5.10 HYDROPOWER

The impacts to hydropower were estimated by evaluating the total value of hydropower production for both the capacity and energy components with respect to alternative replacement costs, as discussed in the Hydropower Economics technical report for the DEIS (Corps, 1994i). Differences in the hydropower benefits for the alternatives are reviewed from different perspectives, including a breakdown of capacity and energy values. The capacity value represents the amount of generation capacity available from the hydropower units in light of various constraints. The energy value is the amount of power generated during a specified time period.

It should be noted that the numbers presented in this RDEIS reflect a recent reanalysis of the basic unit values for capacity and energy. The basic application of these values in the hydropower economic impact model has not changed from that discussed in the Hydropower Economics technical report (Corps 1994i); only the monetary amounts assigned to these values have been adjusted.

The total economic hydropower benefits for the alternatives are presented in Table 5.10-1 and Figure 5.10-1. Table 5.10-1 also includes data for each of the six mainstem dams. The greatest total average annual benefits for the 100-year period of analysis occur under the FWS30 alternative ($755.47 million), and the least occur under the MLDDA alternative ($737.41 million), a difference of approximately 2.5 percent.

The CWCP has a flat release of 34.5 kcfs from Gavins Point Dam during spring and summer of most years; during major droughts, this release is reduced to 28.5 kcfs. This operational pattern results in $741.52 million of total average annual benefits for the Mainstem Reservoir System hydropower production. The majority of the hydropower benefit comes from two dams, Oahe (29.7 percent) and Garrison (20.6 percent). The contributions of the remaining four dams are as follows: Big Bend (17.8 percent), Fort Randall (16.6 percent), Fort Peck (9.5 percent), and Gavins Point (5.8 percent).

Figure 5.10-1 depicts the distribution of the total benefits of the alternatives. Two alternatives—BIOP and FWS30—are grouped at the top of the distribution, separated by only $0.20 million. The MLDDA alternative results in the least average annual benefits, $4.11 million (0.6 percent) below the CWCP. The other alternatives all result in greater average annual benefits than the CWCP. The greatest increase occurs under the FWS30 alternative, closely followed by the BIOP alternative. The ARNRC, MODC, and MRBA (in descending order) form a loose grouping between the CWCP and the FWS30 and BIOP alternatives.

The MLDDA alternative differs from the CWCP by setting aside an extra 2 MAF of system storage for flood control. The resulting decrease in capacity produces a slight (0.6 percent) reduction in total average annual hydropower benefits compared to the CWCP. Total hydropower benefit reductions, ranging from 0.2 percent to 1.1 percent, occur at five of the six dams. A 0.3 percent increase in average annual hydropower benefits occurs at Big Bend Dam.

The combination of increased drought conservation measures, periodic spring rise, and annual decreased summer releases under the ARNRC alternative results in a 1.2 percent increase in total average annual hydropower benefits, compared to the CWCP. The bulk of this increase comes from Garrison and Oahe Dams, which show increases of 5.1 percent and 2.5 percent, respectively. At the three lower dams (Big Bend, Fort Randall, and Gavins Point), the ARNRC alternative results in

Table 5.10-1. Average annual hydropower benefits ($millions).

Alternative	Total	Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point
CWCP	**741.52**	70.28	152.59	220.04	132.19	123.34	43.08
MLDDA	**737.41**	70.13	151.27	217.60	132.53	122.91	42.97
ARNRC	**750.52**	70.82	160.32	225.53	130.33	121.64	41.88
MRBA	**747.14**	71.06	155.78	222.51	131.98	122.89	42.92
MODC	**749.38**	70.97	156.74	223.55	131.94	123.23	42.95
BIOP	**755.27**	71.21	158.23	225.86	132.88	123.10	43.99
FWS30	**755.47**	71.31	158.94	225.68	133.04	122.68	43.82

decreases in average annual hydropower benefits ranging from 1.4 to 2.8 percent.

Similar to the CWCP, the MRBA and MODC alternatives maintain a flat release from Gavins Point Dam during the summer; however, intrasystem regulation is unbalanced under these alternatives, and drought conservation in the upper three lakes is increased. These changes result in small increases in total average annual hydropower benefits, 0.8 percent for MRBA and 1.1 percent for MODC. For both alternatives, increases in hydropower benefits come from the three upper dams, while decreases occur at the three lower dams.

The greatest average annual hydropower benefits occur under the BIOP and FWS30 alternatives, which feature increased drought conservation measures and spring rises at Gavins Point and Fort Peck Dams, but higher summer flows than the ARNRC alternative. Both of these alternatives result in 1.9 percent increases in total average annual hydropower benefits compared to the CWCP. Under both alternatives, increases occur at all dams except Fort Randall.

The annual values of total hydropower benefits for the alternatives are shown in Figures 5.10-2 through 5.10-4. Hydropower benefits are highly variable during the entire period of analysis, and none of the alternatives performs consistently better or worse than any of the others. For all alternatives, the lowest total hydropower benefit values occur during the 1930 to 1941 drought. Additional low points occur during the late 1950s and late 1980s. The figures indicate that the alternatives that feature drought conservation measures (i.e., all except the MLDDA alternative) generally provide higher benefits than the CWCP during drought periods.

Figure 5.10-2 shows that the MRBA and the MODC alternatives, with essentially the same increased drought conservation measures, exhibit very similar patterns, producing higher annual hydropower benefits than the CWCP during most of the 1930s and 1940s. In Figure 5.10-3, the ARNRC alternative, with its highest drought conservation measures, results in higher benefits than the CWCP during and after the 1930 to 1941 drought, as well as during the 1960s and 1990s. In contrast, the MLDDA alternative remains very close to the CWCP, showing higher values only for brief periods during the 1930s and 1940s (Figure 5.10-3). As shown in Figure 5.10-4, the BIOP and FWS30 alternatives, with the same increased drought conservation measures as the MRBA alternative, match each other almost exactly and are very similar to the MRBA alternative. The most noticeable differences occur during the 1940s, 1950s, and 1990s, when the BIOP and FWS30 alternatives produce greater benefits than the MRBA alternative (as well as the CWCP).

The month-to-month distributions of the average annual generating capacity values for the full 100-year period of analysis are presented in Table 5.10-2 and Figures 5.10-5 through 5.10-7. In general, the total generating capacity at the mainstem dams is at its highest level in the summer months. Under most alternatives, the lowest levels of generating capacity occur during spring and fall and an intermediate peak occurs during winter. The exception to this pattern occurs under the two alternatives that maximize benefits to fish and wildlife (BIOP and FWS30), both of which lack the capacity drop-offs during spring and fall, showing instead a gradual increase in capacity from winter to summer. The relative effects of the other five alternatives remain consistent throughout the year. The MLDDA results in slightly lower monthly average peaking capacities than the CWCP, and the MRBA, MODC, and ARNRC alternatives result (in increasing order) in higher levels. During autumn,

Table 5.10-2. Monthly average hydropower peaking capacity (MW).

Alternative	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CWCP	2,146	2,148	2,053	2,009	2,130	2,244	2,270	2,255	2,089	2,071	2,150	2,141
MLDDA	2,132	2,134	2,037	1,995	2,117	2,231	2,259	2,243	2,069	2,050	2,133	2,127
ARNRC	2,210	2,213	2,112	2,058	2,179	2,292	2,322	2,322	2,158	2,139	2,220	2,206
MRBA	2,179	2,183	2,085	2,035	2,162	2,276	2,299	2,286	2,118	2,095	2,180	2,174
MODC	2,190	2,194	2,093	2,041	2,166	2,282	2,307	2,295	2,127	2,103	2,190	2,185
BIOP	2,224	2,226	2,238	2,255	2,253	2,279	2,313	2,312	2,295	2,270	2,237	2,219
FWS30	2,229	2,231	2,243	2,261	2,259	2,280	2,315	2,315	2,298	2,274	2,242	2,224

winter, and spring, the BIOP and FWS30 alternatives result in the highest peaking capacities, but they fall slightly below the level of the ARNRC alternative during the summer. The energy distributions, in thousands of megawatt-hours, or gigawatt-hours (GWh), are presented in Table 5.10-3 and in Figures 5.10-8 through 5.10-10. Overall, the annual patterns of the alternatives fall into two groups. Under most alternatives, the values are lowest in March, increasing each month to peak during the summer, and then gradually returning to the low value in March. In contrast, the three alternatives with a Gavins Point spring rise followed by summer flows lower than those of the CWCP (the ARNRC, BIOP, and FWS30 alternatives) have two peaks (in May and September), separated by a secondary low during the summer months.

Compared to the CWCP, the lower base of flood control under the MLDDA alternative results in slightly lower energy values throughout the year, except in February and March. As a result of the Gavins Point Dam spring rise and summer low releases, the ARNRC alternative results in higher energy values than the CWCP during the spring and fall, but considerably lower values during late summer. The increased drought conservation measures of the MRBA and MODC alternatives generally result in lower energy values during the winter months, but higher values during spring, summer, and autumn, relative to the CWCP. The BIOP and FWS30 alternatives follow a pattern similar to that of the ARNRC, although they do not fall as far below the CWCP during the month of July.

For the region in which the Mainstem Reservoir System hydropower facilities operate, Federal hydroelectric generating capacity is marketed based on the peak season firm demand in both the summer and winter seasons. In the early 1980s, the marketing agency, the Western Area Power Administration (WAPA), chose to use 1961 water conditions to determine adverse-year capability for the sale of firm capacity. The lowest peak capacities in the summer and winter periods for the Corps' 1961 annual operating year (March 1961 through February 1962) represent the criteria that determine the capacities that WAPA marketed. Table 5.10-4 presents the summer and winter values for dependable capacity in 1961 for all the alternatives. This table also presents the currently marketed capacities in both seasons.

Table 5.10-3. Monthly average hydropower energy values (GWh).

Alternative	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CWCP	729	637	554	711	928	912	1023	1053	973	928	857	722
MLDDA	727	638	593	708	922	893	1022	1047	945	923	854	714
ARNRC	723	623	568	827	1048	980	732	901	1039	971	892	719
MRBA	710	611	550	739	931	920	1030	1049	1020	976	776	727
MODC	715	603	591	752	932	913	1047	1025	988	968	799	723
BIOP	723	615	555	797	1031	907	882	887	1060	998	876	710
FWS30	719	611	557	795	1086	934	859	876	1044	985	864	704

Table 5.10-4. Marketable capacity from the Mainstem Reservoir System hydropower facilities (MW).

	1961 Operating Year Minimum Capacity	
Alternative	**Summer Season**	**Winter Season**
Currently marketed	2,070	2,010
CWCP	2,068	1,973
MLDDA	2,061	1,968
ARNRC	2,227	2,123
MRBA	2,102	2,015
MODC	2,118	2,042
BIOP	2,177	2,100
FWS30	2,173	2,096

Under current depletion levels, the CWCP does not meet the currently marketed levels identified in the early 1980s at depletion levels assumed at that time. The CWCP almost meets the level in the summer (-2 MW), but falls much shorter of meeting the level in the winter (-37 MW). Five of the alternatives to the CWCP exceed the currently marketed level both in summer and winter. Only the MLDDA alternative does not meet that level, falling short both in summer (-9 MW) and winter (-42 MW). All of the other alternatives have greater drought conservation measures than the CWCP and MLDDA alternative; this is the primary factor resulting in hydropower capacity increases above currently marketed levels. The ARNRC alternative, which has the greatest drought conservation measures, goes the furthest, exceeding currently marketed levels by 157 MW in summer and 113 MW in winter.

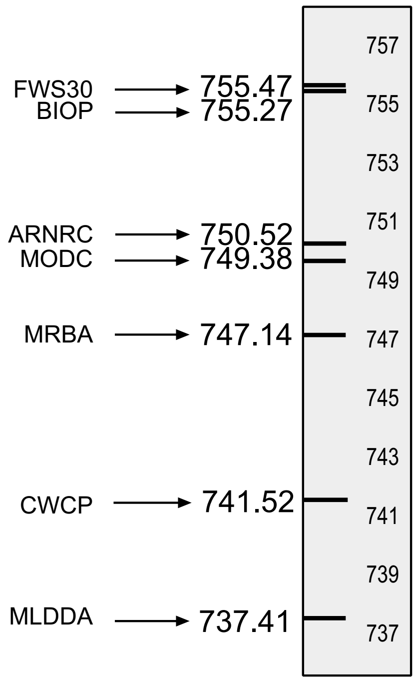

Figure 5.10-1. Average annual hydropower benefits for submitted alternatives ($millions).

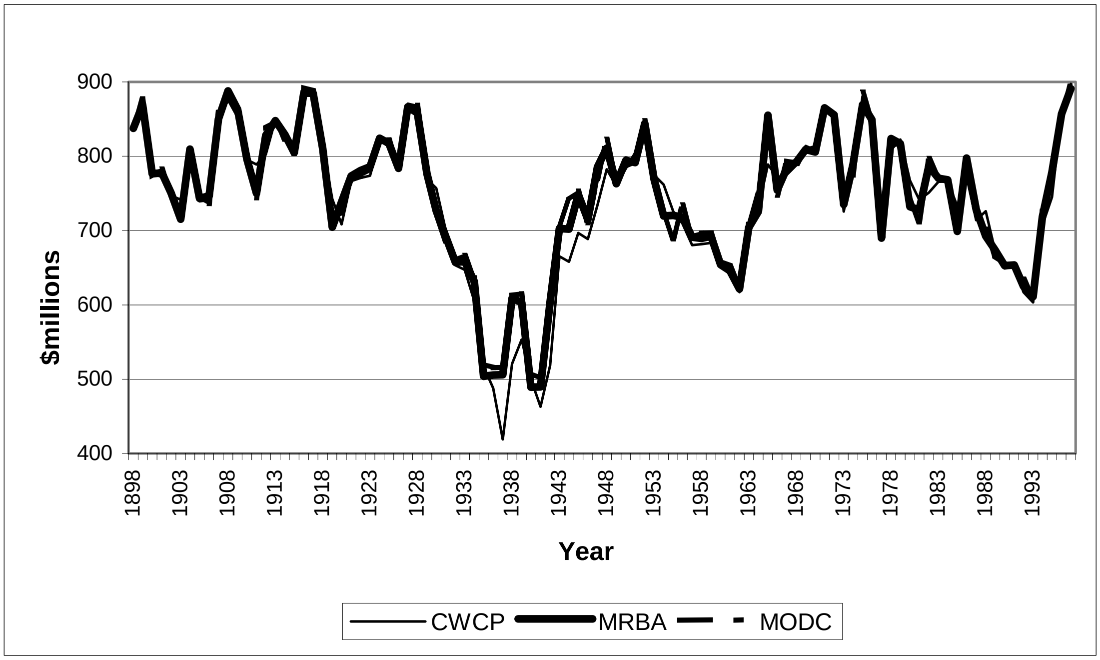

Figure 5.10-2. Average annual hydropower benefits for alternatives CWCP, MRBA, and MODC.

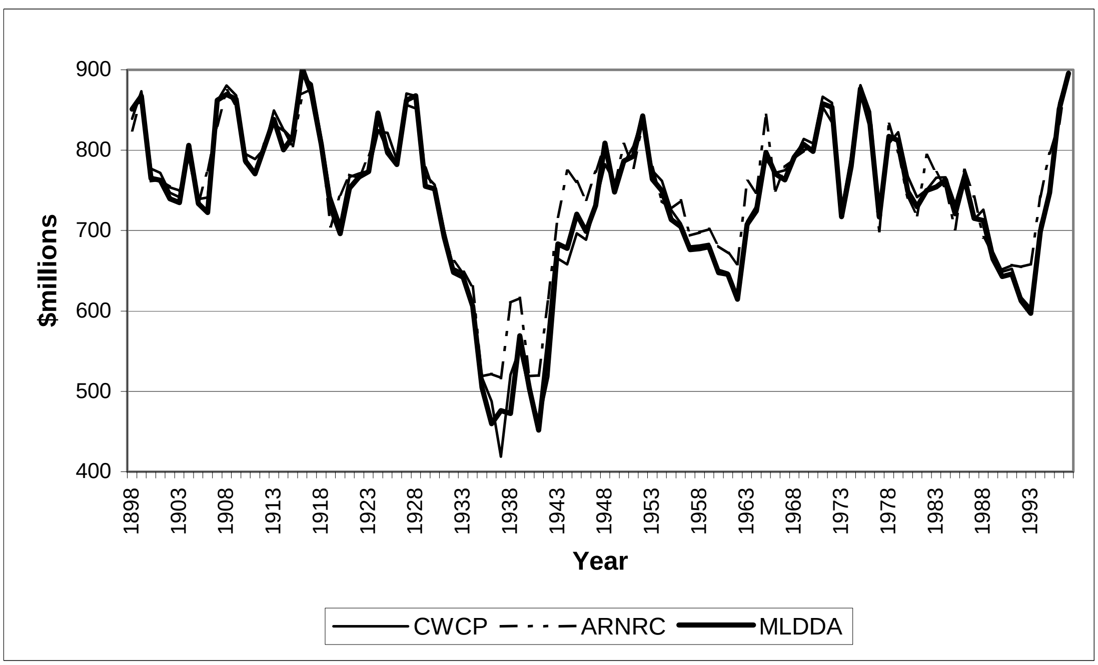

Figure 5.10-3. Average annual hydropower benefits for alternatives CWCP, ARNRC, and MLDDA.

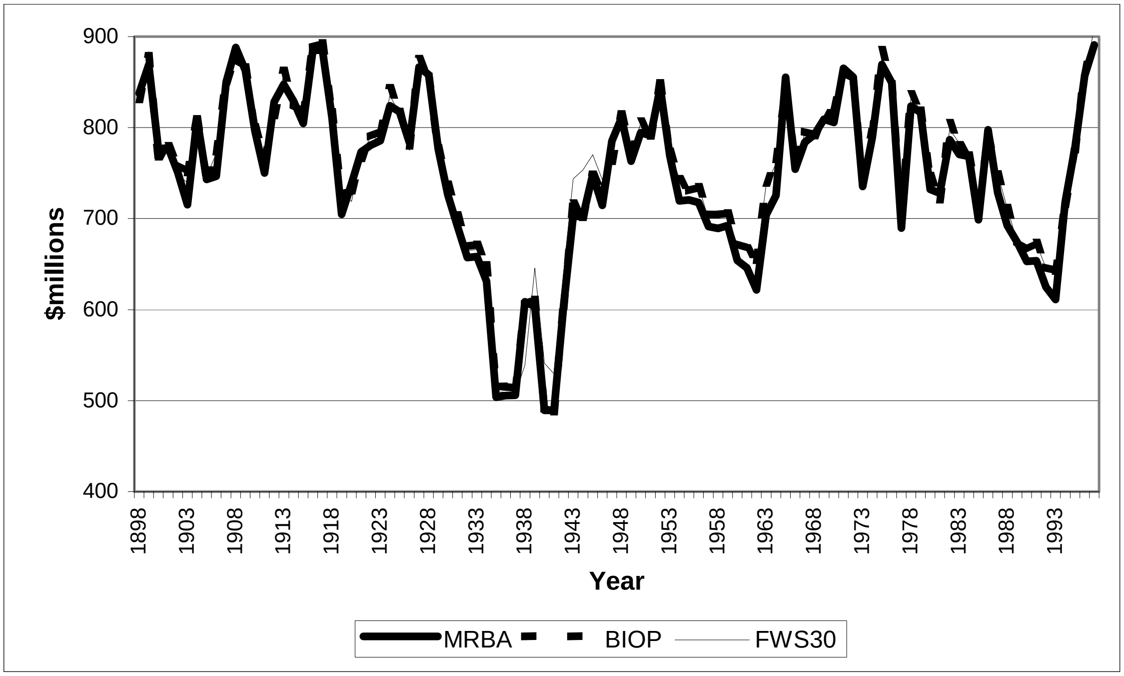

Figure 5.10-4. Average annual hydropower benefits for alternatives MRBA, BIOP, and FWS30.

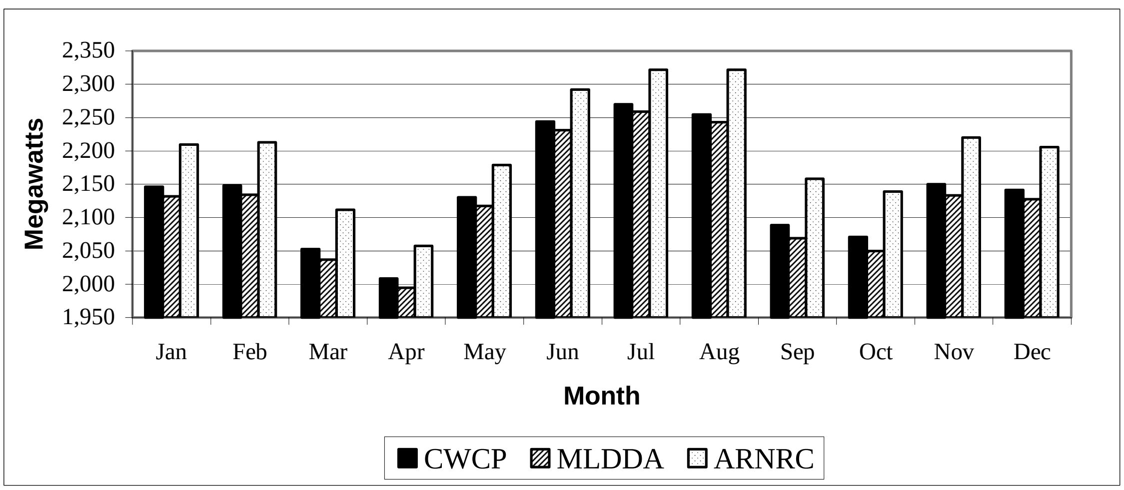

Figure 5.10-5. Monthly average hydropower peaking capacity for alternatives CWCP, MLDDA, and ARNRC.

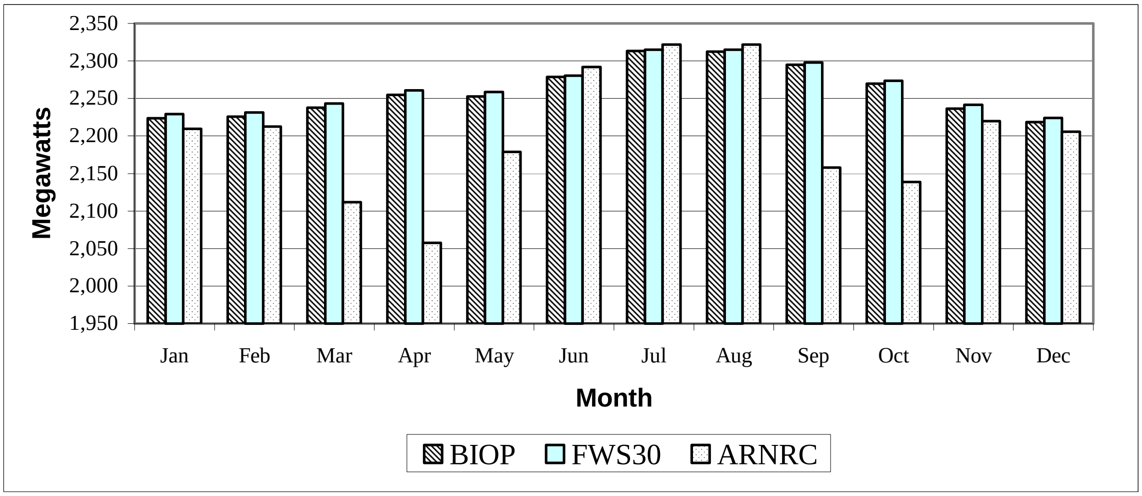

Figure 5.10-6. Monthly average hydropower peaking capacity for alternatives BIOP, FWS30, and ARNRC.

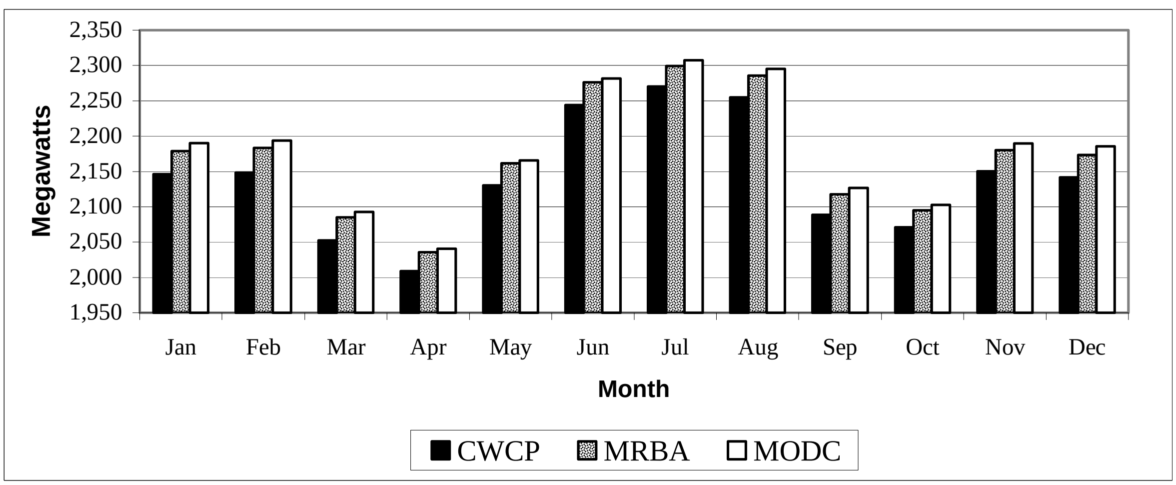

Figure 5.10-7. Monthly average hydropower peaking capacity for alternatives CWCP, MRBA, and MODC.

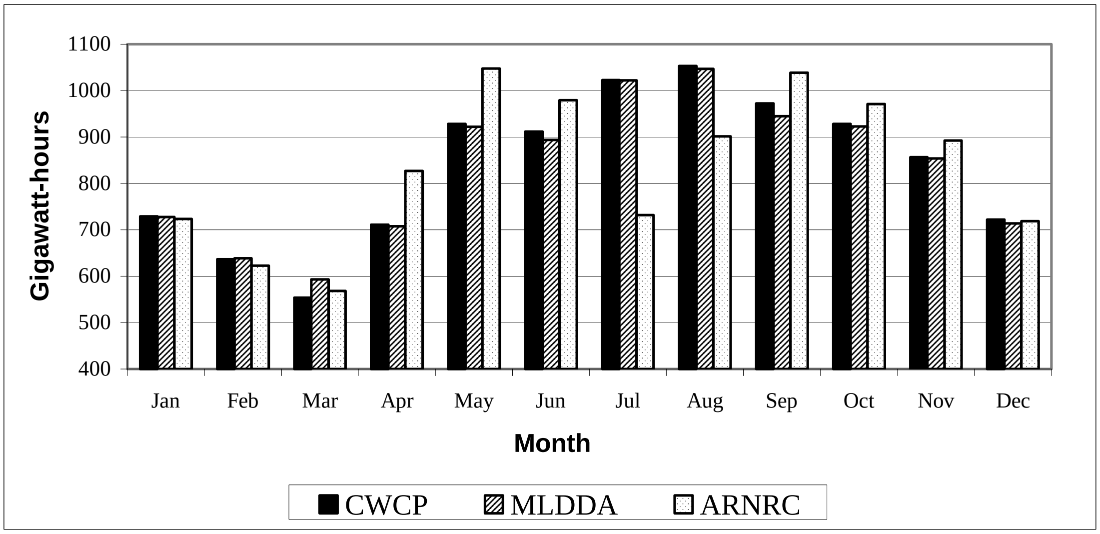

Figure 5.10-8. Monthly average hydropower energy for alternatives CWCP, MLDDA, and ARNRC.

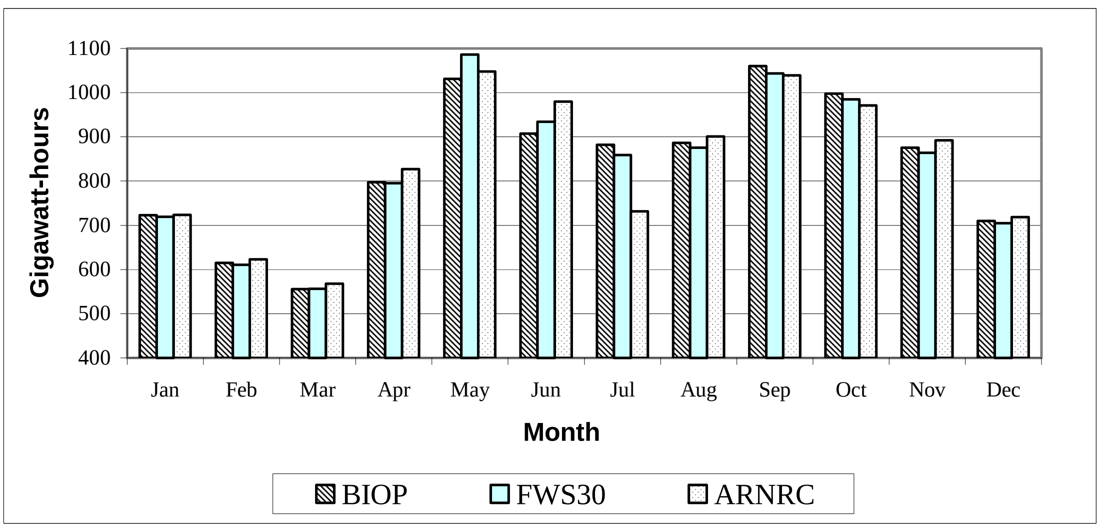

Figure 5.10-9. Monthly average hydropower energy for alternatives BIOP, FWS30, and ARNRC.

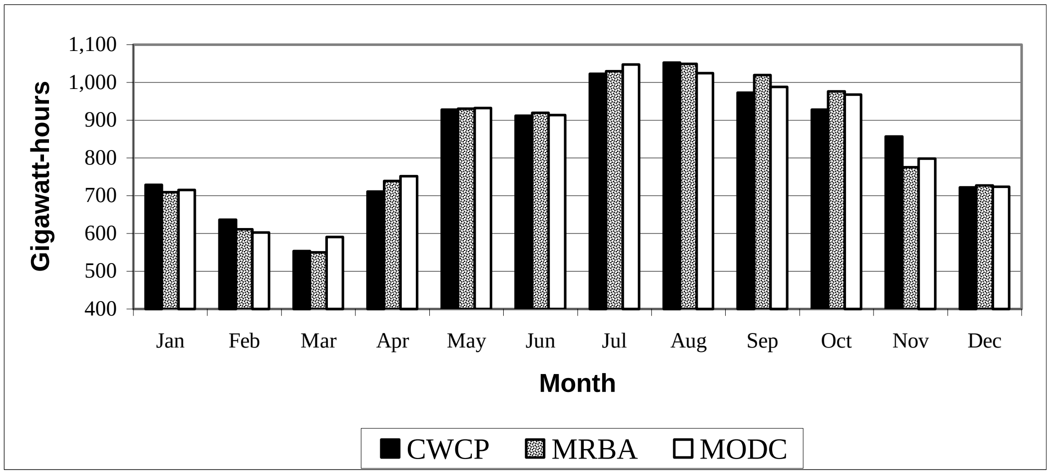

Figure 5.10-10. Monthly average hydropower energy for alternatives CWCP, MRBA, and MODC.

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