

REV. 1.1.

WATER PUMPING, GRAIN MILLING AND FRUIT SORTING: NEW OPPORTUNITIES FOR REMOTE VILLAGES



The use of the draft animal power, spread in the world with at least 200.000.000 of heads, has not exhausted all its potential.

In fact, further to transport and soil cultivation, its energy can be now, profitably, utilized to move water pumps, grain mills, sieves, milking machines, threshers and winnowers

Today the use of the draft animal power for the generation of electricity is a reality that today can no longer be ignored.

With a medium-sized draft animal is now possible to generate a power of approximately 400 Watts of electricity.

For instance this amount of energy is capable to lift, at least, at six meters, ten thousand liters of water in four hours.

Similar results are achievable also for grain milling, fruit sorting and other processing of rural products.



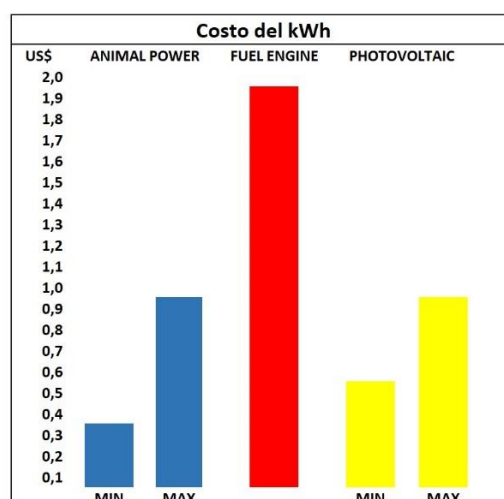
This has become possible thanks to the new design of a rural tool. With this equipment a draft animal, walking on a round path, moves a rev multiplier that moves an electric generator.

The electricity so generated can move every rotating equipment such as, for instance, pumps or mills.

1. The field of application

The system is tailored for those geographical areas where (i) the rural economy is prevailing, (ii) where there are in operation working animals, (iii) where an electrical power of less than one kW can be very useful, (iv) where the farmer's monthly wage is around US\$ 67.93 and (v) where the average cost of fuel is of US\$ 1.43 per liter.

In these situations, present in very large areas of the world, it is possible to say that the average cost of the electricity derived from the animal traction is approximately US\$ 0.90 per kWh with a minimum percentage of this amount spent outside the village. In some cases this cost can go as low as US\$ 0.51 per kWh and sometime even less.



Using combustion engines in similar situations entails a higher cost of around \$1.95 per kWh.

The annual cost of a photovoltaic system, and consequently that of the kWh produced, is in most cases comparable with that of the animal-powered systems, sometimes even more expensive, i.e. 412.53 US\$ of the photovoltaic against the annual management cost of the animal-powered system equal, in certain situations, to US\$ 333.47 or less.

In the last two cases, fuel engines and photovoltaic, all the costs are to be spent outside the village whereas the costs of the above animal driven system are almost totally to be spent for resources produced in the village.



The method of the calculation of the above costs is available in www.wedap.it/img/ea.pdf

2. The system

A working animal walking on a circular path moves a rounds multiplier that moves an electric generator.

In a lot of remote villages the only really available primary source of energy, further to the man labor, is the draft animal power, today supplied by at least 200.000.000 of working animal.

Several scientific institutions in the world, mainly in India, have studied the possibility to use the draft animal power to produce the electrical current. Dozen on patents have been obtained on the matter. Several examples are available on the web. But none of the solutions till now proposed has reached the market. This is mainly due to a mechanical issue: the enormous torque developed by the first shaft of the revs multipliers.

WEDAP has solved, with an innovative design, this problem of the high torque.

Having made available this modernized source of energy WEDAP has studied the update of specific tools, now driven, in the villages, by cranks and pedal. Duly transformed these tools now are moved through the electricity generated by the draft animal power. This will increase the productivity of the farmers by 3 to 5 times and several times more in the case of water lifting, transport and distribution.

3. Ready to transfer the technology

WEDAP is ready to transfer the technological information, developed by it, in order to allow the villages and the rural areas to improve their productivity.

Its technology transfer package comprises the detailed drawings of the equipment, the list of the parts, the procedure to assemble them, the names and addresses of the suppliers of the parts, the assembly manual, the maintenance manual and the operation manual.

The operation manual comprises information on the taming and training of the animals with stringent recommendations on the cure and promotion of their welfare, in accordance with the most reputed international standards.

The presence of foreign personnel in the village, for the vocational training, will be temporary and only in the first stage of the diffusion of the technology.



WEDAP is conscious that the diffusion of the technology could be successful only if the following steps will be implemented. Then it is ready to:

- Prepare a list of the electrical and mechanical parts with the name and the addresses of the possible local suppliers and, alternatively, with the names of foreign at easy reach foreign supplier
- Prepare a construction and assembly manual
- Prepare a maintenance manual
- Prepare a vocational training manual
- Prepare a layout of the workshop and of the testing field.

Possibly the manuals will be prepared in the local language.

The project will reach the maximum of its benefit (i) if the systems are built in the villages by the local people, (ii) if in the area there are easily available the spare parts, (iii) if widespread competences to manage the machines and the animals are transferred in the area, (iv) if several machines will be in operation in order to create synergies between the operators, (v) if in the project there are involved the beneficiary of the services of the systems and (iv) if the mills and the other equipment are those present in the villages and properly transformed and not equipment purchased outside the village that often are difficult to maintain.

With reference to point (v) it is possible to say that, in most cases, the beneficiaries of the services are the women that in many villages have the task of the water lifting and transport.

It is well known the situation in which a supplied equipment definitively falls down because there are absent spare parts and maintenance competences. For this case, it shall be remembered that the possible maintenance problems are really negligible, in fact the machine is as simple as a big bicycle. The electrical parts - easily replaceable - have a very high MTBF (Mean Time Between Failures).

WEDAP is ready to propose the design both in metric and in imperial system.

4. The program

The project will be tentatively implemented according to the following steps:

| PACKAGES | Months | | | | | |
|--|--------|----|----|----|----|----|
| | 1° | 2° | 3° | 4° | 5° | 6° |
| Local Survey | ■ | | | | | |
| Detailed design of the machines, of the equipment to be driven with electricity and of the workshops | | ■ | ■ | | | |
| Selection of potential at easy reach suppliers | | | ■ | | | |
| Construction on site of the equipment and of the tools | | | ■ | ■ | ■ | |
| Animal selection and training | | | ■ | ■ | ■ | |
| Operations | | | | | ■ | ■ |



5. The packages

a. The Local Survey

The local survey will be finalized to the analysis and selection of the mechanical and electrical parts really available in the place where the systems will be utilized. Among these parts there are iron bars, cables, diodes, sprockets and electric generators. Alternatively there will be identified one or more local firms capable to manage the supply chain for those parts not easy available in the country.

In the same way it will be identified the villages that have the characteristics to absorb the said technology.

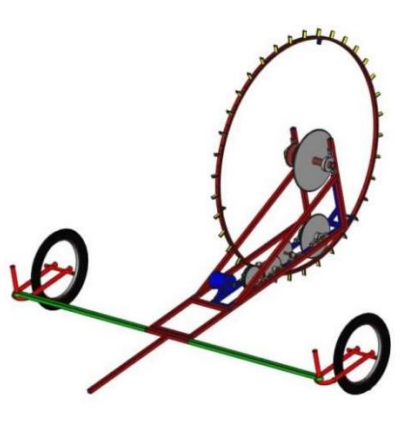
An analysis will be conducted on the acceptability of the system by the local population in terms of confidence and habit of using working animals.

Due attention shall be given to the working animals available in the area, to their aptitude to the taming and training and to their stamina and confidence with farmers.

b. Detailed design of the machines

In the design of the machines, suitable for the chosen site, the following elements will be considered:

- Stamina and size of the typical animals in the area
- Metric or imperial system i.e. centimeters or inches
- Parts available or easily available
- Local operators and workshop capabilities
- Layout, equipment, tools and flowchart of the manufacture and maintenance workshops.



c. Electrical and mechanical parts supply

WEDAP will monitor the first supply of the parts and of the equipment that will be easy available in the area.

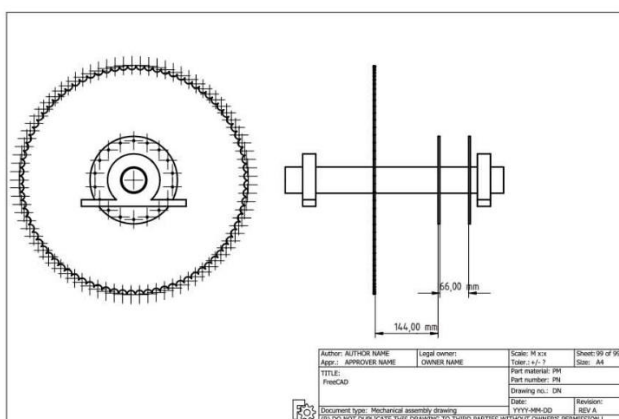
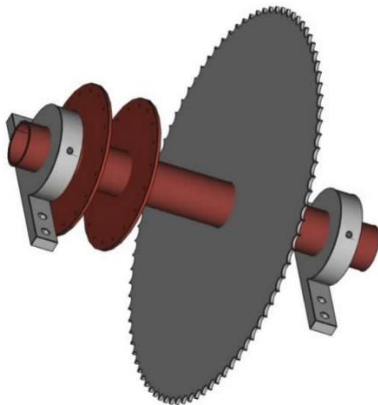


d. Construction of the machines

WEDAP will supervise the construction of the first machines in an equipped workshop.

The workshop tools needs are represented by a welder and some other very simple tools.

Small lathe works may be requested outside the village.



e. Animal selection and training

The taming and training of the animals will be conducted in accordance to the most stringent international standards for the animal welfare.

f. Operations

Personnel of WEDAP will be present on site for the vocational training during the first operations.

Alternatively the first training of local operators could be implemented in the premises of WEDAP in Crispiano and Grottaglie, in Southern Italy, North East of Taranto in Italy.

6. Costs

| | | | |
|--|-------|--|--|
| Project coordinator | 180 d | | |
| Engineer | 120 d | | |
| Technician | 90 d | | |
| Vocational training expert | 90 d | | |
| Expert for animal selection and training | 90 d | | |
| Parts supply | | | |
| Travel and accommodation expenses | | | |
| Overheads and contingencies | | | |

7. Personnel and organization

The project will be coordinated by Antonio Perrone. He has been for several years head of division in the Division Research of the Directorate for the Sustainable Development at Ministry of Environment in Italy

He has been, among others, Visiting Scholar at the New York University with a grant of the National Council of Researches of Italy for studying the procedures for the international transfer of technologies.

He has carried out missions in 15 countries on four continents, some of which - on account of his ministry - at intergovernmental meetings of the United Nations Agencies.

Partner in several activities of WEDAP has been IBF, the International Buffalo Federation, the federation of technicians and scientist engaged in the promotion of buffalo farming. IBF is present in several countries of all the continents and has recently celebrated its twelfth triennial world congress. For the purposes of the present project, the Regional Government of Regione Puglia, in Italy, has entrusted to WEDAP two donkeys raised in its governmental breeding farm.

Other initiatives have been performed with the Brescia University and the Research Center of the Ministry of Agriculture in Italy.



The work here shown was a finalist in the global EBL *Empowering a Billion Lives* competition, announced by the IEEE, the largest technical-scientific organization in the world which brings together over four hundred thousand registered experts in electrical engineering.

In this capacity, in March 2023, Antonio Perrone was a guest of the IEEE, in Orlando, Florida, for the final phase of the competition. IEEE, in addition to the hosting, financed part of the field tests and also organized a crowdfunding for the project.

The work here described was also rewarded, in 2020, in Rimini at Ecomondo, by the Foundation for Sustainable Development and, in Bari in June 2023, on the occasion of the Apulian Award announced by Confindustria and CNR.

Other references are available in www.wedap.it/eeref.html

WEDAP is a social responsibility initiative promoted by a rural farm, Masseria Coppola, established in Grottaglie and Crispiano, north east of Taranto in Southern Italy.

8. Benefits

a. The water lifting

Generally speaking, it is considered that the working animals increase the productivity of the men from three to five times. This is true for transports and soil cultivation. Let consider the case of the difference between the soil cultivated with the spade, the hoe and the shovel with respect to the use of the animal pulled plow.

The case of water lifting is more significant. In most of the remote villages of the areas where the rural economy is prevailing the collecting of water is often delegated to women and children. They are not able to transport by foot more than approximately ten liters of water. And to reach the households often they are obliged to walk for hundreds and hundreds of meters. A distribution tower solves excellently this tedious work. A six meters tower can distribute thousands of liters to hundreds of taps in hundreds of households within an area of square kilometers. Further, for the water purification from sediments, the distribution tower can be supplied also with one or more settling tanks.

b. The relation between climate change and draft animal power

As per bibliography after mentioned, if all the work performed today, in the world, by the animal traction should be supplied by fuel engines, the parts per thousand of fossil CO₂ emitted in the atmosphere and the oil consumed - by any kind of engines and for any kind of transports and duties – should increase of a rough 5 per thousand.

The energy developed by working animals is a percentage of 1.4% of all the renewable energies produced in the world



c. The role of the draft animal power in 2022

The annual report of the FAO on the state of agriculture SOFA 2022, in page 45, among other says
..... Animal traction can be an important source of power for very small and fragmented farm holdings, For the majority of African small-scale producers, the transition to animal draft power would mean a real progress In many cases, advanced manual tools and animal traction are probably the best options for increasing power supply....

d. The system and the Sustainable Development Goals

The relation between the project and the Sustainable Development Goals are the following:

- More water means more food production and *no poverty*
- Mechanical energy for grain milling means trend to *zero hunger*
- More water and more food means *more health and wellbeing*
- Less time spent, very often, by children to collect water means *quality education*
- More water collected and more grains milled alleviate women labor and this means *gender equality*
- More water means *clear water and sanitation*

e. The installation and maintenance costs

The needed skills to build, assemble, operate and maintain the plant are no more than those requested to maintain a bicycle. Also the requested electrical skills are very simple.

The system is tailored for those geographical areas where (i) the rural economy is prevailing, (ii) where there are today in operation working animals, (iii) where an electrical power of less than one kW can be very useful, (iv) where the farmer's monthly wage is around US\$ 67.93 and (v) where the average cost of fuel is of US\$ 1.43 per liter.

In these situations, present in very large areas of the world, it is possible to say that the average cost of the electricity derived from the animal traction is approximately US\$ 0.90 per kWh with a minimum percentage of this amount spent outside the village. In some cases this cost can go as low as US\$ 0.51 per kWh and probably even less.

Using combustion engines in similar situations entails a higher cost of around \$1.95 per kWh, all to be spent outside the village.

The annual cost of a photovoltaic system, and consequently that of the kWh produced, is in most cases comparable with that of the animal-powered systems, sometimes even more expensive, i.e. 412.53 US\$ of the photovoltaic against the annual management cost of the animal-powered system equal, in certain situations, to US\$ 333.47 or less.



The connection to the electrical grid has costs not comparable with the village economy.

The data and calculations on the above costs are in <https://www.wedap.it/img/ea.pdf>

f. The technological leap

The design of the above tested equipment is much more efficient than the design developed and tested, by various scientific institutions, mainly in India. The innovative design adopted by WEDAP has in fact solved the problem of the enormous torque of the first shaft of the rev multiplier.

The pumps moved electrically offers the following advantages: (i) a larger amount of available water because the pumps makes possible the supply of water from water layers deeper than those exploited with traditional mechanical pumps, (ii) less salty water because lifted from deeper layers and then not evaporated, (iii) the use of an electrical pump allows to lift water from plastic or iron tube and this can avoid the closure of the hole now so frequent due to the fall down of the walls of the large well.

Portability and work around the clocks are precluded to photovoltaic and wind systems, not to this system.

There is shortage of area with wind speed of more the 3 meters per second (considered minimum speed necessary to generate electric energy). The wind turbines aren't transportable and do not produce electricity when required but when the wind is present.

Differently from wind turbines and photovoltaic the system has not need of accumulation. The accumulation is represented by the rest of the animal.

g. The safety

The system guarantees also excellent standards for safety at work. It has been observed, for instance, that the use of certain hand equipment, such as the grain milling stones, frequently wounds the fingers of the farmers, almost always women, procuring septicemia and sometime, as a consequence, the death. The use of the alternative power source here described could transform and make safer this kind of jobs.

9. Documentation

8.1. Technical documentation

The web site is www.wedap.it/ii.html

The patent documents are available on Patentscope of the World Intellectual Property Organization
https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2011099043&_fid=IN211608392

Independent consultant engineer certification is in www.wedap.eu/fl/or/ingsardellarep.pdf

Veterinary certificate is in www.wedap.eu/fl/or/allavoro.pdf



8.2. Bibliography

Antonio Perrone, [Sustainable energies for remote villages: a new target for the Corporate Social Responsibility](#) 2020 AEIT International Annual Conference (AEIT), Catania, Italy, 2020, pp. 1-6, doi: 10.23919/AEIT50178.2020.9241182.

A Perrone, M. R. Nasab and M. L. Scala [Draft Animal Power Versus Photovoltaic: A Benchmark](#) 2023 AEIT International Annual Conference (AEIT), Rome, Italy, 2023, pp. 1-6, doi: 10.23919/AEIT60520.2023.10330346.

Perrone, Antonio, [A tool for the achievement of the Sustainable Development Goals set up by United Nations](#) Staatliche Schlösser und Gärten Hessen, Kropp, Claus und Zoll, Lena (Hrsg.): Draft Animals in the Past, Present and Future, Heidelberg: Propylaeum, 2022, p. 185-190.

Other bibliography is in www.wedap.it/bib.html and in www.wedap.eu/rcb.html

