Chapter 6. THE ECONOMICS OF RENEWABLE ENERGY SOURCES IN UZBEKISTAN

In order for the renewable energy sector to develop, as is true for any economic sector, significant investments have to be made whose focus must be determined during the drafting of investment projects which includes assessing the feasibility and the effectiveness of those investments.

Since stakeholders in a project's implementation include not only project managers but also the government, local authorities and local residents, the assessment of the benefits of investment costs has to be conducted for all stakeholders on the assumption that they are pursuing different aims. In implementing renewable energy projects, the government's main goal is to increase the amount of energy produced from renewable energy at minimum cost, whereas the main goal of investors is to recoup invested resources and make a profit. In this regard, the amount of profit should justify their not using their resources (capital) on another project and justify the risks associated with the uncertainty of the final outcome.

In assessing the consequences of implementing a project, the government requires that a socio-economic or economic cost analysis be done. Taxes, subsidies and possible incentives do not usually figure in the price of fuel, energy and technologies because they can be treated as capital redistributed within the country and as such do not impact the general results of the analysis. Furthermore, analyses and assessments conducted for the national level can cover greenhouse gases emission reductions and project impact on employment of local residents.

In assessing the consequences of project implementation for investors, a financial cost analysis is conducted which takes into consideration all taxes and possible subsidies in the price of fuel, energy and equipment.

Review Studies for National Strategy on Renewable Energy in Uzbekistan [31], a UNDP project, analyzed the cost effectiveness of renewable energy technology in Uzbekistan (Box 6.1) using energy, environmental, so-

Box 6.1

Cost Benefit Analysis Methodology

1. Selection and determination of number of case studies covering the bulk of renewable energy technologies relevant to Uzbekistan. Each case study compares a given renewable energy system with its counterpart fossil fuel system.
2. Identification of possible investors in the renewable energy systems selected (energy utilities, industrial enterprises, the agricultural sector, urban and rural household consumers).
3. Identification of requirements for investor financial solvency.
4. Identification of special assumptions that are not technology-related:
   - General assumptions (anticipated inflation, salary levels in the country, etc.);
   - Current level of fuel prices. Current rates for buying and selling energy;
   - Assessment of trends in changes of fuel and energy prices and rates;
   - Possibility of using Clean Development Mechanism credits.
5. Identification of special technology-related assumptions:
   - Energy balances;
   - Greenhouse gases emissions;
   - Investments and operating costs.
6. Analysis of financial viability, including relevant sensitivity analyses.
7. Illustration of an application of financial incentive schemes.
8. Review of financial incentives requirements with a view to bringing them into line with the minimal requirements.
9. Analysis of the economic viability and effectiveness of CO_2 emissions reduction costs.
10. Overall assessment of the possibilities for employing more local residents for selected case studies.

cio-economic and financial criteria with the case study method and a computer model for comparing renewable energy technologies with a number of traditional fossil fuel based energy producing technologies.

6.1. Case studies and assumptions

As part of conducting the case studies, traditional energy producing technologies were compared with the following renewable energy technologies:

- Small hydro power plants functioning as part of a power system;
- Wind-driven generators connected to a power system;
- Heat producing biogas generators replacing natural gas heating and producing fertilizer as an additional product;
- Solar photovoltaic systems for off-grid (stand-alone) production of electricity;
- Solar water heaters replacing individual gas boilers to produce hot water for urban household consumers;
- Solar water heaters replacing individual electric steam heaters;
- Thermoelectric water heaters for urban household consumers; and
- Solar water heaters replacing combustion of wood to produce hot water for rural household consumers (for public baths and showers).

A series of actual renewable energy technology projects already implemented or to be implemented in the near term were selected for the analysis. More specifically, for the small hydro power plant cost effectiveness analysis, the Asian Development Bank considered technical-economic indicators for the Gulba, Pionersk, Karkidonsk, Shaudars and Bagishamsk hydro power plants for purposes of phased investments as part of a proposed USD 30 million loan for development of small hydropower in Uzbekistan.

Investors in these systems are or can be energy utilities, industrial and agricultural enterprises, hospitals, schools and other public services entities, collective farms and private farms, urban and rural residents. Each of them selects a technology based on several criteria for assessing economic viability. In practice, however, they all select the same one - payback period – for which each has its own requirements. Payback period was therefore chosen as the one criterion for assessing the viability of the technologies under consideration (Table 6.1).

Furthermore, a whole series of economic and technical assumptions had to be made due to the fact that energy prices, inflation rates, exchange rates, equipment technical indicators and costs, taxes, average salary level, per unit cost of greenhouse gases emission reductions and other indicators are subject to significant changes over time.

Considering how significantly energy resource prices and rates in Uzbekistan differ from world market prices and rates and the possibility of their increasing in the future, renewable energy technology (those that were part of the study) cost effectiveness calculations were done for two energy price scenarios: *low prices, reflecting Uzbekistan's energy prices, and high prices, reflecting world prices (as of the end of 2005 and the beginning of 2006).*

How renewable energy project viability is impacted by Kyoto Protocol CDM carbon credits from selling carbon dioxide emission reductions was also assessed.

There are many countries with economies in transition whose people are limited by how much more they can afford for energy services. Studies conducted in Estonia found that 50% of individual consumer interest groups in Tallin could not afford to pay any more for energy services than what they were already paying at that moment [24]. In this connection, stability of energy costs during the first year following capital investment in RE was adopted as a criterion for household consumers investing in renewable energy. On that basis, requisite financial schemes were chosen to reduce the burden on the consumer to repay loans on renewable energy technologies during the years renewable energy technologies and equipment were first in use.

Table 6.1
Selection of case studies [24]

Study	Renewable energy systems	Types of investors	Investor payback requirement (maximum, in years)	Comparable system
1	**Small hydro power plant** Gulba Pionerskaya Karkidonskaya Shaudarskaya Bagishamalskaya	State institutions; Specialized Company Uzsuvenergo	12	Power system
2	**Wind-driven generator facility:** Mashikuduk, Navoi oblast	Industrial investors (Cement producer enterprise)	Usually: 6 In this case: 10-12	Power system
3	**Biogas plant:** Farm, Tashkent oblast	Investor in agricultural sector (farm)	3	Natural gas for heating
4	**Solar photovoltaic systems:** Kostruba village, Karakalpakstan	Consumer group in rural regions	1	Stand-alone gasoline generator
5	**Solar water heating, hot water supply** Average apartment (60 m^2) [24]	Individual consumers in areas supplied with natural gas	1	Gas boiler (in areas supplied with natural gas)
	Average apartment (60 m^2) [24]	Individual consumers in areas supplied with electricity	1	Electrical heater (in areas supplied with electricity)

6.2. Results of financial analysis

Table 6.2 summarizes the results of the financial analysis of certain technologies studied. The results show that at current *low energy prices* (Figure 6.1) only two small hydro power plants would meet investor requirements. Higher energy prices would make the other small hydro power plants financially viable as well (Figure 6.2).

However, the other renewable energy technologies, particularly photovoltaic systems, given their current costs and efficiency, are not yet competitive with traditional energy producing technologies at today's low energy prices or at the high energy prices used for purposes of the analysis.

The possibility of carbon credits had no effect on the results of the analysis.

It must be emphasized that a biogas generator's viability depends entirely on income from sales of organic fertilizers produced at the same time biogas is produced.

It should be pointed out here that a solar water heating panel and biogas generator provide the consumer with greater comfort and reduce/eliminate the use of human labor and time lost in delivering wood and that a PV system provides access to electricity, although not in large amounts. These advantages are not quantifiable.

Figure 6.1

Financial payback period, low energy prices with no carbon credits scenario

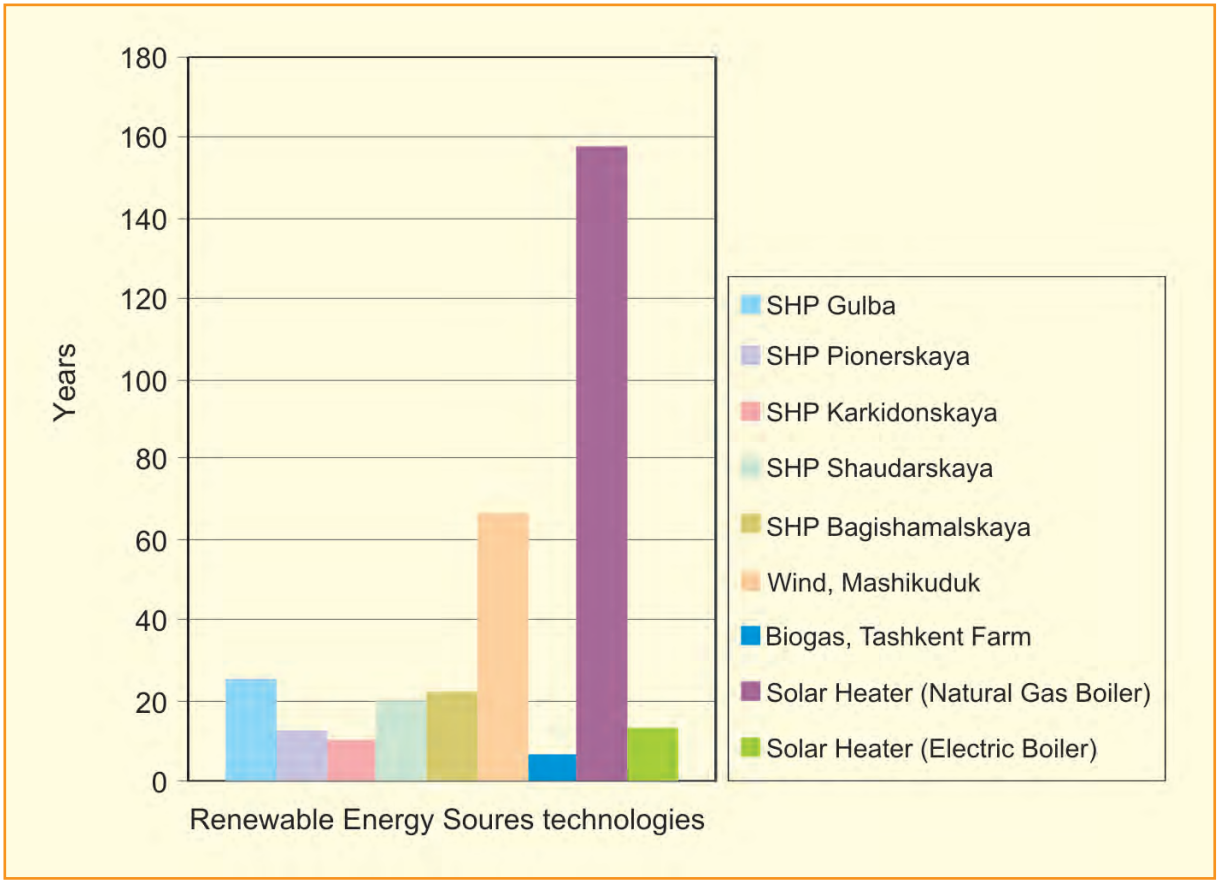


Figure 6.2

Financial payback period, high energy prices with carbon credits scenario

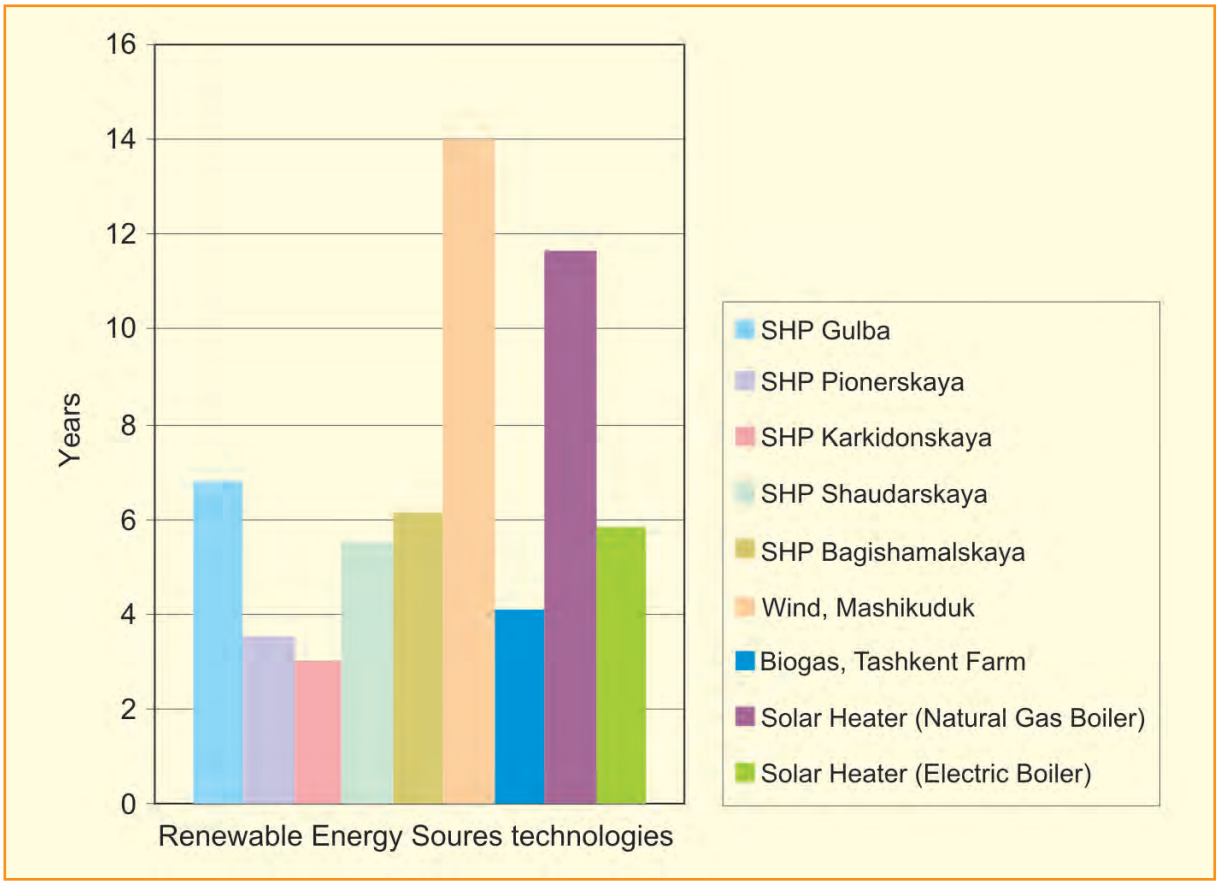


Table 6.2

Results of financial viability analysis [24]

Renewable energy technology	Case study	Payback period (years)				
		Investor requirement (years)	Low energy prices scenario		High energy prices scenario	
			No carbon credits	With carbon credits	No carbon credits	With carbon credits
Small hydro power plants	Gulba	12	25.4	19.6	7.2	6.8
	Pionerskaya		12.3	9.7	3.9	3.6
	Karkidonskaya		10.0	8.0	3.2	3.0
	Shaudarskaya		19.8	15.5	6.0	5.6
	Bagishamalskaya		22.4	17.4	6.7	6.1
Wind-driven generator	Mashikuduk facility, Navoiy province	6 (10-12)	66.3	47.2	15.3	14.0
Solar photovoltaic systems	Village of Kostruba, Karakalpakstan	1	Incalculably greater			
Biogas generator	Farm, Tashkent oblast With **25** % of fertilizer sold	3	6.7	5.9	4.5	4.1
	With **100**% of fertilizer sold		158	1.5	1.4	1.4
Solar water heating installation	Replacing natural gas	1	158	72.0	13	12
	Replacing electricity		13.1	11.3	6.0	5.6

6.3. Possible measures to make renewable energy projects more attractive

International renewable energy studies and projects, as well as case studies conducted in Uzbekistan, show that it is still too early to draw any conclusions about the need to use special financial incentives to make renewable energy projects viable.

Nevertheless, the following should be taken note of.

Small hydropower

The Development of Small Hydropower in Uzbekistan Program is now underway, although belatedly so: specialized company Uzuvenergo is using income from the hydro power plants it owns and operates to build small hydro power plants. But its income is not sufficient to bring them on line in a timely manner, i.e., the main problem in small hydropower is attracting capital investment. Efforts must be continued to attract foreign investments in the hydropower sector where the potential for small HPP construction projects is largely determined. Moreover, studies must be made of the possibilities to expand the list of viable projects by adding projects to build small hydro power plants on the nation's natural watercourses. Possibilities of using Kyoto Protocol CDM credits should also be studied.

Wind energy

No large modern wind-driven generator has been installed in Uzbekistan yet.

Data cited above regarding the Mashikuduk facility (Tables 6.1 and 6.2) located in Navoiy province are based on approximate extrapolated wind velocities measured at 10 to 105 meters aboveground. To obtain optimal wind-driven generator parameters sta-

tistical data on wind conditions at all heights above-ground where they are installed are necessary.

Efforts must be concentrated on identifying those areas in Uzbekistan where wind conditions are favorable for the installation of modern large wind-driven generators. The first thing to be done should be to take wind velocity measurements in accordance with international standards for such measurements.

Even when good wind conditions are found, for example, in the Aral Sea region, it still may be necessary to consider the possibility of using financial incentives, such as using special fixed rates for purchasing electricity produced using renewable energy sources. Those rates must include, in addition to the already existing special purchase rate for electricity produced using renewable energy sources, a 'green' or clean energy surcharge associated with wind-powered generation of electricity.

Biogas

One large biogas plant has been recently installed in Uzbekistan. The biogas technology case study meets the financial viability requirement (a three year payback period), if the fertilizers are sold for USD 25 per ton. If only 25% of the fertilizer is sold at that price, the payback period increases to six or seven years, and if no fertilizer is sold at that price, the payback period becomes approximately 30 years. A biogas market study needs to be done to assess the potential and conditions for selling fermented manure, produced by a biogas generator, as organic fertilizer.

Solar photovoltaic systems

Even though solar photovoltaic systems are still a very expensive way of producing electricity, they can be the best option for rural areas with no energy system. It is possible that in villages where houses are spaced widely apart a solar photovoltaic system would turn out to be cheaper than using a diesel or gasoline drive to produce electricity.

Regardless of which energy supply is chosen for a rural village (fossil fuel engine, solar photovoltaic system, micro hydro power plant), the main economic issue is whether village residents can afford it.

In this regard, existing financial schemes, including micro-financing, need to be evaluated using the criterion of affordability for rural residents.

Solar water heating panels

At the present time there is a small market for average or high income household consumers who can afford solar water heating panels, probably largely for the increased comfort level they provide.

The reason this renewable energy technology has such a long payback period is the low price household consumers are charged for natural gas. The first step that should be taken to make the use of solar water heating more attractive to consumers is to reduce the subsidies household consumers receive for using natural gas. Reducing those subsidies would cut the solar water heating payback period to one quarter of what it is now.

At some point after natural gas subsidies have been reduced, it will be necessary to determine what impact national policies for providing particular regions of the country with a reliable energy supply and national environmental protection policies have on the development of industrial production of solar water heating and on the effectiveness of economic incentives.

Also in need of assessment is the use of financial schemes designed to lower the financial burden during the first year following capital investment in solar water heating systems to replace electric heaters.

The cost effectiveness of renewable energy technologies can be increased by developing cooperation between the financial sector and the government: the financial sector must lengthen the crediting period and the government must help with market definition and by providing small subsidies in the form of interest payments.

Furthermore, it is advisable that consideration be given to the possibility of expanding the use of solar water heating by making the appropriate amendments to the Construction Code to allow the installation of solar heating in new buildings. Experience shows that the marginal cost of installing a solar water heating system when building a new building is very low.

6.4. Results of economic analysis

The economic analysis showed that at current low energy prices only two small hydro power plants and one biogas facility have sufficiently short payback periods and meet cost effectiveness requirements. The payback period must be in the 8 to 12 year range which is in line with the refinancing rate of the Central Bank of Uzbekistan and in line with criteria used in the Development of Small Hydropower in Uzbekistan Program (Figure 6.3). The analysis showed that the payback period for solar water heaters (to replace natural gas), though hardly what the public would like it to be, is still significantly less than the payback period obtained using the economic price of natural gas which is six times greater than the price actually paid for it.

Bringing energy prices into line with their economic cost makes renewable energy technologies tolerable to the Government, as shown in Figure 6.4.

Exceptions not meeting the affordability criterion are expensive photovoltaic systems and the Mashikuduk wind energy facility.

Figure 6.3

Economic payback period, low energy prices scenario

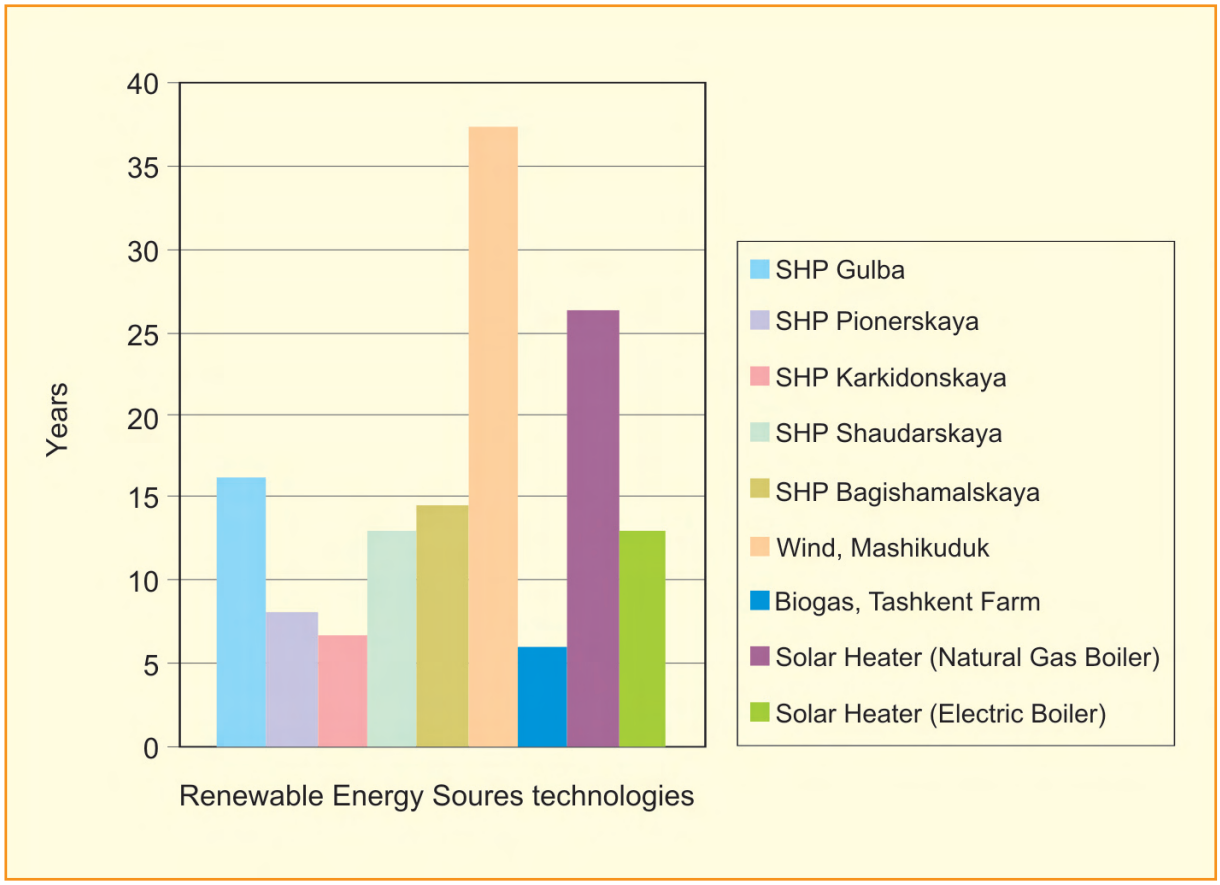
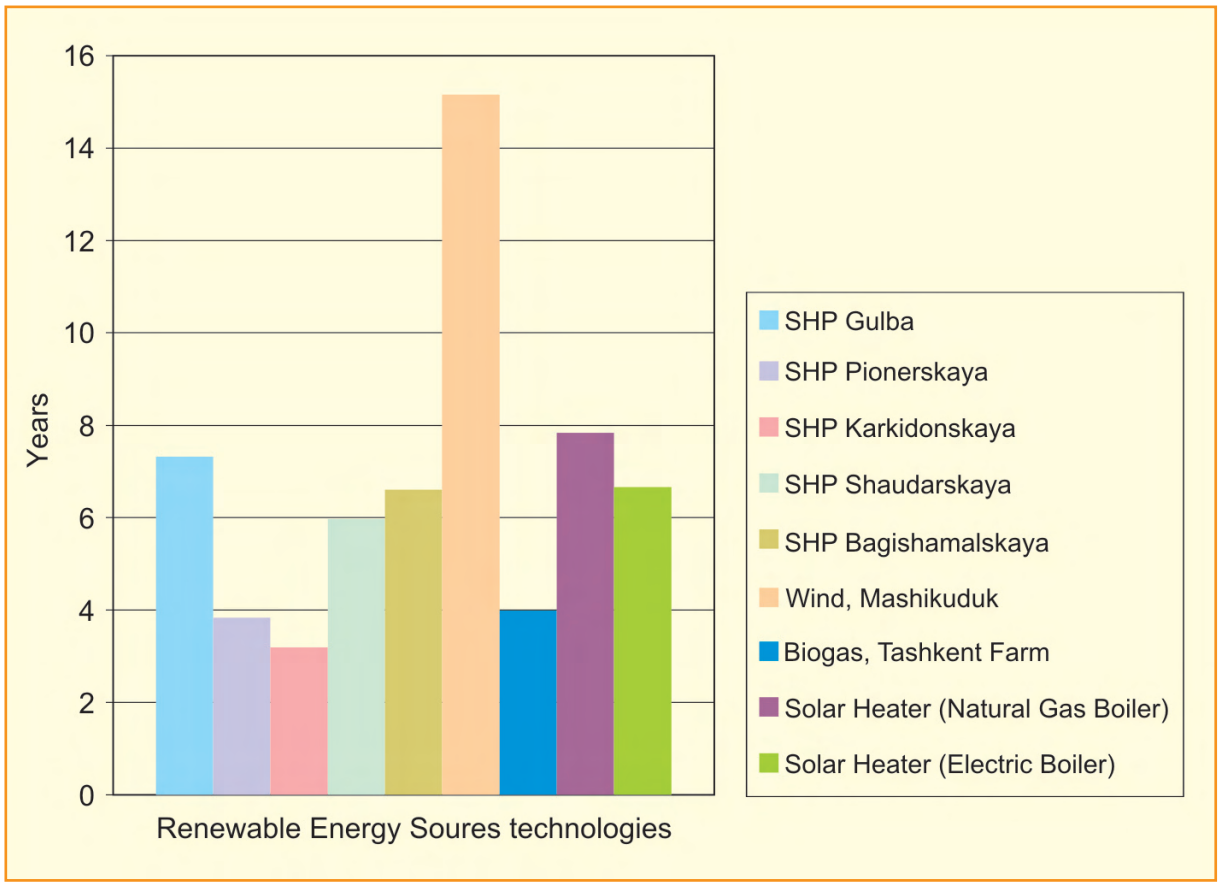


Figure 6.4

Economic payback period, high energy prices scenario



6.5. Reduction of greenhouse gas emissions

Combustion of fossil fuel results in the emission of greenhouse gases. The specific volume of greenhouse gases emissions depends on the type of fuel burned and the type of combustion technology used to burn it.

As Figure 6.5 shows, gasoline engines produce the highest carbon dioxide emissions per unit of energy produced (for those technologies studied thus far) while boilers using natural gas produce the lowest.

As already noted, using renewable energy technologies makes it possible to reduce greenhouse gases emissions. For example, when biogas is used, atmospheric emissions of gases (methane) more harmful than carbon dioxide are reduced.

The economic analysis found that at low energy prices the cost of CO_2 emission reductions depends on what renewable energy technology is used and can go as high as 100,000 sums per ton (Figure 6.6) which is enough to qualify for "carbon credits."

At the same time, certain technologies, even with low energy prices, are able to earn net income for the Government and investors: the two small hydro power plants and the biogas facility which produce energy at a cost lower than that used in calculating the economic price of electricity.

Higher energy prices result in significantly lower greenhouse gases emission reduction costs and even result in costs savings, as shown in Figure 6.7.

When CO_2 emission reductions have a negative cost that means that using renewable energy technologies one can save society money and at the same time reduces CO_2 emissions.

Figure 6.5

CO_2 emissions per kWh of electricity or thermal energy produced

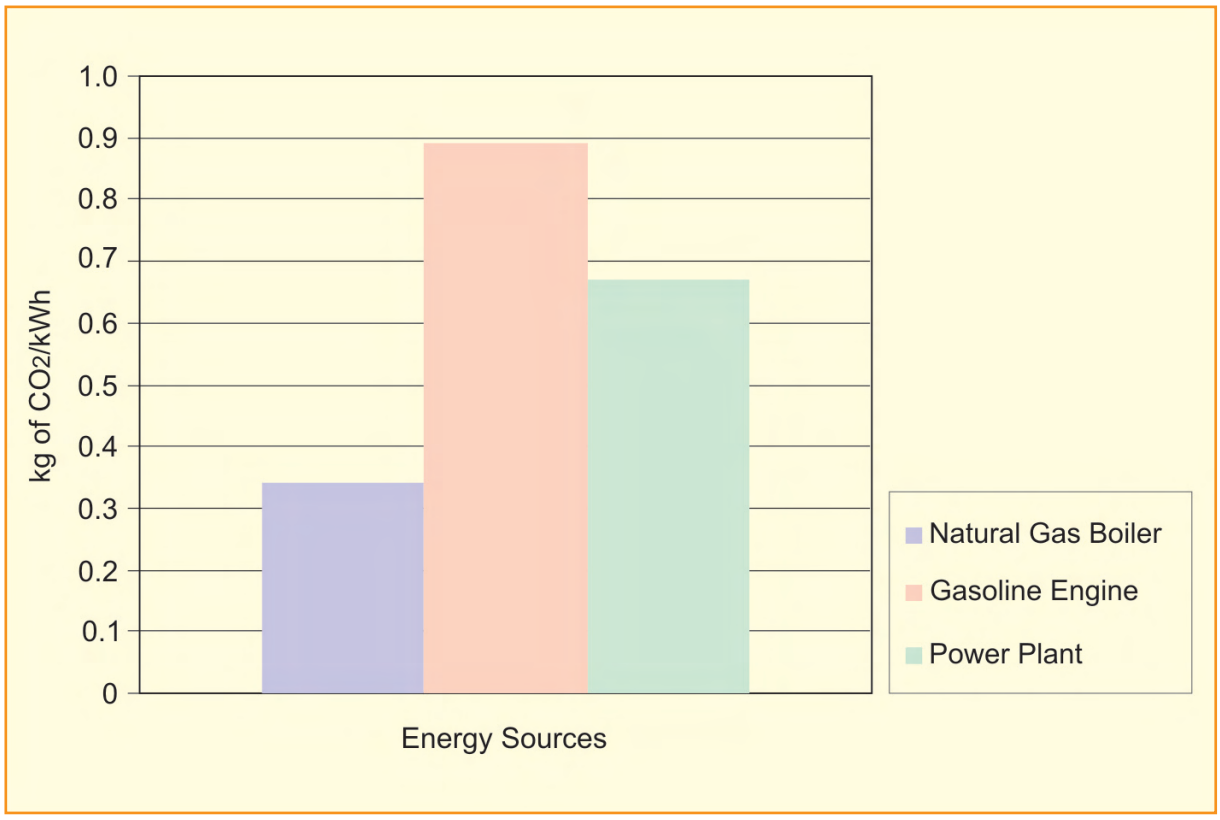


Figure 6.6

Cost of CO_2 emission reductions, low energy prices scenario

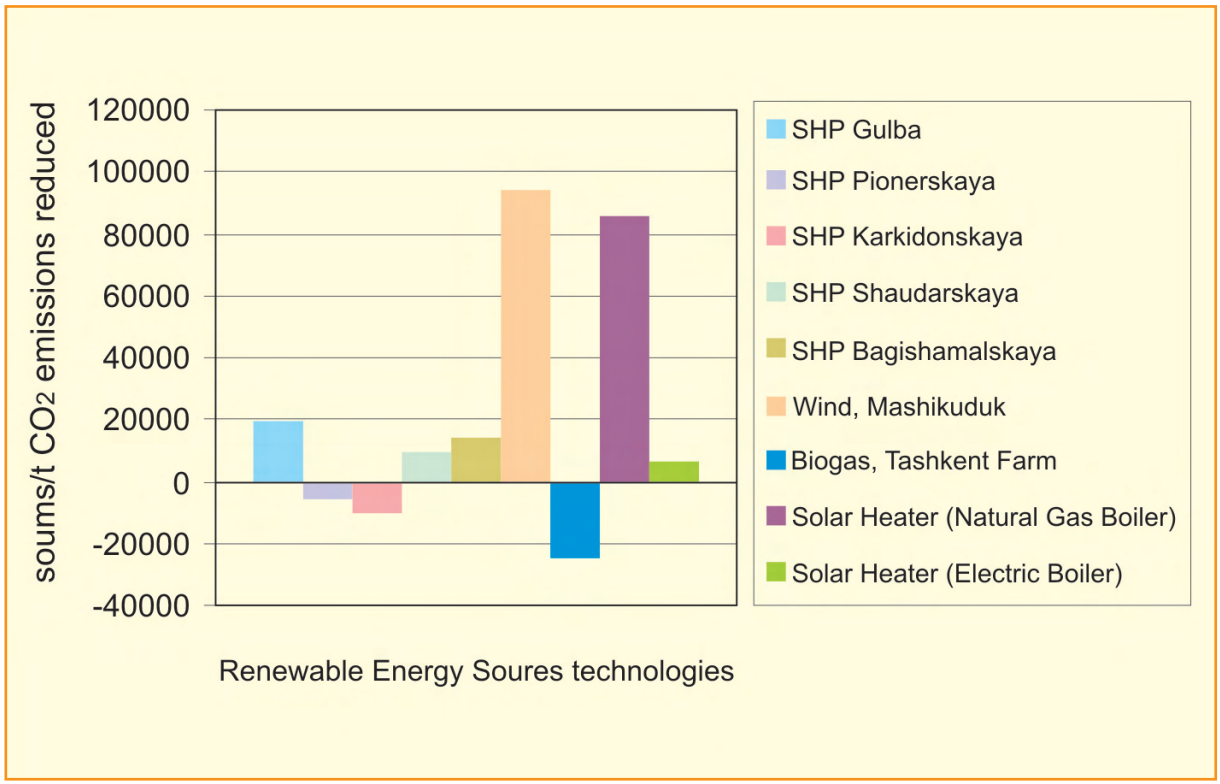
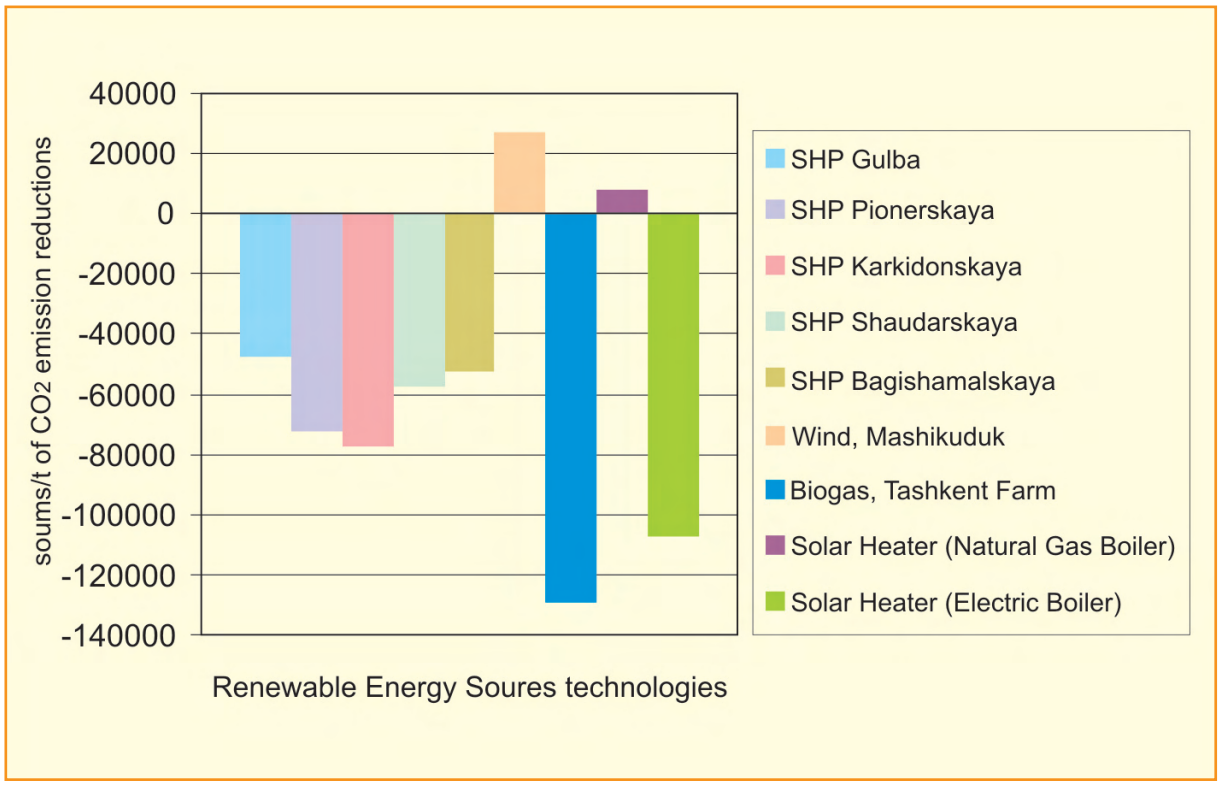


Figure 6.7

Cost of CO_2 emission reductions, high energy prices scenario



6.6. Work opportunities for local residents

Generally, new jobs created in the domestic job market by RE projects have a positive effect because renewable energy projects attract higher capital investments than traditional fossil fuel energy projects do. Other advantages associated with manufacturing renewable energy technologies and equipment locally and importing equipment for other energy producing technologies are also possible.

A thorough assessment of opportunities for local residents to work on renewable energy projects in Uzbekistan can not be done yet for a number of reasons:

- Assembly line production of renewable energy technologies in Uzbekistan has not begun yet and as a result it is hard to assess what renewable energy components might be produced in-country in the future and it is also rather difficult to quantify what share of investments would be made by local investors;
- Investments in renewable energy systems should result in comparable reductions of investments in traditional energy technologies. But that does not necessarily happen when new energy services are created, for example, in rural areas without electricity or natural gas. In such cases, certain allowances must be made, and if renewable energy projects result in lower investments in traditional energy technologies, then the share of local residents employed in traditional technologies needs to be assessed as well;
- No official data assessing the share of salaries of local residents coming from local investments is available;
- Major investment projects, for example small hydro power projects, can result in reduced investments in corresponding sectors with low unemployment. Salary level varies significantly by economic sector and also depends on renewable energy sector development.

Preliminary analysis reveals that the sectors providing the best job opportunities are those producing solar panels for heating water, solar photovoltaic systems and biogas generators.

Opportunities are good for establishing local pro-

duction of equipment for biogas generators (tanks, metal structures, pipes, cables and wire, mechanical and rubber articles, and concrete structures).

Nonetheless, since local production of biogas generators has not yet begun, there is greater uncertainty regarding biogas generator production than there is about solar water heating panels, photovoltaic systems, already being produced in Uzbekistan.