Integrated Capacity Analysis Working Group - Long Term Refinement Topics Scoping Document

Prepared for the ICA Working Group by More Than Smart

Background:

A June 7, 2017 Assigned Commissioner Ruling (ACR) set a scope and schedule[1] for continued long-term refinement (LTR) discussions on both Integrated Capacity Analysis (ICA) and Locational Net Benefit Analysis (LNBA). This ACR includes pre-Working Group (WG) deliverables, status reporting, and final reporting milestones for continued long-term refinement discussions. This ACR groups the identified long-term refinement topics into four tiers, which front-loads work on topics of relatively high complexity and/or importance to the further development of ICA (please refer to Table 3 in the ACR). The June ACR also states, "The Working Group shall develop succinct scoping documents, no longer than ten pages in length, that briefly summarize discussions on these topics to date and detail relevant framing questions or considerations to move discussions forward from the outset… More Than Smart shall facilitate the compilation of the scoping documents, which will entail engaging with Working Group members and referencing previous reports to capture all previous discussions and stakeholder positions on the scoped topics". This scoping document summarizes discussions on topics to date and details relevant framing questions or considerations to move discussions forward, drawn from the discussion points already highlighted in the Interim Long-Term Refinement Report[2] and the Final ICA WG Report[3] previously filed. More Than Smart will facilitate the long-term refinement Working Group meetings, lasting six months from the date of the first meeting.

ICA Working Group Long-Term Refinement Topics as outlined in the June ACR

Group I:

1. Further define ICA planning use case and methodologies

Objective: The ICA WG will determine how the ICA may inform and identify DER growth constraints and opportunities in the planning process, in which applications and how ICA may be used, and what methodology (streamlined or iterative), levels of granularity and frequency of updates, may best serve the planning use case.

Background: The ICA WG identified two use cases for ICA: 1) to inform and improve the Rule 21 interconnection process, and 2) to inform and identify DER growth constraints and opportunities in the planning process. The interconnection use case is detailed in the Final ICA WG report. With regards to planning, the ICA may be used to inform the distribution planning process by identifying when and where capacity upgrades may be needed as a result of DER growth, as well as where there is opportunity for additional DER deployment and where DERs could be used to address capacity constraints using various growth scenarios. The ICA has been identified by the CPUC for use in multiple planning processes, including, but not limited to, grid modernization (within DRP) and the IRP. The IOUs have proposed using the streamlined methodology, given that the iterative methodology creates a large

[1] http://drpwg.org/wp-content/uploads/2016/07/189819375_ACR_06.08.17.pdf
[2] http://drpwg.org/wp-content/uploads/2016/07/R.14-08-013-ICA-Status-Report.pdf
[3] http://drpwg.org/wp-content/uploads/2016/07/ICA-WG-Final-Report.pdf

amount of data and requires considerable resources to conduct multiple scenario analysis, which may not be necessary or appropriate for distribution planning efforts. The Working Group has not yet reached a full consensus on whether the streamlined or the iterative methodology is more appropriate for this use case. WG members would like additional information regarding the annual distribution planning process, discuss the full suite of potential applications for ICA within planning, and evaluate methodological needs to meet each of these applications.

The ICA Final Demo A Report identifies several discussion items from WG members. These discussion items for consideration are:

i) Within LTR, the WG should form a specific list of uses of ICA in planning, evaluate the methodological needs for each use case, and determine whether the iterative or streamlined method may better serve that use case, and define what, if any, changes to these methodologies may be necessary to best serve the use case.
ii) Some of the steps the IOUs will take to implement the first system-wide rollout of ICA for the interconnection use case could also eventually benefit the deployment of ICA for the planning use case.
iii) Achieving the ICA values for these identified uses may require a blended approach (using aspects of both iterative and streamlined methodology) based on future discussion on planning use cases.

Some WG members have suggested discussion points for consideration that were included in the ICA WG Final Report, but not necessarily met with full consensus by the entire WG. These discussion points are as follows: a) The scale, pace and prioritization of ratepayer funded grid modernization investments may be guided by projected ICA values. ICA may be one tool to guide and prioritize ratepayer-funded investments for grid modernization as determined by other proceedings; b) IOUs may use the ICA to evaluate DER as potential solutions to address needs identified in the IRP process, or other processes under the DRP (i.e., grid modernization); c) The current system capacity revealed through the ICA may be combined with location-specific projections of DER growth (i.e., DER growth scenarios) to project hosting capacity needs; and d) IOUs and stakeholders may consider the ICA and LNBA in tandem to identify opportunities where additions to hosting capacity can enable DER growth and avoid more costly distribution system upgrades.

Scoping questions: the ICA WG should work to determine:

i) What are the uses of ICA in planning as identified by other Tracks of DRP, other related proceedings (e.g., IDER) and other Commission guidance?
ii) From this pre-identified list of discussion questions, are there any to be added or subtracted?
iii) From these known uses, what methodological needs are required to meet these use cases? Would a streamlined, iterative, or blended approach be most sufficient to serve this use case?

2. Develop standard PV generation profile for use in online maps

Objective: The WG will develop a standard PV generation profile in the first system-wide rollout.

Background: The ICA WG reached full consensus on the six ICA values which will be published on the online maps within the first system-wide roll out. This includes publishing the uniform generation ICA, a

uniform load ICA, and a solar PV ICA value based on a common PV shape. Two sets of these ICA values will be published, addressing two different operational flexibility constraints. The ICA WG is tasked with developing a standard PV generation profile to be used within the online map display within the first system-wide rollout of ICA. This profile should be sufficiently conservative to be relied upon for interconnection approval, and will include monthly variation in solar production.

Scoping questions: the ICA WG should work to determine:

i) A proposed PV generation profile using standard assumptions
ii) Determine whether this profile is sufficiently conservative to use for interconnection approval and will include monthly variation in solar production

3. Develop methods and tools to model smart inverter functionality in ICA calculations

Objective: The WG should determine which additional studies are needed, and then use results to develop a methodology to include smart inverters within ICA.

Background: Within Demo A, the IOUs did not recommend methods for evaluating hosting capacity with smart inverter functionality, but tested smart Volt-var function within Demo A on a limited basis on one distribution feeder, to determine how smart inverters may be able to increase hosting capacity. Resulting studies revealed that smart inverters may be able to support higher levels of hosting capacity in certain system conditions.

While CYME and Synergi already contain the ability to include some advanced inverter functionality, these tools do not have the automation scripts necessary to complete ICA with smart inverters efficiently. Additionally, the WG has not yet discussed and agreed on operational assumptions. Smart inverter standards are not yet finalized. After standards are finalized and the tools are able to implement smart inverter technology in an automated an efficient manner, smart inverter functionality may be included in ICA calculations, and may be included in either the first system-wide rollout or subsequent iterations, depending on timing of methodology development and tool enhancement.

The ICA WG acknowledges that additional studies are needed to develop an appropriate methodology for smart inverters, and that the use of engineering resources for this purpose will need to be prioritized alongside additional ICA study requirements for long-term refinement.

Some studies identified by the WG for consideration include:

i) How the following smart inverter functions and applicable function ranges affect ICA values: 1) Volt-var; 2) fixed power factor; 3) Volt-watt; 4) function prioritization; 5) Phase II communication implications; 6) Phase III advanced functions implications; and 7) future IEEE 1547 oversizing implications, if approved
ii) Determine the range of settings and curves that can provide maximum ICA without negatively affecting the distribution system
iii) Determine the effects of the applications of smart inverter functions to the distribution system reactive capacity and system efficiency

Some stakeholders posed additional study questions with regards to smart inverters within the ICA Final Demo A Report. However, these were not met with consensus by the full ICA WG, with some research studies considered to be more within the scope of the Smart Inverter Working Group. These studies include understanding how ICA may consider dynamic inverter functions, which may include settings to

be changed by season, TOU period, and weekday vs. weekend, and in response to price signals and temperature forecasts, and evaluate this capability in coordination with a need for Rule 21 to include verification of operating profiles before systems can be approved based on dynamic functions.

Scoping questions: Within long-term refinement, the ICA WG will discuss prioritization of studies, and work to develop an appropriate methodology for including smart inverter functionality within ICA.

4. ***Perform comparative assessment of IOUs' implementation of ICA methodology on representative CA circuits.***

Objective: The IOUs are asked to conduct comparative assessment on one or more representative California feeders, consistent with the May 23 ACR.

Background: In Demo A, the IOUs used the IEEE 123 test feeder as a reference circuit to compare IOU Demo A results (using both methodologies) and between power system analysis tools (PG&E and SCE use CYME software, while SDG&E uses Synergi software). It was concluded that ICA results do not show significant variation when tested across the IEEE 123 test feeder, with slight variations attributed to how power flow models are treated between CYME and Synergi. In the ICA WG Final Report, the WG recommended utilizing more representative California feeders as a long-term refinement issue, while considering prioritization of other LTR studies with regards to costs and resources.

Scoping questions:

i) What characteristics, and which representative CA feeder or feeders may be used as a more indicative reference circuit?
ii) How long and how many resources will it take to conduct comparative analysis?
iii) How will the results of comparative analysis be evaluated and acted upon?

Group II:

1. ***Expansion of ICA to single phase feeders (requires creation of network models for single-phase feeders)***

Objective: To expand ICA to single phase line sections, IOUs need to invest in the development of single phase network models. For the first system-wide rollout, IOUs will identify locations of single-phase line sections and their points of connection with three-phase feeders with a unique color on the online map.

Background: ICA values are currently calculated at the three-phase feeder level. The ICA WG, in its long-term refinement discussions, will focus on two activities: 1) development of single phase network models; and 2) evaluation of single-phase ICA tests and development of methodology to include single phase line sections.

With regards to the development of single phase network models, the ICA WG agreed that the first system-wide rollout of ICA would identify single phase line sections on the online maps with a unique color where they connect to three phase line sections. The ICA values would, however, will not be provided for single phase ICA radials. IOUs also need to develop single phase network models. Currently, no complete source of information for network models exists.

With regards to development of methodology, the IOUs proposed to evaluate the impact of performing single-phase ICA on at least one circuit in each Demo A area to test the capability of single-phase radials. It was noted during a November WG meeting that single phase radials are limited in accepting significant additional DER load primarily because of 1) the capacity of the single phase wire; 2) fusing

practices where fuses are used to protect the single phase line from system faults; and 3) a need to maintain overall system balance. The IOUs also asked whether potential alternatives may achieve the same result, such as conducting ICA at the single-phase transformer level, rather than at the single-phase node. Once network models are developed and a single-phase ICA methodology is developed, the WG may also consider implications to initial review screens in the Rule 21 proceeding.

Scoping questions:

i) What resources are necessary to develop single phase network models?
ii) Will the results of the IOU-proposed test on at least one circuit be sufficient for the WG to determine an agreed-upon means of developing single-phase ICA?
iii) How may the ICA results on the single phase feeders alter the Rule 21 review process and what recommendations can the ICA WG share with the Rule 21 proceeding?

2. Method for reflecting effect of potential load modifying resources on integration capacity

Objective: The interim long-term refinement report details initial proposed scoping questions on this non-consensus topic. The WG should aim to refine and clarify the topic, determining what are appropriate analyses or studies to undertake to develop a potential methodology.

Background: This activity was identified in the May 23 ACR. SoCal REN provided scoping proposal for initial discussion, included in the interim long-term refinement report, that interprets the topic in two ways: 1) DER resources not currently dispatched but remain potential load modifying resources; and 2) identified DER resources based on a specific load forecast. It is not clear to the full WG whether this is the best appropriate definition for this topic. The WG was in non-consensus on whether ICA should only focus on grid engineering analyses (e.g., thermal levels, steady state voltage, voltage fluctuation, operational flexibility, and protection limits) or whether non-engineering analysis should be included (e.g., econometric modeling).

Scoping questions:

i) Is it realistic, and does it improve the ICA, if the following are further studied for potential inclusion or modification in the ICA? 1) probabilistic modeling approaches (e.g., inclusion of resource reliability/uncertainty variables); 2) resource impacts modeled on specific key indicators of ICA; 3) potential impacts of new and existing load modifying resources on ICA, based on their impact of historical and forecast load profiles on the distribution grid?

3. Develop non-heuristic approach to modeling operational flexibility

Objective: The WG will develop a proposed non-heuristic methodology for operational flexibility as an alternative to the method used in Demo A.

Background: Demo A tested operational flexibility as a power system limiting criteria. The IOUs tested two scenarios of operational flexibility in Demo A: 1) a no-reverse power flow across SCADA devices, and 2) an ICA value irrespective of flow direction. The first test provides an operational flexibility limit that allows the highest amount of DER to be connected without reducing operational flexibility.

Members of the WG discussed that, while the operational flexibility limit as tested in Demo A is based on solid engineering practice, the way it is currently modeled may be overly conservative. The WG is in agreement that there may be an improved approach to evaluating DER adoption limits related to

operational flexibility and will work to develop a proposed, non-heuristic methodology for operational flexibility.

Scoping questions:

i) What components of the existing operational flexibility limit are considered heuristic, and could be improved?
ii) What are some methodological suggested improvements to the existing methodology that still ensures distribution system reliability?

4. Consider how online maps could reflect queued projects on a given circuit (requires coordination with Rule 21 rulemaking and public interconnection queue)

Objective: The ICA WG will determine an agreed-upon means for online maps to show changes in queued DER since the map was last updated.

Background: The ICA WG identified that the ICA maps should be able to show changes in queued DER since the last map update and changes in the underlying data, so that the map may verify that available capacity has not been absorbed by another interconnection application submitted since the publication of the ICA value. This coordination will require discussion within revised Rule 21 rulemaking.

Scoping questions:

i) How can the ICA maps demonstrate queued capacity in a manner that can inform applicants and the Rule 21 process?

5. DERs that serve peak load

Objective: The ICA WG will evaluate whether a proposal to add four additional load shapes to ICA would allow DERs to better serve high-load conditions while maintaining grid stability at low-load conditions.

Background: Stakeholders from Solar Retina presented on a proposal to modify the ICA to include additional load shapes on occupancy and temperature-driven load patterns, which would allow DERs using simple control schemes to both serve higher load (hotter temperatures, weekdays) as well as self-restrict generation during times of low net-load (colder temperatures, weekends). To achieve this, the ICA would need to include four minimum load shape profiles to include occupancy and temperature-driven load patterns (hot day, weekday; hot day, weekend; cold day, weekday; cold day, weekend).

Scoping questions: Additional discussion is necessary to determine data requires for producing additional profiles, and level of effort needed to analyze additional profiles, with consideration of expected results, computational time, engineering resources, and other constraints.

Group III:

1. Ways to make ICA information more user-friendly and easily accessible (data sharing)

Objective: Within the wider discussion around data access for ICA and LNBA, the ICA WG will specifically work on the means of making ICA information for user-friendly and accessible, including for non-engineers (e.g., community planners, etc.).

Background: The ICA and LNBA WGs have worked on data sharing issues. The WGs developed a spreadsheet of data requests sorted by the following categories: 1) stakeholder type; 2) function

requiring data; 3) rationale for function; 4) data types required; 5) rationale for data type; 6) confidentiality issues; 7) data availability; 8) alternative data sources; and 9) scope.

As part of the interim long-term refinement report, WG members identified the following issues for discussion: a) Understanding linkages to the general DRP proceeding, including potential overlap with issues to be addressed in Track 3, as well as linkages to other proceedings such as the IDER proceeding; b) Understanding data access requests in regards to the identified ICA and LNBA use cases, as well as potentially addressing data in a stepwise approach using the Walk/Jog/Run framework; c) Further refining the data access template; d) Develop ways to make ICA information more user-friendly and accessible, including for non-engineers (e.g., community planners, etc.); and e) Understand capacity and means to share market-sensitive information (e.g., type and timing of the thermal, reactance, or protection limits associated with the hosting capacity on each line)

Scoping questions:

i) What does a more "user friendly" ICA look like, and which users would this include?
ii) Does accessibility include both data access (such as available downloadable data) and overall public access? What useful formats should the downloadable data be provided? What changes would be made to make a public ICA portal more easily accessible?

2. Interactive ICA maps

Objective: The ICA WG will work to determine what improvements may be made to the ICA maps developed through Demo A to make them more interactive while maintaining usability.

Background: The IOUs have published the results of Demo A as additional layers within existing respective Renewable Auction Mechanism (RAM) maps. ICA results and load profiles are also published and available on the Commission's DRP webpage. The WG will first review the ICA maps published through Demo A to determine what improvements could be made to existing maps, including reducing overlap and ensuring a user-friendly interface. The IOUs have suggested proposed updates to the maps that could improve their interactive capabilities, as well as potential challenges with publishing large amounts of data on the map, which will require significant computation resources, and may take the user longer to load the information or navigate through map options, such as by DER growth scenario or by reverse flow options. Additional development of interactive ICA maps will first require an understanding of IT requirements and the benefits of increasing data directly visualized onto ICA maps.

Scoping questions:

i) What are the compared benefits of additional data displayed in an interactive layer versus through downloadable files?
ii) What are the additional IT requirements necessary for expansion of ICA heat maps?

3. Market sensitive information (includes IIT requirements for data sharing, access to market sensitive information, and expanding the functionality and range of data displayed on ICA maps)

The ICA WG agreed in the interim long-term refinement report to group this topic within the wider discussion of data access (see above).

4. Incorporate findings and recommendations from DRP Track 3 Sub-track 1 on DER and load forecasting into ICA as appropriate

Objective: The ICA planning use case envisions that ICA will assist with future planning decisions. ICA, combined with DER growth forecasts (discussed under DRP Track 3, Sub-track 1), can be used to identify circuits that require upgrades to accommodate forecasted DER. This activity will take findings and recommendations from the Revised Frameworks and Assumptions document[4] and/or the ACR Ruling on DER Growth Scenarios and incorporate any necessary changes into ICA, as appropriate.

Background:

Demo A was conducted using two growth scenarios: the a) base distribution planning scenario, and b) the Very High scenario (included in July 2015 DRP filings). The ICA WG concluded before the beginning of the DER Growth Scenarios Working Group (GSWG)[5] process. Some of the discussion that was posed in 2016 and early 2017 with regards to integration of ICA within growth scenarios may be addressed following the conclusion of the GSWG.

The Interstate Renewable Energy Council (IREC) additionally presented discussion questions regarding methodologies for determining growth scenarios are integrated with ICA, and how the ICA results can be used for planning and decision-making processes (including recommendations and results from the DRP Track 3 Sub-Track 1 workshops on DER growth scenarios). These questions are summarized from the original scoping proposal below:

a. An evaluation of the results of the ICA analysis integrated into the growth scenarios (and if the methodologies used provide accurate results that can be used for planning purposes, including annual distribution planning and informing assessments proposed for grid modernization).
b. Are the results actionable over a useful time period, and accurate and granular enough to identify where upgrades will be needed? Do the results inform which type of action that can be taken, or should they?

Scoping questions: As part of Track 3 Sub-Track 1, and as a result of the GSWG, the IOUs have published a Revised Distributed Energy Resource Assumptions & Framework document. Discussions will start with the information here, as well as considering other rulings related to this sub-track.

5. Voltage regulating devices: If the Commission authorizes the IOUs to model voltage regulating devices as they did for Demo A in the initial systemwide ICA rollout, the ICA working group should work with software vendors to include this functionality as a long-term refinement topic.

Objective: If the Commission authorizes IOUs to use the iterative methodology for the first system-wide rollout of ICA for interconnection purposes, then the WG will develop operational assumptions for "unlocked" devices for inclusion into future power flow tools functionalities, and continue to evaluate the value of not locking down the voltage regulator.

Background: The IOUs take various approaches to how they treat voltage regulating devices within the iterative methodology. Devices may be "locked" (voltage regulating devices do not adjust from one simulation to the next in the ICA) or "unlocked" (voltage devices adjust to maximize voltage profile from

[4] http://drpwg.org/wp-content/uploads/2017/04/R-14-08-013-Revised-Distributed-Energy-Resource-Assumptions-Framework-....pdf
[5]

one simulation to the next). In the field, the voltage regulating devices are not locked, so locking them in the model the calculated ICA does not accurately reflect field conditions.

Currently, CYME software (used by PG&E and SCE) does not have the capability for "unlocked" operations allowing voltage control devices to adjust during ICA iterations (referred to as "float"), while Synergi (used by SDG&E) does have that capability. Through WG meetings, the IOUs explained that the CYME module used for Demo A locked voltage devices to better allow for modeling convergence. Although allowing devices to float more closely models real-world conditions, it adds to model complexity which increases divergence and runtime.

The WG is in consensus recommendation that voltage regulating devices should be "unlocked" within the iterative methodology, but are not in consensus with regards to process and timing of implementation which would allow the IOUs to enable this feature. If the Commission authorizes the IOUs to model voltage regulating devices in the same manner they did for Demo A, then the ICA WG will work to develop operational assumptions for inclusion into power flow tools in subsequent iterations of ICA. The WG should continue to evaluate the value of not locking down the voltage regulator.

Scoping questions:

i) What is the difference between CYME and Synergi with regards to capabilities to allow voltage control devices to float? What resources are needed to incorporate "unlocked" devices within ICA?
ii) What is the added value of not locking down the voltage regulator in ICA?

Group IV:

1. Development of ICA validation plans, describing how ICA results can be independently verified

Objective: The WG will consider remaining questions regarding validation, beginning with the scoping questions proposed in the interim long-term refinement report but not yet discussed.

Background: This activity was outlined in the May 23, 2016 ACR as a long-term refinement item. A scoping proposal was presented by LNBL/LLNL, and discussed by the WG. The scoping proposal identifies that any of the concerns with the initial ICA methods have been addressed by moving to more of the iterative methods (i.e., direct simulation of the distribution grid using the commercial models), applying the analysis to all feeders, etc. Some questions regarding validation still remain, as outlined below, and more fully in the scoping proposal.

Scoping Questions:

The original scoping proposal developed a number of questions – a summary of the types of questions are included here. The WG should refer to the original proposal when it begins discussion of this topic.

i) What are the objectives of validation (e.g., believability, repeatability, applicability, etc.)?
ii) Which components need to be verified (input, methodology, tools)?
    i. With regards to input data, what steps should be taken by IOUs, and how well are capabilities and impacts of DER captured in the hourly profile?
    ii. Within the methodology, are methods/assumptions transparent, and can results be compared across ICA methods (e.g., EPRI, Sandia, NREL)
    iii. With regards to verifying the tools, how do results compare across tools (e.g., CYME, Synergi, OpenDSS, GridLab-D)?

iii) How much uncertainty exists, how much is acceptable, and where can it be reduced?
iv) What are the appropriate datasets to serve as a reference point for validation and third-party improvements to the method (e.g., IEEE 123, IEEE 8500, PG&E 12 representative feeders)?

2. Definition of quality assurance and quality control measures (Need to solidify ICA methodologies for interconnection and planning use cases before developing validation and QA/QC methods)

Objective: Define QA/QC measures that are appropriate for ICA after defining the planning use case.

Background: This activity was listed in the May 23 ACR, but the WG had decided to re-visit this topic after Demo A results are published and after the planning use case methodology is solidified before identifying what QA/QC measures may be needed.

Scoping question:

i) What QA/QC methods are necessary for ICA, for both use cases?
ii) Are there additional QA/QC verification needed by either the software vendor or IOU?

3. Explore divergences and tradeoffs between methods employed by SCE and PG&E vs. SDG&E to create load shapes at the feeder, transformer, and customer levels. WG reached consensus on utilizing IOUs' Demo A load shape development methodologies for initial system-wide rollout

Objective: The WG will revisit the means the IOUs develop load shapes, first fully understanding the differences and tradeoffs between those methods used in Demo A, then discussing proposed improvements.

Background: The ICA WG discussed how smart meter data was used by utilities within ICA methodology. It was explained that PG&E and SCE aggregated smart meter measurements to their corresponding distribution transformers, taking distribution transformer load hourly to generate load shapes for each transformer. These load shapes are used in combination with circuit level loading profiles to allocate feeder level forecasted loading down to the service transformer level or individual customer level. SDG&E uses AMI data at the time of the peak of each customer to establish demand, then leverages this data to develop different customer class' load profiles. Each customer class has its own profile and is created per substation bus. The profile curve adding all the customers consumption on each customer class by hour for that specific class and bus. LoadSEER creates monthly profiles curves per circuit for peak and minimum day (48 points per month) using SCADA data at the breakers. These curves get imported into Synergi and the load gets allocated on the feeder using the combination of Customer class's curves at the transformer level and Feeder profile curves at the breaker level.

Scoping questions: The WG discussed these methodologies in some detail, and agreed upon their use in Demo A, but would like to further explore reasons for divergence in methodology, as well as trade-offs between methods, as part of long-term refinement.