5.2. Use of storage technologies for ancillary services provision and its potential for climate change mitigation

Appendix C

Short circuit capacity and PV-curves

October, 2020

MEDIO AMBIENTE
SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES
INECC
INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
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This report is part of the study:

Technology Roadmap and Mitigation Potential of Utility-scale Electricity Storage in Mexico

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Appendix C

Short circuit capacity and PV-curves

To identify the electrical robustness of the buses, the short circuit capacity metric (SSC) of each one is appropriate. This depends primarily on the connectivity of each of the busbars. Below is a summary of the most robust buses per control area, sorted by capacity. Figure A.1 indicates the geographical area where they are located.

Occidental	Oriental	Central	Noreste
QUERETARO MAN (SCC = 1)	POZARICA (SCC = 0.84)	TULA (SCC = 0.81)	CHAMPAYAN (SCC = 0.64)
QUERETARO POT (SCC = 0.94)	POZARICA1 (SCC = 0.83)	TEOTIHUACAN (SCC = 0.77)	TAMPICO (SCC = 0.62)
SALAMANCA (SCC = 0.85)	POZARICA3 (SCC = 0.83)	TEOTIHUACAN2 (SCC = 0.77)	ANAHUAC (SCC = 0.43)

Noroeste	Norte	Peninsular
MAZATLAN1 (SCC = 0.07)	MOCTEZUMA (SCC = 0.08)	CHICBUL (SCC = 0.01)
MAZATLAN2 (SCC = 0.07)	MOCTEZUMA-CEVF (SCC = 0.07)	ESCARCEGA (SCC = 0.01)
MAZATLAN3 (SCC = 0.07)	CASASGRANDES (SCC = 0.06)	SABANCUY (SCC = 0.01)

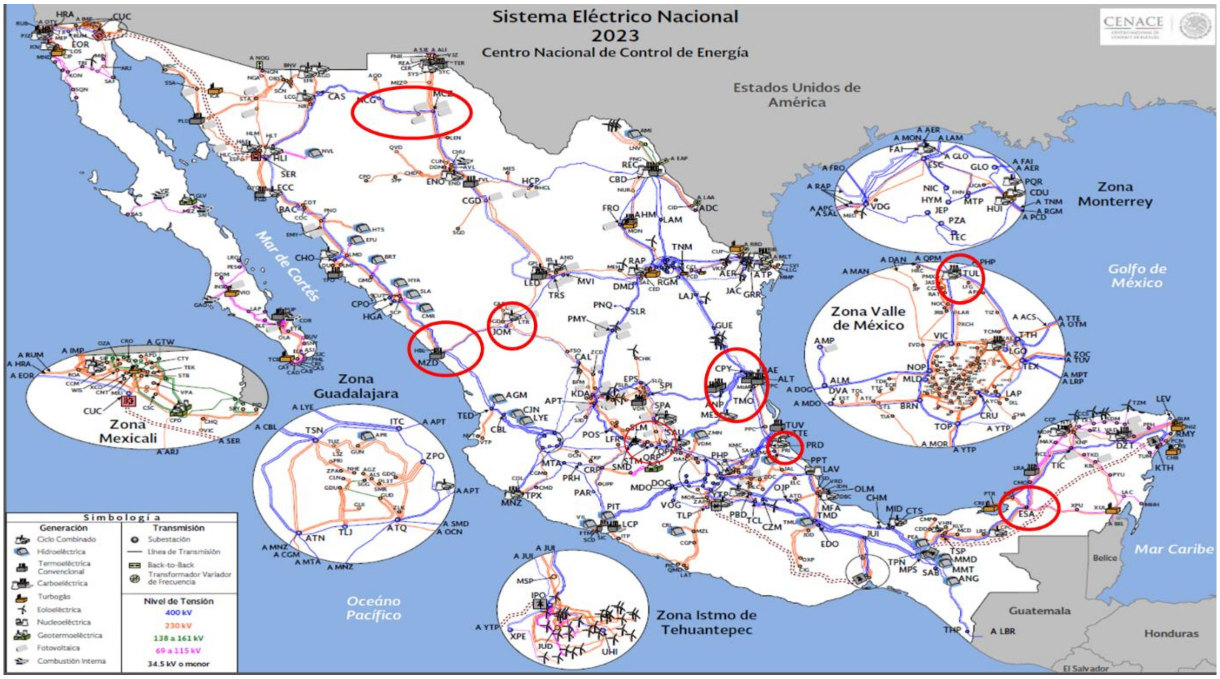

Figure C.1 The red circles indicate the most robust electrical zones per control area.

Note an important difference in the short circuit capabilities of the MIS. Note that towards the geographic center of the country the buses with greater electrical robustness are presented (Salamanca-Querétaro-Tula zone). On the contrary, the Peninsular and Northwest control areas exhibit much lower values than the rest of the areas, indicating their electrical weakness. Finally, this shows that such areas require attention for their operation.

Difficulties with voltages

Reactive power cannot be transmitted over large power angles, even with large voltage differences. Large angles are due to long lines and large active power transfers. The requirement to maintain voltage profiles at approximately 1 ± 0.05 pu contributes to this problem. In contrast to real power transfer, reactive power cannot be transmitted over long distances.

PV curves

The process of obtaining P-V Curves involves a series of load flow solutions by increasing the real power (MW) transfer from source to sink and as a result variation of voltage at different buses is monitored. As the relation between P and V is nonlinear, it involves the full power flow solution. The real power transfer is incremented as at constant power factor, and the bus voltages are monitored. Curves are plotted for load buses. It can be observed that the voltage decreases rapidly at knee point, which is indicative of instability. This nose point or knee point indicates the stability limit and power system should never be operated near the stability limit as it may lead to large scale blackout. Sufficient power margin should be allowed for satisfactory operation of the system.

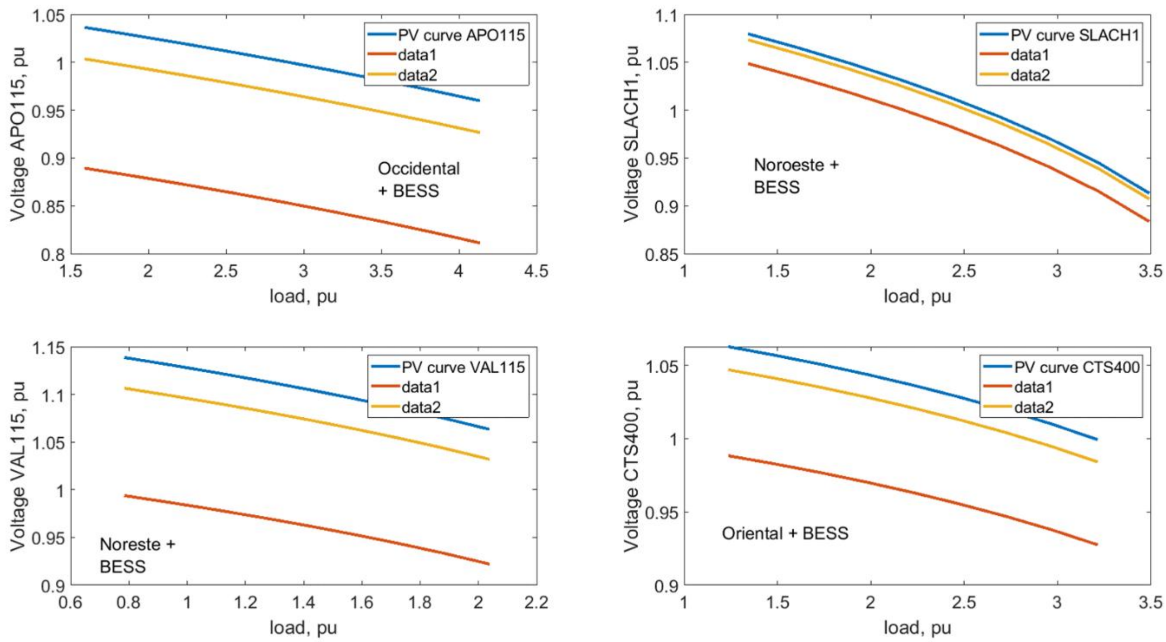

Figure C.1. PV curves with and without BESS

Some advantages of using compensation

- Loss reduction
- Improved voltage profile
- Frees up capacity on transmission lines

	maximum MW range				
SIN	21	339	679	1018	1696

That represents a maximum MW range reserved to correct frequency deviations and Area Control Error for that hour. We know that MWh is what drives emissions production.

Let us assume three scenarios: replace 10%, 25% and 50% of the base case conventional generation MWs assigned for reserve by energy storage. For the 1700 MW frequency regulation reserve margin for that hour, it means that the 10% scenario replaces 170 MW of fossil generation with storage; the 25% scenario replaces 425 MWs, and the 50% scenario replaces 850 MW. For such hour, that represented a maximum MWh output reduction from fossil units of (170*100/60,000 =) 0.283%, 0.708% and 1.417%. Note that the calculations were made assuming a peak demand of 60 GW.

- Most hours the frequency regulation requirement is much lower than the requirement during the daily system peak hour.

- During a substantial number of AGC cycles over a 1 hour period the resources are lowering their output (and thus reducing emissions) rather than increasing their output to correct for over frequency and positive ACE deviations.

- ·The mix of conventional resources actually providing frequency regulation favors combined cycles, rather than coal or combustion turbines.

- In actuality, the amount of MWs required for regulation is relatively small compared to the overall energy requirements for the reliable and economic operation of the system. Hence, by examining the entire system when comparing the emissions differences, the savings will appear relatively small compared to the total emissions required for the operation of the system.