

**PROJECT PROPOSAL ON;**

**Design And Installation of Solar-Powered Water Pump to Provide Clean Water; A Case of Hase-Haro Kebele, Wonago Woreda, Gedeo Zone**

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# EXECUTIVE SUMMARY

In underdeveloped countries like Ethiopia, the demand for an improved drinking water source is not met sufficiently. The lack of access to an improved water source for drinking is the challenge being faced in Ethiopia. Solar energy generation utilizes solar cells or photovoltaic cell devices to convert the energy of light directly into electricity. To tackle the water shortage problems with an improved water source with the least budget Solar Powered Water Pumping System (SPWPS) will be the best solution. The goal of this project is to use renewable energy to guarantee long-term access to clean drinking water. Ethiopia's rural communities frequently face challenges related to climate change and their reliance on traditional energy sources, including restricted access to clean drinking. The idea uses solar technology, which is abundant and environmentally friendly, to try and address these pressing issues. Project findings indicate that solar-powered systems have the potential to greatly improve the availability of safe drinking water, thereby contributing to food security in marginalized areas Hase-Haro Kebele, Wonago Woreda, Gedeo Zone. These programs support the sustainable development goals (SDGs) for sustainable agriculture and clean water, as well as community resilience against the effects of climate change by reducing reliance on fossil fuels. This initiative aims to build on these findings and empower rural communities through capacity building and technological innovation by incorporating solar technology into local water management methods.

# INTRODUCTION

## 1.1 Background

One abundant and never-ending source of energy is solar energy. Around 2.9 x 1015 MW of solar energy is intercepted by the earth, a quantity thousands of times more than the current global consumption rate of all commercial energy sources. Photovoltaic or solar cell technologies are used in solar energy generation to directly convert light energy into electrical power. It has been demonstrated recently that as the population has grown, so has the requirement for energy and related services to support human social and economic development as well as health [1].

According to Water.org research, 42% of people have access to a clean water source, but only 11% of them also have access to sufficient sanitary facilities. These numbers are much lower in rural parts of the nation, which causes health issues for the locals.

Droughts have destroyed or made extremely shallow ponds, wells, streams, and lakes in a number of the nation's impacted areas throughout the last 20 years. These shallow water sources are used by many people who live outside of cities to gather water, but they are frequently tainted with disease, worms, and human and animal waste [1, 2]. Small towns and villages are devastated by disease throughout the months and perhaps years of drought. There is frequently insufficient water to bathe, which puts children at risk for infections and illness. In Ethiopia, waterborne infections like cholera and diarrhea are the main cause of death for children under five years old.

A lot of Ethiopian youngsters, particularly girls, struggle in school in addition to being sick. Only 45% of children are said to attend primary school. The others are forced to work every morning fetching water and assisting their families in making ends meet.

Given the dearth of better drinking water sources in Ethiopia's Gedo Zone, it is evident that the issue is serious. Since the availability of better water sources and population growth are incompatible. The population of the Woreda in the Gedeo Zone is growing, but the water supply industry is finding it difficult to meet the growing demand for better water sources. The purpose of this project is to determine how pure the water is in the several settlements surrounding Dilla City and installation of the system to provide for the users.

To tackle the water shortage problems with an improved water source and the least budget Solar Powered Water Pumping System (SPWPS) will be the best solution. Solar Powered Water Pumping System can be an easy and affordable solution in underdeveloped countries like Ethiopia.

The SPWPS system operates on power generated using a solar PV (Solar Photo Voltaic Module) system. The photovoltaic array converts the solar energy into electricity, which is used for running the motor pump set. The pumping system draws water from the bore well. The system requires a shadow-free area for the installation of the solar panel [1,3]. This Solar water pump is used to provide portable drinking water. The solar water pump uses peak solar array output which frequently coincides with high water demand during long, dry summer days. The lack of clean water in different villages around Wonago woreda is the motivation of the research study.

## 1.2 Statement of the problem

The lack of access to improved water sources for drinking is the challenge being faced in Ethiopia. This problem is significant in the Gedeo zone, the Southern region, of Ethiopia. In underdeveloped countries like Ethiopia, the demand for improved drinking water sources is not met sufficiently. The population is continuously growing however the supply for drinking water is becoming scarce. Gedeo zone has a high potential for photovoltaic power as a study shows and its sunshine throughout the year. Hence using this solar energy power to run a water pump the problem of lack of drinking water can be solved with the least budget. The photovoltaic array from the sun converts the solar energy into electricity, which is used for running the motor pump set, and the pumping system draws water from the bore well. This project focuses on the design and installation of solar-powered water pumps to provide clean water in Hase-Haro Kebele, Wonago Woreda around Dilla, in Ethiopia.

## 1.3 Questions and/or Hypotheses

* What are the main challenges being faced to provide clean water for the given community?
* How to achieve the minimum cost of the project and specific application of the project and address the product for customer satisfaction at the same time?
* How to achieve a solar-operated water pump with the required efficiency and What amount of energy is required to operate the designed pump?

## 1.4 Objectives

### 1.4.1 General Objectives

The main objective of this project is Design and Installation of a Solar-Powered Water Pump to Provide Clean Water; A Case of Hase-Haro Kebele, Wonago Woreda, Gedeo Zone.

### 1.4.2 Specific objectives

 To achieve the above general objectives the specific tasks that will be performed are:

* Identifying research area (Site inspection)
* Design and select the materials (components) needed for carrying out the project
* To determine the load required for the pump
* To determine how many rural community members are beneficiaries of this project

## 1.5 Beneficiaries from the project

### Direct Beneficiaries

**Local Households:** Residents will gain immediate access to clean drinking water, significantly reducing health risks associated with waterborne diseases.

**Women and Children:** Women, often responsible for water collection, will save time and effort spent fetching water, allowing them to engage in other productive activities, including education and income-generating tasks. Children will benefit from increased access to clean water, reducing school absenteeism due to illness.

**Community Health Workers:** Health professionals will see a decrease in water-related illnesses, allowing them to focus on other health issues and improving overall community health.

**Local Entrepreneurs:** Businesses that support agricultural activities, such as suppliers of seeds and fertilizers, will experience increased demand due to improved farming productivity.by health community.

### Indirect Beneficiaries

**Broader Community**: The entire community will benefit from improved public health, leading to a healthier population and reduced healthcare costs.

**Local Government**: The government will benefit from reduced healthcare burdens and improved agricultural productivity, contributing to local economic growth.

**Environmental Advocates**: By promoting the use of renewable energy, the project supports broader environmental sustainability initiatives, positively impacting climate change efforts.

**Future Generations**: Sustainable water management and access to clean water will benefit future generations, ensuring long-term community resilience and health.

**Educational Institutions**: Schools will benefit indirectly as healthier students are more likely to attend classes regularly, improving overall educational outcomes.

## 1.6 Scope and Significance of the Study

This project considers the areas around Gedeo Zone having scares of clean water and providing for the users using solar-powered water pumps. In addition to this, the solar-powered water pump will be designed and installed with the required specifications.

The significance of this project is using renewable solar power increases the availability of clean water for the users having scares of water and decreases the community challenges due to finding pure water (clean water) and saving their time people living in Hase-Haro Kebele, Wonago Woreda, Gedeo Zone around Dilla.

# 2. MATERIALS AND METHODS

## 2.1 Project Implementation Area

The Solar-Powered Water Pump Design and Installation project will be implemented in the area of the Hase-Haro Kebele, Wonago Woreda, Gedeo Zone, Ethiopia. This region is characterized by its agricultural activities and reliance on seasonal rainfall for water supply. The project will focus on rural communities within Wonago woreda, targeting areas most affected by water scarcity.

The methodology will be adopted for the study and design of solar-powered water pumps to provide clean water for the Hase-Haro Kebele, Wonago Woreda, Gedeo Zone community.

Water supply-demand analysis based on population data and national standard water provision of Wonago Woreda; we are planning to include 500 households from the village and the drinking water demand. We will be considering 6 families per household and the total family in 500 households is 3000 individuals.

The basic steps involved in system sizing are [3,4];

* Determine the water demand for the given community;
* Use designs the design analysis as the hours of pumping to find the pumping rate;
* Find the total Heads (H) and Flow rates (Q);
* Find the capability of the pump to deliver the required head, flow rate, and Pump efficiency.

## 2.2 Average daily consumption of water

A study conducted in SNNP, Ethiopia [2], described the average daily consumption of water per household per day as 53.8 liters per person per day as 9 liters.

Let us take a general estimation of around 9 liters per person per day.

The total daily water requirement of these families is 27, 000 liters, which will select the pump with a capacity of 27, 000 liters and the amount and load of the solar panel to operate this pump.

* To determine the energy required from the source and the size of the photovoltaic module;
* Economic analysis of the system in general and cost comparison of different energy sources.
* PV system design is the process of determining the size of each component of a standalone photovoltaic power system to meet the load requirement.

## 2.3 Design Method

‎PV system design is the process of determining the size of each component of the standalone photovoltaic power system to meet the load requirement. The design is done through the following steps [2]:

Step 1: Site inspection

Step 2: Determining load requirements

Step 3: PV module sizing

Step 4: Pump selection

Step 5: Water tanker

Step 6: Cable size

Step 7: Analysis of Cost

**Pump size determination**

The total head is the vertical distance the water needs to be lifted, usually measured in meters (m). This includes the static lift (the vertical distance from the water source to the discharge point) and any friction losses in the pipes.

Let us assume that the pump works 8 hours per day and the total amount of water needed per day converted the total volume of water to a flow rate. In this case, the total water needed per day is 23, 000 Liters, and the pump flow rate is calculated as;

The hydraulic power (P) required to lift water can be calculated using the formula:

The estimated pump power requirement to operate is 600 Watt we are estimating the water total head up to 40m

Where:

P = Power (Watts)

 = Density of water (approximately 1000 kg/m³)

g = Acceleration due to gravity (approximately 9.81 m/s²)

h = Total head (meters)

Q = Flow rate (m³/s)

η = Pump efficiency (as a decimal, e.g., 0.7 for 70% efficiency)

Therefore, in this design, friction losses are neglected because it is very small. Assume total head, HT =Hs+Hf+Hd where Hs, Hf, and Hd aresuction head, friction head, and discharge head respectively [5,6]. Figure 2.1 shows the schematic diagrams of solar-powered water pumps and their components and their arrangements.



Fig 2.1 Schematic diagram of solar-powered water pump

## 2.4 Stakeholder Analysis

**The main stakeholders who will be involved in this project are listed in Table 2.1**

**Table 2.1 Stakeholders involved in solar-powered water pump systems**

|  |  |  |  |
| --- | --- | --- | --- |
| **No.**  | **Stakeholders**  | **Role**  | **Participation level** |
| **1** | **Local Government Authorities** | Provide regulatory support and facilitate project implementation | High; involved in planning, approvals, and monitoring |
| **2** | **Community Leaders** | Act as liaison between the project team and the community, ensuring local needs are represented | High; actively engaged in community consultations and decision-making |
| **3** | **Local NGOs and Civil Society Organizations** | Offer expertise in community engagement and capacity building | Medium; involved in training and awareness campaigns |
| **4** | **Health Workers** | Monitor public health outcomes related to water access | Medium; provide feedback on health improvements |
| **5** | **Technical Experts and Contractors** | Responsible for the technical design, installation, and maintenance of the water pumps | High; actively involved throughout the project lifecycle |

# 3. EXPECTED OUTPUTS

The goal of the community engagement plan is to guarantee the active involvement and support of local stakeholders in the solar-powered water pump design and installation project in Hase-Haro Kebele, Wonago Woreda, Gedeo Zone.

The anticipated results consist of:

**Enhanced Community Awareness**

* **Increased Knowledge**: By learning more about the advantages of solar technology and access to clean water, community people will be better able to support the project with knowledge.
* Health Education: Public awareness programs will inform locals about the dangers of drinking contaminated water and the significance of utilizing clean water.

**Stronger Community Ownership**

* Local Investment: The initiative will encourage communities to take pride in and maintain the water systems by letting them participate in the planning and implementation stages.
* Sustainable Practices: Community members will advocate for appropriate water use and management through active engagement, which will foster a culture of sustainability.

**Improved Stakeholder Collaboration**

* Development of Partnerships: The project will improve ties between community organizations, NGOs, and local government, making it easier to work together on next projects.
* Resource Sharing: Improved stakeholder communication will result in more efficient use of resources and a pool of knowledge for managing water resources.

**Increased Participation in Decision-Making**

* Empowered Voices: To guarantee that the project is in line with regional interests, community members will have the chance to express their wants and worries.
* Inclusionary Planning: Involving various community groups, such as farmers, women, and young people, will guarantee that all viewpoints are taken into account when making decisions about the project.

**Enhanced Project Sustainability**

Building Capacity: Workshops and training will give locals the know-how to maintain and run the solar-powered water pumps, guaranteeing their long-term operation. The sustainability of the project will be enhanced by cultivating local leaders who can promote continued upkeep and assistance for the water systems.

**Positive Social Impact**

Better Health Outcomes: Better health and a lower prevalence of waterborne illnesses will result from greater access to clean drinking water, improving the general well-being of the population.

**Documentation and Feedback Mechanisms**

* Continuous Improvement: By putting in place feedback systems, the community can continue to provide input, which will enable the project be implemented more effectively and adaptably based on actual experiences.
* Lessons Learned: Gathering and disseminating community participation insights will yield important data for upcoming initiatives, both domestically and internationally.

# 4. Sustainability of the project

The solar-powered water pump is environmentally sustainable. It means that it doesn’t harm the environment. It only means that we need energy from sunlight to run the pump and feed the water for the user having scares of clean water at Hase-Haro Kebele, Wonago Woreda, Gedeo Zone using sun’s energy that can be used indefinitely without diminishing its future availability.

# Monitoring and Evaluation

The local community's sustainable access to clean water is the goal of the solar-powered water pump project in this project. This project describes the framework for monitoring and evaluation that will be used to evaluate the impact, efficacy (ፍጥነት), and efficiency of the project.

## 5.1. ****Monitoring****

**Regular Data Collection**:

Install automated data logging for solar power and water output, and execute manual equipment performance and maintenance needs checks once a month.

**Community Surveys**:

Conduct surveys every month to get user opinions on the accessibility and quality of the water. You should also obtain qualitative information about how enhanced water access has affected community practices.

**Site Inspections**:

Plan monthly site inspections to check the solar panels and pumps' physical state and look for any negative effects on the surrounding area.

## 5.2. ****Evaluation****

**Baseline Assessment**: To determine the beginning conditions (community demographics, water access), do a baseline analysis before to installation.

**Mid-term Evaluation**: At the 12-month mark, conduct a mid-term evaluation to gauge progress toward KPIs. Then, modify project plans in light of results and input from the community.

**Final Assessment**: Compare data to the original goals and offer suggestions for upcoming initiatives.

# Risk mitigation option

The installation of solar water pumps in Wenago, Wereda aims to enhance access to clean water. However, various risks may hinder the successful implementation and operation of this project.

## Risk Identification

**Technical Risks**

* System Failure: The possibility of ineffective or malfunctioning equipment.
* Poor Design: Dangers of a design that doesn't take into account regional requirements or circumstances.

**Hazards to the Environment**
Climate Variability: Modifications to weather patterns that impact the efficiency of solar power.

**Financial Risks**

* Budget Overruns: Inflation-driven costs that surpass original projections.
* Funding Shortfalls: Possible delays in funding or loss of financial support

**Social Risks**

* Community Resistance: Insufficient support or involvement from the community in the project;
* Maintenance Knowledge Gaps: Inadequate system maintenance training for local staff.

**Regulatory Risks**

**Policy Changes**: modifications to laws or rules that affect water management or solar energy.

## 6.2 Risk Mitigation Strategies

**Technical Mitigation**

* Thorough Site Assessment: To guarantee appropriateness, carry out thorough assessments of installation locations.
Selecting
* High-Quality Equipment selection: Make use of dependable, superior solar panels and pumps that have a track record of success.
* Frequent Maintenance Schedule: To guarantee optimum performance, create and follow a maintenance schedule.

**Environmental Mitigation**

* Plans for Disaster Preparedness: Create emergency response procedures and backup plans for natural disasters.
* Strategies for Climate Adaptation: Include adaptable design elements that can vary with the climate.

**Financial Mitigation**

* Detailed Budgeting: Create a thorough budget that accounts for unforeseen expenses.
* Diversified Funding Sources: To lessen dependence on one organization, look for several funding sources.

**Social Mitigation**

* Community Engagement: To promote ownership and support, include local communities in the planning and implementation stages.
* Training Programs: Give local technicians thorough instruction on how to operate and maintain systems.

# 7. TIME MANAGEMENT

The total time for this project will be two years. This Twenty-four-month schedule is divided into four phases in each phase different separable tasks will be accomplished as follows.

Table 7.1 Time management.

|  |  |  |
| --- | --- | --- |
| **Phase**  | **Time**  | **Work details**  |
| Phase one | 6 Months | Studying and selecting the areas having scares of water around Wonago woreda. In this phase, small villages will be considered and the data will be collected from those areas. After the areas are inspected, studying the groundwater properties and the depth of water in the ground will be performed. In this stage, hydraulic engineers will be included in studying the groundwater.  |
| Phase two  | 8 Months | Performing the design analysis, Purchasing, transporting, and installation of the solar-powered water pump with the help of technical personnel. |
| Phase three  | 4 Months | Monitoring and evaluation, at this stage different tasks are performed including feedback analysis form the users |
| Phase four | 6 Months  | Overall assessment of the project, user satisfaction analysis and Reporting the finalized project output. |

Table 7.2 work plan

|  |  |  |
| --- | --- | --- |
| No | Activity | **Year 2024/25/26** |
| Months |
| 2024 | 2025 | 2026 |
| Nov  | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct |
| 1 | Data collecting  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Literature review  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | Research area identification  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | Study ground water properties and the depth of water in the ground |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | Design analysis of the project |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | Purchasing and transportation  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Progress report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 | Installation  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Monitoring and evaluation, |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | Continuous Project assessment  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | Documentation  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | Final report  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# 8. Cost Estimation of the Project

Table 4.1 below outlines the budget required to conduct the project specifically for each breakdown of the activity for the design and installation of a solar-powered water pump to provide clean water around Dilla (Hase-Haro Kebele, Wonago Woreda) as follows.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.**  | **Item/Activity**  | **Unit**  | **Quantity**  | **Unit price (ETB)** | **Total cost (ETB)** |
| **1**  | Per diem | Person  | 3 person for 100 days | 477 birr/day | 143,000 |
| **Sub-total (A)** | **143,000** |
| **Manpower Cost (B)** |
| **1** | Data collector  | Person  | 6 person for 100 days | 300 birr/day | 180,000 |
| **2** | Data entry Clerk | Person | 2 person for 60 days | 250 birr/day | 30, 000.00 |
| **Sub-total (B)** | **210, 000** |
| **Documentation and stationery (C)** |
| **1** | Photocopy | Page  | 1275 | 5 birr/ pages | 6,375.00 |
| **2** | Printing | Page  | 950 | 5 birr/ pages | 4, 750.00 |
| **3** | Binding | Pieces | 10 | 50 birr/ pieces | 500.00 |
| **4** | A-4 Paper | bundle | 5 | 800 birr/ bundle | 4, 000.00 |
| **Sub-total (C)** | **15, 625** |
| **Local travel and communication (D)** |
| **1** | Transportation cost | 50 Trip | 3 | 500 birr/trip | 75,000 |
| **2** | Mobile card (Internet & phone) | - | - | - | 5,000.00 |
| **Sub-total (D)** | **80, 000.00** |
| **Training and orientation of data collector (E)** |
| **1** | Training hall rent | - | 20 days  | 1500 birr/day | 30,000.00 |
| **2** | Training and orientation |  | 20 days | 2,000 | 40,000 |
| **2** | Coffee/tea expensefor training | - | 3 days | 500 birr/day | 1,500.00 |
| **Sub-total (E)** | **71, 500.00** |
| **Refreshment (F)** |
| **1** | Refreshment | - | - | 50,000  | 50,000.00 |
| **Sub-total (F)** | **50, 000.00** |
| **Publication cost (G)** |
| **1** | Journal |   | 1 | 50,000  | 50,000.00 |
| **Sub-total (G)** | **50, 000.00** |
| **Budget Summary = (A+B+C+D+E+F+G)** **143,000+210, 000+ 15, 625+80, 000+71, 500+50, 000+50, 000= 556,125 ETB** |  **620,125** |
| **Contingency (5%)** | **31,006.25** |
| **Grand Total in ETB** | **651,131.25** |

**Material purchase cost**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Device** | **Model** | **Qty** | **Unit Price (ETB)** | **Cost of Devices (ETB)** |
| Module | 300W-36volts | 4 | 11, 500 | 46,000 |
| Pump  | 1.25-inch Submersible DC | 1 | 285,000 | 285,000 |
| Tanker | 10,000 Liter | 3 | 20, 000 | 60, 000 |
| Panel structure |  | - |  | 10,000 |
| Pipe, fittings and pump controller | 76mm32mm | 2 | 5980 | 11,960 |
| Cement  | Kg  | 8 | 1950 | 15,600 |
| Transportation and loading | - |  |  | 10,000 |
| Screws, bolts, nuts, and other accessories, cables |  |  |  | 10,000 |
| Chemicals  |  |  |  | 5,000 |
| Installation Cost |  |  |  | 15,.000 |
| **Subtotal** | **468,260** |
| Contingency cost 5% | **23,413** |
| Total | **491,673** |
| Total Capital | **651,131.25+491,673= 1,142,804.25** |

#

# REFERENCE

1. Barot Apurv, Nagangouda H, Ananthachar Ramprasad, Design and proposal of solar photovoltaic power plant for medium scale industry, International Journal of advances in scientific research and engineering, vol. 3(6) 2017.
2. Esan Ayodele Benjamin, Egbune Dickson, Estimating the solar home system sizing for rural residential apartments using a panel tilt angle of 82 degrees, American Journal of Electrical and Computer Engineering, vol1(2), 2017, Pp 90-96.
3. Soteris A. Kalogirou, Solar Energy Engineering: Processes and System, USA: Elsevier Ltd. 2009.
4. Ndagijimana, M. Tech, b. Kunjithapathan, Design and Implementation PV Energy System for Electrification Rural Areas, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958, Volume-8 Issue-5, June 2019.
5. Grid-connected PV systems design guidelines for accredited designers, Clean Energy Council l (CEC), Issue 3 July 2007, updated November 2009. Published.
6. The Marshall Islands. Herb Wade, PV system sizing. Solar PV Design Implementation O & M”, March 31 – April 11, 2008.
7. Ch. Breyer, A. Gerlach, M. Hlusiak, C. Peters, P. Adelmann, J. Winiecki, H. Schützeichel, S. Tsegaye, W. Gashie, Electrifying the poor: highly economic off-grid PV systems in Ethiopia – a basis for sustainable rural development.