

**GCDAMP Knowledge Assessment: Drivers & Constraints**

Resource Topic:	Hydropower and energy
Preparer(s):	WAPA: Craig Ellsworth, Shane Capron, Clayton Palmer, Dave Welker, Chrystal Dean; Reclamation: Paul Davidson and Nick Williams; GCDAMP: [unclear]
Version Date:	2/14/2017

Resource Characteristic	Driver or Constraint	Strength	Direction	Confidence	Rationale: Strength & Direction	Rationale: Confidence	Recommendations
Electric generation (energy production)	Declining reservoir elevation	Strong	Negative Effect	High	Lower reservoir elevations reduce the efficiencies of electrical generation	Can be modeled and measured	Look for ways of increasing reservoir elevation at Lake Powell.
Electric generation (energy production)	Experimentation (HFEs, LSFs, etc.)	Moderate	Negative Effect	High	Experimentation generally reduces the amount of power with the use of the bypass tubes.	Bypass can be easily measured and described.	Look for ways to conduct experiments that enhance the value of power.
Electric generation (energy production)	Ramp rate limits	Weak	No Effect	High	Energy production is unaffected by ramp rates		
Electric generation (energy production)	Monthly volume distribution	Weak	Negative Effect	High	Monthly volumes affect reservoir elevations which may affect energy production		
Electric generation (energy production)	Daily fluctuation limits	Weak	No Effect	High	Energy production is unaffected by daily patterns		
Electric generation (energy production)	Minimum and maximum release caps	Weak	No Effect	High	Energy production is unaffected by caps		
Electric generation (energy production)	Equalization events	Weak	Negative Effect	High	May reduce reservoir elevations which may affect energy production		
Electric generation (energy production)	Transmission constraints	Weak	Unknown	Medium	Energy production would only be affected in transmission-related emergency conditions		
Electric generation (energy production)	Maintenance constraints	Moderate	Negative Effect	High	The reduction in unit availability decreases the amount of energy produced		
Electric generation (energy value)	Declining reservoir elevation	Strong	Negative Effect	High	Monthly volumes affect reservoir elevations which reduce the amount of energy produced when lake levels decline		
Electric generation (energy value)	Experimentation (HFEs, LSFs, etc.)	Strong	Negative Effect	Medium	Experimentation generally results in power being produced off-peak or bypassed which reduces value.	Sometimes ways are found to conduct the experiment to occur coincident with power production but generally power production is a lesser concern when developing the experiment.	Look for ways to conduct experiments coincident with power production.
Electric generation (energy value)	Minimum and maximum release caps	Strong	Negative Effect	Medium	Limitations on maximum fluctuations can reduce the value of power because additional water can't be utilized during high demand times		
Electric generation (energy value)	Ramp rate limits	Weak	Negative Effect	Medium	Limitations on ramp rates reduce the value of power because additional water can't be utilized during high demand times		
Electric generation (energy value)	Daily fluctuation limits	Strong	Negative Effect	High	Limitations on fluctuations reduce the value of power because additional water can't be utilized during high demand times		
Electric generation (energy value)	Monthly volume distribution	Strong	Negative Effect	High	Restrictions in moving water or limiting water movement between months reduces the value of power because shoulder months typically have lower power values while peak winter and summer months have higher values		
Electric generation (energy value)	Equalization events	Weak	Positive Effect	Medium	Equalization can increase revenues but often result in equal or lower prices for power produced due to the nature of high flow years, may limit ability to follow load due to volume constraints and generator availability		

HYDROPOWER and ENERGY

Electric generation (energy value)	Transmission constraints	Strong	Negative Effect	Medium	Can limit energy production by locations and limit value due to pathway limitations		
Electric generation (energy value)	Maintenance constraints	Strong	Negative Effect	High	Reduced unit availability results in less energy available to economically schedule end of month release targets		
Electric generation (capacity)	Declining reservoir elevation	Strong	Negative Effect	High	Monthly volumes affect reservoir elevations which reduce the amount of energy produced when lake levels decline		
Electric generation (capacity)	Experimentation (HFEs, LSFs, etc.)	Strong	Negative Effect	Medium	Experimentation generally results in power being produced off-peak or bypassed which reduces capacity values.	Sometimes ways are found to conduct the experiment to occur coincident with power production but generally power production is a lesser concern when developing the experiment.	
Electric generation (capacity)	Minimum and maximum release caps	Strong	Negative Effect	Medium	Limitations on maximum fluctuations can reduce capacity because additional water can't be utilized during high demand times		
Electric generation (capacity)	Ramp rate limits	Weak	Negative Effect	Medium	Limitations on ramp rates reduce capacity because additional water can't be utilized during high demand times		
Electric generation (capacity)	Daily fluctuation limits	Strong	Negative Effect	High	Limitations on fluctuations reduce capacity because additional water can't be utilized during high demand times		
Electric generation (capacity)	Monthly volume distribution	Strong	Negative Effect	High	Moving water from peak winter and summer months to shoulder months reduces capacity.		
Electric generation (capacity)	Equalization events	Weak	Positive Effect	Medium	Equalization can increase capacity may limit ability to follow load due to volume constraints and generator availability		
Electric generation (capacity)	Transmission constraints	Strong	Negative Effect	Medium	Can limit energy production by locations and limit value due to pathway limitations		
Electric generation (capacity)	Maintenance constraints	Strong	Negative Effect	High	Reduced unit availability results in less energy available to economically schedule end of month release targets		
Load following capability	Declining reservoir elevation	Weak	No Effect	High	No effect to power production		
Load following capability	Experimentation (HFEs, LSFs, etc.)	Moderate	Negative Effect	Medium	HFEs redistribute monthly volumes, LSF will limit fluctuations, bugflows reduce fluctuations on the weekend/increase fluctuations on the weekday		
Load following capability	Minimum and maximum release caps	Strong	Negative Effect	High	Restrictions directly reduce load following capability		
Load following capability	Ramp rate limits	Strong	Negative Effect	High	Restrictions directly reduce load following capability		
Load following capability	Daily fluctuation limits	Strong	Negative Effect	High	Restrictions directly reduce load following capability		
Load following capability	Monthly volume distribution	Moderate	Unknown	High	Mixed affect: sometimes positive, sometimes negative depending on how monthly volumes are redistributed.		
Load following capability	Equalization events	Moderate	Unknown	High	Mixed affect: sometimes positive, sometimes negative. High volumes can reduce load following in order to pass volume.		
Load following capability	Transmission constraints	Strong	Negative Effect	Medium	May require daily/monthly redistribution of volume		

HYDROPOWER and ENERGY

Load following capability	Maintenance constraints	Strong	Negative Effect	High	Reduced unit availability results in less energy available to economically schedule end of month release targets		
Emissions	Declining reservoir elevation	Strong	Negative Effect	High	Reduces efficiency, decreases MWh produced thus other energy sources must be utilized		
Emissions	Experimentation (HFES, LSFs, etc.)	Strong	Unknown	Medium	Mixed effects. Experiments that bypass power generally increase emissions.		
Emissions	Minimum and maximum release caps	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Ramp rate limits	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Daily fluctuation limits	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Monthly volume distribution	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Equalization events	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Transmission constraints	Moderate	Unknown	Medium	The effects on emissions are complex and depend on when power is produced and the fuel mix at that time.		
Emissions	Maintenance constraints	Moderate	Unknown	Medium	The effects on emission are complex and depend on when power is produced and the fuel mix at that time.		
Net firming purchases	Declining reservoir elevation	Strong	Negative Effect	High	Decreases MWh produced and increases firming costs.		
Net firming purchases	Experimentation (HFES, LSFs, etc.)	Moderate	Negative Effect	Medium	Decreases MWh produced, or alters on peak/off peak ratio, and increases firming costs \$.		
Net firming purchases	Minimum and maximum release caps	Strong	Negative Effect	High	Firming required to meet customer peak demands.		
Net firming purchases	Ramp rate limits	Strong	Negative Effect	High	Firming required to meet customer peak demands.		
Net firming purchases	Monthly volume distribution	Strong	Unknown	High	Mixed effect: sometimes positive, sometimes negative depending on how monthly volumes are distributed to meet customer load and pricing.		
Net firming purchases	Daily fluctuation limits	Moderate	Negative Effect	High	Firming required to meet customer peak demands.		
Net firming purchases	Equalization events	Moderate	Positive Effect	High	Equalization likely results in net zero firming purchases (flows above 10 MAF) - not sure what flows define equalization flows vs balancing		
Net firming purchases	Transmission constraints	Strong	Negative Effect	Medium	May require daily/monthly redistribution of volume which can affect purchase power amounts and net cost		

HYDROPOWER and ENERGY

Net firming purchases	Maintenance constraints	Strong	Unknown	Medium	Mixed Effect: Reduced plant capacity results in a flatter daily and monthly pattern, resulting in increased purchase costs in the peak hours, but could result in sales in the off peak hours netting the firm purchase power closer to zero		
Hydro-mechanical equipment	Experimentation (HFES, LSFs, etc.)	Weak	Negative Effect	High	Increased use of the bypass tubes during HFES results in accelerated wear of the bypass tube coatings and valves.	Sediment modeling for the LTEMP shows HFES are likely to occur frequently over the 20-year operations period. There is high confidence that HFES will continue to occur annually, on average.	Identify maintenance costs for bypass tubes/valves and clarify funding source for this maintenance.