Business Requirements Specification

<Regulation Energy Management (REM) - Non Generator Resource (NGR) >

Version 1.1

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Revision History

Date	Version	Description	Author
06/08/2011	0.8	Created the external business requirement document based on internal business requirement draft	CAISO
8/2/2011	0.12	Updated the external business requirement document based on ongoing internal business requirement specification draft, add examples and clarify the terms and language.	CAISO
10/19/2011	0.16	Updated the external business requirement document based on ongoing internal business requirement specification draft.	CAISO
05/10/2012	1.0	Restore the REM-BRQ0264, REM-BRQ0264 for external BRS, enforce EMS 50% rules; Clarify that the implementation will first deploy the LESR model. Absent of DDR model, for the demand response resource that only provides REM, the load is remained at existing LAP, scheduled by the LSE. The REM portion can be modeled as a LESR. Clarify NGR must bid continuously between Demand and supply, or Demand side only, or supply side only.	CAISO
06/07/2012	1.1	Remove Regulation Insufficient Stored Energy No Pay. Change BRQ0930, remove BRQ0932, 0933.	CAISO

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1. Introduction

1.1 Purpose

The purpose of this document is to capture and record a description of what the Users and Business Stakeholders of the Regulation Energy Management (REM) project wish to obtain by providing high-level business requirements. REM will be a part of the functions for non-generator resources (NGR). This BRS document will use **NGR** as the acronym for non-generator resources and will use **NGR-REM** as the acronym for non-generator resources that only provide regulation and allow the ISO to manage their energy and State of Charge (SOC) in the Real Time Market.

The information in this document serves as inputs to determine the scope of Information Systems projects and all Business Process Modeling and System Requirements Specifications efforts.

These requirements are intended for submission to the Information Technology Services (ITS) department and will serve as the initial set of business unit requirements for the appropriate software application/systems development effort. It is understood that ITS will perform additional requirements and systems analysis and may produce Business Process Models, System Requirements Specifications, and Use Cases to serve as the set of requirements documents used by the ITS development teams to purchase, modify, or build the necessary software and hardware systems. The Business Unit(s) involved in the project will have an opportunity to review and approve all ITS requirements documentation produced.

1.2 References

All references represent external requirements documents or stakeholder requests developed and submitted by the Business Units.

1. Revised Draft Final Proposal-Regulation Energy Management is located in *<http://www.caiso.com/2b05/2b05e7075f6d0.pdf>*

2. Details of Business Need/Problem

2.1 Description

From an implementation perspective, the ISO addresses the participation of NGR in the ISO's energy and ancillary services market. The functionality of the NGR must meet the requirements set up by the REM policy initiative.

The NGR resources are resources that operate as either generation or load and can be dispatched seamlessly within their entire capacity range, inclusive of the generation and load. They are also constrained by an energy (MWh) limit to generate (curtail the consumption of energy in the case of demand response) or consume energy on a continuous basis. Such resources can participate in the ISO's energy and ancillary services market when they meet eligibility requirements. Under the REM policy initiative, non-generator resources that require an offset of energy in the real time market to provide regulation can elect to participate only in the ISO's regulation markets. REM functionality will allow an NGR resource to purchase or sell energy in real-time to meet the continuous energy requirements for regulation procured in the day-ahead market and real time market. When a resource elects REM, the regulation capacity awarded in the day-ahead market is evaluated as four times the regulation energy it can provide within 15 minutes. An NGR resource electing REM may only provide regulation service to the market.

2.2 Business Need

Currently, the ISO market rules limit certain resource's ability to provide regulation in both the day-ahead and real time markets.

1. Full hour energy requirement in Day-Ahead Market (DAM): The ISO procures total forecasted regulation requirements in the day-ahead market in one hour intervals. Currently, a resource must certify that it can produce energy or reduce energy consumption to satisfy a regulation up award and reduce energy production or increase energy consumption to satisfy a regulation down award over the entire hour. The 60 minute requirement for regulation creates a barrier for resources that can provide regulation, but only produce or consume energy for a limited duration.
2. No real time demand bids for recharge. The real-time market has a 30-minute requirement for any additional regulation procured. The market timelines require the submission of supply bids 75 minutes prior to the operating hour and the real time market does not allow demand bids. The rules create barriers for resources that need to recharge to maintain the energy level to provide regulation.

Proposed NGR-REM functionality allows a resource to purchase or sell energy in real-time to meet the continuous energy requirement for regulation procured in the day-ahead market and real time market. By selecting NGR-REM:

1. A resource's scheduling coordinator will allow the ISO to maintain the resource's operating point by balancing the energy dispatched from the resource through the ISO Energy Management System to meet ISO regulation requirements.
2. The ISO will manage NGR-REM through the Real Time Market for the next Real Time Dispatch interval to offset the energy produced/consumed during the previous interval's regulation energy dispatch.
3. The NGR-REM resource will satisfy the 60 minute continuous energy requirement for regulation in the day-ahead market by ensuring the energy offset is met in the real time market.

4. The NGR-REM resource is required to only provide regulation in the intervals when it responds to ISO dispatch.

2.3 Problem Understanding /Analysis

The ISO considered NGR-REM as part of the project to address the participation of non-generator resources (NGR) in the ISO's ancillary services market. REM is designed to enable NGR to meet the one hour continuous energy requirement for regulation purchased in the day-ahead market. Since REM will need to purchase or sell energy in the real time market, a resource modeled as a generation with a negative to positive operation range is a logic functionality. It is important to note that an NG can provide energy, spinning reserve and non-spinning reserve in addition to regulation service if it qualifies to do so under applicable technical and operating requirements. REM is one market option that a NGR with 15-minute continuous MW basis can elect to use but not the only option for NGR resources.

The ISO believes that facilitating the provision of regulation by limited energy non-generator resources may help address future system requirements under California's Renewable Portfolio Standard (RPS). The ISO's renewable integration studies highlight the potential need for additional procurement of both regulation up and regulation down.

The ISO considered NGR-REM within the scope of Renewable Integration: Market and Product Review RI-MPR Phase 1. The NGR-REM enhancements to existing market products should be seen as reasonable accommodations for the physical characteristics of different technologies that can provide regulation, similar to the ISO's efforts to improve modeling of multi-stage generation in the energy markets. NGR-REM will be a part of the expanded functions for non-generator resources (NGR).

NGR include limited energy storage resources (LESR) and dispatchable demand response (DDR). These resources can play an increasing role to efficiently integrate the large amount of intermittent energy resources. By modeling the generation range from negative to positive, the ISO NGR model will provide non generator resources the same opportunity as generators to participate in the ISO energy and ancillary service markets. Equal treatment for traditional and non-traditional resources will allow the market to find the most cost effective way to achieve system reliability.

3. Business Process Impacts

3.1 High Level Business Process

3.1.1 Business Process Impacts

Implementing the NGR will impact the following business processes:

Master File Updates
Manage Real Time Operations
Manage Day Ahead Market
Mange Real Time Market
Manage Generation Outages
Manage Market Billing & Settlement

3.1.2 Description of NGR and NGR-REM model

NGR-REM is a subset of NGR resources. Though NGR-REM must fulfill REM functionality, the NGR-REM model will, in principle, be consistent with a comprehensive NGR model design. This document presents the efficient and appropriate NGR design for NGR-REM. Table 1 illustrates the relationship between NGR and NGR-REM.

Table 1: NGR and REM

Project	Technology	Model	Option to REM (Special Treatment)	Regulation	Spin/Non-Spin	Energy	Qualified MW
Non-Generator Resource (NGR) *New functions in EMS, market from Bid to Bill*	Limited Energy Storage Resource **(LESR)** (Flywheel, battery, energy storage)	Operation range between negative (Charge) and positive (Discharge), constrained by State of Charge (SOC)	REM	SC Bid	No	No	15 minute continuous delivery
			Non REM	SC Bid	SC Bid	SC Bid	Depending on registration and certification
	Dispatch-able Demand Response **(DDR)** Implementation of the Participating Load (PLR) model	Operation range is non-positive, constrained by Curtailable Energy Limit (CEL).	REM	SC Bid	No	No	15 minute continuous delivery
			Non REM	SC Bid	SC Bid	SC Bid	Depending on registration and certification

NGR model requirements are based on the following broad assumptions:

- NGR is a device that has a continuous operating range from a negative to a positive power injection; i.e., it can operate continuously by either consuming energy or providing energy, and it can seamlessly

switch between generating and consuming electrical energy. NGR functions like a generation resource and can provide energy and ancillary services.

- NGR can be used to model a LESR or a DDR. If a demand response resource combining with generation ability can inject power into the grid, the combined resource can be modeled as a LESR. In general, a LESR is not limited to a storage resource; any resource that can operate seamlessly from negative to positive can use the LESR model.
- The implementation will first deploy the LESR model. Absent of DDR model, for the demand response that only provides regulation, the regulation portion can be modeled as a LESR resource by the demand response service provider. Stored energy limit will be observed as a general REM resource if registered. If the stored energy limit is not registered, the resource will be assumed capable of providing regulation without that limit. The direct telemetry and revenue meter requirement is required for this demand response resource. It is also important to point out that, the load behind the demand response remains at the existing LAP, scheduled by the LSE. Therefore the load and the demand response can be managed under different scheduling coordinators.
- CAISO is working with different stake holders on the generic demand response model at both policy and technical level. Upon the finalization of this type of discussions and decisions, the DDR model will be re-visited at a later time.
- NGR does not have start up constraints while it operates to either consume or generate power or switches between generating and consuming electrical energy. This simplifying assumption eliminates the need for binary status variables. There are concerns from market participants regarding the possibility of combining storage device with generators and hence the need to model startup constraints. This will not be considered in this phase of the NGR model.
- The power output of a NGR is limited between a minimum and a maximum capacity. The minimum or maximum capacities can be negative. The maximum capacity is greater than the minimum capacity.
- For a LESR, the maximum capacity (positive) represents the MW inject to the grid when it is discharging at maximum sustainable rate, minimum capacity (negative) represents the MW withdraw from the grid when it is charging at maximum sustainable rate.
- DDR operates as negative generation. The maximum capacity (negative or zero) represents the lowest load level to which it can be reduced; minimum capacity (negative) represents the maximum load level at which it can consume energy.
- LESR has distinct ramp rates for operating in a consuming mode (charging) or in a generating mode (discharging). DDR has one ramp rate for curtailment and restoring the load.
- NGR is typically an Energy-Limited Resource (ELR);

  For an LESR, the energy limit (MWh) is the maximum energy the device can store; this energy can be stored in the form of electrical charge, chemical energy, potential energy, or kinetic energy and it can be discharged to generate electricity. Based on an initial stored energy (state of charge (SOC)), the continuous energy consumption or generation is constrained by the Maximum Stored Energy Limit, accounting for inherent losses while charging and discharging.

  For DDR, the energy limits (MWh) constitute the maximum energy that can be curtailed from the DDR for the period.

  The energy limits for NGR are not required for the resource; nevertheless, if the NGR resource has a stored energy limit or curtailable energy limit, it must register the limit value with the ISO so that the ISO can observe the limit in the market.
- LESR and DDR can provide energy and ancillary services.
- LESR can provide ancillary services continuously while it is charging or discharging. The dispatch of a LESR providing ancillary services must employ a Stored Energy Management (SEM) scheme to

manage the state of charge and ensure that there is sufficient stored energy in the device to dispatch to satisfy the ancillary service award.

- NGR can provide regulation from anywhere within its regulation range.
- NGR resources will be subject to rescission of ancillary service capacity payments based on the device energy limit.

Under the NGR general framework, the implementation must accomplish the NGR-REM essential functionality:

- Model NGR-REM in the framework of the NGR model as a new subtype of generation resource;
- Allow NGR-REM to bid in DAM/RTM regulation up and regulation down markets, optimize regulation awards in both IFM and RTPD;
- Certify the NGR-REM regulation capacity based on its maximum amount of energy in15 minutes;
- Model NGR-REM as a resource with negative or positive power injection;
- Manage the NGR-REM Energy Offset (purchase or sale) in the Real Time Dispatch (RTD) market. Optimize the energy offsets for regulation, constrained by the NGR-REM energy level, i.e. State of Charge (SOC), charge rate and efficiency.
- Settle NGR-REM energy (regulation and offset) at the real time LMP.

3.2 Justification

NGR-REM functionality will:

- Remove barriers that limit the full participation of limited energy resources, such as storage, in the ISO regulation markets, including DAM and RTM,
- Compensate NGR-REM resources for providing regulation up and regulation down, and
- Ensure that the Energy Offset for NGR-REM resources can be met.

The general NGR design will facilitate the participation of more resources in the ISO energy and ancillary services market to meet the increased regulation requirements and load following requirements associated with a higher Renewable Portfolio Standard and also increase the system capability to supply or consume energy.

4. Business Requirements

The sections below describe the Business Processes and the associated Business Requirements involved in the project. These may represent high level functional, non-functional, and reporting and/or infrastructure requirements.

4.1 Non-Generator Resource (NGR) Model Overview

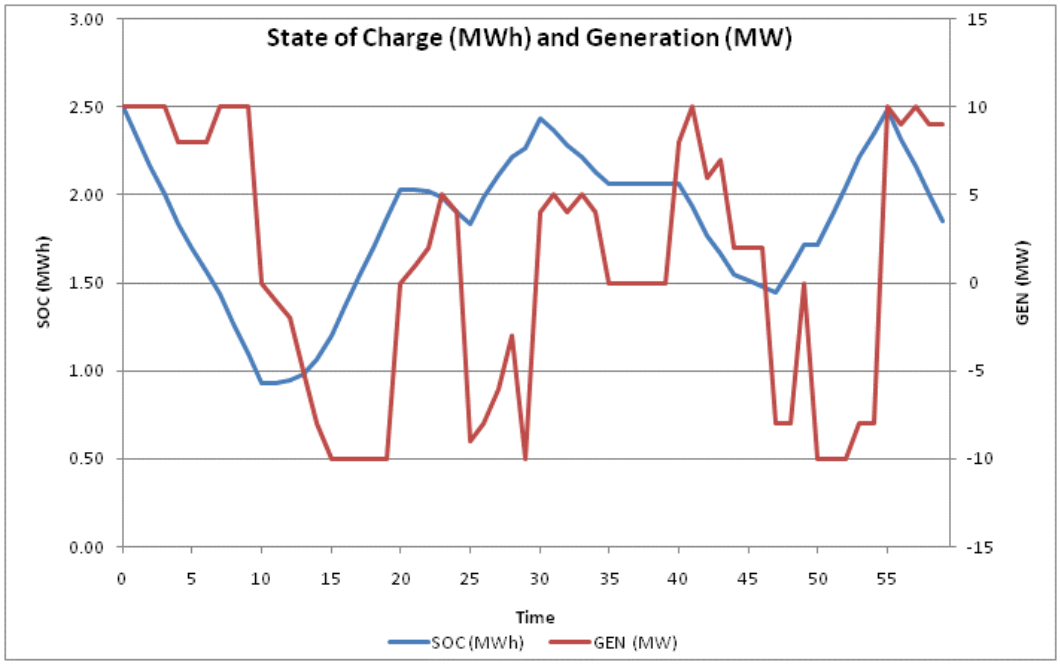
The NGR model applies to the resources that are subject a limited energy constraint to provide energy and ancillary services. NGR resources such as flywheels, batteries, and some demand response resources will require a real-time energy offset; whereas, a traditional hydro or thermal unit does not.

NGR will be subject to the capacity and operation range limits similar to the generator. However, the NGR operating range can be negative. The negative production from NGR reflects that NGR can withdraw energy from the grid. In addition, the ability of an NGR to provide energy and ancillary services will depend on the NGR's stored energy level (for LESR) or load curtailment limits (for DDR) and the device ramp (charge/discharge) rate and efficiency.

The graph below represents the relationship between energy and generation of the NGR storage device (LESR). State of Charge (SOC in MWh) indicates the remaining stored energy level of NGR. Generation (Gen in MW) indicates the instantaneous MW of NGR to inject (discharge as positive value) or withdraw power (charge as negative value) from the system. For the period of time that Gen >0 (discharge), the SOC will decrease. For the period of time that Gen<0 (charge), the SOC will increase. In the example, the LESR has an upper charge limit (UCL) 2.5 MWh and a lower charge limit (LCL) 0 MWh, Pmax = 10 MW, and Pmin = -10MW. The limits will be enforced in the market and operation. The SOC will be constrained by lower and upper charge limits. The Gen will be constrained by the minimum and maximum capacity.

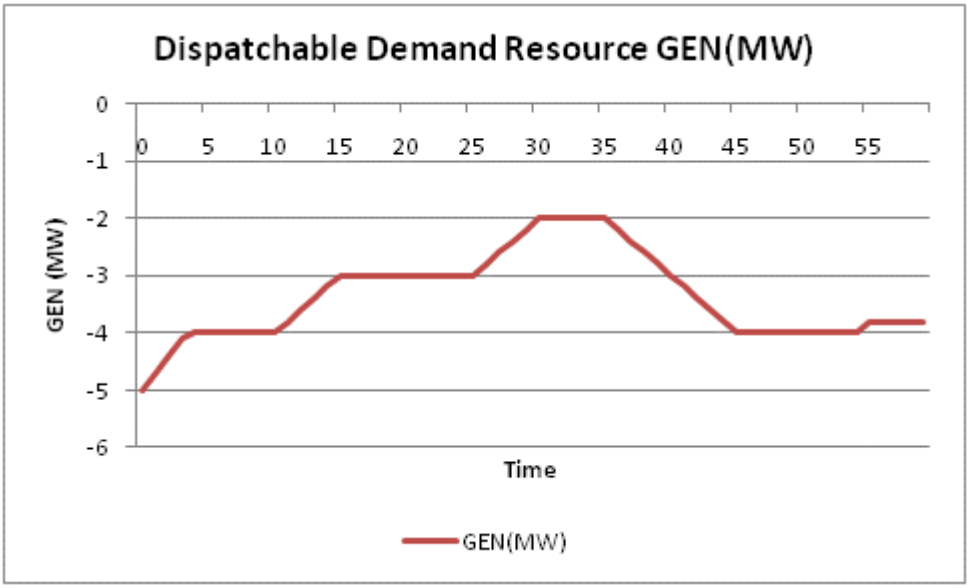
$$SOC(T) = SOC(T-1) - \int GEN(t) * dt$$

The energy schedule and ancillary service awards are subject to SOC constraints and capacity constraints



The NGR can model the dispatchable demand resources (DDR) as a negative generation resource. Pmin will represent the maximum load level; Pmax will represent the minimum load level. Pmin to Pmax is the response operation range. The GEN will represent the load response level. In the example, the DDR Gen starts at Pmin = -5 MW. The DDR Pmax = -2 MW. GEN is negative, representing the dispatched load level. If GEN=-4 MW, the curtailment is (GEN-Pmin)=-4-(-5) =1 MW. By modeling DDR as a negative generator resource, the dispatch instruction sent to the resource is its actual load level, not the curtailment amount.

$$Pmin < GEN(t) + AS(t) < Pmax$$



The following constraints will be enforced in the Market under the NGR model:

- NGR optimal schedule and AS awards shall be limited by capacity constraints.
- NGR optimal schedule and AS awards shall be limited by ramping constraints.
- NGR LESR optimal schedule and AS awards shall be limited by the available stored energy (State of Charge, SOC) between the Lower Charge Limit and Upper Charge Limit. The SOC constraint shall be observed on a continuous base.
- NGR DDR optimal schedule shall be limited by the Curtailable Energy Limits and operation range. The remaining curtailable energy limits are maximum energy (MWh) that can be curtailed for the optimization horizon.

The NGR model will require modifications to various systems:

- **Master File (MF):**

1. Master File shall support NGR as a new subtype of generation resource with positive and negative power injection.
2. Master File shall define the different types of NGR, Limited Energy Storage Resource (LESR) and Dispatchable Demand Response (DDR).
3. Master File shall designate REM qualification as an NGR that provides only regulation service and the ISO will manage the resource's energy through the real time market to ensure the regulation capacity is sufficient when it is called upon.
4. Master File shall register the REM regulation capacity. The REM regulation capacity shall be certified to meet the 15 minute continuous energy requirements.
5. Master File shall register NGR minimum and maximum capacity and upper regulation and lower regulation limits. It has to also ensure that maximum operating capacity >= upper regulation limit >= lower regulation limit >= minimum operating limit.
6. Master File shall ensure NGRs have a continuous operation range. NGR cannot be a multi-stage generator, MSG. NGR cannot have a forbidden region.
7. Master File shall facilitate NGR to register ramp rates to represent the resource ramp in MW/min. Ramp rate curve will be one or two segments. For LESR, Pmin (<0) to 0 (negative side, charge rate) is the first segment, 0 to Pmax (>=0, positive side, discharge rate) is the second segment. For the DDR, the ramp rate will be one segment curve for Pmin to Pmax (≤ 0). Ramp rate value in MW/min is always positive.
8. Master File shall allow NGR (LESR and DDR) to register as an aggregated resource with generation distribution factors (GDF); $0 \leq GDF_i \leq 1$, $\sum(GDF_i) = 1$ for aggregated NGR, assuming all the underling resources operate in one mode: either all positive (ex: discharging mode) or all negative (ex: charging mode).
9. Master File shall allow NGR to register continuous energy limit. For an LESR, the continuous energy limit represents Maximum Stored Energy (MSE) in MWh and Minimum Stored Energy. If LESR has no real physical energy limit, then the maximum and minimum stored energy do not have to be registered in Master File.
10. Master file shall allow a DDR to register its maximum curtailable energy limit (CEL). If DDR does not have CEL, then CEL does not have to be registered in Master File.
11. Master File shall facilitate a LESR to register energy efficiency which is the percentage of charging energy that the device can store and later discharge; $0 \leq \eta \leq 1$.
12. Master File shall allow a NGR to register the qualified MW to provide energy, regulation up, regulation down, spinning reserve, and non-spinning reserve.
13. Master File will designate qualified NGR (Non REM) to provide RUC capacity.
14. Master File will ensure NGRs do not register as reliability must run (RMR) resources.
15. Master File will ensure NGRs are not subject to market power mitigation.
16. NGR AS award/self-provision optimization flag shall be set ('Y').
17. NGR resources will not be a MSS load following resource.

- **FNM:**

1. Model LESR as a generation resource with positive or negative power injection; similar to the manner pumped storage hydro generators are modeled. The LESR shall provide telemetry if providing AS.
2. Model DDR as a generator with negative generation. The DDR shall provide telemetry if providing AS.

- **SIBR:**

1. SIRB shall support NGR, as a subtype of generation resource with positive or negative power injection.
2. SIBR shall support NGR type of storage (LESR) or demand response (DDR).
3. SIBR shall support REM resource to bid in or self-schedule regulation up and regulation down in IFM/RTPD.
4. SIBR shall ensure no energy bids are required or allowed for the NGR-REM.
5. SIBR will allow NGR to submit an energy bid curve for each trading hour; the energy bid curve must be a monotonically increasing stepwise curve in $/MWh versus MW between a Lower Economic Capacity (LEC) and an Upper Economic Capacity (UEC) with at most ten segments.
6. SIBR will allow NGR to submit an energy self-schedule (SS) in MW for each trading hour; only price taker self-schedules shall be allowed.
7. SIBR shall support NGR to bid or self provide regulation up and regulation down services. SIBR shall verify that NGR regulation capacity must be within the registered operation range;
8. SIBR shall support NGR to bid or self provide spinning and non-spinning services.
9. SIBR shall support LESR's submission of Lower Charge Limit (LCL) and Upper Charge Limit (UCL) in DAM and RTM on a daily basis. LCL in MWh (zero by default) is the lowest stored energy that should be maintained in the device and can be changed on a daily basis. UCL in MWh (MSE by default) is the highest stored energy that should be allowed in the device and can be changed on a daily basis. $0 \leq LCL \leq UCL \leq MSE$.
10. SIBR shall support DDR to submit Curtailable Energy Limit (CEL) in DAM and RTM on a daily basis.
11. SIBR shall support DDR's submission of hourly energy bids from Lower Economic Capacity (LEC) to the Upper Economic Capacity (UEC) in DAM and RTM. The DDR energy bids will define the operation range of DDR. $Pmin \leq LEC \leq UEC \leq Pmax$.
12. SIBR shall support DDR's submission of self-schedules at the hourly operation capacity (load level without response).
13. For NGR (non-REM), IFM initial operation point of SOC(0) shall be determined by prior day's day-ahead schedules.
14. Aggregated NGR can submit Distribution Factors (GDF) for each trading hour; $0 \leq GDF_i \leq 1$, $\sum(GDF_i) = 1$.
15. SIBR shall not require or allow the SC to bid in or self-schedule energy for NGR-REM; the ISO will manage the NGR-REM energy in RTD based on the SOC constraints and ramp rates.
16. SIBR shall not allow the NGR-REM to bid or self-schedule spinning reserve, non-spinning reserve or RUC capacity.
17. For NGR (Non REM), AS self-provisions or bids and RUC bids must have energy bids or energy self-schedules for the same trading hour to support in similar way as for generation resources..
18. AS capacity and energy schedules for NGR must be within the registered operating range and/or regulation range.

- **Outage Management System (OMS/SLIC):**

1. OMS/SLIC shall support NGR, as a subtype of generation.
2. OMS/SLIC shall support NGR type, Storage (LESR) and Demand Response (DDR).
3. OMS/SLIC shall allow NGR LESR to register unavailability.
4. OMS/SLIC shall support NGR to de-rate the Upper Operation limits (UOL) for Pmax and re-rate of the lower operating limit (LOL) for Pmin..
5. OMS/SLIC shall support LESR to de-rate Upper Charge Limit (UCL in MWh) and de-rate Lower Charge Limit (LCL in MWh).
6. OMS/SLIC shall support DDR to de-rate the maximum Curtailable Energy Limit (CEL).
7. OMS/SLIC shall support NGR to de-rate ramp rates on its ramp rate curve with one or two segments.
8. OMS/SLIC shall support NGR DDR to register its unavailability. (Note that DDR unavailable is not equivalent to DDR load offline. A DDR's unavailability is used to indicate that the DDR is no longer capable of responding to economic load curtailment. The market will set the DDR at its self-schedule level in DAM, set at telemetry in RTM and disqualify all the AS self provision and awards.).

- **Market DAM/RTM:**

1. DAM/RTM shall model NGR, as a subtype of generation resource with power injection from negative to positive;
2. DAM/RTM shall recognize NGR type, with Storage (LESR) and Demand Response (DDR);
3. DAM/RTM shall recognize REM resources, defined by REM FLAG.
4. DAM/RTM will model NGR with bids or self-schedule of energy and/or AS as on-line in terms of commitment if it does not register as unavailable.
5. DAM/RTM will model REM with regulation bid as on-line in terms of commitment if it does not register as unavailable.
6. In DAM, the NGR without bids or self schedules shall be modeled as unavailable;
7. In RTM, the NGR without bids or self schedules shall be modeled as unavailable, unless it has a nonzero Telemetry/State Estimator (SE) solution or telemetry, then the market will set the Dispatch Operating Target (DOT) equal to SE solution or telemetry in the optimization horizon.
8. DAM shall set DDR with declared unavailability from OMS/SLIC at its self-schedule level and disqualify the AS for DDR.
9. RTM shall set DDR with declared unavailability from OMS at its nonzero SE solution or real time telemetry level and disqualify AS awards for DDR.
10. DAM/RTM shall model LESR offline with declared unavailability from OMS and disqualify AS awards for LESR.

11. DAM/RTM shall ensure the NGR optimal schedule and AS awards are based solely on its energy bid curve, including penalties for self-schedule, reserved contingent operation reserve capacity, and exceptional dispatch as applicable. DAM/RTM shall include penalties for AS award and AS self-provision as applicable; no other costs (startup, shutdown, minimum load, or transition costs) apply to NGR;
12. DAM/RTM shall optimize NGR energy and AS awards subject to NGR's capacity constraints and ramping constraints, and efficiency.
13. DAM/RTM shall optimize LESR energy and AS awards subject to State Of Charge (SOC) constraints;
14. For LESR (Non REM), SOC constraint shall be included and enforced in the IFM, RTPD and RTD if LESR has stored energy limit.
15. For LESR (REM), SOC constraint shall be only included and enforced in RTD. IFM and RTPD shall not include SOC constraints.

16. For DDR, DAM shall optimize DDR based on the resource's bids. In DAM, the curtailable energy limit constraint shall be enforced. RTM shall optimize DDR subject to curtailable energy limits (CEL). The CEL will be submitted by the DDR through EMS. If the telemetry of the DDR's CEL is not available, the CEL for the RTM shall fall back to value in order of SLIC , SIBR, the default value specified in the Master File.
17. IFM/RTPD shall optimize the NGR-REM regulation awards based on the regulation bids subject to the capacity constraints in the same manner as generators.
18. RTD shall dispatch the NGR-REM energy schedule subject to state of charge constraints, ramping and efficiency constraints based on the RTPD regulation capacity awards. The NGR-REM energy schedule shall be modeled as price taker in RTD.
19. NGR will not be subject to local market power mitigation (LMPM) but is included in the MPM as part of the optimization.
20. DAM/RTM will allow exceptional dispatch (ED) for the NGR.
21. DAM will assume LESR (Non REM) SOC initial state determined by prior day's day-ahead schedules at the end of the day.
22. RTM shall receive from EMS the latest SE solution and telemetry for each NGR, including the actual SOC for each LESR, remaining curtailable energy limit (CEL) for DDR and shall use this information to calculate the initial condition for each NGR.
23. NGRs that not provide AS will not be required to have telemetry.
24. The existing No Bid and Compliance logic shall apply to NGR (Non REM). NGR-REM resources are always assumed compliant during dispatch.
25. RTM shall calculate and publish the optimal Dispatch Operational Target (DOT) and dispatch trajectory (DOP) in MW for each NGR. DOT and DOP can be negative.
26. RTM shall include the effective ramp rate corresponding with DOT in the payload to EMS.
27. SOC and CEL shall be published in the schedule payload, historical tables, and the save case along with the schedule.

- **EMS (PRODUCTION):**

1. EMS shall model NGR as generation resource with supply range of negative to positive;
2. EMS shall support NGR type of storage (LESR) and Demand Response (DDR).
3. NGRs that not certified for AS will not be required to have telemetry.
4.
5. EMS shall control NGR regulation up and down through AGC based on NGR DOT, regulation awards and energy ramp rate; EMS dispatch NGR above DOT for regulation up, below DOT for regulation down.
6. EMS shall receive NGR (LESR and DDR) telemetry of the following data every four (4) seconds:
   - Maximum Operating Limit (MW);
   - Minimum Operating Limit (MW);
   - Resource Instantaneous Output (MW);
   - Resource Charge Rate (MW/min);
   - Resource Discharge Rate (MW/min);
   - Resource Connectivity Status (On/Off);
   - Resource AGC Control Status (On/Off);
   - State of Charge (SOC), which is the actual stored energy (MWh) remaining in the device for LESR;
   - Maximum Energy in MWh
   - Minimum Energy in MWh
   - (Option) for DDR, curtailable energy limit (CEL in MWh) remaining in the resource
7. Instantaneous Output (MW) measure the operation state of NGR. The Instantaneous Output (MW) for LESR is positive when LESR is discharging, negative when LESR is charging. The Instantaneous Output (MW) is negative for DDR, representing the load of DDR.
8. The SE solution shall include the estimated output for each NGR based on its telemetry.

9. DDR is modeled as a generator with negative output. DDR is connected at Cnode.
10. EMS shall send to the RTM every minute the SE solution and all telemetry for each NGR, including the SOC, and CEL if it is available.
11. EMS shall receive from RTM the NGR Dispatch Operating Target (DOT) and AS awards and effective ramp rate. The DOT can be negative.

- **MQS**:

1. MQS shall model NGR, as subtype of generation resource with positive and negative power; MQS shall support the NGR type LESR and DDR.
2. Expected energy and capacity allocation formula shall incorporate negative generation and negative operating/economic limits.
3. MQS shall calculate NGR expected energy. All expected energy types applicable to generation shall apply to NGR, except for Pumping Energy, and Hour-Ahead Scheduled Energy. The calculation of expected energy remains the same except that it must account for the negative range and schedules.
4. NGR shall be eligible for Bid Cost Recovery for its Energy/AS bids; there is no commitment cost recovery for NGR.

- **ADS**:

1. ADS shall model NGR as a generation resource with positive and negative power; using existing generation resource functionality.
2. ADS shall send RTD's DOT/DOP and Exceptional Dispatch for NGR as a generator;

- **CAPS:**

1. NGR shall be subject to existing Regulation Non-Compliance rules;
2. ~~NGR LESR shall subject to a new category of Regulation Non-Compliance for Insufficient Stored Energy.~~

- **CMRI:**

1. CMRI shall support NGR as a generation resource with negative to positive power, using existing generation resource functionality.

- **OASIS:**

1. OASIS shall support NGR as a generation resource type for publishing T+90 bids.

- **OMAR:**

1. OMAR shall be able to recognize and support NGR as generation resources and receive revenue meter data. OMAR shall provide the revenue meters to settlement, using generation resource functionality.
2. Meters for a single NGR resource can vary between positive generation and negative generation between intervals. This approach will be supported using similar convention as channel 1 and channel 4 today.

- **SAMC/CAPS**:

1. Support NGR, as a subtype of generation resource with negative to positive power output.
2. Support NGR Type of LESR or DDR.
3. Support NGR REM.
4. Ensure NGR subject to all existing categories for rescission of AS/RUC capacity payments.
5. NGR LESR shall be subject to a new category for ~~AS~~ spin and non-spin Non-Compliance for Insufficient Stored Energy. Cascading rule of ~~AS~~ spin and non-spin calculation for rescission of capacity payments is applicable to rescission of spin and non-spin~~AS~~ capacity payments for Insufficient Stored Energy.
6. Settle the NGR AS awards the same as Generators in IFM and RTPD.
7. Settle the NGR energy schedule at LMP in IFM and RTD as generator; recognize the NGR energy can be positive or negative.
8. Settle NGR-REM regulation up awards and regulation down awards in DAM and RTPD.
9. NGR-REM will not be subject to IFM energy settlement.
10. Settle real time energy produced/consumed by NGR-REM at the real time LMP.
11. Settle NGR-REM regulation energy dispatched by AGC at real time LMP. NGR-REM receives payment at RTD LMP for regulation up energy, NGR-REM is charged at RTD LMP for regulation down energy.
12. Ensure NGR-REM is subject to the applicable Grid Management Charges for the regulation schedules and real time energy.
13. Ensure the portion of the demand of NGR-REM providing Regulation Energy in any Settlement Interval is not allocated uplift costs that apply to measured demand.
14. Ensure NGR be eligible for Bid Cost Recovery (BCR) for the energy and AS bids. NGR is not eligible for commitment cost recovery.
15. The load represented by DDRs will be subject to the applicable cost allocation for Participating Load.
16. The positive or negative generation represented by an LESR is subject to applicable cost allocation for generators.

4.2 Business Process: Regulatory Contracts Implementation Process

4.2.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0001	NGRs that operate as generation and load but have a MWh limit to generate, curtail or consume Energy on a continuous basis must sign a PGA and a PLA. DDRs must sign a PLA.	Regulation Tariff	

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0010	The NGR-REM shall meet the technical qualification and requirements: 1. Only the resource that requires a real-time energy offset to provide regulation can select REM; Such as flywheels, batteries and some demand response resources. 2. The resource that does not require a real-time energy offset to provide regulation is not eligible to select REM. Traditional Hydro and thermal units will not be accepted as REM. 3. REM resource must be able to run continuously within its operating range, from negative to positive. 4. REM resource must provide the same regulation service to the ISO as traditional generation. REM must response to each 4 second EMS signal and produce or consume the energy necessary to balance the grid as directed by the ISO AGC. 5. REM regulation capacity certification must meet the 15 minute continuous energy requirements. 6. The ISO will maintain the REM regulating range through the real-time market. 7. REM resources shall be subject to existing ISO requirements for providing Regulation Reserves. Such requirements include telemetry requirement, registration requirement and compliance requirement. 8. REM shall subject to the same settlement rules and provisions relating to the rescission of regulation service capacity payments as traditional generation.	Regulation Tariff	

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0011	The ISO shall conduct the regulation certification process to ensure NGR-REM is certified for provide regulation services. The NGR-REM must meet 10 minute ramping requirement, same as generator. The regulation up capacity must meet the 15 minute continuous energy deliver requirements when it is fully charged; and regulation down capacity must meet the 15 minute consumption of continuous energy requirements when it is completely discharged. For example: 1. A fully charged 5 MWh storage can provide a maximum 20 MW to the grid for 15 minute continuously. The storage will be certified for 20 MW regulation up capacity. 2. The completely discharged 2.5 MWh storage can consume maximum 10 MW from the grid for 15 minute continuously to be fully charged. The storage will be certified for 10 MW regulation down capacity.	Core; NGR-REM	
REM-BRQ0012	Participating generation and participating load agreements are needed for NGR. The NGR (Non REM) will be subject to existing ISO requirements for the traditional generator to certify the capacity for regulation, spinning, non-spinning and maximum capacity. For example, the NGR (Non REM) offering regulation capacity must be dispatchable on a continuous basis for at least 60 minutes. A fully charged 5 MWh storage device can provide 5 MW regulation up capacity.	Core; NGR	
REM-BRQ0013	For LESR (Non REM), the certification criteria for a generation resource applies. To participate in the energy and AS market, the LESR shall meet the requirements that apply to generators.	Core; NGR	

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0014	For DDR (Non REM), the certification criteria for generation resource is applicable. DDR cannot inject power to the grid. Therefore, the operation range will be non positive. The Pmin will be negative and represent the maximum load level. The Pmax will be negative or zero and represent the minimum load level that can be curtailed to. Pmax =0 means the load can be totally shut down. Pmin to Pmax will be the curtailable load range. Ex: A facility can consume maximum power at 5 MW, the Pmin = -5MW. It can sustain at 2 MW, the Pmax = -2MW. Or, if it can be totally shut down, the Pmax = 0 MW.	Core; NGR	

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0015	Certified maximum capacity for the resource will be determined by the option of REM or Non REM: Example 1: Resource 1: LESR 10 MWh, Pmax = 40 MW, Pmin = -40 MW. Ramp rate = 10 MW/min MW / REM / Non REM Regulation Up: 40 / 10 Regulation Down: 40 / 10 Spinning: n/a / 20 Non-Spinning: n/a / 20 Pmax: 40 / 40 Pmin: -40 / -40 Note: The Non REM capacity certification is consistent with generator, 60 minute continuous energy for Regulation, 30 minute for Spin, 15 minute for Pmax/Pmin. Example 2: Resource 2: LESR 40 MWh, Pmax = 10 MW, Pmin = -10 MW. Ramp rate = 10 MW/min MW / REM / Non REM Regulation Up: 10 / 20 Regulation Down: 10 / 20 Spinning: n/a / 20 Non-Spinning: n/a / 20 Pmax: 10 / 10 Pmin: -10 / -10 Note: The Non REM AS capacity is the maximum capacity it can provide. The regulation up capacity is 20 MW, if the energy is scheduled at -10 MW. There is no energy schedule for the REM, so the REM regulation up capacity cannot exceed 10 MW.	Core; NGR	

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0016	To participate in the ISO market, The NGR must meet the same minimum capacity requirements as a generator: The LESR capacity must be no less than 0.5 MW, representing the device capacity to inject the power into the grid; If LESR certified to provide AS, the LESR AS capacity of regulation, Spinning, non-spinning must not be less than 0.5 MW. The DDR curtailment capacity (Pmax-Pmin) must be no less than 0.5 MW. If DDR certified to provide AS, the DDR AS capacity of regulation, Spinning, non-spinning must not be less than 0.5 MW.	Core; NGR	

4.3 Business Process: *<Perform Master File Updates>*

Schedule Coordinators (SC) that have signed agreements with the ISO to provide NGR shall be assigned Resource IDs. The SCs should be responsible for providing the NGR attributes to the ISO according to the templates provided by the ISO.

4.3.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0020	Master File Resource Data Template (RDT) shall allow Scheduling Coordinators to submit NGR as a subtype of generation resource with negative to positive operating range. SC must submit NGR default values of the attributes to ISO using the existing manner. The template shall include the identifier for NGR Limited Energy Storage Resource (LESR) or Dispatch-able Demand Response (DDR) .	Core; NGR	Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0030	The NGR RDT template shall support the NGR option for REM. The NGR-REM will provide regulation service at DAM and RTM, and the ISO will manage its energy offsets. REM FLAG shall be set in the Master File. The NGR can only change the option for REM in Master File. The frequency of the change is no more frequent than quarterly (3 months).	Core; NGR-REM	Master File
REM-BRQ0040	Master File shall ensure NGR that opt REM only provide regulation services, and the ISO manage NGR-REM energy offset. Both LESR and DDR can select REM. The NGR, LESR, DDR and REM option Resource (GEN_ TECH) / Type (FUEL_ TYPE) / REM FLAG / Regulation / Spin/Non-Spin / Energy NGR / LESR / Y / SC Bid / No / No NGR / LESR / N / SC Bid / SC Bid / SC Bid NGR / DDR / Y / SC Bid / No / No NGR / DDR / N / SC Bid / SC Bid / SC Bid	Core; NGR-REM	Master File
REM-BRQ0041	The NGR attribute information submitted to ISO must be validated; any error will be reported to the SC.	Core; NGR	Master File
REM-BRQ0050	A unique Market Resource ID will be issued by the ISO for each NGR resource to its Scheduling Coordinator (SC) for the SC to engage in energy and regulation market activities such as bidding and settlements.	Core; NGR;	Existing function in Master File
REM-BRQ0060	Master File shall define NGR resources as a subtype of generation resource that has operating range from negative to positive, can both produce and consume energy. NGR and NGR type LESR and DDR must be able to be identified by the downstream systems.	Core; NGR;	Master File
REM-BRQ0061	Master File shall define the REM resources. REM must be able to be identified by the downstream system. REM flag shall be set in Master File.	Core; NGR;	Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0071	Master File shall ensure the NGR-REM is designated for regulation market and register the NGR-REM certified regulation up capacity and regulation down capacity.	Core; NGR-REM	Master File
REM-BRQ0080	Master File should ensure NGR not have start up cost, start up time, minimum up time, minimum down time, forbidden regions, and transition time.	Core; NGR	Existing function in Master File
REM-BRQ0090	Master File should ensure NGR not register as multi-stage generator (MSG).	Core; NGR	Existing function in Master File
REM-BRQ0100	Master File should ensure NGR not be registered as a Reliability Must Run (RMR) resource or Metering Subsystem (MSS) load following resource.	Core; NGR	Existing function in Master File
REM-BRQ0110	The following NGR resource attributes shall be defined: 1. NGR shall be a new subtype of generation resource 2. NGR shall have LESR or DDR type 3. NGR shall have the option for REM 4. NGR shall have a registered minimum capacity (Pmin); Pmin can be negative. 5. NGR shall have a registered maximum capacity (Pmax); Pmax can be positive for LESR, zero or negative for DDR. 6. NGR will be designated to DAM if it is certified for DAM. 7. NGR will be designated to RTM if it is certified for RTM. 8. NGR will be designated and specified for regulation up capacity, if it is certified for regulation up service. 9. NGR will be designated and specified for regulation down capacity, if it is certified for regulation down service. 10. NGR will be designated and specified for spinning capacity, if it is certified for spinning service. 11. NGR will be designated and specified for non-spinning capacity, if it is certified for non-spinning service. 12. NGR will be designated to provide RUC if it is certified for RUC.	Core; NGR	Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0114	Master File shall ensure that maximum operating capacity ≥ upper regulation limit ≥lower regulation limit ≥ Minimum operating Limit.	Core; NGR	Existing function Master File
REM-BRQ0115	Master File shall ensure for LESR: The maximum operating capacity must be no less than 0.5 MW; If the LESR provide regulation, the certified regulation capacity must be no less than 0.5 MW. If the LESR provide spinning/non-spinning reserve service, the certified spinning capacity must be no less than 0.5 MW.	Core; NGR	Master File
REM-BRQ0116	Master File shall ensure for DDR: (maximum operating capacity – minimum operation capacity) must be no less than 0.5 MW; If the DDR provide regulation, the certified regulation capacity must be no less than 0.5 MW. If the DDR provide spinning/non-spinning reserve service, the certified spinning capacity must be no less than 0.5 MW.	Core; NGR	Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0120	Master File shall facilitate NGR to register ramp rates curve in MW/min to represent the resource ramp rate in MW/min. NGR ramp rate curve will be one or two segments, ramp rate value MW/min is >0. LESR may have up to two segment ramp rate curve with Pmin (<0) to 0 (negative side) as first segment, 0 to Pmax (positive side) as second segment. An LESR can also define a single segment from Pmin to Pmax if applicable. For the DDR, the ramp rate will be one segment curve for Pmin to Pmax. Ramp rate segment for 0 to Pmax is applicable to the range when the LESR is discharging (providing energy), either when LESR increase the MW output or decrease the MW output. The same ramp rate. Ex: Discharge rate =1 MW/min. Assume LESR operation (discharge) is 2 MW. If the next operation instruction is 4 MW, it will take 2 minute for the LESR to 4 MW. The following operation instruction is 1 MW, even the operation MW decreases; the same ramp rate is applied. It will take 3 minute to 1 MW. Ramp rate segment for Pmin to 0 is applicable to the range when LESR is charging (consuming energy), either when LESR increase the MW consumed or decrease the MW consumed. Ex: Charge rate =0.5 MW/min. Assume LESR operation (charge) is -2 MW. If the next operation instruction is -3 MW, it will take 2 minute for the LESR to -3 MW. The following operation instruction is -1 MW, even though the operation MW increases; the same ramp rate is applied. It will take 4 minute to -1 MW. The one ramp rate is set for DDR operation range; the DDR ramp rate is applicable for either reducing or increasing the load.	Core; NGR	Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0121	Master File shall define the NGR storage resource LESR attributes: 1. LESR shall register Maximum Stored Energy (MSE) in (MWh) 2. LESR shall register Minimum Stored Energy (MWh) (Optional, default to zero if not registered.) 3. LESR shall register Energy Storage Efficiency (η), 0 ≤ η ≤1, which is the percentage of charging energy that the device can store and later discharge. Ex: For 1 MWh inject to the grid, η_t =0.9, the 1.11MWh charge energy will be needed. 1.11*0.9=1 MWh. These attributes need to be in the RDT.	Core; NGR	Master File
REM-BRQ0122	Master file shall allow NGR DDR to register the Curtailable Energy Limit (CEL), which represent the maximum energy (MWh) that can be curtailed continuously.	Core; NGR	Master File
REM-BRQ0123	The energy limits (MSE or CEL) for NGR are not required for the resource; nevertheless, if the NGR has a stored energy limit or curtail energy limit, the resource must register the limit value with the ISO, the ISO shall observe these respective limits within the market.	Core; NGR	Master File
REM-BRQ0140	All NGR register as continuous energy limited resource.	Core; NGR	Master File
REM-BRQ0143	Master File shall ensure: 1. NGR cannot be hourly tie resource; 2. NGR cannot be RMR; 3. NGR cannot be MSS load following resources; 4. NGR cannot be MSG. 5. NGR cannot be resources outside of the ISO control area. 6. NGR is not subjected to must offer obligation.	Core; NGR	Master File
REM-BRQ0150	Master File should define NGR not subject to local market power mitigation (LMPM)	Core; NGR	Existing function in Master File

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0160	NGR can be an aggregated resource. Master file must define the distribution factors (GDF) for Aggregated NGR. $0 \leq GDF_i \leq 1$, $\sum(GDF_i) = 1$ for aggregated NGR, assuming all the underling resources operating at either all positive or all negative. An aggregated NGR resource shall be treated same as Aggregated Generator that connect at Anode and Priced at APnode.	Core; NGR	Existing function in Master File
REM-BRQ0170	NGR-REM is not eligible for RUC, Day-Ahead Energy, Spinning and Non-Spinning markets. REM is not subjected to Must Offer Obligation. REM is not eligible for RTM Energy, Spinning and Non-Spinning market. NGR-REM not subject to local market power mitigation (LMPM).	Core; NGR-REM	Master File
REM-BRQ0180	NGR-REM is eligible for regulation market in DAM and RTM.	Core; NGR-REM	Master File

4.4 Business Process: < Full Network Model Maintenance >

4.4.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0190	The FNM shall accommodate the NGR resource as a generator operating range from negative to positive. The NGR shall be able to inject power or withdraw power from the Grid.	Core; NGR	FNM
REM-BRQ0200	A NGR can be a single resource defined with a Cnode and a Pnode. A NGR shall be treated same as generator that is connected at Cnode and priced at Pnode	Core; NGR	FNM
REM-BRQ0210	A NGR can be an aggregated resource defined with an Anode and APnode. The corresponding individual units will be defined on corresponding Cnodes in FNM.	Core; NGR	FNM

4.5 Business Process: < Energy Management System Maintenance (EMS) and Simulator (GOTS)>

4.5.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0220	EMS shall support connection for NGR via Secure ICCP protocol	Core; NGR	EMS
REM-BRQ0230	EMS shall support point to point connection for NGR.	Core; NGR	EMS
REM-BRQ0240	EMS shall model NGR as a generation resource with supply range of negative to positive. For LESR, the operation output is positive when the LESR discharging (providing energy) and negative when the LESR is charging (consuming energy) Ex: A battery is discharging at 2 MW, the operation output will be 2MW. A battery is charging at 2 MW, the output will be -2 MW. For DDR, the operation output is non positive. Ex: DDR load level is 10 MW, the operation output = -10 MW. DDR load level is curtailed by 2 MW, operate at 8 MW, the operation output = -8 MW.	Core; NGR	EMS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0250	EMS AGC module shall have a logic to handle regulation up and down for LESR/DDR based on LESR/DDR regulation awards in the market and ramp rate, in particular, recognize 1. LESR operation range is from negative to positive. 2. LESR can provide regulation up and regulation down services from the whole regulation operational range of the energy storage level (MWh). 3. For LESR, the ramp rate (discharge rate) shall apply to the LESR positive operation range, either LESR increase MW output or decrease the MW output. The LESR shall inject the power into the Grid, running at discharge mode. 4. The ramp rate (charge rate) shall apply to the LESR negative operation range, either LESR consume more MW or less MW. The LESR shall consume the power from the grid, running at charge mode. 5. For DDR, a regulation up will equal to load reduction and regulation down will equal to load increase, the ramp rate shall apply to either load reduction or load increase. 6. NGR provides regulation up if AGC dispatches the NGR above its Dispatch Operating Target DOT. 7. NGR provides regulation down if AGC dispatched the NGR below the DOT.	Core; NGR	EMS
REM-BRQ0251	AGC shall always send Setpoint instruction to the NGR resources (LESR and DDR) the actual operation level (MW).	Core; NGR	EMS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0260	EMS shall receive NGR telemetry of the following data every four (4) seconds: • Maximum Operating Limit (MW); • Minimum Operating Limit (MW); • Resource Instantaneous Output (MW); • Resource Charge Rate (MW/min); • Resource Discharge Rate (MW/min); • Resource Connectivity Status (On/Off); • Resource AGC Control Status (On/Off); • For LESR, State of Charge (SOC), which is the actual stored Energy (MWh) left in the LESR device; • Maximum Energy in MWh • Minimum Energy in MWh • (Option) for DDR, curtailable energy limit (MWh) remained going forward	Core; NGR	EMS
REM-BRQ0261	LESR Instantaneous Output (MW) telemetry is negative when the LESR is charging. LESR Instantaneous Output (MW) telemetry is positive when the LESR is discharging. LESR Instantaneous Output (MW) is zero when the LESR is neither charging nor discharging.	Core; NGR	EMS
REM-BRQ0262	DDR Instantaneous Output (MW) telemetry is negative for its load level. DDR Instantaneous Output (MW) telemetry is zero if the load shut down totally. Ex: DDR load level is 10 MW, the Instantaneous Output = -10MW. If DDR response AGC to reduce load by 2 MW, AGC will send -8 MW to the DDR, DDR will reduce its load to 8 MW. Instantaneous Output = -8MW	Core; NGR	EMS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0264	For the LESR REM, EMS and AGC shall apply 50% rule that maintain the SOC at 50% if system condition is normal and it is not impacting the grid reliability by doing so. If SOC is below 50%, AGC will calculate the MW charge level, and send set point to LESR for charging. If SOC is above 50%, AGC will calculate the MW charge level, and send set point to LESR for discharging.	Core; NGR	EMS
REM-BRQ0265	If the system condition is under stress, the AGC shall use the available energy left indicated by SOC to meet the Regulation requirement. The 50% rule will not enforced. In such events, the REM resources are expected to recover the SOC so that they are capable of providing the awarded regulation capacity in both directions.	Core; NGR	EMS
REM-BRQ0270	The State Estimator (SE) solution shall include the estimated output for each NGR based on its telemetry.	Core; NGR	EMS
REM-BRQ0280	EMS shall send to RTM every minute the SE solution and all telemetry for each NGR, including the state of charge (SOC) for LESR, or curtailable energy limit (CEL) for DDR if it is available the payloads for NGR should be the same format as the generator with additional attribute for SOC/CEL in the telemetry payload.	Core; NGR	EMS; RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0290	EMS shall receive from RTM the NGR energy dispatch (DOT) in RTD. The DOT for NGR can be negative, zero or positive. EMS shall receive NGR ramp rate. The value is the NGR effective ramp rate applicable at the DOT MW level. EMS shall receive from IFM/RTPD the NGR AS awards, include regulation awards and spinning, non-spinning awards. EMS shall receive from RTM the NGR maximum operation capacity and minimum operation capacity as used in the RTD dispatch. The payloads from RTM for NGR should be the same format as the generator.	Core; NGR	IFM, EMS, RTPD, RTD
REM-BRQ0300	Regarding reserve calculation, EMS will apply the current methodology for generators to NGR resources by recognizing the dispatched regulation MWs in the same manner as generation.	Core; NGR	EMS
REM-BRQ0320	EMS/PI shall store all necessary data for NGR resources as a generator. In addition, EMS/PI shall store the SOC telemetry data for NGR, for regulation and other AS performance monitoring and calculate AS No Pay.	Core; NGR	EMS, PI
REM-BRQ0330	PI must support NGR's that have an operation range from negative to positive. PI must support store the LESR SOC telemetry data and DDR CEL data.	Core; NGR	EMS, PI
REM-BRQ0331	PI must support store the NGR SOC telemetry data and support the following function: The 10-minute upward capacity shall be available to SAMC for spin/non-Spinning No Pay calculation.	Core; NGR	PI, SAMC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0350	EMS shall use re-rate, de-rate and outage information from RTM for NGR's and apply them to applicable time period in the same manner as it is for generators. This includes, De-rate of ramp-rate; De-rate of Pmax; Re-rate of Pmin; Out of Service Status (Y/N);	Core; NGR	EMS; RTM; SLIC
REM-BRQ0351	The NGRs that are not certified for AS will not be required to have telemetry.	Core; NGR;	EMS; RTM;

4.6 Business Process: < Manage Outage Management System (OMS)>

4.6.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0360	OMS shall recognize NGR's as a generation resource, using existing generation resource functionality when it is applicable.	Core; NGR	OMS/SLIC
REM-BRQ0370	OMS shall support NGR resource types: LESR and DDR.	Core; NGR	OMS/SLIC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0380	OMS shall have the following functionality in support of NGR de-rate: 1. Be able to specify de-rates of ramp rate curve on the ramp rate one or two segments with applicable time period. De-rate regulation ramp-rate) with applicable time period. The de-rated value shall be less than the original MF defined value. 2. For LESR, be able to specify the de-rate of Pmax with applicable time period. De-rated value shall be less than the default Pmax defined in MF. 3. For LESR, be able to specify the re-rate of Pmin with applicable time period. Re-rated value shall be greater than the Pmin defined in MF; 4. For LESR, be able to specify the de-rate Maximum Stored Energy with applicable time period. De-rated maximum stored energy limit shall be lower than the value defined by MF. Be able to specify de-rate minimum stored energy with applicable time period. De-rated minimum stored energy limit shall be lower than the value defined by MF.. 5. For DDR, be able to specify de-rate for the maximum curtailment limit. The de-rated value shall be lower than the MF registered value.	Core; NGR	OMS/SLIC
REM-BRQ0382	Market participant will not be required input negative de-rated Pmin.	Core; NGR	OMS/SLIC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0390	OMS shall support LESR and DDR to specify an out of service status (Y/N) with applicable time period. The out of service status (Y) indicates the entire LESR resource is out of service. The out of service status (Y) indicates the DDR no longer capable of responding to load curtailment. The out of service status (Y) does not mean that DDR load is offline. Market will set the DDR at its self-schedule level in DAM, set at telemetry in RTM and disqualify all the AS self provision and awards.	Core; NGR	OMS/SLIC
REM-BRQ0391	OMS must be able to publish the Outage/de-rate information described in BRQ0380 and BRQ0390 to down-stream systems.	Core; NGR	OMS/SLIC
REM-BRQ0400	OMS must be able to publish the de-rate or outage information of NGR as specified above to downstream systems in the same manner as for generation outages.	Core; NGR	OMS/SLIC

4.7 Business Process: < Manage Load Forecast >

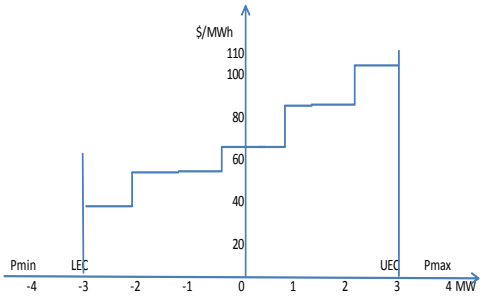
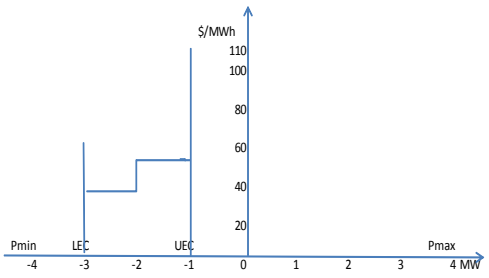
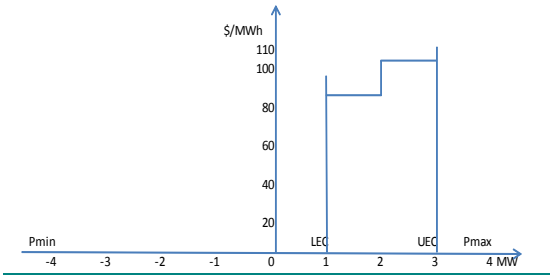
4.7.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ00401	The load consumption related to any NGR DDR needs to be excluded from any DLAP or CLAP load forecast. Note: The NGR DDR resource will be included in the power balance equation as a generation resource (negative gen). So we need to exclude that from load forecast.	Core; NGR	ALFS

4.8 Business Process: < Manage Day Ahead and Real Time Market >

4.8.1 Business Requirements

<table>
<tr><th>ID#</th><th>Business Feature</th><th>Requirement Type</th><th>Potential Application(s) Impacted</th></tr>
<tr><td>REM-BRQ0410</td><td>Market applications shall recognize NGR as a generation resource, using existing generation resource functionality when it is applicable. This document will specify the new requirements for NGR explicitly.</td><td>Core; NGR</td><td>SIBR, DAM, RTM</td></tr>
<tr><td>REM-BRQ0411</td><td>SIBR shall support a negative to positive operation range for NGR.. SIBR shall support submission, reception and validation of NGR bids.
<table>
<tr><th>Resource</th><th>Tech</th><th>REM</th><th>Regulation</th><th>Spin/Non-Spin</th><th>Energy</th></tr>
<tr><td rowspan="4">NGR As a generation resource</td><td rowspan="2">LESR</td><td>Y</td><td>SC Bid</td><td>No</td><td>No</td></tr>
<tr><td>N</td><td>SC Bid</td><td>SC Bid</td><td>SC Bid</td></tr>
<tr><td rowspan="2">DDR</td><td>Y</td><td>SC Bid</td><td>No</td><td>No</td></tr>
<tr><td>N</td><td>SC Bid</td><td>SC Bid</td><td>SC Bid</td></tr>
</table></td><td>Core; NGR</td><td>SIBR, DAM, RTM</td></tr>
<tr><td>REM-BRQ0420</td><td>SIBR shall recognize the NGR Type LESR and DDP and apply validation rule accordingly.</td><td>Core; NGR</td><td>SIBR, DAM, RTM</td></tr>
<tr><td>REM-BRQ0430</td><td>SIBR shall recognize the NGR-REM option, apply validation rule accordingly. Only the NGR can be REM.</td><td>Core; NGR-REM</td><td>SIBR, DAM, RTM</td></tr>
</table>

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0440	NGR shall be allowed to submit an energy bid curve for each trading hour. The energy bid must be a monotonically increasing stepwise curve in $/MWh versus MW between a Lower Economic Capacity (LEC) and an Upper Economic Capacity (UEC) in NGR operation range from negative to positive. The submitted Energy Bid Curve shall be limited to a maximum of 10 segments. Energy Bid Curve shall be continuously between demand and supply, or supply only, or demand only. Ex: The energy bids for LESR can be: 1. Bid between Demand and Supply (0>LEC=<UEC>0)  2. Self-schedule at demand side, Bid must be limited at demand side only (LEC=<UEC<=0)  3. Self-schedule at Supply side, Bid must be limited at Supply side only (0=<LEC=<UEC) 	Core; NGR	SIBR, DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0441	DAM and RTM optimize NGR in the same manner as generator. The objective function of optimization will include NGR (bid price *MW award), recognize that NGR MW awards can be negative or positive. Using NGR DDR model for demand response, the MW award is for the demand load level. The curtailment itself is implied by the difference from the energy MW award to the Lower Economic Capacity (LEC).	Core; NGR	DAM, RTM
REM-BRQ0442	To properly address the NGR resource load in the power balance used in the MPM/RRD, RUC and RTM processes, The following principle shall be used in the power balance equation: Generations + Imports – Exports +NGR resources = Load Forecast Load forecast excludes NGR (LESR and DDR). For IFM: Generations + Imports – Exports +NGR resources – Non Participating Load = 0	Core; NGR	DAM, RTM; ALFS
REM-BRQ0450	NGR (Non REM) shall be allowed to submit an energy self-schedule (SS) in MW for each trading hour. The NGR self schedule bid must between Pmin and Pmax. Only Price Taker self-schedules shall be allowed.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0460	SIBR shall ensure DDR must submit self schedule for the lower operation limit.	Core; NGR	SIBR, DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0470	SIBR shall support NGR to bid in AS markets if applicable based on MF certifications: 1. Bid Regulation Up capacity in single $/MW in Day-Ahead Market (DAM) and Real Time Market (RTM), if the NGR certified for regulation up; 2. Bid Regulation Down capacity in single $/MW in DAM and RTM if the NGR certified for regulation down; 3. Bid Spinning capacity in single $/MW in DAM and RTM if the NGR certified for spinning; 4. Bid Non-Spinning capacity in single $/MW in DAM and RTM if the NGR certified for Non-Spinning;	Core; NGR	SIBR, DAM, RTM
REM-BRQ0480	SIBR shall support NGR to bid in single $/MW in RUC if the NGR certified for RUC.	Core; NGR	SIBR, DAM,
REM-BRQ0490	SIBR shall support NGR self-provision Ancillary Services (AS) Capacity in DAM and RTM if the NGR certified for corresponding AS, including regulation up, regulation down, spinning and non-spinning.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0500	NGR (Non REM) with AS self-provision or bid, and RUC bid also require energy self-schedule or Energy bid in the same trading hour. The SC must submit the energy bid.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0510	If NGR option to be REM: 1. NGR-REM shall be allowed to bid or self-schedule regulation up and regulation down capacity in DAM/RTM. 2. NGR-REM should not be allowed to bid or to self-schedule energy in DAM and RTM; 3. The ISO shall be able to manage the NGR-REM energy as price taker in RTD market driven by the SOC constraints. 4. NGR-REM should not be allowed to bid or self-schedule spinning and non-spinning in DAM and RTM; 5. NGR-REM should not be allowed to bid in RUC.	Core; NGR-REM	SIBR, DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0512	SIBR shall allow NGR to submit the Ramp rate same as generator. LESR may have up to two segment ramp rate curve with Pmin (<0) to 0 (negative side) as first segment, 0 to Pmax (positive side) as second segment. An LESR can also define a single segment from Pmin to Pmax if applicable. For the DDR, the ramp rate will be one segment curve for Pmin to Pmax	Core NGR	System Operation; Power System Technology Operations
REM-BRQ0530	SIBR shall ensure the NGR energy and AS bids within the NGR operation range, the generator capacity limit rule is applicable to NGR. AS capacity must be within operating range: RD+NR+SR+RU≤ Pmax-Pmin Energy Self Schedule (SS) and AS must fit: Pmin + RD ≤ SS ≤ Pmax – RU – SR – NR RU: Regulation Up RD: Regulation Down SR: Spinning NR: Non-Spinning	Core; NGR	SIBR, DAM, RTM
REM-BRQ0531	In RTM, an energy bid curve is required for NGR that have spinning and non-spinning bids and for the RUC schedule that greater than DA schedule.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0540	SIBR shall allow NGR LESR to submit a Lower Charge Limit (LCL) in MWh (zero by default) for each trading day, which is the lowest stored energy that should be maintained in the device. SIBR shall allow LESR to submit an Upper Charge Limit (UCL) in MWh (MSE by default) for each trading day, which is the highest stored energy that should be allowed in the device. SIBR shall ensure 0<LCL<UCL<MSE.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0541	The initial operation point SOC (MWh) in DAM shall be determined by the prior day's day-ahead IFM schedule at the end of the day. No SOC(0) input is allowed from SIBR.	Core; NGR	SIBR, DAM
REM-BRQ0542	SIBR shall allow NGR DDR to submit a Curtailable Energy Limit (CLE) in MWh for each trading day.	Core; NGR	SIBR, DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0550	NGR has following restriction: 1. NGR cannot be hourly tie resource; 2. NGR cannot be RMR; 3. NGR cannot be MSG; 4. NGR cannot be MSS load following resources; 5. NGR cannot be resources outside of the ISO control area. 6. NGR is not subjected to must offer obligation.	Core; NGR	SIBR, DAM, RTM
REM-BRQ0560	SIBR shall allow aggregated NGR to submit distribution factors for each trading hour. $0 \leq GDF_i \leq 1$, $\sum(GDF_i) = 1$ This set of GDFs will be used for the power distribution in both positive and negative generation mode; assuming all the underling resources operating at same direction, either all positive or all negative. Ex: an aggregated LESR with two underlying batteries, GDF1 =0.4, GDF2=0.6. If LESR is operating at 5 MW, the market will assume Battery 1 is discharging at 2 MW, Battery 2 is discharging at 3 MW.	Core; NGR	SIBR, DAM, RTM, NA
REM-BRQ0562	SIBR shall include NGR related limits in the DA and RT clean bids sets. Lower Charge Limit (LCL) in MWh Upper Charge Limit (UCL) in MWh See REM-BRQ0540	Core; NGR	SIBR, DAM, RTM
REM-BRQ0570	DAM and RTM shall support NGR as subtype of generation resource with negative to positive operation range.	Core; NGR	DAM, RTM
REM-BRQ0580	DAM and RTM shall recognize NGR storage Type LESR and Demand Response DDR.	Core; NGR	DAM, RTM
REM-BRQ0590	DAM and RTM will not model start up, minimum up time and minimum down time constraints for NGR. No binary commitment decision variables are needed for NGR. As long as the NGR has energy and AS bids, the NGR is on line.	Core; NGR	SIBR, DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0600	DAM and RTM shall model NGR with energy and/or AS bids as online resource unless it declared unavailable. There is no start up cost and no start up time associated with NGR.	Core; NGR	DAM, RTM
REM-BRQ0610	In DAM, the NGR without bids and without self schedules shall be modeled as unavailable.	Core; NGR	DAM, RTM
REM-BRQ0620	In RTM, NGR without bids and without self schedule shall be modeled as unavailable, unless it has a nonzero Sate Estimator (SE) solution, in which case it is subject to the No Bid and Compliance logic, or unless it has an active Exceptional Dispatch (ED) instruction. In this case, the DOT equal to SE solution in optimization horizon. Ex: If NGR no bids/no self schedule: 1. If SE=0, the NGR shall be modeled offline 2. If SE>0, internal DOT=SE in optimization horizon to reflect the operation reality of the NGR. The external DOT send to the ADS must be 0 to reflect the market instruction.	Core; NGR	RTM
REM-BRQ0630	If DDR declared out of service from OMS, DAM shall set DDR at its self-schedule level; AS awards for DDR shall be disqualified.	Core; NGR	DAM, OMS/SLIC
REM-BRQ0631	If DDR declared out of service from OMS, RTM shall set DDR at its SE solution or real time telemetry level; AS awards for DDR shall be disqualified.	Core; NGR	RTM, OMS/SLIC
REM-BRQ0632	If LESR declared out of service from OMS,: DAM/RTM shall model LESR offline; AS awards for LESR shall be disqualified. If LESR has a nonzero Sate Estimator (SE) solution, RTM set LESR at its SE value, it is subject to the No Bid and Compliance logic.	Core; NGR	DAM, RTM, OMS/SLIC
REM-BRQ0640	Same as generator, AS awards and AS self-provision from NGR shall subject to AS conditional prequalification in preprocessing prior to the optimization.	Core; NGR	DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0650	AS awards for NGR declared out of service shall be disqualified. AS awards for DDR with declared out of service shall be disqualified; the resource can still consume the energy, load can connect to the grid, but the load will not respond the dispatch instruction, therefore, AS awards must be disqualified.	Core; NGR	OMS/SLIC, DAM, RTM
REM-BRQ0660	NGR optimal schedule and AS awards shall be based solely on its energy bid curve, including penalties for self-schedule, reserved contingent OR capacity, and Exception Dispatch as applicable, and on its AS bids, including penalties for AS award and AS self-provision as applicable; no other costs (startup, shutdown, minimum load, or transition costs) apply to NGR.	Core; NGR	DAM, RTM
REM-BRQ0670	NGR AS awards shall be limited by capacity constraints.	Core; NGR	DAM, RTM
REM-BRQ0680	NGR optimal schedule (EN) and AS awards shall be limited by capacity constraints in DAM.	Core; NGR	DAM
REM-BRQ0690	NGR optimal schedule (EN) and AS awards shall be limited by capacity constraints in RTM.	Core; NGR	RTM
REM-BRQ0700	The existing ramping and ramping sharing rules for generator shall apply to the NGR. There is no change to ramping rules for NGR. DAM and RTM shall enforce the ramp sharing constraint for the energy schedule and AS awards. NGR optimal schedule and AS awards shall be limited by ramping constraints:	Core; NGR	DAM, RTM
REM-BRQ0701	LESR Stored Energy Management (SEM) requires an initial state of charge (stored energy) and the calculation of the available SOC at each interval. For NGR (Non REM), the SOC constraint shall be enforced in DAM, RTPD and RTD; for NGR-REM, the SOC constraint shall be enforced in RTD, but not in DAM and RTPD.	Core; NGR	DAM, RTM, EMS
REM-BRQ0702	LESR SOC is subject to upper MWH limit UCL and the lower MWH limit LCL.	Core; NGR	DAM, RTM, EMS
REM-BRQ0703	DAM/RTM shall receive and recognize de-rates of UCL and LCL from SLIC.	Core; NGR	DAM, RTM, SLIC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0710	LESR optimal schedule and AS awards shall be limited by the available SOC. 1. Current interval SOC(t) shall be determined by SOC(t-1), Energy Schedule at EN(t), and energy stored efficiency η_t. 2. SOC(t) plus RD(t)*TR shall be less than the upper charge limit (UCL). 3. SOC(t) - (RU(t)+SR(t)+NR(t))*TR shall be greater than the lower charge limit (LCL). 4. Under contingency, SOC(t) -RU(t)*TR shall be greater than the lower charge limit (LCL). In DAM, set initial SOC(0) equal to Initial operation point (that is determined by the prior day's day-ahead IFM schedule at the end of the day) at a State of Charge level. 5. In RTM, use most recent SOC telemetry as the initial SOC. Note: TR is the reserve time domain (10 minute). For REM, the SOC constraint is enforced in RTD. The reserve time domain is 5 minutes.	Core; NGR	DAM, RTM, EMS
REM-BRQ0711	For NGR-REM LESR, SOC constraint shall be only included and enforced in RTD; IFM/RUC and RTPD shall not include SOC constraints for REM resources. In RTD, protect the regulation as much as possible for the binding interval based on SOC. Ex: SOC(t) = 1MWh. If RegUp =10 MW for the hour, the RTD must ensure the RegUp is protected for the binding 5 minute interval.	Core; NGR-REM	RDT,EMS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0712	For NGR LESR (Non REM): 1. The SOC constraints will be enforced for all the intervals of the optimization horizon in IFM. The initial SOC in DAM is determined by the prior day's day-ahead schedules at the end of the day. 2. The SOC constraints shall be enforced to both binding and non-binding intervals in optimization horizon in RTPD. The initial SOC in RTPD is the most recent telemetry value. 3. The SOC constraints shall be enforced to both binding and non-binding intervals in optimization horizon in RTD. The NGR initial SOC in RTD is the most recent telemetry value.	Core; NGR	DAM, RTM, IFM, RTPD, RDT,EMS
REM-BRQ0720	NGR DDR optimization will subject to constraint of Curtail Energy Limits (CEL). The energy curtailed in the intervals of optimization horizon shall not exceed the curtailable energy limit in the optimization horizon. For NGR DDR: 1. The curtail energy limits (CEL) are maximum demand response (MWh) going forward. The CEL is most recent telemetry value from EMS. 2. The CEL constraint shall be enforced in DAM. 3. The CEL constraint shall be enforced in RTM, include RTPD and RTD. 4. If the CEL telemetry is not available, the CEL constraint shall be enforced at fall back from SLIC to SIBR, if SIBR value is not available, default MF value.	Core; NGR	DAM, RTM; EMS
REM-BRQ0721	IFM and RTPD shall optimize regulation awards of NGR-REM based on regulation bids in the same manner as generator that subject to capacity constraints.	Core; NGR-REM	DAM, RTM

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0722	RTD shall optimize the NGR-REM energy schedule based on the regulation awards in DAM and RTPD. For NGR-REM, RTD shall enforce the State of Charge constraints, ramping constraints and efficiency constraints. The REM energy schedule (EN) shall be modeled as price taker in RTD. For DDR option REM, RTD will **not** enforce the Curtail Energy Limit constraint. The REM energy schedule (EN) shall be modeled as price taker in RTD.	Core; NGR-REM	RTD
REM-BRQ0730	NGR shall not subject to Local Market Power Mitigation (LMPM) in DAM and RTM. But NGR is included the MPM as part of the optimization.	Core; NGR	DAM, RTM
REM-BRQ0740	Exceptional Dispatch instructions shall be applicable to NGR.	Core; NGR	RTM
REM-BRQ0741	Contingency Dispatch instructions shall be applicable to NGR.	Core; NGR	RTM
REM-BRQ0750	RTM shall receive from EMS the latest SE solution and telemetry for each NGR, including the actual SOC for each LESR, CEL for DDR and shall use this information to calculate the initial condition for each NGR, including the initial SOC for each LESR, by projecting the actual status toward the last dispatch.	Core; NGR	RTM, EMS
REM-BRQ0760	The existing No Bid and Compliance logic shall apply to NGR: the internal dispatch shall be fixed at the SE solution for non-compliant NGR or NGR without a bid; the external dispatch shall be the last compliant dispatch for non-compliant NGR and zero for NGR without a bid. For LESR, the logic shall apply until the interval when the SOC reaches LCL or UCL, after which the dispatch shall be zero.	Core; NGR	RTM
REM-BRQ0770	RTM shall calculate and publish the optimal dispatch (DOT) and dispatch trajectory (DOP) in MW for each NGR (positive or negative).	Core; NGR	RTM
REM-BRQ0771	RTM shall include the effective ramp rate corresponding with DOT level in the DOT payload. EMS shall use ramp rate for AGC dispatch.	Core; NGR	RTM, EMS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0772	Dispatch instructions (DOPs/DOTs) from RTD shall follow the same convention as generator as follows, 1. DOT/DOP MWs shall reflect the MW that it dispatches to (negative to positive); 2. Spinning and non-spinning as part of the dispatch components: When it is a spinning/non-spinning dispatch, spinning and non-spinning MWs shall reflect the reserve dispatch amount like generators (positive or zero); 3. Hourly Schedule as part of the dispatch components: It shall reflect the day-ahead energy schedule of the NGR resource. 4. DOPs shall be derived from DOTs with applicable ramp rate like generators.	Core; NGR	RTM
REM-BRQ0773	NGR shall response the ADS DOT instruction.	Core; NGR	RTM, ADS
REM-BRQ0774	The ISO shall manage NGR-REM energy through AGC in EMS. AGC will dispatch NGR-REM based on DOT, regulation awards and ramp rates. NGR-REM must respond to AGC dispatch.	Core; NGR-REM	EMS, RTM
REM-BRQ0791	NGR all output data from the DAM/RTM will be published via web-service in same manners as generator.	Core; NGR	DAM, RTM, CMRI, OASIS, Integration

4.9 Business Process: < Manage Market Quality System (MQS)>

4.9.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0800	NGR shall be a subtype of generation resource with an algebraic power injection in MQS. The generation resource functionality will be applicable to NGR unless specified otherwise.	Core; NGR	MQS
REM-BRQ0810	NGR Type of LESR or DDR shall be supported in MQS	Core; NGR	MQS

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0812	The NGR expected energy calculation shall be the same as for generators except that, It has to accommodate the fact that NGR 's limits and curves can be across positive and negative; the ramping energy can change between negative and positive in an interval, since the NGR can change from positive (discharging) to negative (charging) and reverse output continuously between adjacent intervals.	Core; NGR	IFM, RTM, MQS,
REM-BRQ0813	The ex-post capacity formula shall be the same as for generators. It has to accommodate the fact that NGR 's limits and curves can be across positive and negative, the NGR can change from positive (discharging) to negative (charging) and reverse output continuously between adjacent intervals.	Core; NGR	IFM, RTM, MQS,
REM-BRQ0820	All expected energy types shall apply to NGR, except for Pumping Energy, and Hour-Ahead Scheduled Energy. Day-Ahead Scheduled Energy and Optimal Energy can be negative. Same as generator, NGR energy can be optimal energy. Ex: For a Pmax=8MW, Pmin=-8MW, DA =-3MW. In RTM, DOT=7MW, Optimal Energy = (7-(-3))=10MW. Note the unit dispatch range is Pmax-Pmin=8-(-8)=16MW.	Core; NGR	MQS
REM-BRQ0840	MQS shall support the demand response unavailability declaration of DDR in calculating de-rate energy and AS/RUC No Pay.	Core; NGR	MQS
REM-BRQ0870	NGR shall be eligible for Bid Cost Recovery for its Energy/AS bids; there is no commitment bid cost recovery for NGR.	Core; NGR	MQS, SAMC

4.10 Business Process: < Manage Metering >

4.10.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0880	Metering system shall be able to recognize and support NGR as a generation resource, as revenue meters come in and provide the revenue meters to settlement. Revenue meters for a single NGR resource can vary between positive generation and negative generation between intervals	Core; NGR	OMAR, Master File
REM-BRQ0890	NGR meter data needs to be supported using similar convention as channel 1 and channel 4 today. The SAMC must incorporate the channel 1 and channel 4 meter data accordingly.	Core; NGR	OMAR, SAMC

4.11 Business Process: < Manage Market Billing and Settlements (SAMC) and Compliance (CAPS) >

4.11.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0900	NGR shall be a subtype of generation resource with an algebraic power injection in Settlement System (SAMC). The charge codes and functionality for generation resource are applicable to the NGR unless specified otherwise.	Core; NGR	SAMC
REM-BRQ0910	NGR Type of LESR or DDR shall be supported in SAMC.	Core; NGR	SAMC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0920	NGR shall be subject to all existing AS/RUC No Pay categories. The existing No Pay cascading rule shall be applicable for NGR. It is important to note that, a review of current implementation is needed to ensure that, the business intent is met when a negative schedule and/or a negative limit are existent.	Core; NGR	SAMC/CAPS
REM-BRQ0930	LESR shall subject to a new ~~AS~~ spin/non-spin No Pay under undispatchable capacity category: Insufficient Stored Energy the relevant No Pay quantity (MW) shall be calculated for each interval to see if SOC level can provide enough energy once the awarded ~~AS~~ spin/non-spin called upon. ~~The AS No Pay shall be calculated for Regulation Up, Regulation Down, Spinning, and Non Spin.~~	Core; NGR	SAMC/~~CAPS~~/PI
~~REM-BRQ0932~~	~~Regulation Insufficient Stored Energy No Pay is calculate based on SOC of each interval (TI). The calculation is done on a 1 minute level and summarized to a 10 minute level for settlement.~~	~~Core; NGR~~	~~CAPS, SAMC~~
~~REM-BRQ0933~~	~~CAPS shall get SOC(t) from PI 1 minute average SOC.~~	~~Core; NGR~~	~~CAPS, PI~~
REM-BRQ0935	SAMC shall get 10-minute based upward capacity from PI to calculate the SOC based No Pay amount for Spinning and Non-Spin.	Core; NGR	SAMC, PI
REM-BRQ0936	~~Similar as Regulation Up,~~ Spinning and Non Spinning Insufficient Stored Energy No Pay is calculated based on SOC of each define interval.	Core; NGR	SAMC, PI
REM-BRQ0937	In principle, the settlement rules and cascading rules for generator are applicable for the NGR.	Core; NGR	SAMC, CAPS
REM-BRQ0940	LESR (REM and Non REM) shall be exempt from cost allocations applicable to metered demand.	Core; NGR	SAMC

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0941	SAMC shall settle the NGR AS awards same as generator in IFM and RTPD.	Core; NGR	SAMC
REM-BRQ0942	SAMC shall settle the NGR energy schedule at LMP in IFM and RTD.	Core; NGR	SAMC
REM-BRQ0943	SAMC shall settle NGR-REM regulation up awards and regulation down awards same as generator in IFM and RTPD	Core; NGR-REM	SAMC
REM-BRQ0944	SAMC shall settle energy schedule of NGR-REM (positive or negative) at the real time LMP	Core; NGR-REM	SAMC
REM-BRQ0945	SAMC shall settle NGR-REM regulation energy dispatched by AGC at real time LMP. NGR-REM receives payment at RT LMP for regulation up energy, NGR-REM is charged at RT LMP for regulation down energy	Core; NGR-REM	SAMC
REM-BRQ0947	NGR-REM must not subject to DAM energy settlement.	Core; NGR-REM	SAMC
REM-BRQ0948	NGR (Non REM) shall be eligible for Bid Cost Recovery (BCR) for its Energy/AS bids. There are no commitment costs recoveries for NGR.	Core; NGR	SAMC
REM-BRQ0949	The positive or negative generation amount by LESR shall subject to the same applicable cost allocation as generator.	Core; NGR	SAMC
REM-BRQ0950	The load consumption by NGR DDR (Non REM) will subject to the same applicable cost allocation for Participating Load	Core; NGR	SAMC
REM-BRQ0951	The portion of demand of NGR-REM that provide regulation energy shall not be allocated uplift costs and offset allocations that apply to measured demand.	Core; NGR-REM	SAMC
REM-BRQ0952	NGR-REM shall only be eligible for regulation bid cost recovery.	Core; NGR-REM	SAMC
REM-BRQ0953	NGR-REM shall subject to the applicable Grid Management Charges for the regulation schedules and real time energy.	Core; NGR-REM	SAMC

4.12 Business Process: < Manage CMRI, OASIS and ADS >

4.12.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ0960	CMRI generation resource functionality, include the display tables, shall be applicable to the NGR. CMRI shall recognize NGR can be negative to positive generation. This shall be expected in the exact same manner as generators.	Core; NGR	CMRI
REM-BRQ0970	ADS generation functionality shall be applicable to NGR, as NGR is a subtype of generation resource with negative to positive power injection in ADS.	Core; NGR	ADS
REM-BRQ0990	ADS shall support DOT/DOP and ED for NGR in the exact same manner as generators.	Core; NGR	ADS
REM-BRQ1010	OASIS shall support NGR as a generation resource type with negative to positive generation for publishing T+90 bids.	Core; NGR	OASIS

4.13 Business Process: Metrics and Performance Criteria

4.13.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ1050	All existing metrics and performance criteria for Generator shall still apply when NGR model is implemented; recognize the NGR generation can be negative.		

4.14 Business Process: Information Security Adherence

4.14.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ1060	All existing information security requirement shall still apply when NGR model is implemented		

4.15 Business Process: Proactive Monitoring (PAM) Requirements

4.15.1 Business Requirements

ID#	Business Feature	Requirement Type	Potential Application(s) Impacted
REM-BRQ1100	The ISO will closely monitor the development of REM resources and the regulation procurement from REM.		

5. Appendix A: Definition of Terms

Term	Definition
Regulation Energy Management (REM)	REM functionality allows a NGR resource to purchase or sell energy in real-time to meet the at least 15-minute continuous energy requirement for regulation in the day-ahead market and real time market. When a resource elects REM option, the regulation capacity is evaluated as four times the regulation energy it can provide within 15 minute. A NGR resource electing REM option can only provide regulation service to the market.
Non-Generator Resources (NGR)	The NGR resources are resources that operate as either generation or load and can be dispatched seamlessly within their entire capacity range inclusive of the generation and load. They are also constrained by an energy (MWh) limit to generate (curtail the consumption of energy in the case of demand response) or consume energy on a continuous basis. Such resources can participate in the ISO's energy and ancillary services market when they meet eligibility requirements.
Limited Energy Storage Resource (LESR)	One type of NGR resource such as flywheel, battery, energy storage. The LESR can inject power to the grid when it is discharging and withdraw the power from the grid when it is charging. In general, LESR is not limited to the storage resource. The resource can be LESR as long as it can operate seamlessly between the positive and negative operation range, inject power to the grid and withdraw power from the grid.
Dispatch-able Demand Resource (DDR)	One type of NGR resource such as the participating load. The DDR can response the dispatch by reducing or increasing its energy consumption.
NGR-REM	Acronym for the non-generator resource that only provides regulation and allows the ISO to manage its energy in real time market.
State of Charge (SOC)	The actual stored Energy (MWh) left in the storage device.
REM Regulation Capacity	As REM resource, the regulation up capacity must meet the 15 minute continues energy deliver requirements when it is fully charged; and regulation down capacity must meet the 15 minute continues energy consume requirements when it is completely discharged.
Maximum Stored Energy (MSE)	The maximum energy (MWh) can be stored in the LESR device.
Minimum Stored Energy	The minimum energy (MWh) must be maintained in the LESR device.

Energy Storage Efficiency (η)	Energy Storage Efficiency (η), 0 ≤ η ≤1, which is the percentage of charging energy that the device can store and later discharge
Maximum Demand Response (Emax)	Daily maximum demand response that represents the DDR maximum energy (MWh) curtailment of demand response for the day.
Minimum consumption (Emin)	Daily minimum consumption energy that represents minimum energy consumption (MWh) the DDR need to sustain at for the day.
Stored Energy Management (SEM)	Energy Management for the Limited Energy Storage Resource to ensure that there is sufficient stored energy in the device to dispatch the energy and AS when called upon.
Insufficient Stored Energy	An Ancillary Service (AS) non-compliance category that apply to the Limited Energy Storage Resource. The relevant No Pay quantity (MW) shall be calculated for each interval to see if SOC level can provide enough energy once the awarded AS called upon.
Lower Charge Limit (LCL)	The lowest stored energy (MWh) that should be maintained in the LESR device.
Upper Charge Limit (UCL)	The highest stored energy (MWh) that should be allowed in the LESR device.
Lower Economic Capacity (LEC)	The lowest capacity (MW) of an energy bid curve.
Upper Economic Capacity (UEC)	The highest capacity (MW) of an energy bid curve.
Lower operating Limits (LOL)	The lowest operating limit (MW) after the de-rate.
Upper Operation Limits (UOL)	The highest operating limit (MW) after the de-rate.
Curtailable Energy Limits (CEL).	The maximum energy (MWh) left can be curtailed for the DDR.

6. Appendix B: Examples

NGR will be modeled as a generation resource with which it can ramp through positive and negative generation continuously. It's key differences from a normal generator model are,

1. The Pmin can be negative OR both Pmin and Pmax can be negative;
2. NGR resource's inter-temporal constraints are more tied to the energy (MWh) side instead of power (MW) or time (minutes);
3. NGRs are effectively assumed on-line all the time unless outage.

6.1 Example 1: NGR (No-REM):

Master File definition:

1. Pmin = -10MW, Pmax=10MW;
2. Ramp-rate = {((-10, 0), 5MW/min), ((0, 10), 10MW/min)};
3. Stored Energy Limit: 20MWh;
4. Certified Spin/Non-Spin/Regulation: 20MW

Numbers are used for illustration of the concept. They do not imply a particular certification requirement. ISO will communicate the certification requirement later.

The NGR model is an extension of the generation model to the negative side. The NGR resource in example will look a lot like the following generator with everything shifted upward for 20MW,

1. Pmin = 10MW, Pmax = 30MW;
2. Ramp-rate = {((10, 20), 5MW/min), ((20, 30), 10MW/min)};
3. Certified Spin/Non-Spin/Regulation: 20MW

The major difference is the stored energy limit.

Possible day-ahead or real-time bid curves,

1. Energy Bid Curve:
   {(-10, -3), $30}, {(-3, 6), $35}, {(6, 10), $45}
2. Regulation Bid Curve:
   {(20, $10)} for both regulation up and regulation down;
3. Spin Bid Curve
   {(20, $2)} for Spin
   -- non-Spin is skipped here since it has similar fashion like Spin
4. There is no startup cost or minimum load cost.

Possible IFM or RTPD market clearing results (examples),
Case 1, Energy=7, Spin = 2, Reg-up = 1, Reg-down = 17;
Case 2, Energy=-7, Spin = 2, Reg-up = 11, Reg-down = 3;
Case 3, Energy= 0, Spin=5, Reg-up = 5, Reg-down = 10.

Possible ADS Dispatch Instructions out of RTD (examples),
Case 1, DOT=7
Case 2, DOT=-5
Case 3, DOT= 0

Red area is on purpose to show that RTD can dispatch higher when there is room given Spin/Reg-up capacities.

Possible AGC Signal from EMS (examples) using actual MW signal (positive or negative)
Case 1, DOT=7 (Reg-up = 1, Reg-down = 17)
AGC Set Point = 3 -- Implied Reg-down of 4
Case 2, DOT = -5 (Reg-up = 11, Reg-down = 3)
AGC Set Point = 0 -- Implied Reg-up of 5
Case 3, DOT = 0, (Reg-up = 5, Reg-down = 10)
AGC Set Point = -2 -- Implied Reg-down of 2

6.2 Example 2 NGR-REM

Similarly, a NGR with REM option,
Master File definition,

1. Pmin = -10MW, Pmax=10MW;
2. Ramp-rate = {((-10, 0), 5MW/min), ((0, 10), 10MW/min)};
3. Stored Energy Limit: 2.5MWh;
4. Certified Regulation: 10MW

Numbers are used for illustration of the concept. They do not imply a particular certification requirement. ISO will communicate the certification requirement later.

Possible day-ahead or real-time bid curves,
1. Regulation Bid Curve:
{(20, $10)} for both regulation up and regulation down;
In the optimization, the energy is treated as a price taker to support the regulation award.

Possible IFM or RTPD market clearing results (examples),
Case 1, Energy=0, Reg-up = 1, Reg-down = 17;
Case 2, Energy=0, Reg-up = 11, Reg-down = 3;
Case 3, Energy= 0, Reg-up = 5, Reg-down = 10.
Possible ADS Dispatch Instructions out of RTD (examples),
Case 1, DOT=7
Case 2, DOT=-5
Case 3, DOT= 0
There is no commitment instruction.

Possible AGC Signal from EMS (examples) using absolute MW signal (positive or negative)
Case 1, DOT=7 (Reg-up = 1, Reg-down = 17)
AGC Set Point = 3 -- Implied Reg-down of 4
Case 2, DOT = -5 (Reg-up = 11, Reg-down = 3)
AGC Set Point = 0 -- Implied Reg-up of 5
Case 3, DOT = 0, (Reg-up = 5, Reg-down = 10)
AGC Set Point = -2 -- Implied Reg-down of 2

6.3 Enforce the Stored Energy Limit

The Stored Energy Limit will be enforced as it follows

1. For Non REM NGR, the stored energy limit will be enforced in IFM, RTPD and RTD;
2. For NGR with REM option, the stored energy limit will be enforced in RTD;

EMS will observe stored energy limit for both Non REM NGR and REM NGR; For Non REM NGR and NGR REM, the stored energy limit along with the State of Charge from PI data will be used for Spin/non-Spin/Regulation No Pay in settlement.

Using the same example, Stored Energy Limit is 20MWh. Assuming a SOC at 7MWh at the beginning of interval, the limit for what this resource can do for the next interval,
Eng + Spin + Non-Spin + Reg-up <= 7 / Interval Time And
Reg-down – Eng <= 13 / Interval Time
This constraint will be used along with existing constraints like capacity, ramping, etc. in market and settlement. In market, the energy limit will be considered in the horizon rather than a single interval.

6.4 General Settlement for NGR

1. Expected Energy will be calculated in the same manner as generators. The algorithm will be extended to handle the negative limits. All energy will be still calculated based algebraic difference between different MWs.

For example, a DOT of 7MW with a DA schedule of -3MW will possibly result in Optimal Energy of 10MW;

2. Ancillary service No Pay will use the same methods like generators with one additional No Pay based on stored energy limit evaluation;
3. Energy settlement are still based on resource level LMPs and resource MWs. A negative MW normally results in a charge rather than payment.

6.5 NGR for Dispatchable Demand Response (DDR)

The Pmin and Pmax will be both at the negative side.
Pmin = -10, Pmax = -2
An energy bid curve can be submitted as,
{(-8, -5), $10}, {(-5, -3), $20}
With an Energy Self Schedule of -8. The -8 indicates the maximum load level at which this resource can be consuming energy; The -3 indicates the minimum load level that this resource can be curtailed to.
DOT = -6 MW means curtail the load to 6 MW level. The curtailment is (-6 MW – (-8 MW)) = 2 MW.

Demand Response maximum Load Curtailment
Instead of Stored Energy Limit, a NGR resource modeling demand response can have a constraint for the optimization horizon,

1. Maximum Load Curtailment (MWh);

DDR through EMS will send the maximum load curtailment (1 MWh) from now on to the market.

The difference between DOT (-6) and bid-in maximum load level (-8MW) for the optimization horizon cannot exceed the maximum curtailment (1 MWh) /Interval Time.

Other market and settlement perspectives are similar to the NGR storage resources.