ECONOMIC FEASIBILITY STUDY FOR ESTABLISHING A CENTRAL ELECTRICAL LABORATORY IN SAUDI ARABIA

EXECUTIVE SUMMARY & RECOMMENDATIONS

Prepared for

Consortium of Electrical Utility Companies & Manufacturers
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INTRODUCTION

King Fahd University of Petroleum & Minerals (KFUPM) performed a study entitled Economic Feasibility Study for Establishing a High Voltage Electrical Testing Laboratory. This Executive Summary & Recommendation (ES&R) document presents a summary of the study, the obtained results, professional recommendations and an implementation plan. Complete and detailed information about the research methodology and the results can be found in the main report entitled Final Report: Economic Feasibility Study for Establishing a High Voltage Electrical Testing Laboratory, January 2006 and in the report entitled Progress Report I: Economic Feasibility Study for Establishing a High Voltage Electrical Testing Laboratory. Those interested in detailed information are referred to these report(s).

SUMMARY OF THE STUDY

The objective of the study is to evaluate the economic viability of establishing a central electrical testing laboratory in Saudi Arabia.

This objective was achieved through measuring the demand for electrical testing; collecting information on the testing equipment; scoping detailing for the laboratory; defining the laboratory in terms of its functionality and space requirements; determining the location of the testing laboratory that will maximize its functionality; performing an economic feasibility analysis of the laboratory; and investigating alternative scenarios for funding the establishment of the laboratory. The study team prepared extensive questionnaires to collect relevant information from electrical related organization in the Kingdom and the GCC. The study team carried out an extensive search efforts and visited many international electrical testing laboratories to survey the most relevant equipment for testing HV and HC laboratory. The study team analyzed the outcome of the collected data from local and GCC companies and the information gathered about international laboratories practices to define preliminary scope of the targeted electrical testing laboratory. The team defined the functional program of the laboratory qualitatively by describing the mission and objectives of the project. The team also defined the spaces that will be required for the various facilities. This program will include all the spaces that will be needed for the proper functioning of the laboratory. The team prepared a schematic design layout for the laboratory based on the developed architectural program. This layout is to show the general configuration of the laboratory and is not meant to provide a design solution. The study team performed an economic analysis of the laboratory. The profitability of the project was analyzed according to the criteria of undiscounted measures of project worth, and discounted measures of project worth. The life cycle economic figures are presented to support the recommended alternative. The economic arguments included cost estimate of land which could be used to locate the subject laboratory. The study team investigated alternative scenarios for funding the establishment of the laboratory. The most appropriate funding scenario was recommended to the consortium members to consider.

SUMMARY OF THE RESULTS

This section summarizes the major results which were obtained from the study.

A. Demand Measurement

Users:

1. The participating users reported different voltage levels ranging from 13.8 kV to 420 kV. It's expected, due to increase of demand and expansion of the transmission network, that the Saudi Electricity Company will introduce higher voltage levels for DC and AC in the coming future.

2. Almost all users require electrical equipment manufactures to verify the quality of their manufactured equipment through an independent third party laboratory.

3. The users require the verification tests on many electrical equipment items as shown in Table 1. Also, about fifty percent of the users require verification tests for auxiliaries, which are supporting electric equipment for the main high voltage equipment, such as: bushings, relays, indicators tap changers…etc.

4. The users normally utilize for quality verification tests some of the following international testing laboratories: CESI, Ansaldo Energia in Italy, FALCON and ASTA in UK, VOLTA in France, TOSHIBA, HITACHI, Mitsubishi in Japan, Elin Hotec in Holland, Transelectro in Hungary, Hyundai in Korea, EMACO in Egypt, Elinhleu in Poland, Delta Utility of New Zealand and Doble Engineering of USA.

5. The users agree that the current testing services are reliable, independent, and efficient. Although more than fifty percent of the users are neutral with regard to the cost about forty percent of them agree that the tests are expensive.

6. About 75% of the users perform quality verification tests for in-service equipment mainly for maintenance purposes.

7. It was expected that all the respondents will indicate that establishing an electrical testing laboratory in Saudi Arabia is extremely important. The results though indicated that only 62% of the users believe it is only important to very important.

ELECTRICAL EQUIPMENT MANUFACTURERS

1. The majority of the manufacturers requires testing facilities to cover voltage level up to 69kV.

2. Manufacturers perform routine tests to control quality of their produced equipment. In addition and based on the request of users they subject their equipment to type and especial tests in independent electrical testing laboratories to verify the quality of their equipment. The type tests are usually conducted in Europe, Asia, South America, and North America. Table 2 presents the frequency of tests, the testing standards, and the testing voltage level.

3. Manufacturers in GCC produce transformer (power, current, and voltage), circuit breakers, cables, disconnectors, bus and isolated-phase bus, low voltage boards, unit distribution (S/S), and ring main units. The voltage levels required for testing most of these equipment are mainly between 11 kV and 70 kV. Only one cable manufacturer and LV board manufacturer require voltage levels of 220 kV and 400 kV respectively.

Table 1. Users Purchased Equipment from Manufacturers and Suppliers.

Equipment	**Total Number of Users**	**Total Number of units tested per year**	**Test Conducted**		**Testing Standards**	**Voltage Level**
			Type	Special		
Power Transformers	6	523	6	4	IEC, BS, VDE	11, 13.8, 66, 132, 300
Current Transformers	2	1480	2	2	IEC	11
Voltage Transformer	2	130	2	2	IEC	11
Generators	3	104	3	1	IEC	380
Circuit Breakers	5	294	5	2	IEC	11, 400
Motors	2					
GIS	4	362	3	0	IEC	11, 132, 300
Capacitors	2	550	2	0	IEC	11
Insulators	3	360	3	2	IEC	11, 33
Lighting Arrestors	4	168	3	3	IEC	11, 300
Cables	4	1386	4	2	IEC	11, 66, 132, 220, 1000
Automatic Circuit-Reclosers	1					
Cable Joints	3	16016	3	2	IEC	11, 66, 132, 220
Cable Terminations	3	2016	3	2	IEC	11, 66, 132, 220
Contactors / Starters	2	508	2	2	IEC	11
Disconnectors						
Earthing Switches						
Fuses	2	40008	2	2	IEC	0.6, 11
Line Traps	0					
Station-Type Cubicles Switchgear	3	50	3	2	IEC	11
Bus and Isolated-Phase Bus	0					
Switchgear and Control gear	3	16	3	1	IEC	11, 2500
Reactors	0					
Switch-Fuse Combinations	2	2	2	0	IEC	11
LV Boards	0	0	0	0	IEC	0.415
Unit Distribution S/S	0	0	0	0	IEC	0.415, 11

4. Manufactures spend around SR 3,000,000 and around SR 1,500,000 annually on routine and type tests respectively. These results were obtained only from two participants.

5. The manufacturers indicated the availability of most basic required testing facilities for the routine tests and some special tests in their premises. They indicated that they have equipped their factories with testing capabilities to enable them to control the quality of their manufactured equipment.

6. Very few manufacturers have calibration capabilities.

7. The manufacturers have the capabilities to make routine testing for power transformers at voltage level of 33 kV, 36 kV, and 69 kV according to IEEE, IEC, ANSI standards.

8. Three manufacturers can make routine testing for circuit breakers at voltage level of 36 kV and 38 kV according to IEEE, IEC, ANSI standards.

9. One manufacturer can provide routine testing services for cables at 220 kV, insulators, cable termination, cable joints at 132 kV voltage level.

10. All manufacturers send their equipment to laboratories mostly in Europe for type testing and quality verification tests.

11. The manufacturers agree and strongly agree that the current testing services are reliable, independent, and efficient. Although more than fifty percent of the respondents were neutral with regard to the cost, but about forty percent of the respondents agree that the tests are expensive.

12. All manufacturers as expected support the idea of establishing a testing laboratory in Saudi Arabia. About fifty percent of the manufacturers indicated that it is extremely important to establish the laboratory. The other fifty percent of the manufacturers indicted it is important to very important to establish the laboratory in Saudi Arabia. The high support is not surprising as manufacturers desire to have a laboratory in the region where they can verify the quality of their manufactured equipment for utilities and for research and development.

Table 2. Manufacturers' Tested Equipment.

Equipment	Total Number of units tested per year	Test Conducted		Testing Standards	Voltage Level (kV)
		Routine	Special (Specify)		
Power Transformers	11500	11500	90	IEC, ANSI	13.8, 33
Current Transformers	50	50	50	ANSI	36, 70
Voltage Transformer	50	50	50	ANSI	
Generators	0	0	0		
Circuit Breakers	50	50	50	ANSI	
Generators	0	0			
Motors	0				
GIS	0				
Capacitors	0				
Insulators	0				
Lighting Arrestors	0				
Cables	46000	46000	46000	IEC	33, 66, 132
Automatic Circuit-Reclosers	0				
Cable Joints	0				
Cable Terminations	0				
Contactors / Starters	0				
Disconnectors	1200	1200	0	IEC	11, 36
Earthing Switches					
Fuses					
Line Traps					
Station-Type Cubicles Switchgear					
Bus and Isolated-Phase Bus		100	3		
Switchgear and Control gear		250	53	ANSI	
Reactors					
Switch-Fuse Combinations		0	0		
LV Boards		0	7	IEC	231, 400
Unit Dist. S/S		0	7	IEC	13.8
Ring Main Units		6000	0	IEC	11, 13.8

13. The Saudi and GCC main universities who are teaching electrical engineering worked hard to establish high voltage laboratories to serve their teaching program and research studies. These labs provide limited testing services for the local industries with the current available facilities.

14. The market analysis indicates that the majority of the tests will require the High Voltage laboratory. Some experts assumed that the high voltage capabilities will serve more than 80 percent of the local and regional market.

B. Laboratory Programming

1. Although high current is a capability that is desired to be included in the laboratory, its initial investment cost is very huge and the market demand for such services will not justify the investment cost. Therefore, the laboratory will be established only for providing high voltage testing services.

2. Manufacturers in the GCC manufacture equipment for the distribution network. This fact imposes a heavy factor in the decision on the type of testing laboratory to be established in the region. It seems that the most suitable voltage level for the desired laboratory is in the high voltage level to satisfy the current and future local needs and to provide services to other international customers.

3. Based on the voltage level and the equipment to be tested, the High Voltage Testing Laboratory will include many testing elements. Table 3 presents the general guidelines for the desired high voltage testing laboratory. The listed equipment will make it possible to conduct the following tests**:**

   - Insulation resistance
   - Winding resistance
   - Loss factor, capacitance
   - Power frequency dry and wet tests
   - DC voltage tests
   - Lightning and switching tests
   - Corona and RIV measurements
   - Partial discharge measurements
   - Pollution test
   - Accelerated test
   - EMC test on MV switchgears

4. ***Space Requirements:*** The space requirement for laboratory facilities, administration, supporting facilities are as shown in Table 4. The definition of all required spaces in departments was based on the type of testing equipment that will be installed in the laboratory, the testing laboratory's maximum capacities, and the type of testing services to be offered by such laboratory. The maximum capacity of the laboratory is estimated to be 230 test days.

Table 3. Proposed List of HV Lab testing equipment.

Test Equipment	**Specification**
AC testing voltage (testing transformer)	60 Hz, 800 kV, 2.5 A 60 Hz, 400 kV, 1.5 A
DC testing voltage	±600 kV
Lightning impulse testing voltage	2400 kV, 120 kJ
Switching impulse testing voltage	1600 kV, 80 kJ
Partial discharge testing system with variable frequency source	
Capacitance and Dissipation Factor (tanδ) measuring setup	
RIV instrument	
Chamber for pollution testing of insulators	In accordance with IEC60507

Table 4. Summary of Space Requirements for the High Voltage Testing Laboratory.

Accommodation type	Total Gross Area (M^2)
Testing Laboratories	2288.2
Administration Building	783.6
Mosque	100
Library	50
Restaurant	250
Warehouse	400
Security Department	100
Grand Total	3,971.8

C. Site Selection

1. Selecting the location of the laboratory is of a paramount importance to the optimization of its functionality. Therefore, the proper site for the High Voltage Testing Laboratory was selected with great care. As the Laboratory will provide services to electrical industries in the Gulf States in particular and the other countries in general the country which will host the Laboratory was selected based on the size of the industry. Saudi Arabia has the largest electrical grid and largest electrical industry among other GCC countries. Therefore, it was sensible to select a location in Saudi Arabia that will provide services to its industry and to be central to industries of the other GCC countries. The most suitable location is the Eastern Province which is central to all other GCC countries.

2. The topography of the Dammam, Dhahran, and Al-Khobar was surveyed for determining the proper general location for the project. Among the many sites in the Dammam, Dhahran, and Al-Khobar, a site next to Dammam sea port was identified and considered the most suitable for locating the High Voltage Testing Laboratory project on. This site is very close to the sea port which will allow receiving electrical equipments that will be coming via sea. The location is also very close to the railroad and the highways.

D. ECONOMIC FEASIBILITY STUDY

The economic feasibility study entails defining two major accounts. The first is the costs that will be incurred for developing, designing, building, and operating the proposed High Voltage Testing Laboratory. The second is the revenues that are to be realized from the proposed High Voltage Testing Laboratory project. The components of both accounts are identified and their values are estimated.

Cost Estimates

1. ***Initial Investment Cost:*** The initial investment is the amount of money needed for developing, building, equipping, and furnishing the High Voltage Laboratory and its peripherals. The building is estimated to cost SR 1800 per square meter including Heat, Ventilation, and Air conditioning system. This estimate, although is considered slightly in the high side, is reasonable and probable. Therefore, the construction cost estimate is SR 7,149,240. This cost is preceded by site acquisition and preconstruction cost including, the architecture/engineer services and technical administration. The founders will purchase a site for about SR 6,000,000. The preconstruction cost is estimated to amount to SR 7,000,000. In addition, there will be a need for about SR 29,426,924 for developing the purchased site, and for furnishing and equipping the laboratory. The total initial investment cost, including a 10 percent contingency factor, is estimated to be SR 49,576,164 which is distributed over the cost items as shown in Table 5.

Table 5. Summary of Initial Investment Cost Items.

Cost Item	Cost SR
Site purchase	6,000,000
Architectural/Engineering Program Development	7,000,000
Site development	720,000
Construction Cost	7,149,240
Office Furniture & Small Equipment	750,000
Laboratory Equipment including Computers	17,000,000
Communication System	500,000
Water & Sewage Treatment Plant	500,000
Power Procurement (Connection)	2,000,000
Landscape and Boundary Walls	1,000,000
Vehicles	300,000
Facility Equipment	1,800,000
Warehouse	350,000
Subtotal	45,069,240
Assume a 10% Contingency	4,506,924
Total	49,576,164

The Total needed cash at the beginning of the project is SR 49,576,164 including a 10% contingency.

2. **Operating costs of facilities**: The operation of the Laboratory will result in the following expenditures:

   a. **Salaries**: Engineers, technicians, administrators, accountants, clerks, and others will be in the payroll of the High Voltage Testing Laboratory. The salary distribution is estimated to be as shown in Table 6. The salary is predicted to increase by SR 250,000 annually to account for merit increases and termination benefits. The listed salaries include all associated cost such as the basic salary, housing allowance, transportation, ticket repatriation, and education allowance. The staffing of the High Voltage Testing Laboratory and administrative manpower will be gradual and based on needs. It is assumed that the administrators such as the president and directors and administrative personnel will be employed concurrently with the commencement of the High Voltage Testing Laboratory. The engineers and technicians will be hired gradually as the numbers of services move up in High Voltage Testing Laboratory.

   b. **Buildings and Vehicles Maintenance**: Preventive maintenance and janitorial services are estimated to be contracted out for an annual amount of SR200,000. This cost will increase annually by SR20,000 as the facility becomes old. The vehicles maintenance is estimated to cost the laboratory about SR 60,000 annually.

   c. **Replacement Cost**: It is estimated that furniture will be replaced every 15 years, vehicles will be replaced every five years, and computers will be replaced every four years. No salvage values are expected from the

disposed furniture and computers. It is estimated that vehicles will be salvaged for 20% of their initial cost

d. **Water Treatment Plant**: The water treatment plant system is estimated to be operated at an annual budget of SR400,000.

e. **Utility**: It is anticipated that the laboratory will spend about SR2,000,000 annually in utilities such as electricity, water, gas, and other necessary services. This cost is estimated to increase by SR100,000 to account for equipment increase and inefficiency due to aging.

f. **Consumable**: The Laboratory will consume materials such as stationary items. It is anticipated that the Laboratory will spend about SR 400,000 annually in consumable materials. As inflation is very low in Saudi Arabia, it is assumed that the cost of such materials will change slightly and may increase by SR 40,000 annually.

Table 6. Monthly Salary Distribution by position.

Job Position	Number	Average monthly Salary SR	Monthly Salary SR
TESTING LABORATORIES			
High Voltage Laboratory			
Engineers	6	20,000	120,000
Secretary	1	6,000	6,000
Staff (lab technicians)	2	8,000	16,000
		Sub-Total	142,000
Material Laboratory			
Scientist	1	20,000	20,000
Staff	1	8,000	8,000
		Sub-Total	28,000
Research & Development			
Researchers	3	30,000	90,000
Secretary	1	6,000	6,000
Staff	1	8,000	8,000
		Sub-Total	104,000
ADMINISTRATIVE			
President	1	35000	35,000
Directors	3	25,000	75,000
Managers	7	14,000	84,000
Secretaries	10	5,000	50,000
Security	3	6,000	18,000
Staff	12	4,000	48,000
		Sub-Total	308,000
		Grand Total	582,000
		Annual Grand Total	6,984,000

Revenue Estimates

The High Voltage Testing Laboratory will start generating revenue from their first year of operation

1. **Revenue from the Testing Services**: Good revenue is expected to come from testing services. Some testing requests may be completed in one day. Other tests may need days to be completed. Therefore, for the first few years, it is anticipated that the Laboratory will receive service requests that is equivalent to 150 testing days per year. The number of testing days is expected to increase over years. From experience with international Laboratories, the average testing day fee is estimated to be SR 30,000. The testing day fee is considered reasonable and acceptable. Quality technical services require very expensive resources such as technical engineers and laboratory and workshop equipment. It is expected that the number of requests and test fees will increase gradually over time. It is anticipated that the number of requests will increase by 10 service days annually until it reaches a stable level of 230 service days at the tenth year of the laboratory operation. It is also assumed that the fee will be modified every five years. There will be an increase of 5% to compensate for the loss of value of money due to time. The expected revenue from the testing laboratory is presented in Table 7.

Table 7. Expected Revenue from the High Voltage Testing Laboratory Services.

Year	No. of requests (Service days)	Testing fee SR/service day	Revenue
1	150	30,000	4,500,000
2	150	30,000	4,500,000
3	160	30,000	4,800,000
4	170	30,000	5,100,000
5	180	30,000	5,400,000
6	190	33,000	6,270,000
7	200	33,000	6,600,000
8	210	33,000	6,930,000
9	220	33,000	6,600,000
10	230	33,000	7,590,000
11-15	230	35,000	8,050,000
16-20	230	38,000	8,740,000
21-25	230	40,000	9,200,000
26-30	230	43,000	9,890,000

2. **Revenue from the Consultation**: The High Voltage Testing Laboratory is expected to offer engineering, consulting, and researching professional quality services to utilities and manufacturers. The High Voltage Testing Laboratory is expected to cooperate with researchers and faculty members in the region to perform such services. These programs are expected to capitalize on the resources of the High Voltage Testing Laboratory and the available resources in universities and research institutes in the region. The

expected annual net income is expected to start at two million and increases annually by two million until it reaches SR20,000,000 at the end of the tenth year. The experts and administrators of the visited testing international laboratories indicated that the majority of their income is coming from consultation. The revenue from testing services comprises only less than 15 percent of the laboratories annual income. Therefore, it is anticipated that in a similar fashion the income from consulting services will comprise the significant portion of the revenue of the desired testing laboratory.

3. **Revenue from the Dining Hall**: The dining halls will be available to engineers, staff, and students on campus. The dining halls will be rented out to a catering establishment for SR30,000 annually.

4. **Revenue form Land Salvage** Value: Assume that the price of the land will appreciate by 300 percent after 30 years. The salvage value of the land = 20,000 X 900 = SR 18,000,000.

Viability Analysis

The financial viability of the project was examined based on cash flow analysis, benefit to cost ratio, and payback period. An interest rate of 8% was used for discounting the cash flow and therefore considered the time value of money.

1. **Cash Flow Analysis:** The cost and revenue cash flow were projected over the economic life of the High Voltage Electrical Testing Laboratory which is estimated to be 30 years. Figure 1 depicts the cost and revenue cash flows. The cash flow indicates that the expenditure will exceed the revenue by SR 1,878,000 and SR258,000 in the first and second years, respectively. These deficits may result from low business start. Therefore, the investors are required to allocate about SR 2.2 million to cover the deficit in the first two years of the Laboratory. The cash flow analysis indicates that the Laboratory will realize profits over its economic life excluding the above years as the revenue from the testing and consultation services after the second year start to exceed the growth in operating costs and other overhead costs as shown in Figure 1. The founders will enjoy reasonable dividends from the Laboratory. It is anticipated that the amount of SR 50 million which will be collected from the investors to be sufficient for purchasing a land, building, furnishing, and equipping the laboratory. The cash flow as depicted in Figure 1 indicates that the revenue will exceed the expenditure over the life of the project. The cash flow analysis indicates that the High Voltage Testing Laboratory will realize profits over its economic life as the revenue from the tests and consultation from the start of High Voltage Testing Laboratory will exceed the growth in operating costs and other overhead costs. The founders will enjoy reasonable dividends from the High Voltage Testing Laboratory. The High Voltage Testing Laboratory will have also the leverage to utilize a portion of the gross profit every year for supporting internal research projects.

2. **Internal Rate of Return (IRR):** The Internal Rate of Return on the

investment is 14%. That is, the investment will draw an annual interest of 14%. This rate is higher than the prevailing interest rates that are given by banks in Saudi Arabia.

3. ***Payback Period:*** From the expected annual revenues and costs of the investment, it was possible to determine the payback period which is expected to be at the end of the ninth year from the start of the High Voltage Testing Laboratory. That is, the initial investment will be recovered at the end of the ninth year.

4. ***Benefit to Cost Analysis:*** The viability of the investment is measured by comparing the benefits to the costs. All benefits and costs are normalized for comparison purposes. The viability of the investment is measured by comparing the benefits to the costs. All benefits and costs are normalized for comparison purposes. The net present worth (NPW) was calculated for all the cost and benefit parameters. Therefore, the benefit to cost ratio was calculated as follows:

   Benefit to Cost Ratio = Present Worth Revenue/Present worth Cost

   $$\text{B/C Ratio} = 236{,}323{,}563/189{,}609{,}801$$
   $$= 1.25$$

   The B/C is adjusted to 1.25 to account for uncountable costs for an additional researcher or engineer who will be required for performing consultation and testing services, respectively.

5. ***Sensitivity Analysis:*** The project is machine intensive and therefore any change in its costs will have a significant impact in the investment. It is estimated that a maximum increase in the prices of equipment of 80 percent will lead to a break even situation. A greater increase will cause the expenditure to exceed the revenue. The High Voltage Testing Laboratory will, then, either increase the cost of tests and/or seek endowments from utilities. The project economy and success is heavily dependant on the number of tests performed and consultation services. The revenues from both services are very essential for the success of the investment. Although there is a need for equipment testing among local electrical equipment manufacturers but they may have reservation on the given certification. This factor may impact negatively the number of requests for services from the High Voltage Testing Laboratory and hence the revenue. To alleviate the impact of this factor, the beneficiaries such as electrical utilities and large companies will have to bond themselves with laboratory in a strategic relationship. The users shall request manufacturers to submit verification test certification from the High Voltage Testing Laboratory. Also, the High Voltage Testing Laboratory will have to conduct a continuous awareness campaign to attract new clients. Also, the laboratory shall maintain solid and high quality integrity reputation by providing reliable and independent testing results. It is essential that the laboratory provides the electrical industries with consultation services. If such services are not provided then

the laboratory shall increase the revenue from the testing services by at least 65 percent to break even (revenues equal costs). Of course this increase could be achieved by increasing the testing fee and/or the number of testing days. If such an increase is considered highly not achievable then the project will be economically not viable. That is why the consultation services are essential and important to the success of the project. The laboratory shall consider revenue from consultation as primary source. Therefore, the laboratory shall commence its operation with strong consultation services capabilities which will bring few millions in the first four years and then shall maintain at least SR 12,500,000 net revenue from consultation services over its economic life. It is anticipated that the revenue from consultation services will supersede the revenue from other services. The incomes of prestigious international testing laboratories are mainly from consultation services rather than testing services.

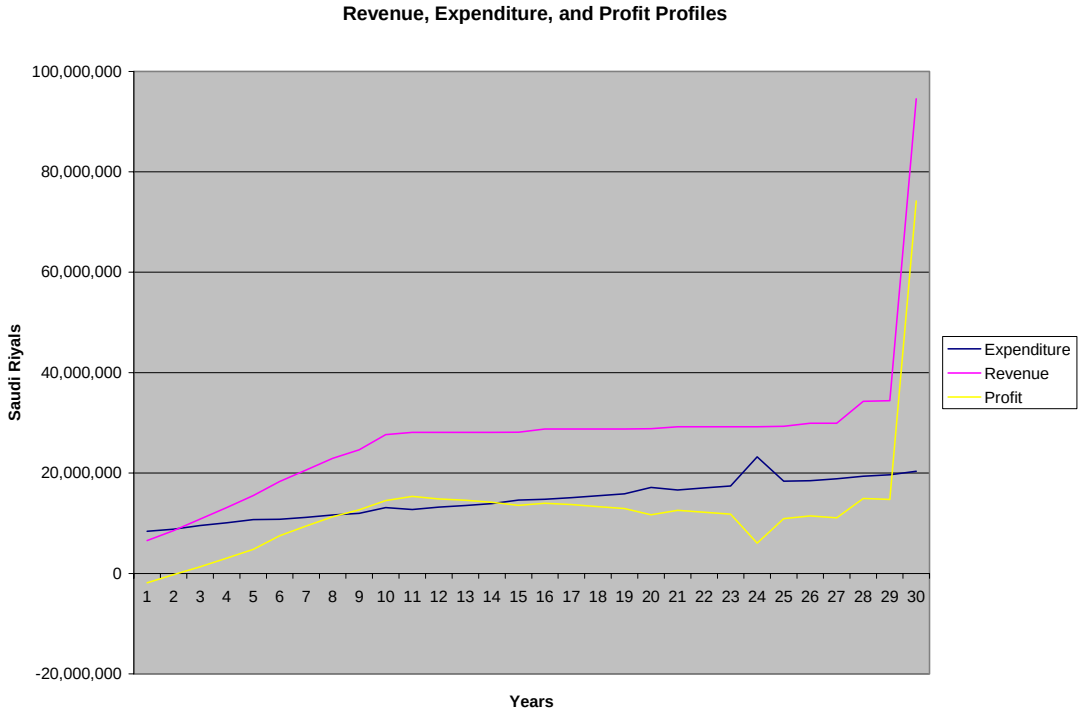

Figure 1. Revenue, Expenditure, and Profit profiles.

CONCLUSION OF ECONOMIC FEASIBILITY STUDY

The economic analysis strongly supports the decision to invest in the High Voltage Testing Laboratory project. The monetary value of the investment is positive where the benefit to cost ratio is greater than 1.8. This ratio is considered lucrative when quality and prestigious services are a priority in the investment decision. The economic analysis indicates that the High Voltage Testing Laboratory will be able to operate self sufficiently. That is, the generated revenues will cover and significantly exceed the running cost. Under this situation, the High Voltage Testing Laboratory will achieve its intended goals and contribute positively to the society by recognizing significant intangible benefits. These intangible benefits are listed below.

1. Creation of new jobs: The operation of the High Voltage Testing Laboratory will provide job opportunities to many individuals in the electrical industry. The project will provide new jobs during the different phases (pre-design, design, construction, operation and maintenance). Priority will be given to Saudi nationals to fill these jobs.

2. Increase Saudization: Qualified Saudi nationals will have the highest priority to fill the newly created jobs. As a matter of fact, many qualified Saudi nationals will compete to gain positions in the High Voltage Testing Laboratory, as they will be honored to serve in a prestigious organization.

3. The project will offer manufacturers and users an excellent opportunity to perform tests locally which will reduce both costs and time.

4. Research development: The project will create opportunities for conducting research in various areas of electrical engineering. Special attention will be focused on problems affecting the electrical businesses in GCC countries in general and in Saudi Arabia in particular. The objective of the research is to find solutions for problems encountered by industries and to contribute to knowledge for the good of all mankind.

5. The High Voltage Testing Laboratory will offer manufacturers an excellent opportunity to improve their products by providing the necessary facilities for testing their newly designed products.

6. The project will encourage manufacturers to invest in high voltage equipment to supply the local users with.

7. Reduce the number of equipments that are sent abroad for testing.

In conclusion, the increasing need for testing services for electrical equipment combined with the above listed tangible and intangible benefits to be derived from such a venture greatly support the case for establishing the High Voltage Testing Laboratory in the Eastern Province of Saudi Arabia.

RECOMMENDATIONS

As per the finding of the study, it is strongly recommended to establish a High Voltage Testing Laboratory in Dammam, Saudi Arabia.

IMPLEMENTATION PLAN

In this section a clear set of instructions and conditions recommended for implementation by major manufactured electrical equipment users such as Saudi Electricity Company, Saudi Aramco, SABIC, and Royal Commission for Jubail and Yanbu.

1- Establish a founding committee to oversee the development of the Laboratory

2- The founding committee shall hire a qualified project manager to administer the development of the Laboratory.

3- The founding committee and the project manager shall seek funds from prospective users to establish and register a company to develop the Laboratory

4- After collecting the needed funds, the company shall purchase the land for the project and prepare the necessary documents to procure the engineering and architectural services.

5- The project manager shall monitor the design process and prepare the necessary documents for selecting the necessary contractors to build the Laboratory and procure and install the testing equipment.