs. The summation of the distribution feeder level resources is the wholesale market resource.

With the addition of distribution dispatches, Participants raised concern about their available capacity to meet distribution and wholesale dispatches. To address this, the SSP II introduced Operating States (Full/Medium/Low) which Participants can designate to resources as an alternative way to recognize available capacity. The Operating States provide allows the Participant to communicate capacity availability to pertinent parties, which ensures that capacity that is nominated into the Pilot is representative of what the resource can deliver.

4 SSP Participation

To participate in the SSP II, participants need to meet several requirements for eligibility as well as enroll through many steps, detailed here. As requirements have changed throughout the pilot, these are identified here.

4.1 Pilot Resources and Eligibility

To facilitate the integration of wholesale-integrated demand response, the CAISO developed a resource model known as Proxy Demand Resource (PDR). Like other conventional resource models (e.g., Multi-Stage Generator or MSG), the PDR models the physical characteristics of a resource supplied to the CAISO and is the basis for bidding, awards, dispatch, outages, and settlement.

The PDR is composed of either a single customer location or an aggregation of customer locations. For example, a commercial or residential aggregator can assemble a collection of customers into a resource that can then bid into the wholesale market as a PDR. A large customer may also directly enroll one or more locations, as long as the set of locations meets the eligibility requirements. For consistency, Olivine uses the term participant to indicate the party that enrolls in the pilot including either the aggregator or direct customer. The term customer identifies the underlying utility customer whether the participant or a customer of the participant.

In general, each participant in the SSP II is allowed to enroll a single PDR resource, composed of an aggregation of one or more customer locations². Due to the volume of residential customers required to achieve the 100 kW PDR requirement, the SSP II has a residential-only 30 kW option. Due to CAISO requirements, resources utilizing this option do not participate in the CAISO markets.

For those resources integrated in the CAISO market, certain CAISO requirements for enrollment and participation must be met, detailed in the following sections.

4.1.1 The resource must meet a minimum of 100 kW of load curtailment

Any PDR at the CAISO is required by tariff to be able to achieve a minimum of a 100 kW load curtailment. Note that this requirement is not defined any further so does not reference seasonality, time of day, or any other operational limitation. For example, if a resource is made up of locations that can achieve a 100 kW load drop only during hot summer days, it would be considered a valid PDR even though on most days it would not be able to achieve that load drop. In addition, the CAISO does not have any requirements for testing energy-only PDRs in the wholesale market and so the actual curtailment is not verified by the CAISO before market entry by the CAISO. Because of this, the Pilot requires a qualified capacity test before entry.

² [REDACTED] was one exception to this rule since their existing resources were grandfathered into the SSP and subsequently the SSP II. In addition, other providers were given the option of an additional resource as long as adding that resource would create further benefit for the Pilot.

4.1.2 Customers must not be enrolled in any other CAISO resource

The CAISO prohibits customer locations from enrolling in more than one market resource at a time. If a customer is found to be enrolled in another CAISO resource, that customer is deemed ineligible for the SSP II, noting that this has not occurred during the life of the SSP II.

4.1.3 Customers must be served by one Load Serving Entity (LSE)

The LSE is the entity responsible for procuring electricity for their customers. For vertically-bundled utility customers, the LSE is always PG&E. For Direct Access customers, the LSE is an Energy Service Provider (ESP) (e.g., Constellation Energy, etc.). Another example of an LSE is one of the Community Choice Aggregators (e.g., Marin Clean Energy, Silicon Valley Clean Power, etc.).

In November 2019, the single LSE requirement for CAISO resources was removed as part of the implementation of the ESDER Phase 3A stakeholder initiative.

4.1.4 Customers must be located within a single Sub-LAP

All of the locations within the resource must be located within a single Sub-LAP. A Sub-LAP is a geographically defined area, such as PG&E East Bay or PG&E San Francisco. Thus, a resource cannot contain locations from both the East Bay and San Francisco.

4.1.5 Customers must not be enrolled in any other DR program or rate

In addition to the CAISO requirement limiting any customer location to a single CAISO resource, PG&E and the CPUC generally limit customers to a single utility demand response program or rate. As such, customers were not allowed to enroll in the SSP II if they were on another program or on the “demand-response”-like rates of SmartRate or Peak Day Pricing.

Note that there was an exception in that a customer could participate in the SSP II and the PG&E Excess Supply DR Pilot (XSP) as long as the resource met certain criteria. One participant elected to participate in joint-enrollment in the beginning of 2018. The joint enrollment exception was discontinued in August of 2018 as part of updates to the participation rules of the XSP.

4.1.6 Residential Option

Residential participation had a lower capacity requirement for entry into the SSP II. Instead of requiring the 100 kW minimum curtailment, residential aggregators were given the option of enrolling at 30 kW. In this case, such participation is not integrated into the wholesale market, but simulated as being in the market. A Participant would meet the same requirements of a conventional participant by bidding and receiving dispatches in the normal way. The difference is that without the resource being in the CAISO markets, Olivine retrieves the market clearing price as applicable to the location of the resource, and then triggers based on participant bids clearing those prices. In this case, there are no wholesale market settlement to pass onto the participant.

4.2 SSP II Rules

Aside from the eligibility requirements enumerated above to gain entry into the pilot, participants had several requirements for qualification and ongoing participation to earn their capacity payment. This is outline in the following figure:

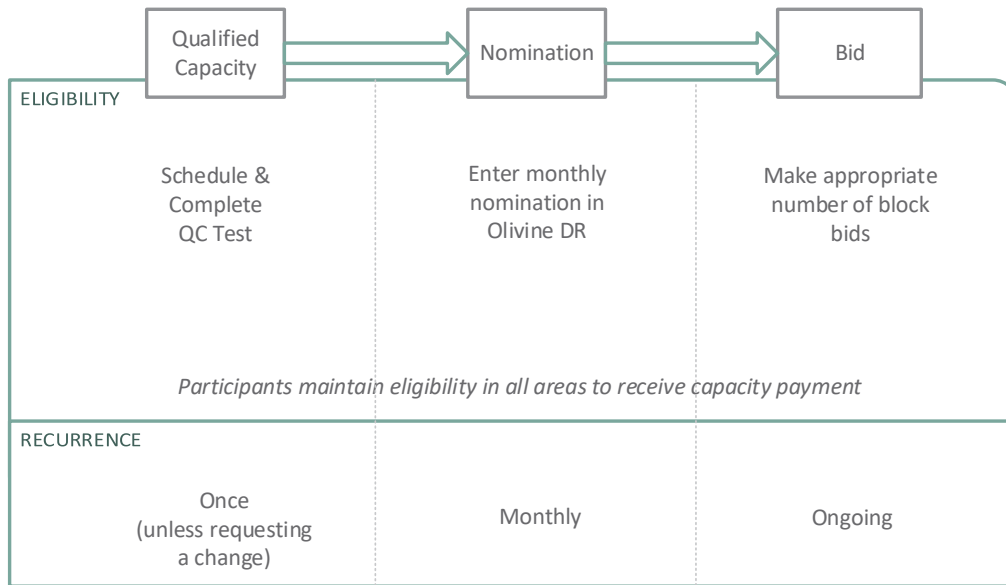


Figure 3: Participant Operational Tasks. Courtesy of Olivine, Inc.

4.2.1 Baseline and Performance Methodology

For the SSP II, the load drop is calculated according to a CAISO Type 1³ baseline methodology. The SSP utilizes the whole premises metering in alignment with CAISO requirements (i.e. no sub-metering). The baseline is a “10-in-10” calculation that takes the average of a target number of the most recent similar day-type non-event days, subject to a morning-of adjustment with a $\pm 20\%$ cap.

Note that as of November 1, 2018, the CAISO has established several new baseline methodologies including:

- A residential specific day-matching baseline, called a “5-in-10” baseline.
- A weather matching baseline that uses actual temperature data to determine baseline usage.
- A control group methodology.

Future participation within the SSP II will take these new baselines into account as appropriate for the customer sector and underlying demand-response technologies.

Below is a detailed example of the baseline calculation process for the “10-in-10” baseline:

1. Identify the target number of previous similar day-type non-event days
 - Day-types are defined as weekdays (Monday – Friday) and weekends/NERC holidays.
 - The target number of days for each day-type are,
 - Weekdays: 10 days
 - Weekends/holidays: 4 days

³ The CAISO Type 1 methodology is based on the North American Energy Standards Board (NAESB) Baseline Type-I methodology which is described in the NAESB WEQ Business Practice Standards WEQ-015, Measurement and Verification of Wholesale Electricity Demand Response. The basis for a Type 1 methodology is that it uses historical whole-premises data to determine a counterfactual of expected usage outside of the DR event.

- Previous event days are excluded.
- The maximum look-back window is 45 days.
- If 10 non-event “Weekdays” cannot be identified within the 45-day look-back window, but at least 5 days can be identified, the baseline is calculated using the available days.
- If at least 5 non-event Weekdays or 4 non-event Weekends/holidays cannot be identified in the look-back window, the highest usage prior event days within the look-back window are then included as needed to reach the minimum number of days.

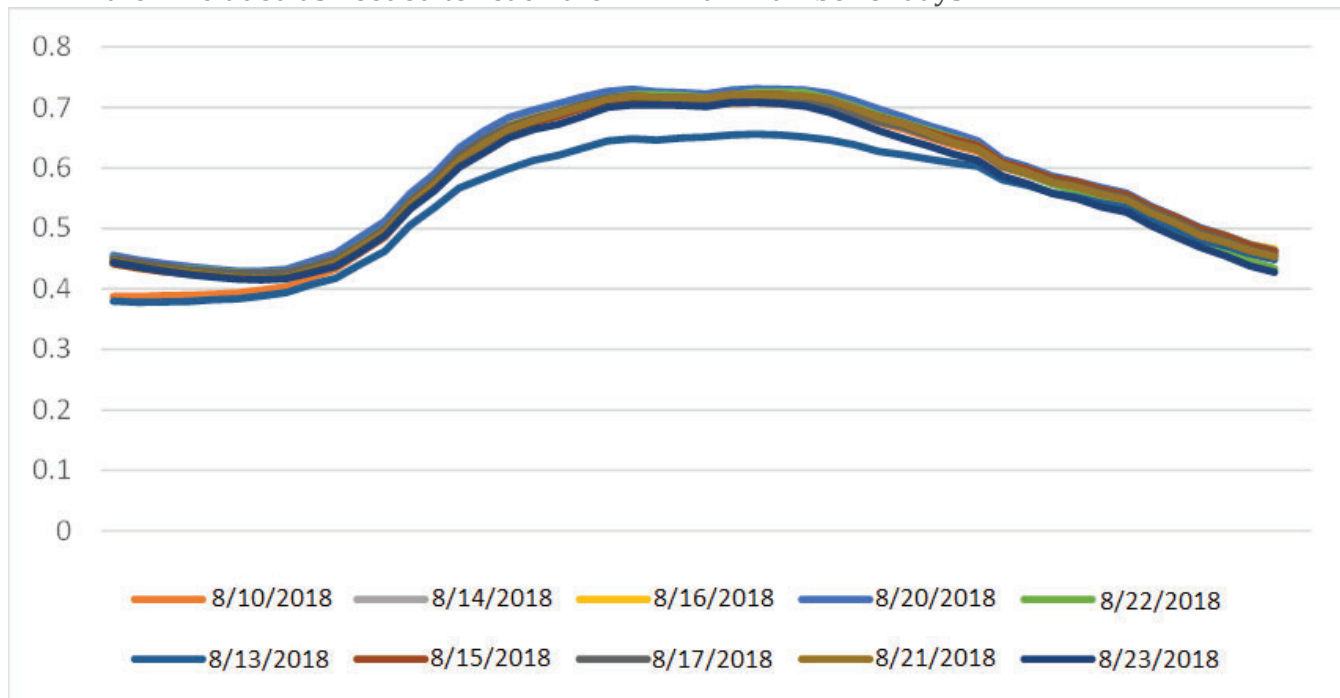


Figure 4: Identify 10 Similar Non-Event Days. Courtesy of Olivine, Inc.

2. Calculate average profile

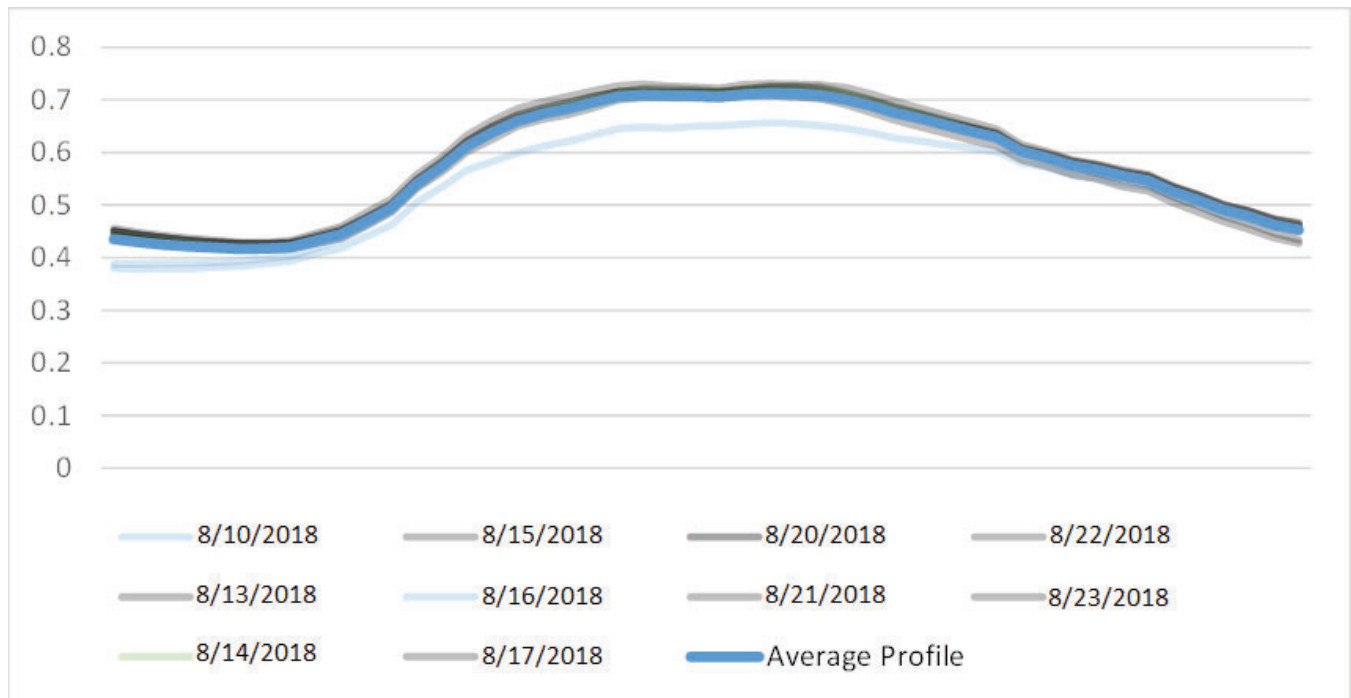


Figure 5: Calculate Average Profile. Courtesy of Olivine, Inc.

3. Determine day-of adjustment

- The day-of adjustment is based on the first three of the four hours prior to the event.
- A multiplier of the ratio of the average load for these three hours to the three-hour average from the baseline is calculated.
- The day-of adjustment is bi-directional (i.e. may be positive or negative) and is capped at $\pm 20\%$.

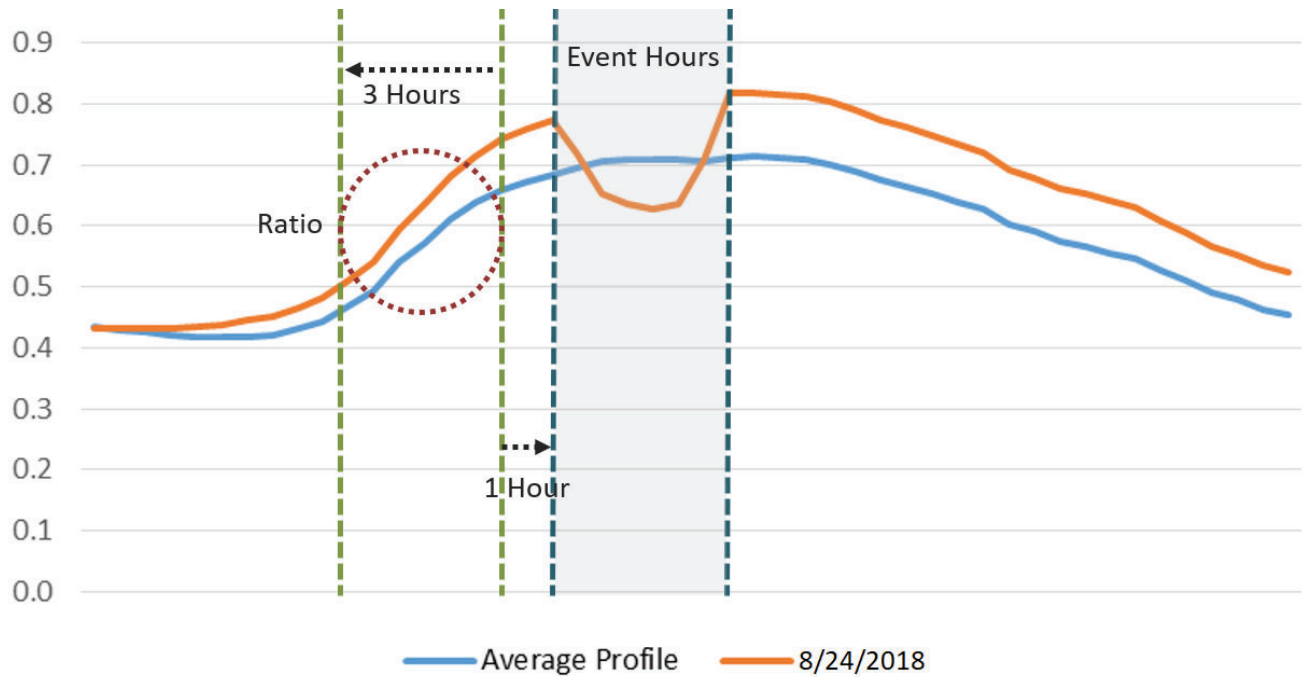


Figure 6: Determine Day-Of Adjustment. Courtesy of Olivine, Inc.

4. Apply day-of adjustment to create baseline
 - The day-of adjustment multiplier is applied to the average profile for all hours of the event to produce the baseline.
 - In the example included, this results in a baseline with higher quantities than the average profile.

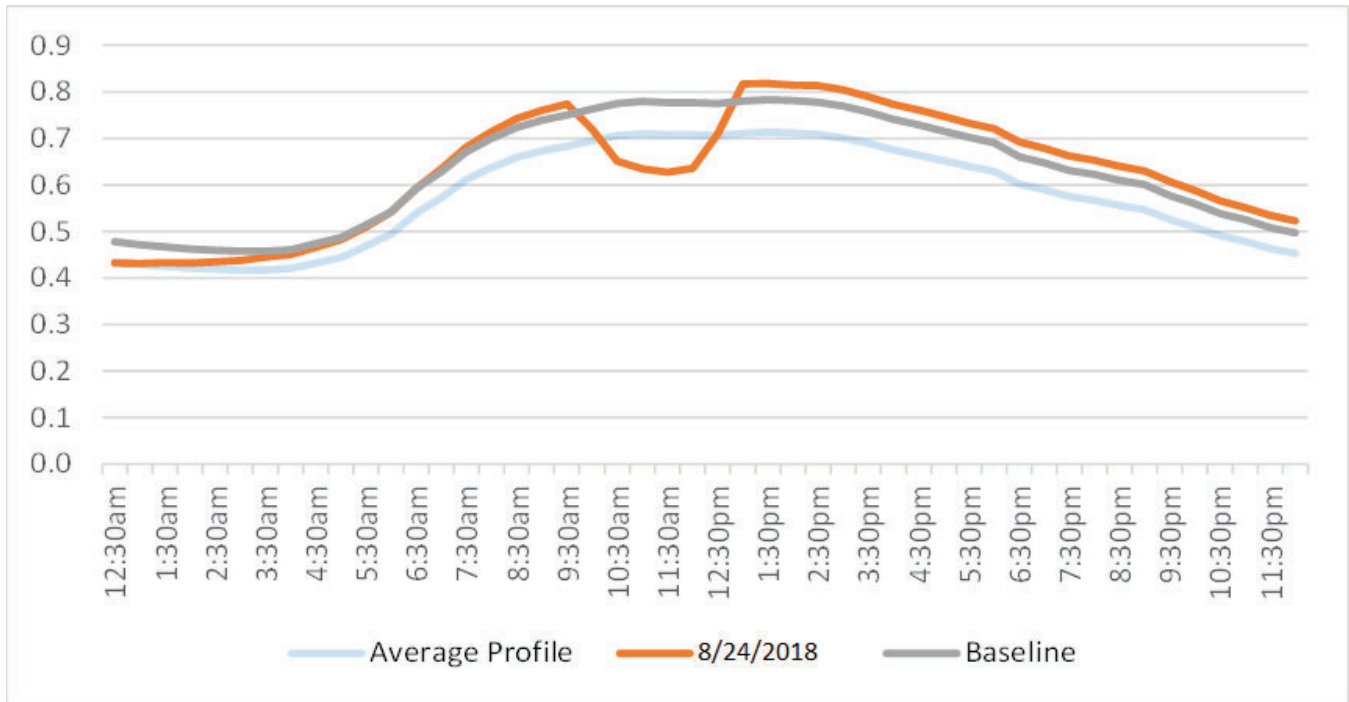


Figure 7: Apply Day-Of Adjustment to Create Baseline. Courtesy of Olivine, Inc.

The same baseline is used by the CAISO for measuring delivery as well as by Olivine for calculating performance for capacity settlement.

4.2.2 Qualified Capacity (QC)

Participants undergo an out of market capacity test prior to becoming operational to determine the resource's Qualified Capacity (QC). The QC test simulated a market dispatch and measured the average energy delivered over a four-hour period against the PDR baseline. The result of the QC test became the resource's QC.

The QC test serves two purposes for the SSP II. The first being to verify a resource's ability to meet the prescribed minimum reductions of 100 kW or 30 kW for a residential resource. The second purpose of the QC test was to set the maximum capacity value participants could nominate into the Pilot. This nomination value also becomes a basis for the capacity incentive calculation as described in Section 4.2.5. Resource's that could not achieve the minimum capacity reduction had the ability to re-test.

4.2.3 Capacity Nominations

On a monthly basis, participants nominate a capacity value for their resource. The capacity nomination must be equal to or greater than 100 kW – or 30 kW for a residential resource – and equal to or less than the resource's QC.

Note that if a Participant routinely delivers below their nomination, the program administrator has the option of lowering their QC going forward; however, this has not been necessary during the Pilot.

4.2.4 Bidding Requirements

Participants are required to submit bids in the Olivine Distributed Energy Resource management system (Olivine DER), whether through the user interface or web API. The bids are ultimately forwarded to the CAISO for inclusion in the market runs.

Resources that do not meet the 100 kW requirement to participate in the wholesale market (e.g. residential) are still required to submit bids to the Olivine DER, though they were not forwarded to the CAISO.

In order to be eligible for the capacity incentive there is a monthly requirement of submitting at least 18 qualified bids across 18 unique days. A qualified bid consists of a 4-hour contiguous block. As such, participants would have 72 bid hours per month. Participants who receive a cumulative total of 24 qualified awards (e.g. dispatches) over the course of the month also satisfy the requirement for the capacity incentive. All bidding obligations are met for the month after 24 hours of qualified awards.

Additional bids that exceed the requirements of the pilot are acceptable. Though they do not result in an increased capacity incentive, it can be an opportunity for the participant to earn additional wholesale market payments. In the early months of the Pilot (from 1/1/2015 through 9/30/2015), participants were expected to bid half of all hours at the Demand Response Net Benefits Test (NBT) price. As of 10/1/2015, this requirement was removed enabling participation at any price between the NBT and the \$150 price ceiling. This requirement was changed both to simplify participation and due to the high number of dispatches that were occurring due to market conditions.

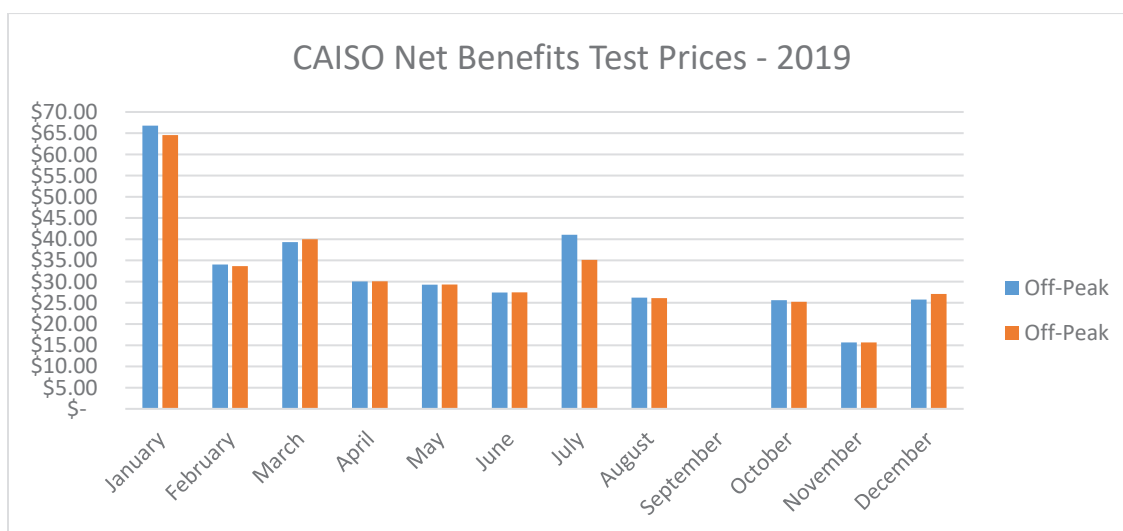


Figure 8: CAISO Net Benefits Test Prices, 2019.

4.2.4.1 Bid Price & Quantity Limits

In the SSP II, the day-ahead (DA) bid has a price floor equal to that of the month's Net Benefits Test (NBT) price⁴ and a price ceiling of \$150/MWh⁵.

$$NBT \leq Bid\ Price \leq Ceiling$$

At the CAISO, bids have a quantity floor of 10 kW and a quantity ceiling of the maximum as detailed in the CAISO's MasterFile for the resource (i.e., the P_{max}). Note that eligibility for the capacity payment is predicated on submitting qualified bids and one aspect of a qualified bid includes bidding the quantity at or above the resource's QC.

$$10\ kW \leq Bid\ Quantity \leq P_{max}$$

Each month the CAISO publishes an NBT value, one for on-peak and one for off-peak periods. In this context, the on-peak periods are defined by the North American Electric Reliability Corporation (NERC) as Monday through Saturday from 6:00 AM to 10:00 PM. Off-peak periods include the complement of the above weekday times, Sundays, and six holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day.

4.2.4.2 Real-Time Bidding

Participants also have the option to participate in the Real-Time market by submitting Real-Time bids, subject to resource operational characteristics, as long as they met the following requirement:

- The SSP II resource must have successfully participated in the day-ahead market for at least three months preceding adding the real-time option.
- The participant must integrate with Olivine DER for real-time dispatch signals using either OpenADR or the PAP 19 Deployment API.

The price floor for real-time bids are maintained at the NBT as described above and the price ceiling aligns with the CAISOs at \$1,000/ MWh. Real-time bidding in the SSP II did not alter any of the pilot participation and bidding requirements: such resources were still required to meet the same day-ahead bidding requirements. In addition, there was no additional capacity payment for

⁴ FERC Order No. 745 requires the CAISO to implement a net benefits test that establishes a price threshold above which demand response resource bids are deemed cost effective. The CAISO must perform a monthly analysis based on historical data from the previous year's supply curve to identify the price threshold estimate that shows where customer net benefits occur and publishes them to the CAISO web site. The CAISO usually publishes the monthly NBT values by the middle of the preceding month.

⁵ The CAISO enforces a \$1000/MWh price ceiling, but prices above \$150 are quite rare particularly at the aggregated-PNode level at which PDRs are priced; the lower price ceiling was designed to ensure that CAISO market awards would not be a rarity in the Pilot.

participating in the real-time market. Any income earned in the real-time market was passed through to the participants.

4.2.5 Capacity Incentives and Wholesale Opportunity

The SSP II provides customers with two main forms of compensation:

1. A performance-based monthly retail capacity payment of \$10/kW-month.
2. Payments – net any imbalance energy charges – arising from wholesale market awards and resulting settlements. These net charges specifically exclude CAISO Grid Management Charges (GMC) which are paid by PG&E. Noting again that these payments are not available for out-of-market resources.

4.2.5.1 Capacity Settlement Calculation

The monthly capacity payment is calculated using the following equation. The capacity price is \$10/kW-month:

$$(Monthly\ Performance) \times (Nomination) \times (Capacity\ Price)$$

Monthly performance is computed from a weighted average of hourly adjusted performance, computed from raw performance and awarded energy:

- a. *Raw performance*: the hourly measurement of performance represented by the ratio of actual hourly delivery to the nomination⁶ for each qualified award hour. Note that these performance numbers utilize the PDR baseline, calculated by the CAISO. The meter data used for retail performance calculations will be based on the PDR registration in effect during that trade date.

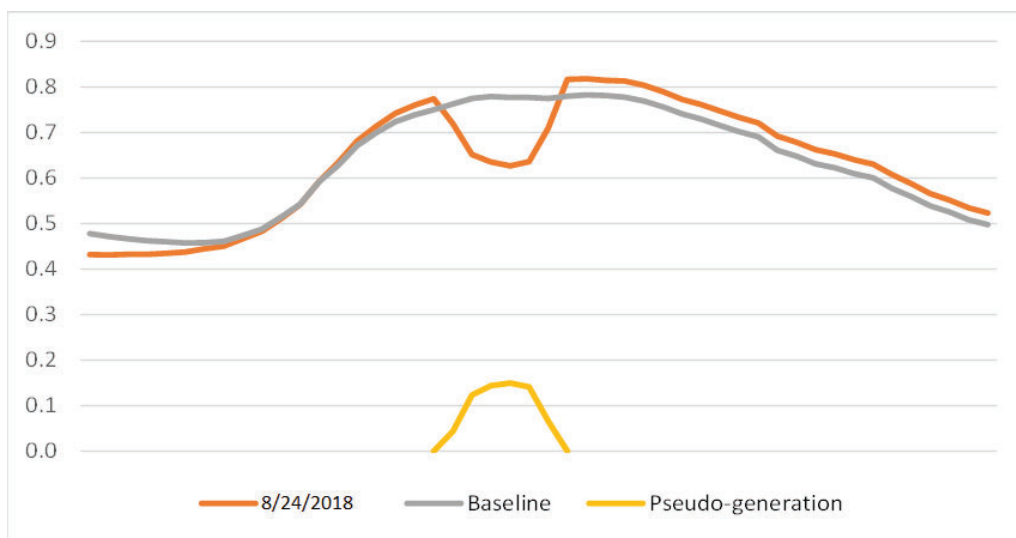


Figure 8: Calculate Performance. Courtesy of Olivine, Inc.

⁶ Note that in the context of a qualified bid, the bid quantity will always be equal to or greater than the nomination; however, under some unusual conditions the awarded quantity may be below the bid quantity. In this case, the raw performance is the ratio of actual hourly delivery to the awarded quantity, not the ratio to the nomination.

- b. *Adjusted performance*: an adjustment to the raw performance for use in Pilot settlement payment calculations using the following step function:

Raw Performance	Adjusted Performance
$0.75 < x$	1.00
$0.50 < x \leq 0.75$	0.75
$0.25 < x \leq 0.50$	0.50
$0 < x \leq 0.25$	0.25
$x \leq 0$	0

Table 1: Adjusted Performance Tiers based on Raw Performance

- c. *Monthly performance*: The monthly performance is an average of all hourly adjusted performance values, weighted by hourly energy award.

If a resource does not meet the Pilot bidding or award requirements for a given month, the Participant will forfeit the entire capacity payment for that month.

The capacity payments have no penalties though are adjusted by actual event performance. They are settled at the enrollment but payment was forfeited if bidding requirements were not fulfilled.

4.2.5.2 Wholesale Energy Settlements

The wholesale settlements that resources earn by participating in the market are calculated by the CAISO. Olivine passes the settlement payments, or charges, received directly to the participant. These payments and charges include:

- Day-Ahead Awards which are paid at the Day-Ahead energy price
- Over-delivery during an event interval is paid at the Real-time Uninstructed Imbalance Energy price.
- Under-delivery during an event interval charged at the Real-time Uninstructed Imbalance Energy price.

All prices are as defined for the PDR itself. Where conventional wholesale market resources are paid at the Locational Marginal Price (LMP) for a specific PNode, PDRs have a price derived from a distribution of PNodes with the Sub-LAP. This type of PNode is referred to as an Aggregated PNode (or APNode). Note that typically, participants would be exposed to grid management charges from the CAISO, but this fee is paid for by PG&E under the pilot.

5 Pilot Operations

5.1 Enrollment Process

Potential participants fill out a declaration of interest (DOI) and provide detailed information on customer locations and DR capacity. In the case that the participant is an aggregator, the participant also provides customer-executed agreements authorizing PG&E to release customer data to the participant. These forms, called customer information service-request forms (CISRs), also acknowledge that the customer is enrolling in the pilot.

Once submitted, Olivine reviews the enrollment materials and submits them to PG&E for final review. PG&E proceeds with validation of the CISRs and checks eligibility of customers for enrollment, including identifying Sub-LAP and LSE membership. Ultimately the Participant acknowledges the enrollment of the eligible customers with the intention of placing them into a PDR for participation, or in the case of the 30-kW option, a simulated PDR.

Following enrollment, the participant executes a participation agreement with Olivine. Two training sessions are held: one on the rules, requirements and process of the pilot, and one on using the Olivine DER system to place bids and manage the resources. A qualified capacity test is then arranged to ensure the participant can meet the minimum curtailment requirements.

5.2 Enrolled Participants

Table 2 summarizes the capacity nominated into the SSP II and the underlying DR technology for all active resources in 2019.

A large black rectangular box redacting the content of Table 2.

Table 2: Active Participants in SSP II, 2019.

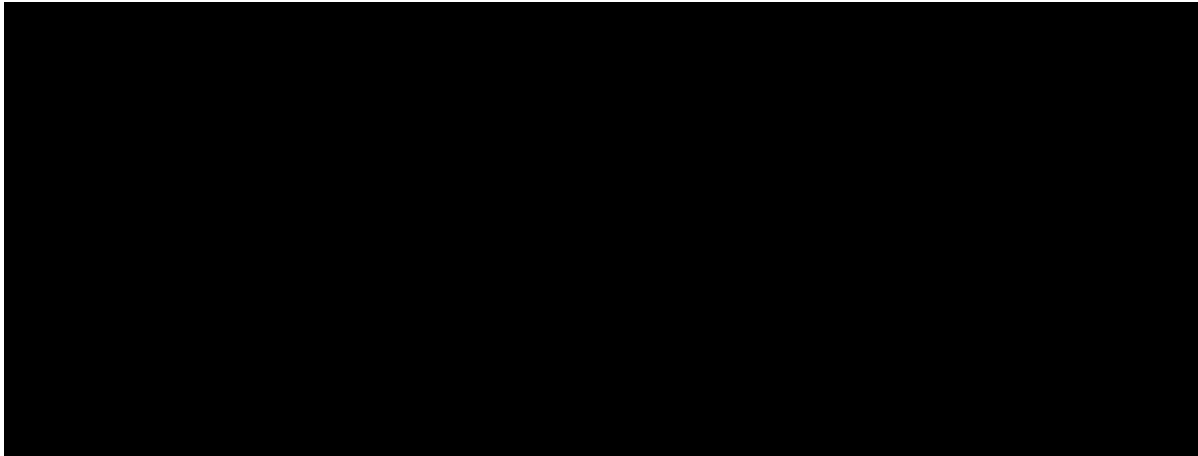
5.3 Awards and Example Events

In the day-ahead market, an award is the signal to the participant that the offer bid to the CAISO has been accepted and should be delivered over the awarded hour(s). Note that although participants submit qualified bids which are contiguous 4-hour blocks, awarded hours can range from 1 to 4-hours and need not be contiguous.

The award notifications are generally posted by the CAISO at 1 PM the calendar day before the trade date. Award notifications from Olivine DER to the participant will be delivered through email or SMS. Participants whose resource(s) has been integrated with Olivine DER can also utilize OpenADR 2.0b or other APIs to receive award notifications. In cases where the CAISO publication

of awards is delayed, Olivine DER will deliver the award notification as soon as the CAISO publishes the results for the day-ahead market.

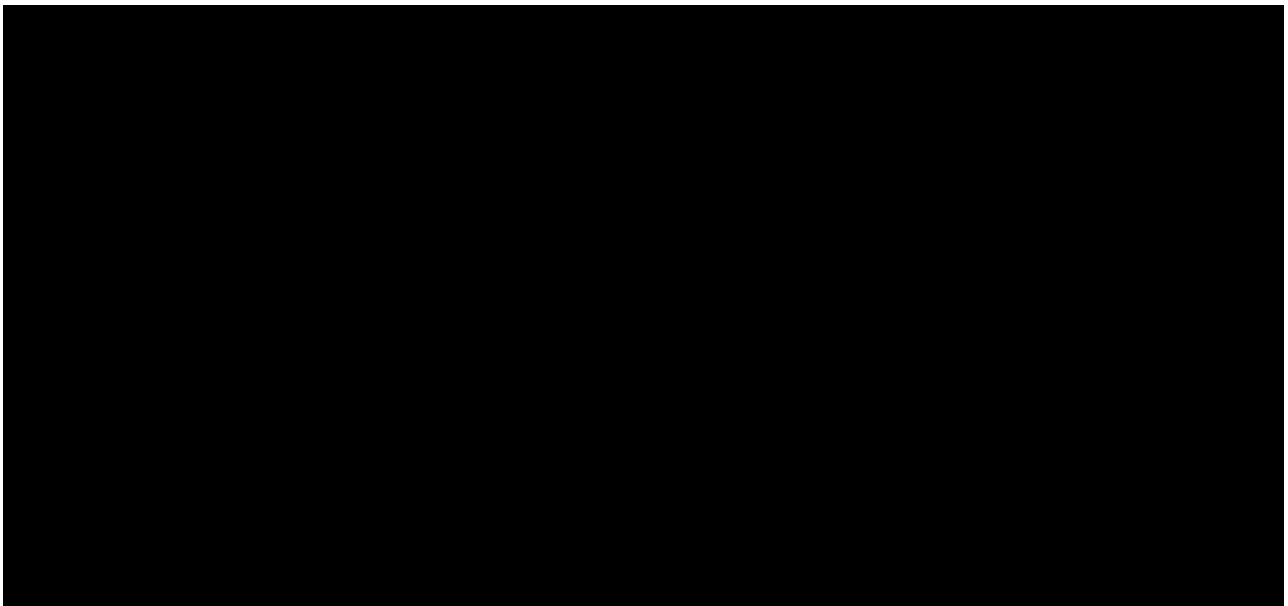
The following figures provide example event dispatches in the SSP II.



[REDACTED]

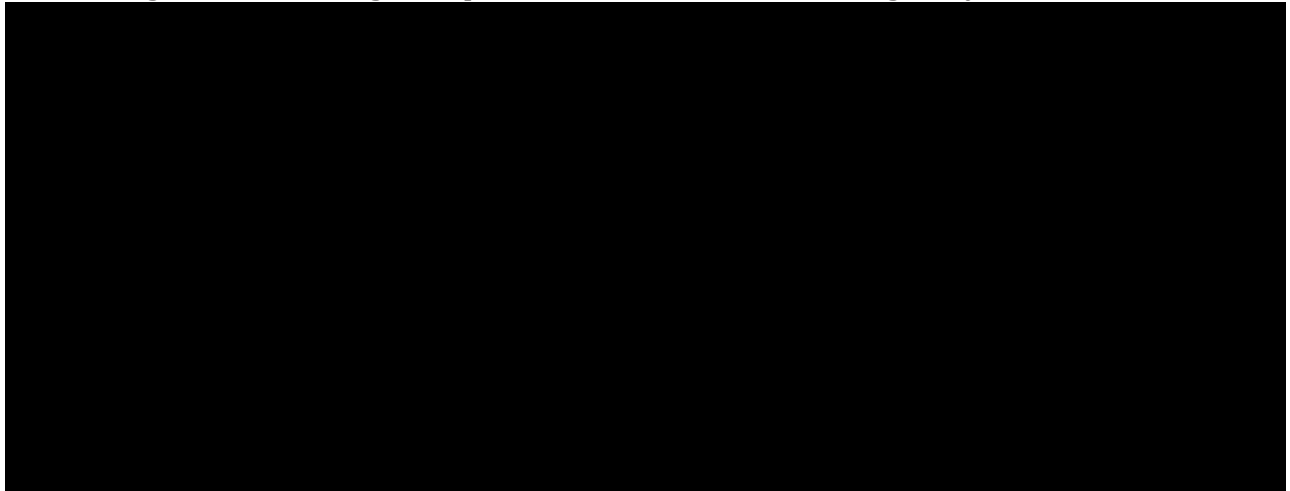
Figure 9 shows the measured load and calculated baseline along with the [REDACTED]. The light blue line identifies the baseline calculated per the rules as defined in Section 4.2.1. The dark blue line identifies the target increase to achieve the [REDACTED]. Finally, the green line identifies the actual load during that time.

No participants have elected to participate and bid in the Real-Time Market since 2016. The following example is a real time event dispatch from 2016.



[REDACTED]

Figure 10 and Figure 11 show an event for the [REDACTED] resource showing both real-time dispatch from [REDACTED], and a day-ahead award from [REDACTED]. In each case, the resource is expected to deliver the energy equivalent of [REDACTED]. Figure 6 shows a closeup of the event. Note that these two different events occurring in the same day are the result of [REDACTED] submitting day-ahead bids to meet the SSP requirements followed by real-time bids. There is no market prohibition against their being multiple discrete events within a single day as seen here.



[REDACTED]

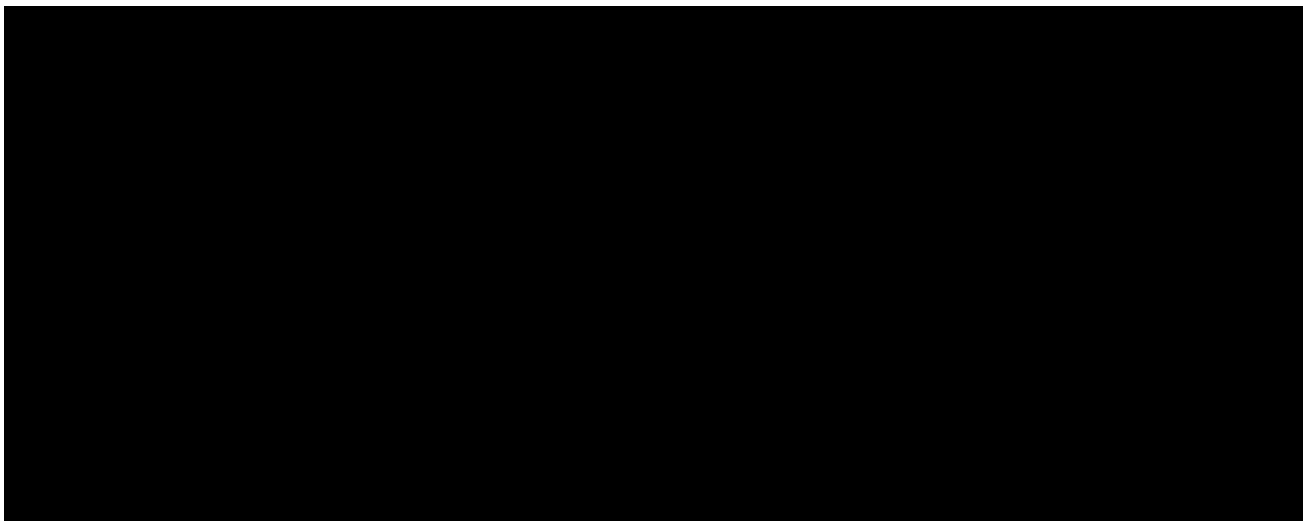
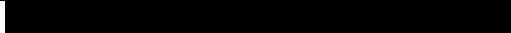
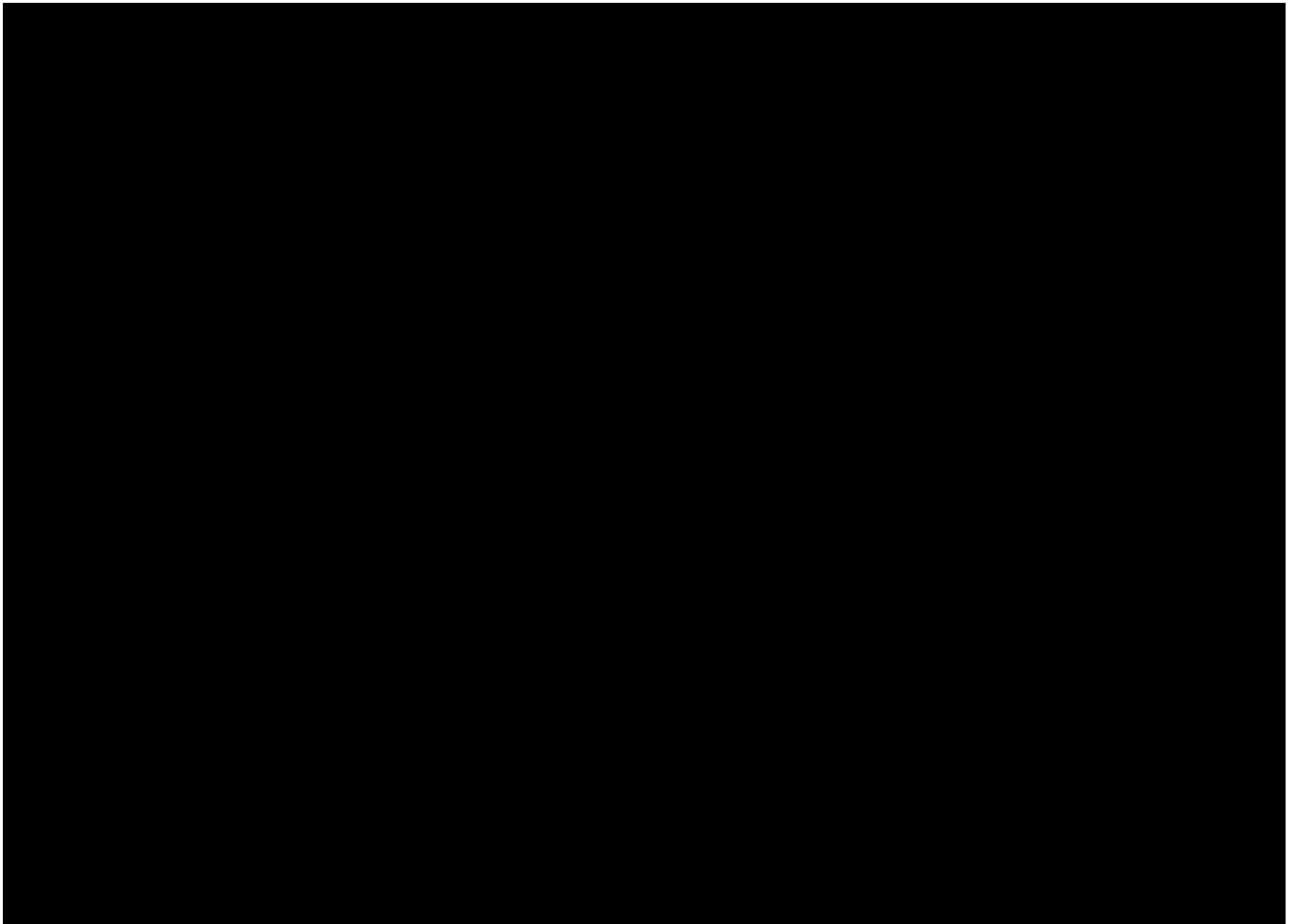
5.4 Distribution Loss Factor (DLF)

Distribution Loss Factors (DLFs) are applied to the metered quantities utilized within the pilot reflecting the fact that power is lost through distribution and transmission. This results in the quantities used for operations (i.e., in nomination values, awards, and settlements) being slightly higher than the quantities metered at the participant's location. The exact amount the DLF fluctuates differs hourly and is specified by PG&E. Participants will find that the loss factors range between 3% and 7%.

5.5 Resource Operations

[REDACTED]

[REDACTED]



[REDACTED]

[REDACTED]

[REDACTED]



[REDACTED]

[REDACTED]

[REDACTED]

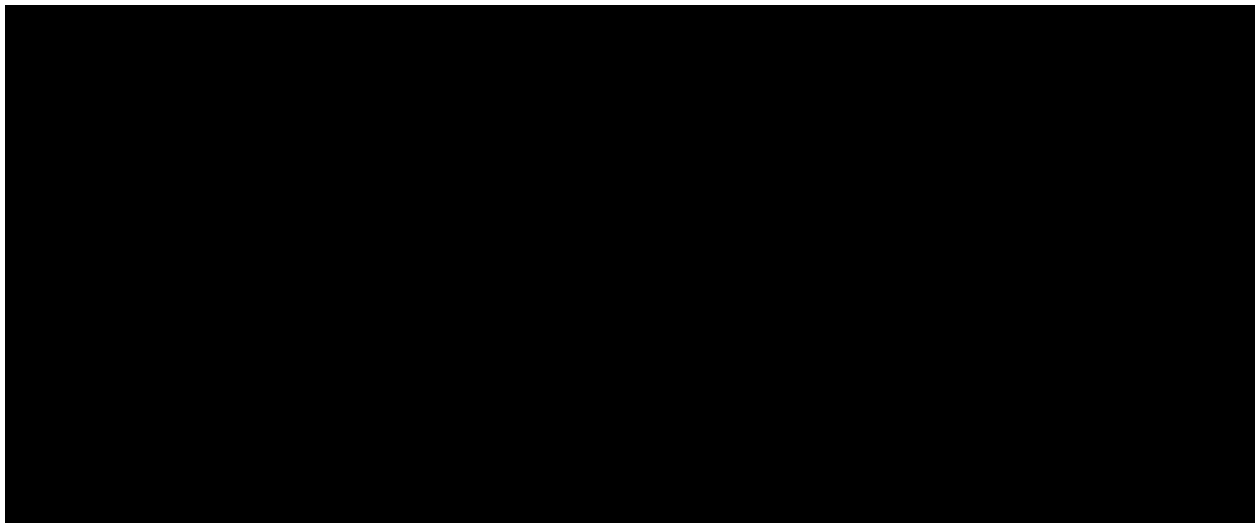
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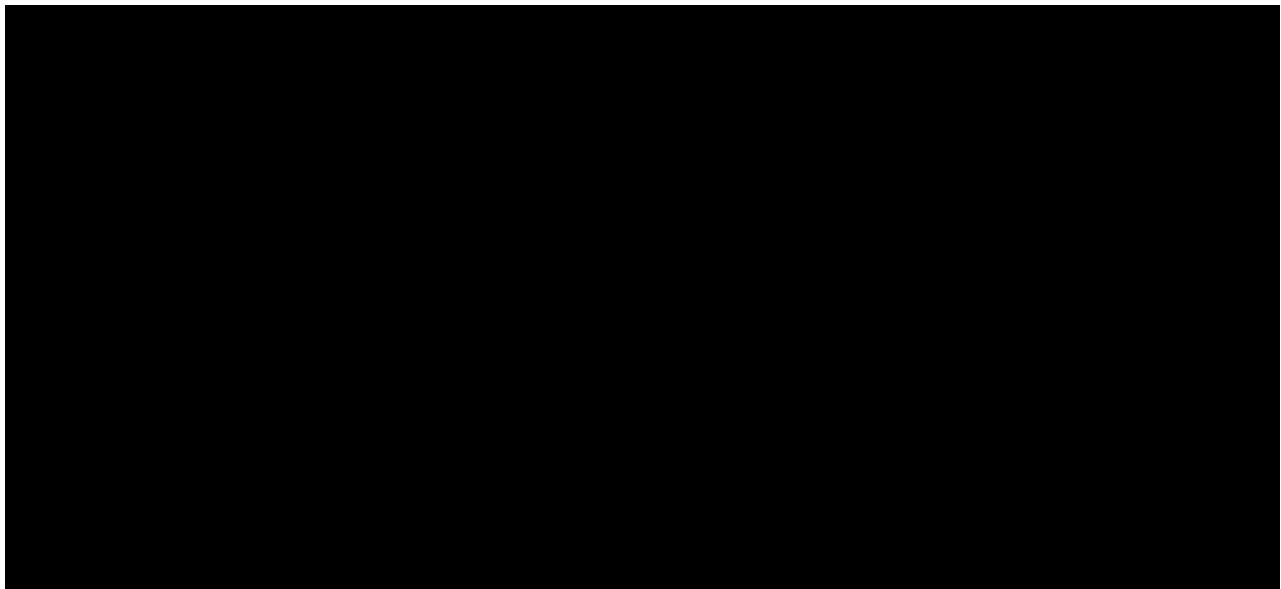
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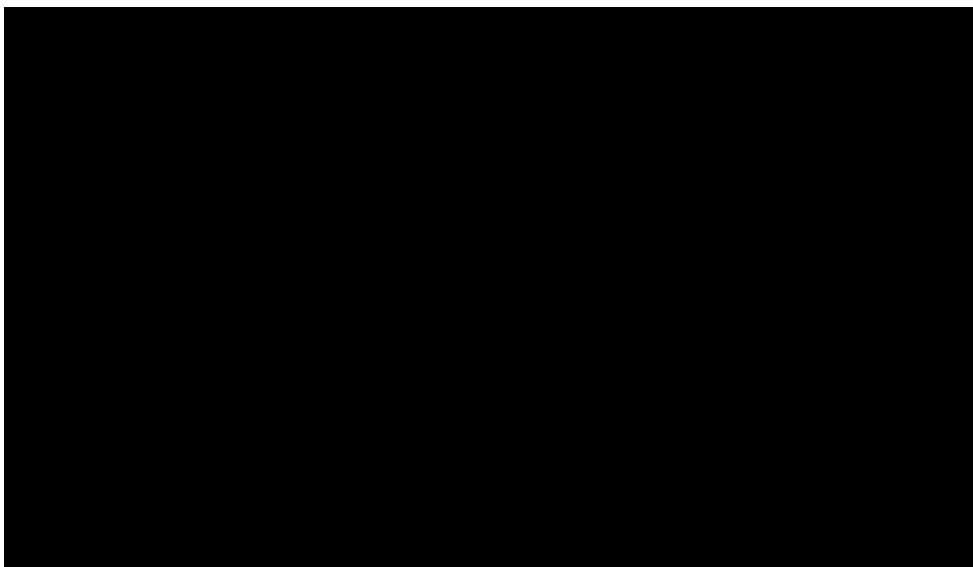


[REDACTED]

5.6 Resource Bidding Characteristics

Figure 18 is a plot of the percentage of bids placed within a given hour for each resource. Throughout 2019, the bid blocks have been fairly consistent month-to-month as Participants have settled with the hours that work best for their resource.

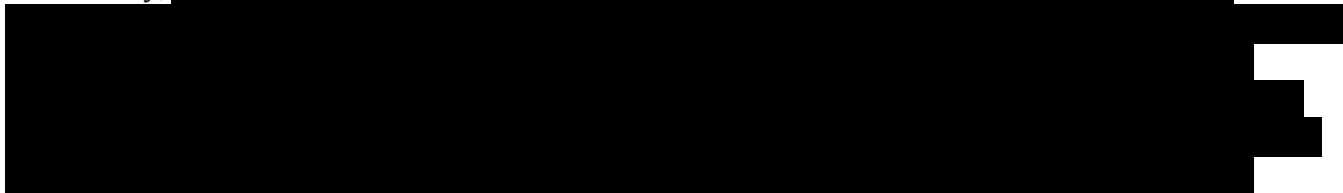




In addition to bid hours, Participants also have the ability to segment their capacity offering in their hourly bids. For example,

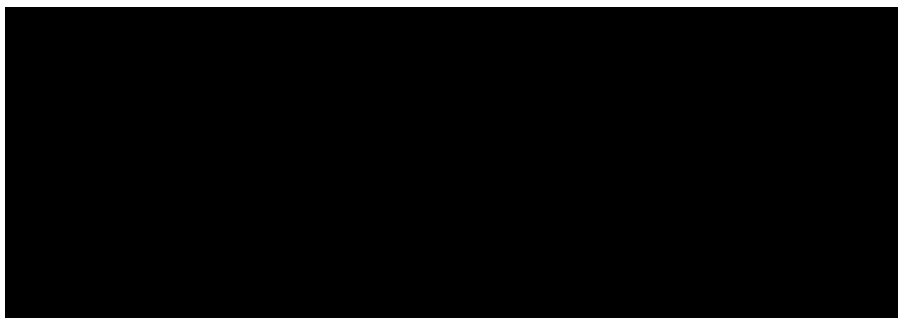


Conversely,



5.7 Value of Participation

Each participant received capacity incentives for each month they nominated resources as well as payments from CAISO for the energy they delivered. Table 6 summarizes capacity and CAISO settlements received in 2019 by each individual resource. As expected, the capacity payments, were significantly higher than the CAISO settlements. A set of monthly data for each resource can be found in Appendix B.



6 Lessons Learned

In this section, we outline the lessons learned throughout the pilot implementation.

We categorize the lessons learned in this pilot into customer acceptance, market transformation challenges (wholesale market, technology), technical and operational feasibility, and value to participants.

6.1 Enrollment

In terms of enrollment, there was initially much interest from parties, but not as much follow through as one might expect. This can be attributed to several factors:

- Engagement in pilot presentation meetings is a way for parties to learn without any cost other than time. In fact, it is the job of many of the attendees to the SSP outreach meetings to network with IOUs, to learn about potential programs, regardless of fit.
- Some prospective participants are looking for funding mechanisms that would help them enroll customers into their own energy management service offerings. As such, a common theme is a declaration of interest, but ultimately the prospect cannot recruit actual customers for the project.
- The DRAM created an alternative for some prospects. This had the effect of forestalling prospects because of their incorrect belief that they would get a DRAM contract, or for those who were awarded a contract, forestalling SSP participation while fulfilling the DRAM. Generally speaking, there is an opportunity cost to participants for participating in any pilot or program. Prospective participants likely have multiple pilots or programs available to them of which they must choose one.
- Some prospective participants were concerned with the limited duration of the SSP (initially approved for 2 years with a subsequent 1-year extension) and the risk that the pilot might not be extended further. Even with further extensions, this concern has continued. As a result, they felt that the investment in time and equipment needed to qualify for and participate in the pilot was not worth the potentially short duration.
- A related issue is that some participants wanted a larger capacity allocation for participation to be impactful. With the SSP limiting participants to 1 resource and 1 MW of capacity, large individual customers and participants who felt they could not reasonably target a single region to meet the one Sub-LAP requirement per resource. An industrial participant chose not to enroll because their load could only be controlled discretely and far exceeded the per-participant cap of 1 MW. As such, participation would have resulted in many MWs of load reduction with a potential payment capped at 1 MW.
- Residential aggregators found recruitment of enough residential customers to meet the minimum load requirement more difficult than anticipated.

It was common for parties to initially overestimate the number of sites that would pass the validation process as well as the potential load reduction that could be achieved by the final resource. As already discussed, this resulted in several prospective participants failing to meet

minimum capacity requirements or deciding that the amount of load that they could control was insufficient to justify participation.

The enrollment process for residential aggregators turned out to be very difficult, particularly with the somewhat manual process of obtaining customer authorization service request (CISR) forms from customers. Attempts have been made in previous years to enroll residential customers into the pilot. [REDACTED] attempted to enroll a [REDACTED] resource but, was unable to demonstrate that capacity in testing. In another case, [REDACTED] was given the option of enrolling a [REDACTED] resource after having failed two attempts at achieving 100 kW; however, they opted out of the SSP at that point. Since then, there has been no interest by any other aggregator to enroll residential customers. While the initial intention of the lower 30 kW requirement was to target residential aggregators, the pilot made an exception for non-residential participants who were interested in joint enrollment with the XSP.

Another major issue – as was seen for both [REDACTED] and [REDACTED] was their inability to judge the actual impact of the then-required 10-in-10 baseline on their viability as a PDR resource. The issue of a potential challenge with the baseline was well known to both organizations; however, their lack of whole-premises meter data likely made it difficult for them to determine in advance if their resources could meet the requirements. Note also that EV charging may generally require a higher penetration of customers to ensure that enough vehicles are at home during the availability hours and charging.

6.2 Value to Participants

- CAISO energy settlements alone do not result in significant value for the participants. The CAISO energy settlements were significantly less than the SSP II capacity incentive. This underscores the need for programs to provide additional incentives (e.g. capacity incentive) and that relying on CAISO energy settlements, alone, will not provide Participants adequate price signals to participate. Additionally, in order to achieve cost-effective results, the participation incentive should be correlated to actual grid needs, which include locational dependencies.
- In one case, a resource was made up of a relatively small (100 kW) controllable load behind a large variable premise load on the scale of megawatts. In this case, the actual response of the resource was not visible using the whole-premises baseline performance methodology because the large premise load masked any performance the smaller controllable load may have contributed. As a result, the participant was unable to receive a fair performance settlement for their participation.
- Many of the sites have been successful without direct integration with the Olivine DER system, presumably reducing the costs of these participants.

6.3 Operational Issues

- Training is needed for customers to understand the basic CAISO market operations, including baselines, determining load shed strategies in response to program requirements, quantifying nominations, qualifying capacity, understanding retail incentives and wholesale settlements.

There are several lessons resulting from [REDACTED] taking the real-time option in the SSP:

- The real-time market operations result in very short dispatch notifications (i.e., 2.5 minutes before the event period). As such, it is clear that real-time operation is best suited for fully automatic control systems.
- Because of the short notice, pre-charging – whether charging an electric battery or pre-cooling a building envelope – is difficult to accomplish without real-time price forecasting.
- A shortcoming of real-time dispatch for demand response at the wholesale market, is that the participant is only paid for the intervals included in the dispatch even though the dispatches may be discontinuous. For example, a DR event might receive 10 minutes of dispatch followed by 10 minutes of no dispatch followed by another 10 minutes of dispatch. Regardless of whether delivery occurs within the middle period, it is not observed by the CAISO so any such delivery is paid \$0. This is different from conventional CAISO resources that are always in the market. In that case, over-delivery during the zero dispatch is still paid by the CAISO.
- Since 2016, no participant has elected to participate in the real-time energy market. Given the challenges enumerated above and the absence of any additional incentive payment from the SSP II for real-time participation, the value proposition for real-time market participation is solely wholesale market energy payments, which is low.

Baseline Calculation for Load Increase and Decrease.

In 2018, [REDACTED] had a resource cross-enrolled in the SSP II and XSP creating the potential that the resource could be dispatched twice in a single day. This did not end up occurring as the SSP II events and the XSP events ultimately did not coincide. However, considerations for how the baseline is calculated if such case were to occur is pertinent. In fact, in the latter half of XSP 2018, the [REDACTED] resource did receive multiple dispatches within the same day. For event days where there are both load increase and decrease dispatches, the later decrease event utilizes the same day-of adjustment from the afternoon increase event. This was implemented to avoid potential overlap between the afternoon event hours and the evening hour adjustment hours. For example, a 12 PM – 1PM load increase event and a 4 PM – 6 PM load decrease event could be dispatched on the same day. If the evening event were to have its own day-of adjustment factor, the adjustment hours used in the calculation (12 PM – 3 PM) would overlap with the 12 PM – 1PM increase event.

6.4 Qualified Capacity (QC)

Inherent in program constructs which require a capacity commitment is the notion that a resource be able to reliably deliver a specified capacity reduction when needed. As such, the ability to set a QC that is reflective of what the resource can reliably deliver is paramount to the effectiveness of the program. The CAISO also recognizes this need as it addresses this issue in its ESDER 4 stakeholder initiative⁷. The XSP currently implements a one-time capacity test for resources prior to becoming operational. While a capacity test is an effective way to determine or validate a resource's capability, it is not a solution that is conducive to ensuring consistency in event performance. Particularly for resources that are weather sensitive or can only operate at discrete levels (e.g. all on or all off). In such cases, deviations from the dispatched operating target—in both under-delivery and over-delivery—is commonplace.

7 Conclusion and Next Steps

As illustrated throughout this report, the SSP II has resulted in a variety of lessons learned for participants, PG&E specifically, and for the IOUs more generally. These lessons have helped inform proceedings at the CPUC and the CAISO and directly influenced the design of the DRAM and the PG&E CBP. There are still unanswered questions around how best to integrate wholesale / retail programs with localized distribution need as is the current focus on the SSP II.

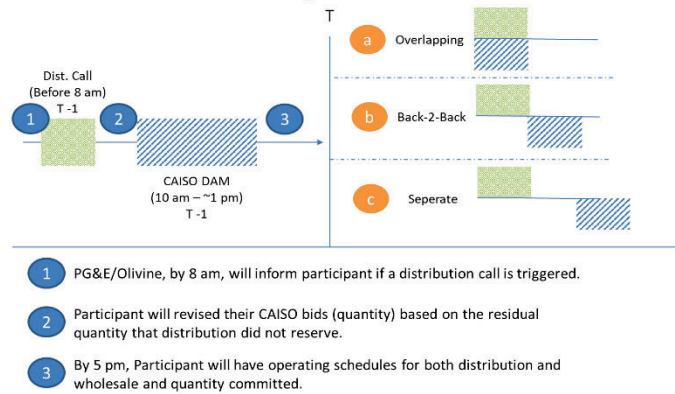
7.1 Next Steps

In 2020, the central focus will be continuing to assess and test the operational process of an aggregated resource providing both wholesale energy services and distribution deferral. Efforts have already begun to develop use cases and operational processes to test the efficacy of a resource providing multiple services.

Partial dispatches of wholesale resources will be accomplished by segmenting the wholesale resource locations by distribution feeder. The geographical granularity of segmenting by distribution feeder will allow a more targeted response to distribution needs. Figure 20 illustrates a proposed timeline and process flow for what the interaction between distribution and wholesale services may look like.

⁷ <http://www.caiso.com/StakeholderProcesses/Energy-storage-and-distributed-energy-resources#phase4>

Notification and Adjustment Timeline



- a Overlapping,** test out day ahead overlapping calls made by both Distribution and CAISO.
- b Back-2-Back,** test out non-overlapping events but are scheduled consecutively.
- c Seperate,** otherwise known as multiple starts per day. Is there a limit on how many events can be scheduled on a given day?

Figure 20: Distribution & Wholesale Interaction

8 Appendix A – 2019 Awards and Performance

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

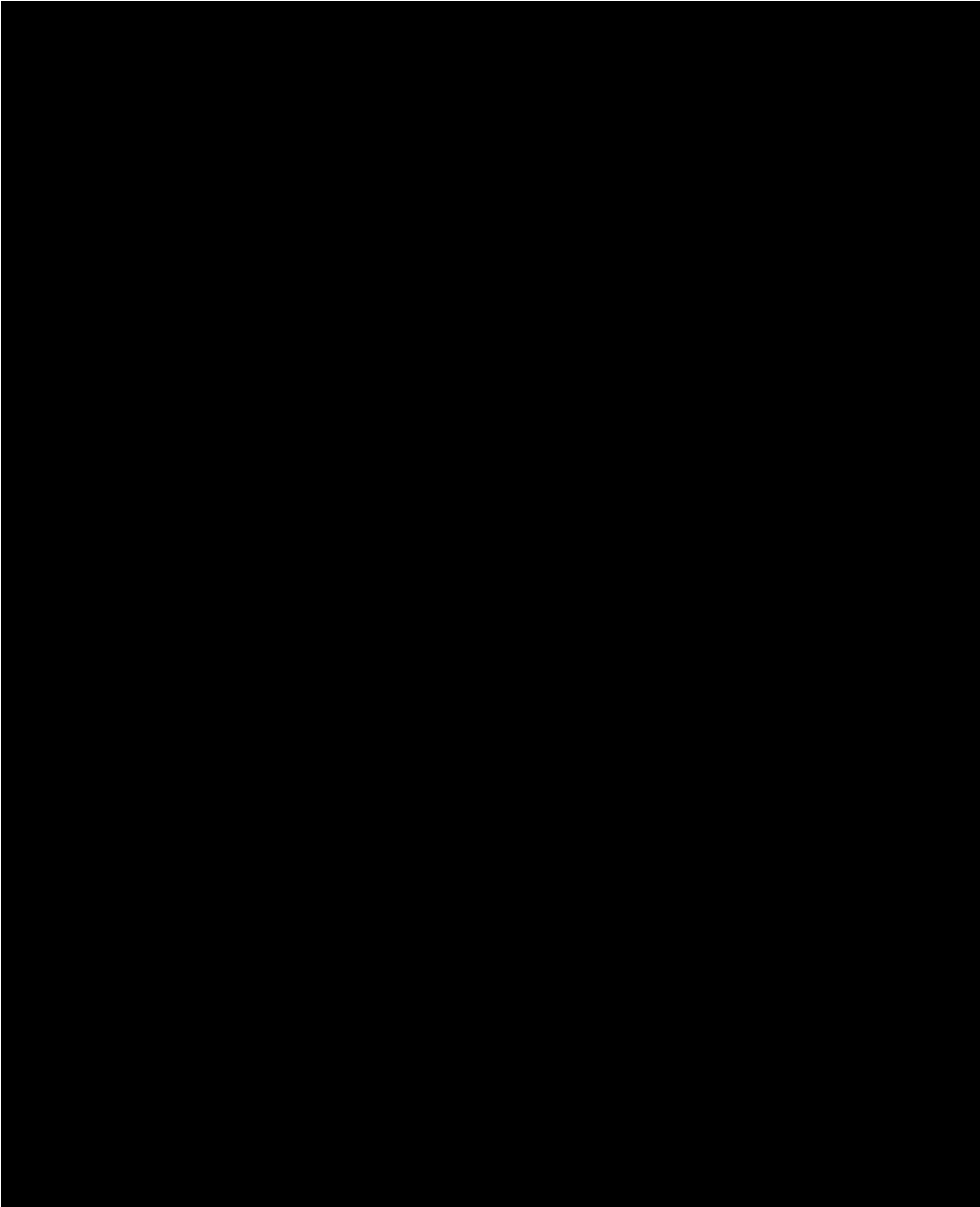
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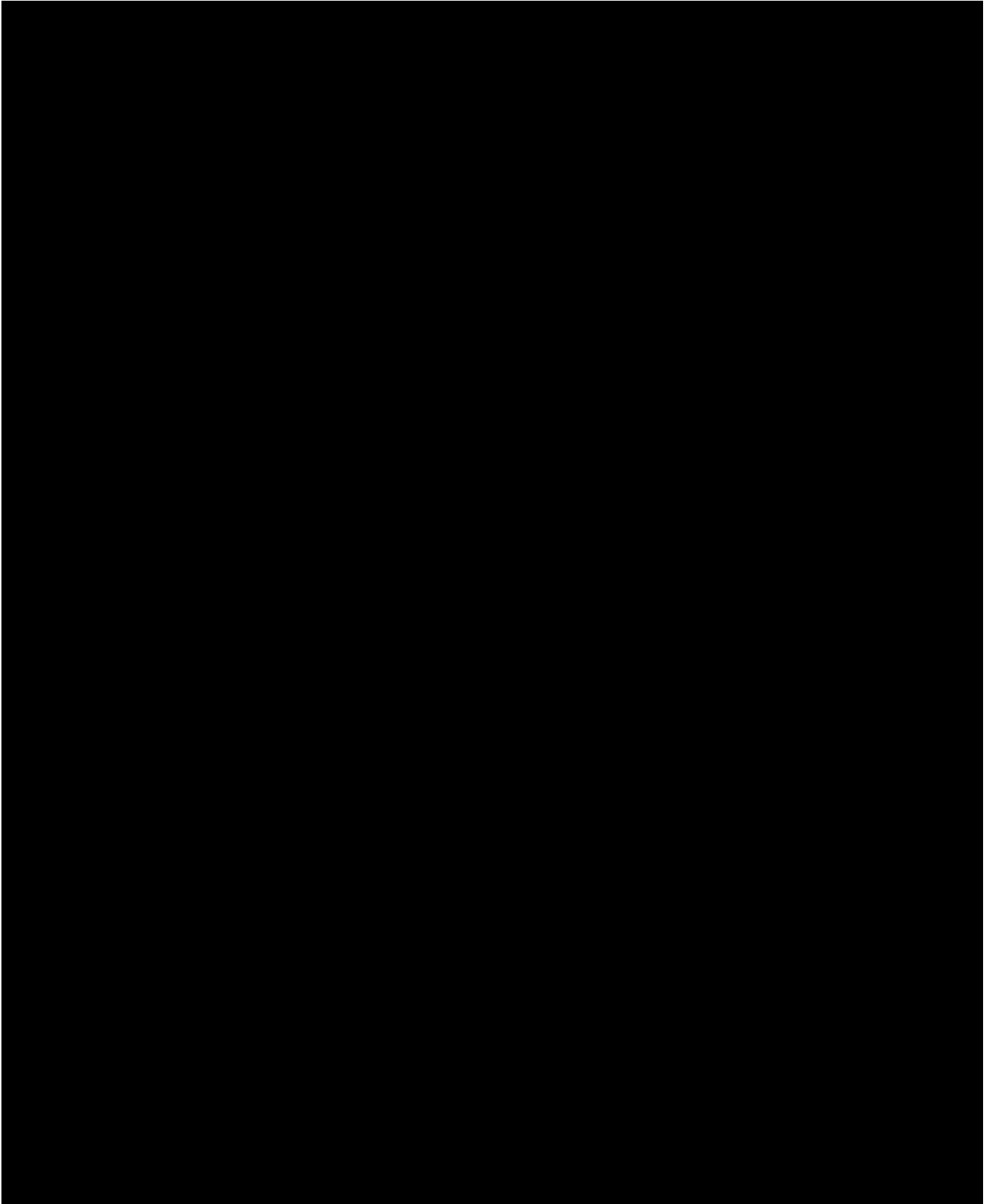
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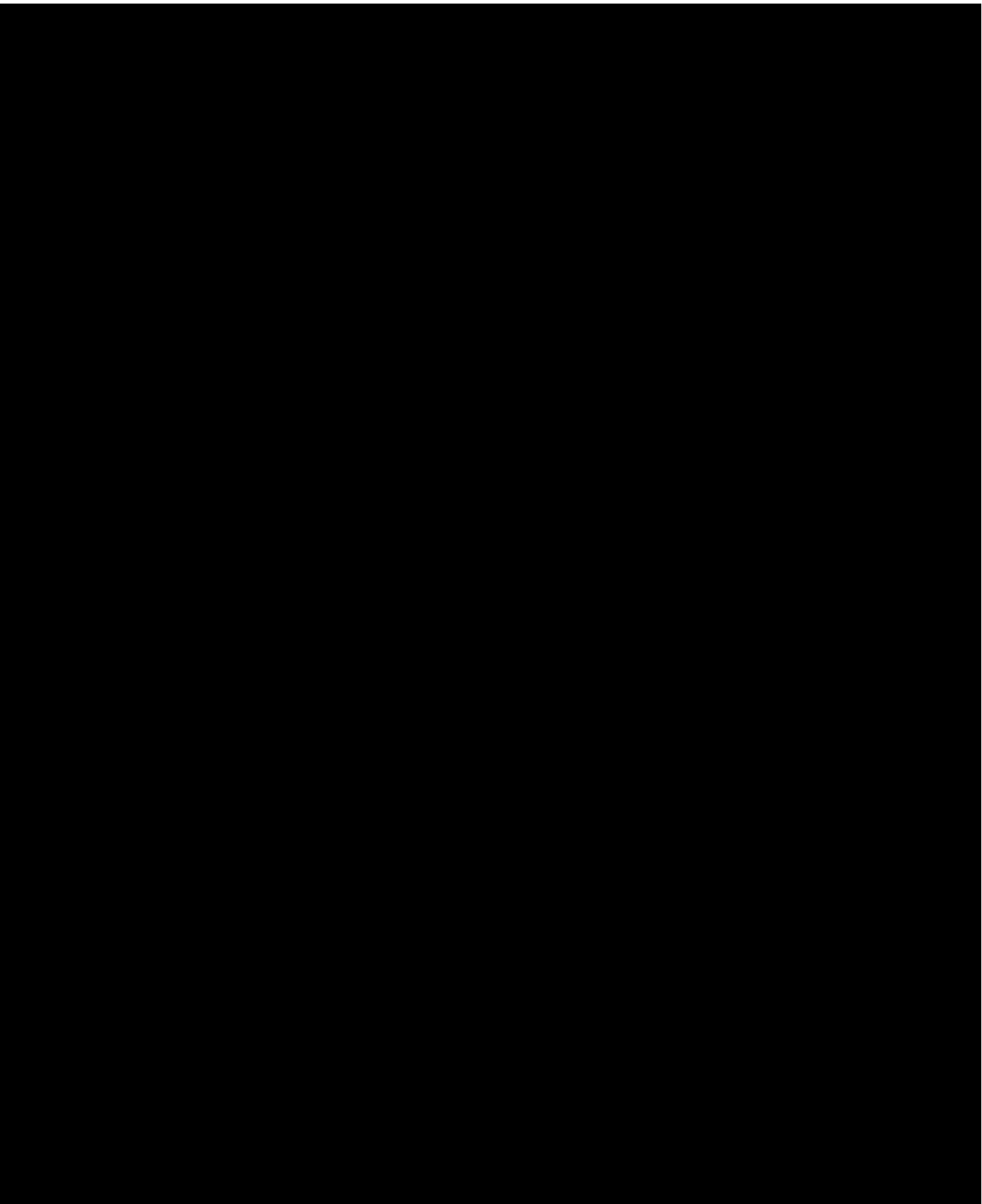
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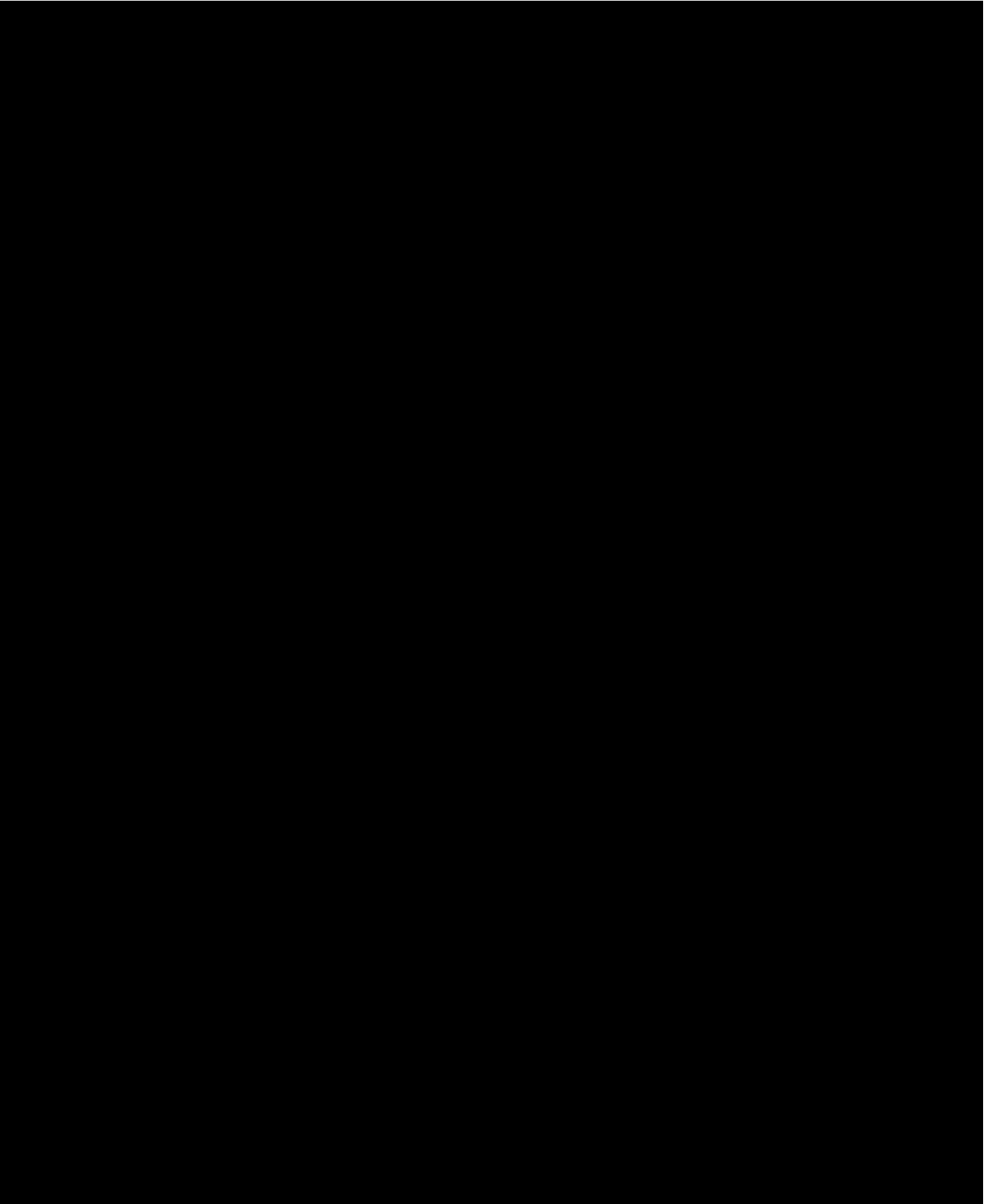
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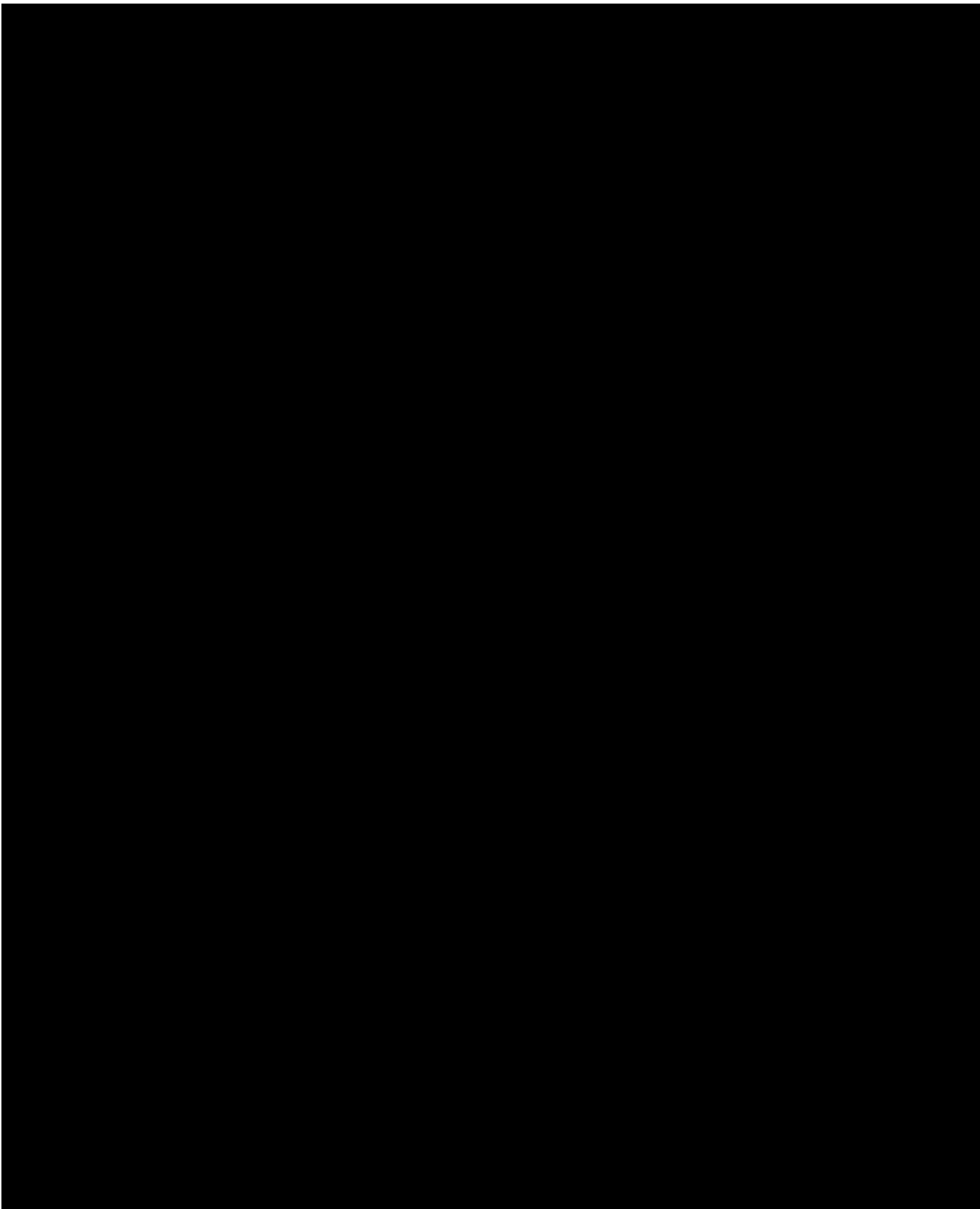
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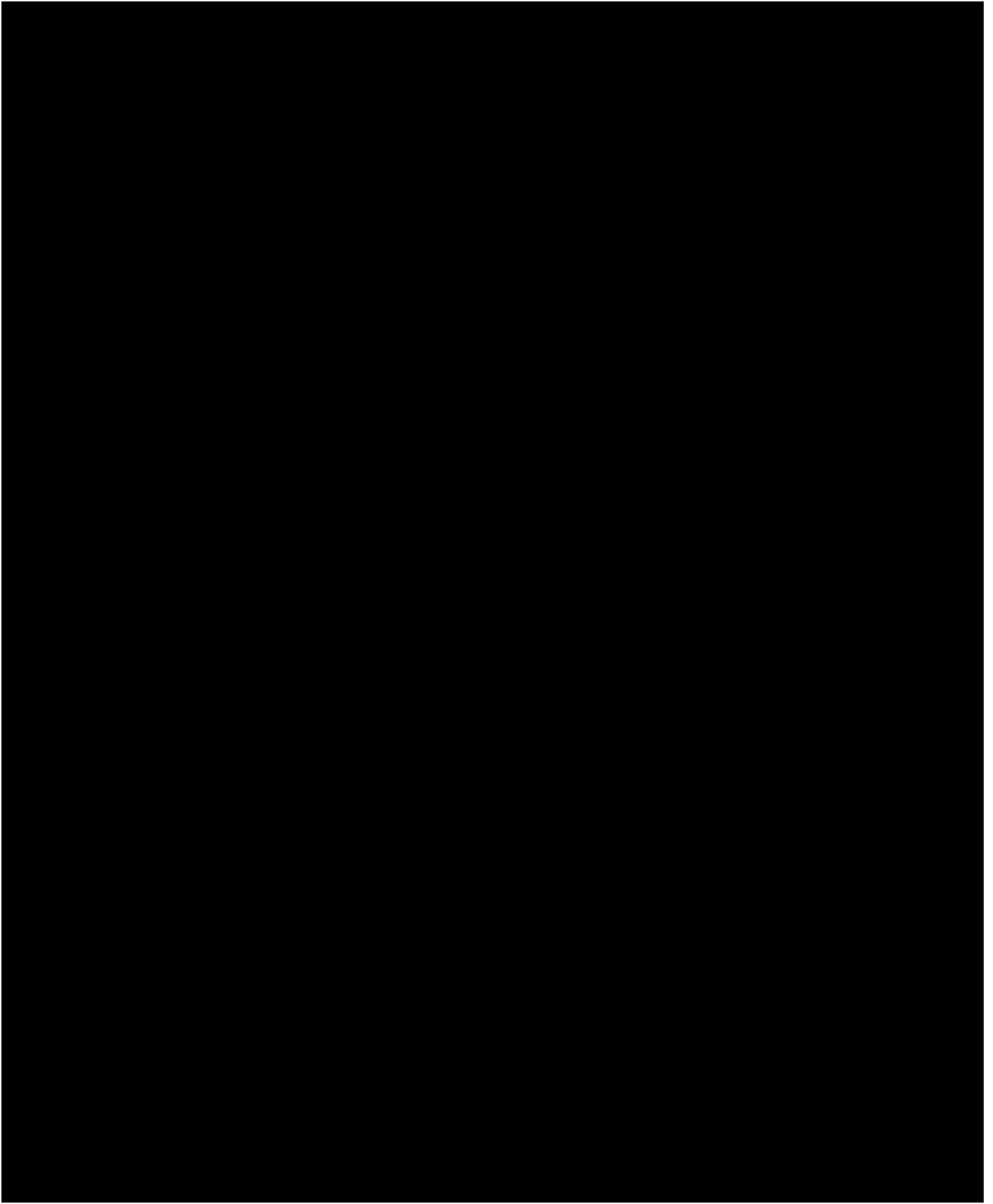














9 Appendix B – 2019 Monthly Payments

	Payment Details
	

	Payment Details
	

[REDACTED]

[REDACTED]

[REDACTED]

10 Appendix C – Enumeration of Payment Rounding

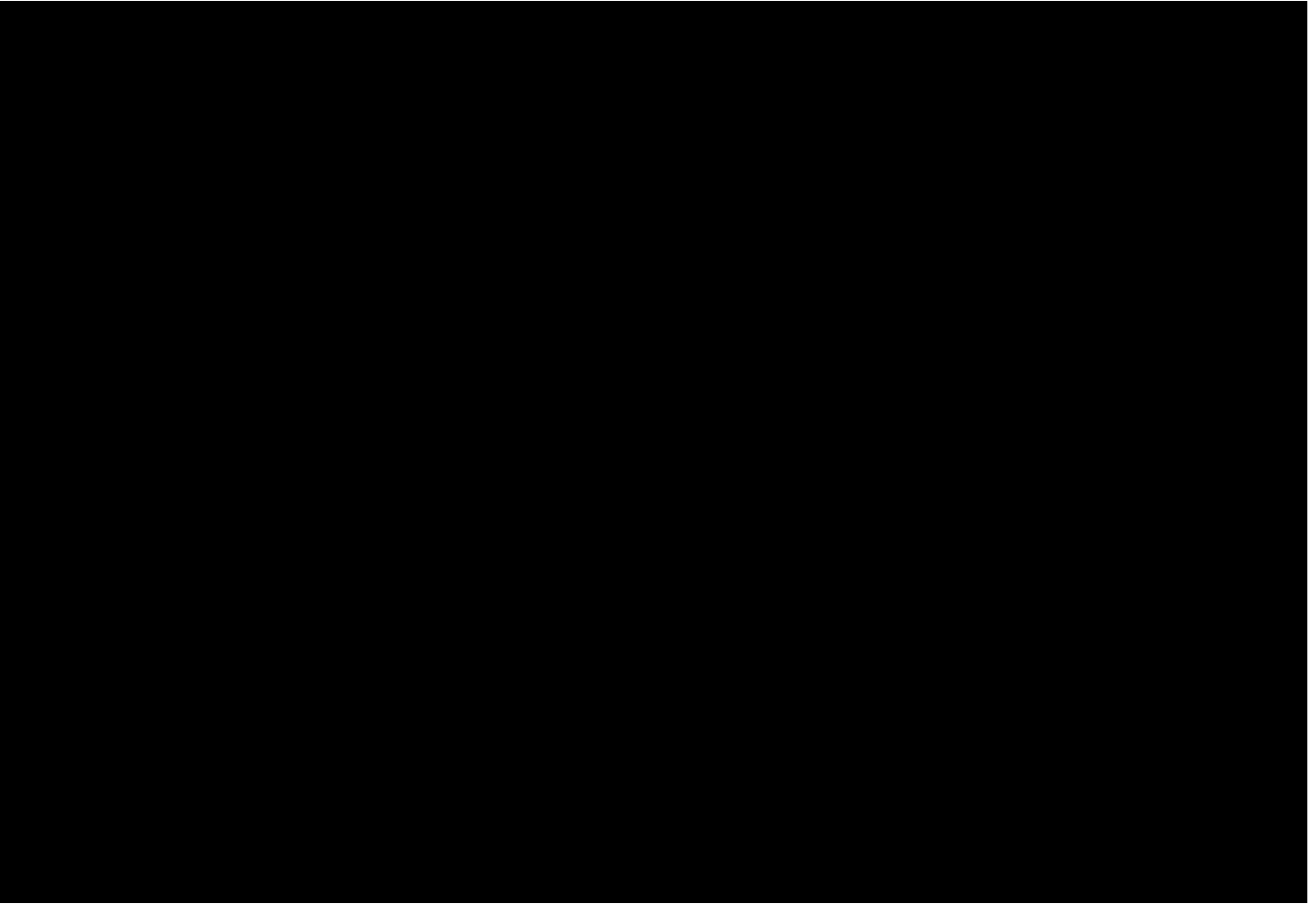
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11 Appendix D – Historical Data



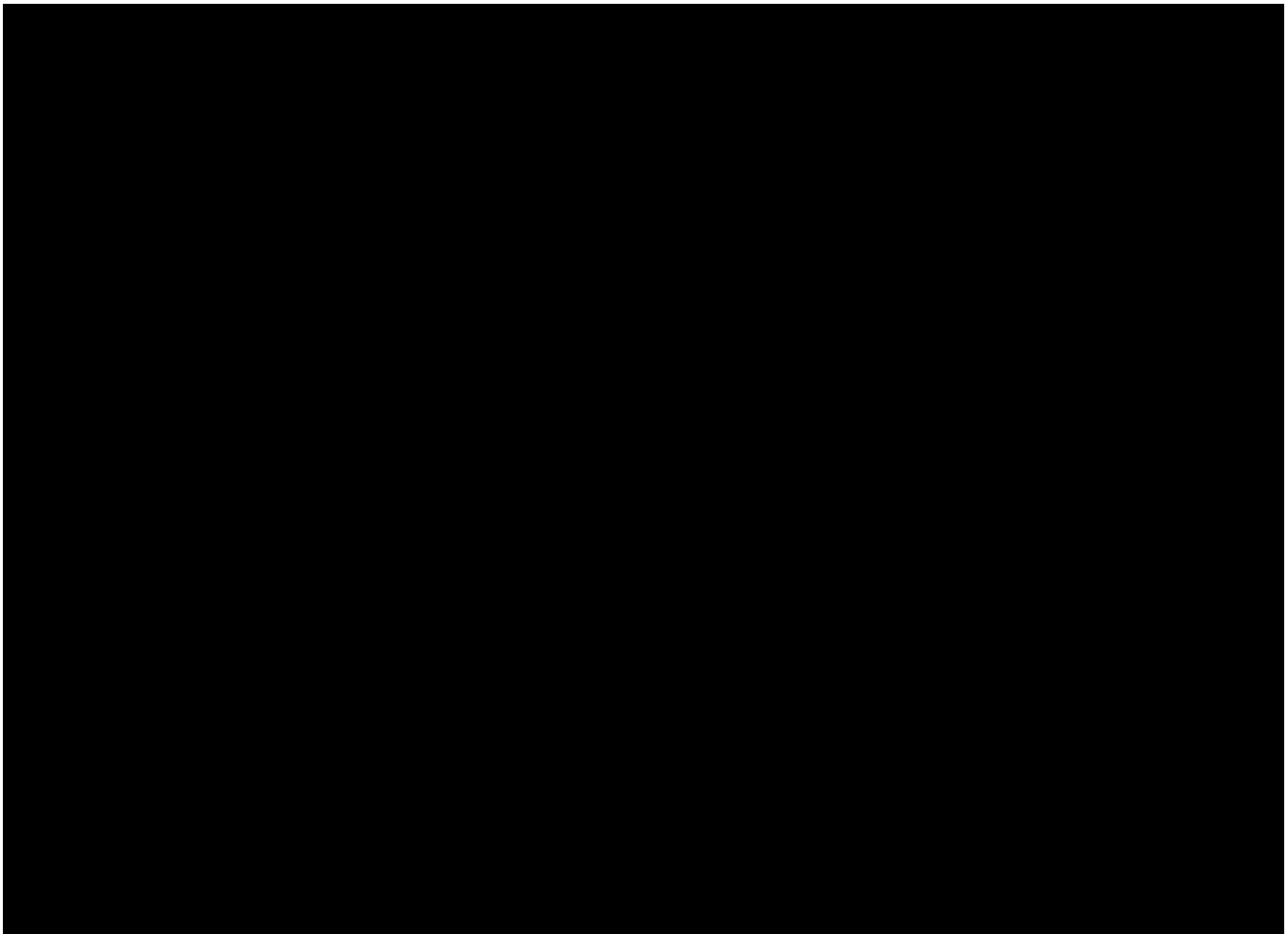


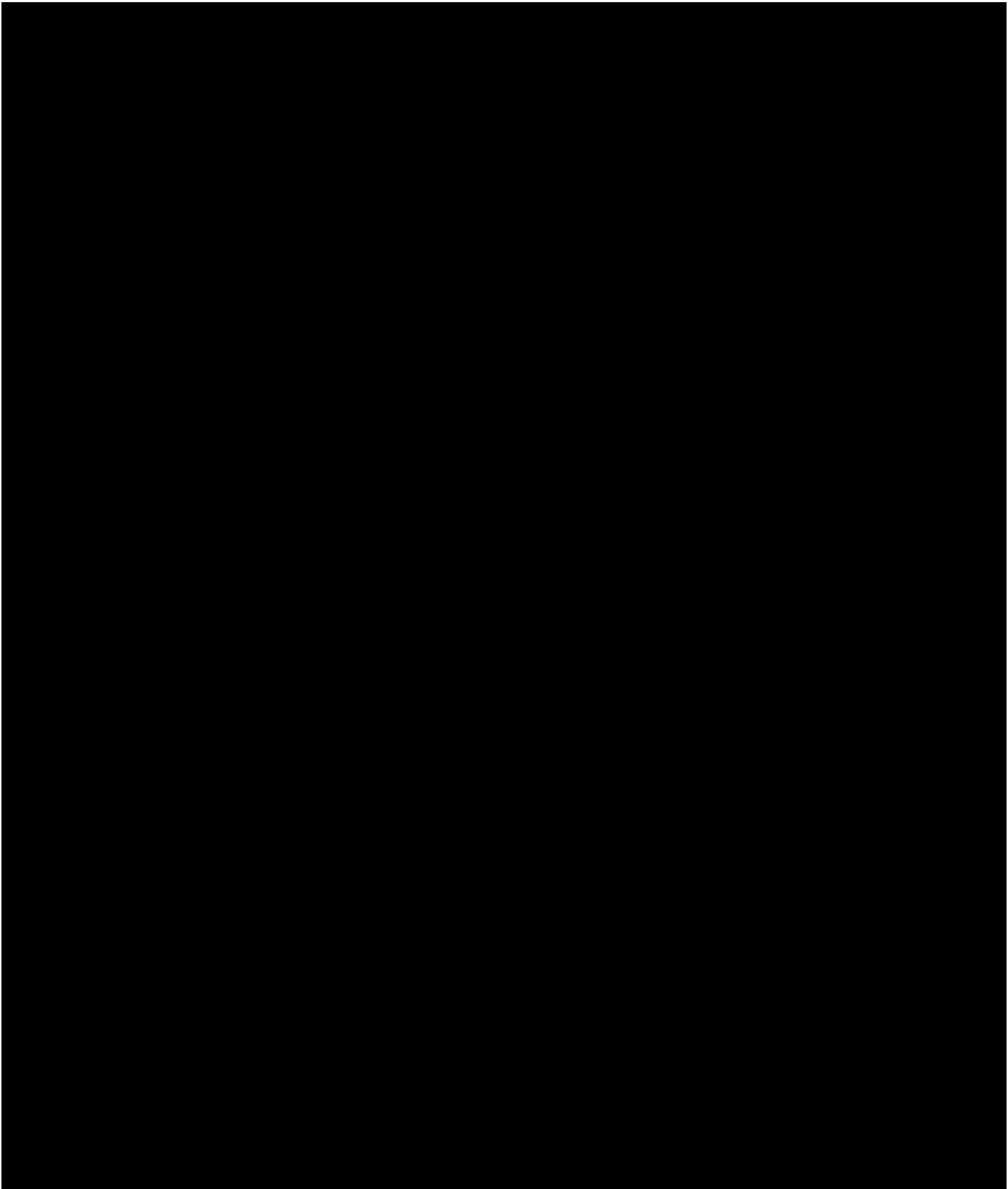
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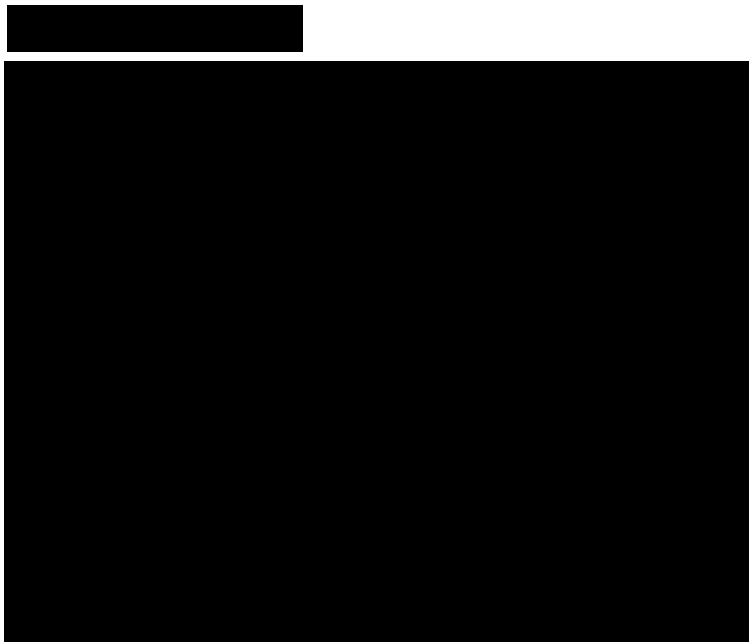
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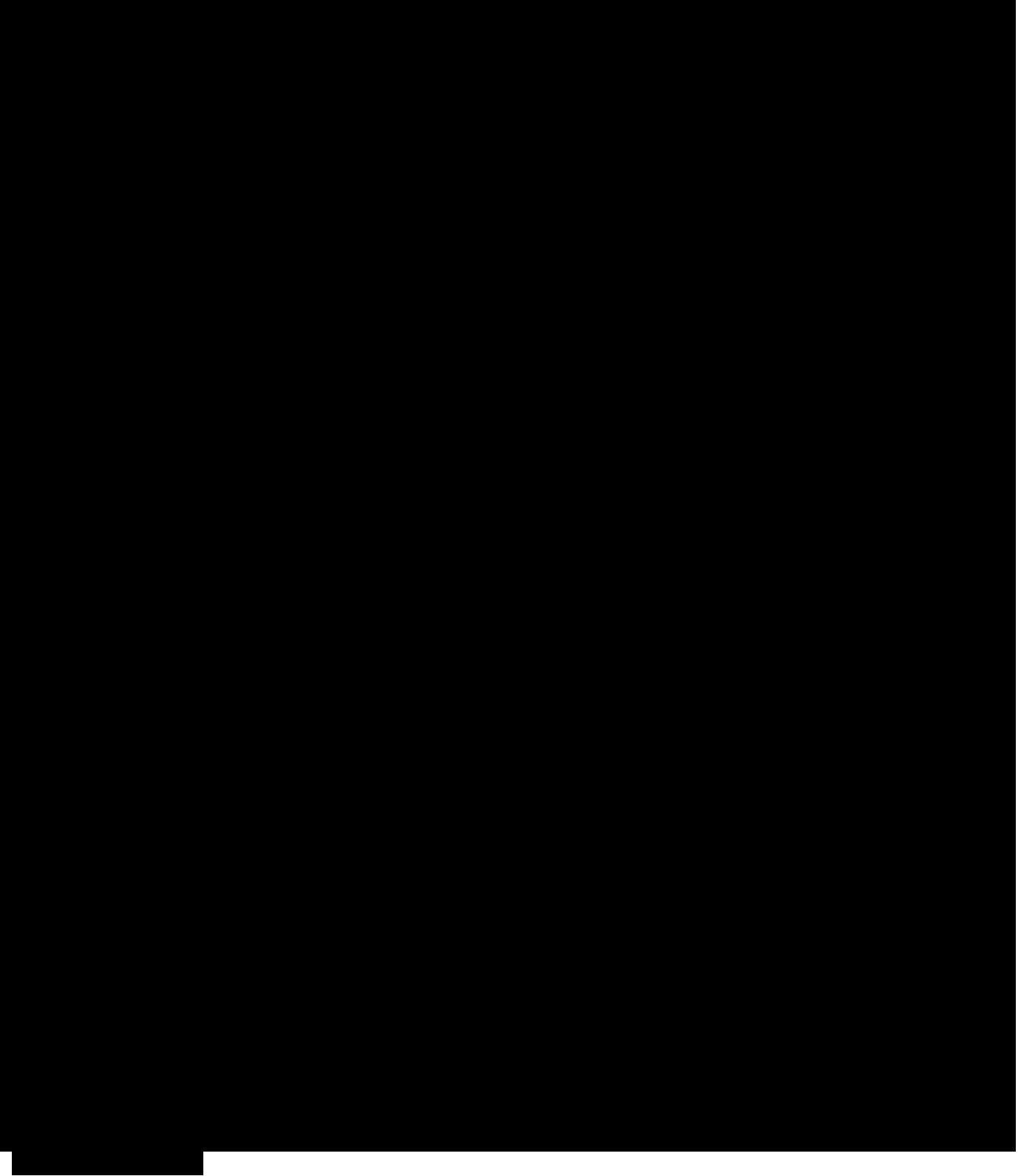
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