Staff Straw Proposal for Conducting Headroom Assessments

Background

The New York utilities performed analyses of their distribution and local transmission systems and identified representative system upgrades that would support achievement of the State's climate policy goals through 2030 in a November 2020 filing, referred to here as the Utility Report.[1] The utilities used several methods for calculating "headroom" for renewable generation in their studies, resulting in some uncertainties as described more fully in Section II of the Initial Power Grid Study Report.[2] Going forward, to identify high-priority and high-value locations for targeted transmission development, and to improve the quality of the information available to policy makers, renewable generation developers, and other stakeholders, more detailed and consistent analyses of headroom will be required than have been performed to date. Future evaluations should quantify the existing headroom available in specific grid locations, and that created by proposed projects (or a portfolio of projects) in transmission-constrained areas on the local and bulk transmission systems. This document discusses potential improvements to the methodologies and assumptions used for headroom calculation.

For the purpose of this proposal, "local transmission" is defined as transmission lines and substations that generally serve local load, and transmission lines which transfer power to other utility service areas and operate at less than 200 kV.[3] The term "headroom" means the projected capability of the grid to support additional renewable energy generation. Headroom may be quantified in the following ways:

1. The electric grid facilities which support the transfer of energy are rated based on power flow capacity or the allowable maximum level use. Hence, the typical limiting condition for additional renewable generation is the rating of specific electric facilities, such as overhead and underground lines, transformers and terminal equipment.[4] **Existing headroom** describes the amount of new renewable generation that can be supported by existing facilities. **Incremental headroom** describes the additional amount of new (or curtailed existing) renewable generation that a new LT&D investment can support.
2. From a installed resource "rating" perspective, headroom can be measured in terms of the MW of new renewable generation capacity that can be supported by the existing grid or the additional new (or constrained existing) renewable generation capacity that

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[1] Case 20-E-00197, supra, Utility Transmission and Distribution Investment Working Group Report (filed November 2, 2020).

[2] See Case 20-E-0197, supra, Initial Report on the Power Grid Study (filed January 19, 2021), subsections II.A.3, II.A.4, and II.C.

[3] This is in contrast to "bulk transmission" facilities that transfer power across or between utility service areas at 200 kV or above.

[4] There are other technical factors that may also present a limiting condition, including voltage control, system stability, fault levels, among others. These should be accounted for if more constraining than the thermal ratings of facilities.

can be accommodated by an upgrade project. For the purpose of this discussion, the MW headroom (existing or incremental) is referred to as the **Capacity Headroom**.

3. Renewable resources, such as solar and wind generators, provide variable renewable energy (VRE) whose total output in MWh varies over the course of days and months and may vary from year to year. It is important to measure this energy in order to track the State's progress towards the Climate Leadership and Community Protection Act (Climate Act) targets. The available energy from a VRE may be limited or curtailed due to the same set of potential limiting conditions that determine Capacity Headroom but, unlike capacity, which is evaluated based on points of maximum system use conditions, energy requires a view of potential curtailments over the course of an entire operating period, such as the entire year. Existing and incremental renewable energy headroom, in this respect, is the MWh amount of additional renewable generation that can be supported without curtailment by the existing grid and incrementally after a upgrade project is placed into service. For the purpose of this discussion, the MWh headroom (existing or incremental) is referred to as **Energy Headroom**.

Types of Local Transmission and Distribution Projects

The Utility Report classifies three types of local transmission and distribution (LT&D) projects based on the manner in which new headroom is achieved.

- **On-ramps** are projects that bring new renewable generation, typically, from lower voltage systems to higher voltage systems. These are projects that connect to the bulk power system (BPS)[5] to transfer power from local generation pockets to load pockets. Distribution projects whose headroom is based on the assumption that distributed energy resources (DER) can backfeed power from distribution feeders to the local transmission level are an example of on-ramps. The backfed power can then combine with other new renewables on the local transmission level to be further on-ramped to the BPS. New renewables may require more than one on-ramp to the bulk power gird to reach load. Careful attention is needed so as not to double count the same new renewable generation being on-ramped more than once.
- **Off-ramps** are projects that deliver generation, typically from higher voltage systems, to serve loads in lower voltage systems. The headroom created by these projects to serve load includes (a) new renewable generation that was on-ramped elsewhere and (b) new renewables that connect directly to the high voltage and extra high voltage[6] system.
- **Projects which address an internal constraint** in a local transmission or distribution circuit allow new renewable generation to feed other loads in the circuit, typically at the same voltage level. The new capacity and energy headroom created by such projects are unique in that these have not been counted in either on-ramp or off-ramp projects.

[5] Bulk Transmission – Transmission line(s) that transfer power across or between states at 200 kV or above. Local Transmission – Transmission line(s) and substation(s) that generally serve local load, and transmission lines which transfer power to other service territories and operate at less than 200 kV.

[6] High voltage includes 115 and 230 kV, while extra high voltage includes 345 kV to 765 kV facilities.

Proposed Improvements to Headroom Determinations

The specific improvements that Staff proposes to consider in conducting headroom assessment analyses are summarized below.

1. **Unified Planning Data and Models**

    a. To help assure consistency and improve the validity of headroom calculations, the utilities should collaborate to periodically produce a unified and shared data base of study assumptions and set of power flow models. The data base and set of power flow models should utilize up-to-date state planning and renewable generation procurement information to reflect the current and projected overall power system assumptions for on-peak, shoulder, and off-peak conditions each on a seasonal basis for a set of defined future model years (e.g., 1 year ahead, 3 years ahead, 5 years ahead and 10 years ahead), reflecting a typical range of renewable generation output levels. The improved study assumptions and power flow models would also provide more accurate and consistent basis for other studies that apply to headroom, such as production cost simulations by the utilities and NYISO.

    b. This endeavor should use the NYISO power system models as the starting point to build more detailed statewide representations. This more global NYISO-wide perspective is particularly important for portions of the system in which two or more utility systems heavily intertwine and are interdependent, and/or where local systems interact more closely with the bulk power system.

    c. The models should reflect likely renewable development locations from a combination of known resources, including the NYISO interconnection queue, utility-specific LT&D interconnection requests, and state planning and renewable procurements.

    d. Detailed sub-transmission and distribution models should be included within these models to the extent they are closely intertwined with transmission and/or may have significant levels of renewable resources. [7] As applicable, these detailed statewide models could be reduced for more localized studies.

    e. The outcome of this effort should include an ongoing mechanism for the utilities to discuss modeling issues that may arise, periodically update models as circumstances change, and facilitate sharing of the most current information.

2. **Assessing local transmission <u>capacity headroom</u> for on-ramp needs:**

    a. Use optimal power flow software (such as TARA's Optimal Transfer feature) to determine the existing headroom for defined regions.

       *(<u>**Note:**</u> The proposed optimal power flow transfer method is similar to the "DFAX" methodology proposed by the Utilities in the Utility study, although, the Utility*

[7] As applicable, remote portions of these detailed statewide models could be equivalenced where there is no impact for more localized studies.

Study proposed this methodology to evaluate the avoided annual MWh curtailments. Our proposal for employing the optimal power flow method to assess annual MWh curtailments is summarized below in Part 2: "Assessing local transmission energy headroom for on-ramp needs")

b. Define regions bounded by electric interfaces, including the NYISO bulk power interfaces and any LT&D interfaces that lead to known curtailments of renewables. Regions should not be defined solely by utility footprints.

c. Develop power flow models that include the details of the bulk power, LT&D, and potential locations for new renewables, expanded from the NYISO models used for planning. Where information is available, represent backfeed from the distribution system, storage buildout, and steady-state representation of advanced technologies.

d. To identify potential size and type of renewable generation at specific locations, consider land availability and topography, siting incentives such as favorable zoning laws, community acceptance, local costs and other relevant factors.

e. Develop a range of capacity headroom values for each model year based on different renewable generation interconnection locations and size cases. Highlight which locations and/or combinations will maximize headroom for on-ramps out of the constrained regions.

f. A simplified example is provided in the Appendix.

3. Assessing local transmission energy headroom for on-ramp needs:

a. Develop multiple power flow cases representing typical operating states that may be expected to occur during a year. For each power flow case, define a percentage of hours in the year for which each case is representative.

b. Determine the annual energy headroom from the individual power flow case headroom estimates and percentages.

c. Additionally, consider developing production simulations (such as an expanded version of NYISO's MAPS simulations) that includes detailed representations of bulk power and LT&D transmission facilities and constraints.

(***Note:*** *This proposed method to assess energy headroom for on-ramps is akin to the "DFAX" methodology proposed by the Utilities in the Utility study, with the exception that the utility study's DFAX method proposed an 8,760 hourly power flow assessment, instead of developing a set of seasonal representative power flow cases to estimate the annual energy headroom. Production cost simulations also are identified as another methodology in the Utility Study. Such production simulations should be performed with the improvements proposed above in part c. (i.e. with detailed representations of bulk power and LT&D transmission facilities and an extensive set of impactful constraints).*

4. **Assessing <u>distribution headroom</u> for on-ramp needs:**

    a. Use a software model that represents the electrical system beyond the substation transformer and can capture the effects of load, renewable generation and storage variations, circuit characteristics, and protection at the distribution level.

    b. Consider downstream constraints, including limitations on thermal, voltage and other factors along the full length of the feeder.

5. **Assessing LT&D <u>off-ramp headroom</u> for delivering new renewable generation to loads <u>radially connected</u> via one off-ramp transmission connection:**

    a. Develop a model of the load pocket or distribution feeder, which includes existing and projected levels of local generation, storage and load. The existing off-ramp headroom capacity is the highest amount of generation that can be delivered to the load pocket or distribution feeder at the location of the off-ramp, typically at a step-down transmission location. The incremental headroom is the additional amount of new generation that can be delivered to the load pocket after an off-ramp project is implemented.

    *(**<u>Note:</u>** This methodology is similar to that proposed in the Utility Study's "Load Duration Curve" method, proposed for stand-alone or embedded load pockets to evaluate the annual amount of energy unbottled by projects, wherein the load hourly profiles are compared with the transfer capability into the load pocket.)*

6. **Assessing LT&D <u>off-ramp headroom</u> for delivering new renewable generation to a <u>meshed</u> load pocket with multiple off-ramp transmission connections:**

    a. Develop power flow models of the meshed load pocket representing selected cases for generation, load, and other variables within the load pocket. The external system may be represented by a reduced equivalent where new renewable generation can be represented by a single source model.

    b. Use optimal power flow software (such as TARA's Optimal Transfer feature) to determine the amount of generation from the single source model that can be delivered to the load pocket via the meshed off-ramp network.

Appendix: Simplified Example of Assessing Local Transmission Capacity Headroom for On-ramp Needs

Study System

The study focuses on a specific region in New York where there is significant developer interest in interconnecting renewables. The local on-ramp-constrained region has 4 identified potential points of interconnection (POI) for renewable generation referred to as POIs A, B, C and D.

Study Objective

The objective of the study is to determine the existing capacity headroom and the incremental capacity headroom for a specific transmission project.

Assumptions:

- Considers one study year, three load levels (heavy load, shoulder load and light load). The potential renewable generation is dispatched at the appropriate output for each power flow model. Each power flow case is sufficiently modeled in accordance with **Unified Planning Data and Models** described in the main text**.**
- Transmission constraints based only on thermal limits under n-0 and n-1 conditions.
- Analysis conducted using the TARA Optimal Transfer function.

Analysis

For each of the 3 study power flow cases, the four POIs are identified as the Sending Area while an external portion of the New York system is designated as the Receiving Area. The POIs in the Sending Area have generation that can be adjusted to increase output using the SCRD TARA defaults. The Receiving Area generators likewise can decrease output to match the increases from the Sending Area plus losses. The TARA optimal transfer function is run to obtain the maximum Sending Area generation and the contributions from each POI for each study power flow case.

The results of the runs are as follows:

Table of Sending Area MW for each of the Study Power Flow Cases

Power Flow Case	Optimal Transfer	POI A	POI B	POI C	POI D
Heavy Load	380	0	60	140	180
Shoulder Load	400	0	130	90	180
Light Load	400	20	50	170	160

From these results, the existing capacity headroom is designated as 380 MW, using the lowest of the optimal transfer values.

The proposed transmission project is added to each of the study power flow models and the analysis repeated. The results of the runs with the added transmission project modeled are as follows:

Table of Sending Area MW for each of the Study Power Flow Cases with Transmission Project added

Power Flow Case	Optimal Transfer	POI A	POI B	POI C	POI D
Heavy Load	1620	680	40	850	50
Shoulder Load	1700	780	0	750	170
Light Load	1760	860	0	610	290

Based on the results with the transmission project in service, the new capacity headroom is designated as 1620 MW, using the lowest of the optimal transfer values. Comparing with the existing headroom, the incremental capacity headroom provided by the transmission project is 1240 MW.

It is important to note that these capacity headroom values are applicable only before any new renewable is added to the models. For example, adding a 100 MW renewable project at POI A modeled at the appropriate output level for each of the power flow models will change the optimal transfer values and the associated POI values. Hence, there would be a need to periodically renew the headroom calculations as the grid changes.

Exclusions

Note further that capacity headroom values are not the same as installed capacity or nameplate headroom. An additional calculation is needed to convert the optimal transfer values to specific technology nameplate capacity.

The results of this simplified example will require subsequent verification under:

- Other system conditions, such as the pumping state of pumped storage facilities, dispatch of nuclear units and other likely conditions.
- Other reliability tests including n-1-1, voltage criteria, stability, short circuit withstand.
- Other study years