
CHAPTER 10 INVESTMENT PLAN

10.1 Development of the Investment Plan

The IPM optimization modeling provided results in terms of capacity investment requirements for 2000-2020. Optimizing for this twenty-year period instead of on a yearly basis, allowed for the consideration of more options and for a clearer definition of the optimum long term solutions for the power system's development. However, this multi-year optimization approach does not provide the sort of detailed results that are needed to develop annual plans for commissioning new plants.

Once an optimum solution, or set of alternative solutions, has been identified, the IPM model has reapplied on the basis of a year-by-year analysis, to provide output in terms of annual unit capacity additions. These results were then used to develop annual capacity expansion plans and capital investment forecasts. This technique was used to develop an annual investment plan on the basis of the optimized Base Case model run discussed in Chapter 9. A series of year by year model runs were performed using input derived from the multi-year optimization results.

The annual commissioning schedules were then used to determine the annual capital expenditures that will be needed to meet the required start-up dates. This was done by entering the annual construction costs for specific plants into a spreadsheet, and tallying the results on a year by year basis.

10.2 Proposed Commissioning Schedules and Investment Requirements for Economic Base Case

An annual commissioning schedule was prepared through 2020 for the Base Case. This time span was necessary to take into account the substantial levels of capital expenditures that must be made during the design and construction periods that precede the actual commissioning of major power projects.

Table 10.1 below shows the proposed 2000 to 2020 commissioning schedule for major generating facilities. Table 10.2 provides the details of financing requirements for the Economic Base Case.

10.3 Proposed Commissioning Schedules and Investment Requirements for Strategic Base Case

Table 10.3 below shows the proposed 2000 to 2020 commissioning schedule for major generating facilities. Table 10.4 provides the details of financing requirements for the Strategic Base Case.

Table 10.1 – Proposed Commissioning/Decommissioning Schedule (Base Economic Case)

	Nameplate Capacity	Years																				Comments	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		2020
Yerevan TPP																							
Yerevan CHP 1-1	65	■	■	■																			Economic retirement in 2003
Yerevan CHP 1-2	65	■																					Economic retirement in 2001
Yerevan CHP 1-4	65	■																					Economic retirement in 2001
Yerevan CHP 1-5	65	■																					Economic retirement in 2003
Yerevan 2-1 (6)	160	■																					Economic retirement in 2001
Yerevan 2-2 (7)	160	■																					Economic retirement in 2001
Yerevan CC	82				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	In-service in 2003 instead of existing CHP plant
Hrazdan TPP																							
Hrazdan CHP 1-1	50	■	■	■																			Retirement in 2002
Hrazdan CHP 1-2	50	■	■	■																			Retirement in 2003
Hrazdan CHP 1-3	100	■	■	■																			Retirement in 2003
Hrazdan CHP 1-4	100	■	■	■																			Retirement in 2002
Hrazdan 2-1	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-2	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-3	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-4	210	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement
Hrazdan 5	440																						Completion as CC. In-service in 2004
CFB Unit	60																						
Combined Cycle	400												■	■	■	■	■	■	■	■	■	■	New modern CC in-service in 2011
ANPP																							
Unit 2	440	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Retirement in 2005
New Unit	640																						
Rehabilitated Hydro																							
Sevan - Hrazdan Cascade	560	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full planned rehabilitation
Vorotan Cascade	405	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full planned rehabilitation
Dzorages	25	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Private rehabilitation
Small Hydro	31	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Private rehabilitation
New Hydro																							
Megri	85																						
Shnokh	70																						
Loriberd	56																						

■ - In Operation

Table 10.2 – Investment Requirements (million \$US Y2000) – Base Economic Case (Case 1)

	Nameplate Capacity	Years																				SUM	Comments	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019			2020
Yerevan TPP																							0	
Yerevan CHP 1-1	65																						0	Economic retirement in 2003
Yerevan CHP 1-2	65																						0	Economic retirement in 2001
Yerevan CHP 1-4	65																						0	Economic retirement in 2001
Yerevan CHP 1-5	65																						0	Economic retirement in 2003
Yerevan 2-1 (6)	160																						0	Economic retirement in 2001
Yerevan 2-2 (7)	160																						0	Economic retirement in 2001
Common Facilities			0.4	0.4																			0.8	Cooling towers rehabilitation
Yerevan CC	82		16.8	33.7	5.7																		56.2	In-service in 2003 instead of existing CHP plant
Hrazdan TPP																							0	
Hrazdan CHP 1-1	50																						0	Retirement in 2002
Hrazdan CHP 1-2	50																						0	Retirement in 2003
Hrazdan CHP 1-3	100																						0	Retirement in 2003
Hrazdan CHP 1-4	100																						0	Retirement in 2002
Hrazdan 2-1	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.
Hrazdan 2-2	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.
Hrazdan 2-3	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.
Hrazdan 2-4	210																						0	Full maintenance, no retirement
Common Facilities			6.8		6.6	6.6																	20	Cooling towers rehabilitation
Hrazdan 5	440			75	50																		125	Completion as CC. In-service in 2004
CFB Unit	60																						0	
Combined Cycle	400										69.7	139.4	23.2										232.3	New modern CC in-service in 2011
ANPP																							0	
Unit 2	440					225																	225	Retirement in 2005
New Unit	640																						0	
Rehabilitated Hydro																							0	
Sevan - Hrazdan Cascade	560			14.9	12.2	8.2	4.5																39.8	Full planned rehabilitation
Vorotan Cascade	405				19.1	12.6																	31.7	Full planned rehabilitation
Dzorages	25																						0	Private rehabilitation
Small Hydro	31																						0	Private rehabilitation
New Hydro																							0	
Megri	85																						0	
Shnokh	70																						0	
Loriberd	56																						0	
TOTAL		0	24	126	93.6	252	4.5	0	0	0	69.7	139	23.2	0	732.9									

Table 10.3 – Proposed Commissioning/Decommissioning Schedule (Strategic Base Case)

	Nameplate Capacity	Years																			Comments		
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		2019	2020
Yerevan TPP																							
Yerevan CHP 1-1	65	■	■	■																		Economic retirement in 2003	
Yerevan CHP 1-2	65	■	■	■																			Economic retirement in 2001
Yerevan CHP 1-4	65	■	■	■																			Economic retirement in 2001
Yerevan CHP 1-5	65	■	■	■																			Economic retirement in 2003
Yerevan 2-1 (6)	160	■	■	■																			Economic retirement in 2001
Yerevan 2-2 (7)	160	■	■	■																			Economic retirement in 2001
Yerevan CC	82				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	In-service in 2003 instead of existing CHP plant	
Hrazdan TPP																							
Hrazdan CHP 1-1	50	■	■	■																			Retirement in 2002
Hrazdan CHP 1-2	50	■	■	■																			Retirement in 2003
Hrazdan CHP 1-3	100	■	■	■																			Retirement in 2003
Hrazdan CHP 1-4	100	■	■	■																			Retirement in 2002
Hrazdan 2-1	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-2	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-3	200	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement. DH extraction.
Hrazdan 2-4	210	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full maintenance, no retirement
Hrazdan 5	440				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Completion as CC. In-service in 2004
CFB Unit	60																				■	■	New CFB Unit. Subject to coal resource confirm.
Combined Cycle	400																				■	■	
ANPP																							
Unit 2	440	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Retirement in 2005
New Unit	640																						
Rehabilitated Hydro																							
Sevan - Hrazdan Cascade	560	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full planned rehabilitation
Vorotan Cascade	405	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Full planned rehabilitation
Dzorages	25	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Private rehabilitation
Small Hydro	31	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Private rehabilitation
New Hydro																							
Megri	85																				■	■	New hydro in-service in 2011
Shnokh	70																				■	■	New hydro in-service in 2011
Loriberd	56																				■	■	New hydro in-service in 2011

■ - In Operation

Table 10.4 – Investment Requirements (million \$US Y2000) – Strategic Base Case (Case 1s)

	Nameplate Capacity	Years																				SUM	Comments			
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019			2020		
Yerevan TPP																							0			
Yerevan CHP 1-1	65																						0	Economic retirement in 2003		
Yerevan CHP 1-2	65																						0	Economic retirement in 2001		
Yerevan CHP 1-4	65																						0	Economic retirement in 2001		
Yerevan CHP 1-5	65																						0	Economic retirement in 2003		
Yerevan 2-1 (6)	160																						0	Economic retirement in 2001		
Yerevan 2-2 (7)	160																						0	Economic retirement in 2001		
Common Facilities			0.4	0.4																			0.8	Cooling towers rehabilitation		
Yerevan CC	82		16.8	33.7	5.7																		56.2	In-service in 2003 instead of existing CHP plant		
Hrazdan TPP																							0			
Hrazdan CHP 1-1	50																						0	Retirement in 2002		
Hrazdan CHP 1-2	50																						0	Retirement in 2003		
Hrazdan CHP 1-3	100																						0	Retirement in 2003		
Hrazdan CHP 1-4	100																						0	Retirement in 2002		
Hrazdan 2-1	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.		
Hrazdan 2-2	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.		
Hrazdan 2-3	200			0.7																			0.7	Full maintenance, no retirement. DH extraction.		
Hrazdan 2-4	210																						0	Full maintenance, no retirement		
Common Facilities			6.8		6.6	6.6																	20	Cooling towers rehabilitation		
Hrazdan 5	440			75	50																		125	Completion as CC. In-service in 2004		
CFB Unit	60																			23.6	23.6	11.8	59	New CFB Unit. Subject to coal resource confirm.		
Combined Cycle	400																						0			
ANPP																							0			
Unit 2	440					225																	225	Retirement in 2005		
New Unit	640																						0			
Rehabilitated Hydro																							0			
Sevan - Hrazdan Cascade	560			14.9	12.2	8.2	4.5																39.8	Full planned rehabilitation		
Vorotan Cascade	405				19.1	12.6																	31.7	Full planned rehabilitation		
Dzorages	25																						0	Private rehabilitation		
Small Hydro	31																						0	Private rehabilitation		
New Hydro																							0			
Megri	85									48	48	32	16	16									160	New hydro in-service in 2011		
Shnokh	70									36.3	36.3	24.2	12.1	12.1									121	New hydro in-service in 2011		
Loriberd	56									29.1	29.1	19.4	19.4										97	New hydro in-service in 2011		
TOTAL		0	24	126	93.6	252	4.5	0	84.3	113	85.3	47.5	47.5	0	23.6	23.6	11.8	937.6								

10.4 Implications of Sensitivity Studies

The results of sensitivity cases (performed in addition to economic and strategic base cases) were not analyzed in terms of concrete investment plans. Many assumptions were made in the design of those cases, which may or may not come about. However, the sensitivity can be used to identify the potential impacts of events on the overall investments needs of the electric power system.

High/Low Demand Growth Scenarios

The sensitivity study based on the high and low economic growth scenario indicated little if any change would occur in terms of the need for new plants during the 2001 – 2010 period. This is largely due to the assumption that, if accelerated growth comes about, it will be on the basis of an economic structure that is much less energy-intensive than the Base Case scenario. However, it should be noted that during the years following 2010 electricity demand under the high scenario is expected to grow much more rapidly than for the base scenario, and this will bring additional requirements for investments in the electric system at that time. No quantifiable impacts were identified for the 2000-2010 investment plan as potential results of this scenario. The same is true for the low demand forecast.

ANPP Retirement Sensitivity

The sensitivity analysis based on various years for ANPP decommissioning shows that the investment requirements for 2000-2010 do not vary significantly. Most of capacity additions take place after 2010, except for new CC CHP and Hrazdan Unit 5, which are added in 2003 and 2004 in almost all cases (special cases are described below).

Steam Sensitivity

Most of the cases assume high steam demand in Yerevan region. Special sensitivities that reflect current steam demand and “no steam” demand eliminate the need for new CC CHP at Yerevan TPP. The hypothetical “no steam” demand scenario assumes non-centralized (distributed) steam generation for households and industry. Steam production in these cases is done by existing Yerevan CHP units. Capital investment need of \$56 million for 82 MW CC CHP in this case is eliminated.