- **Regulation up and down:** Modeled as 1% of hourly load
- **Load following up and down:** Modeled as 3% of hourly load

6.2 Additional LSR Dam Power System Benefits (not modeled)

As described in this report, RESOLVE covers replacement of most power services provided by the LSR dams. However, RESOLVE does not model transmission grid operations (power flow, voltage and frequency, dynamic stability, etc.). Therefore, E3 notes that the LSR dams ~~may~~ provide the following additional essential reliability services to the transmission grid. In general, E3 expects that the replacement of these services can be achieved either through siting and operations of the incremental replacement capacity selected or by additionally ~~(relatively small)~~ local transmission investments.

- **Reactive power and voltage control**: the LSR dams, like hydropower resources generally in the Northwest, provide significant reactive power capabilities that supports reliable power flow by optimally controlling voltage levels. Replacing this function likely requires siting additional resources with reactive power capabilities in a similar section of the transmission grid as the LSR dams. ~~The LSR dams are also highly tolerant of operating during high and low frequency events without sustaining blade damage.~~
- **Frequency response and inertia**: the LSR dams provide both primary and secondary frequency response capabilities. As synchronous generators they also provide system inertia that would be ~~is~~ lost if the LSR dams are removed and as other synchronous generators retire. New efforts are underway to allow renewable generators or battery storage to provide "synthetic inertia" (or equivalent fast frequency response services), but this provision has not yet been proven to date at scale. The LSR dams are also highly tolerant of operating during high and low frequency events without sustaining blade damage.
- **Blackstart**: Large hydro resources have the capability to provide black start services when required, though not all hydro plants are chosen to provide this capability. Small ~~(low-head)~~ hydro typically cannot black start on their own; however, the Idaho National Laboratory has experimented with enhancing this capability through retrofitting small hydro systems with ultracapacitors.
- **Participation in remedial action schemes**: Hydropower is a robust resource for participation in remedial action schemes because it can withstand being suddenly tripped off-line as part of a RAS action.
- **Short circuit and grounding contribution**: Synchronous generators (like hydropower) provides a large short circuit current that is important for the proper operation of protective relaying schemes~~can be sustained; exact contribution depends on the hydro generator type~~.

Comment [AB42]: Q for BPA - NWEC did some transmission analysis in their 2018 study. Is it appropriate to reference that work? Or should we keep it generic?

Comment [AB43]: Also, note that I incorporated BPA Tx team's feedback here, but would welcome their review of this appendix before we publish.

Comment [EAJ44]: Maybe instead say "comparatively small" since they are still big costs, just not as big as the RESOLVE modeled costs.

Comment [JA45]: I think the term "relatively small" should be removed. I don't think we fully know what all the costs will be in order to fully replace on these various services.

Comment [JA46]: I am not sure that this statement is technically correct. It is also unclear as to what they consider "small hydro" to be. Our Lower Columbia projects are considered low head, but they are certainly not small.

Comment [AB47]: BPA - we propose deleting this appendix placeholder section that was here on the Regional Capacity Needs. There already is a ton of info out there on near-term capacity needs, the report is quite long already, and we don't have much extra budget to draft a comprehensive appendix here. Please confirm you're ok dropping it or your thoughts.