MOGUĆNOSTI REDUKCIJE EMISIJE CO_2 NA MLJEČNIM FARMAMA

CO_2 REDUCTION POTENTIALS IN DAIRY FARMING SECTOR

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Sadržaj:
Kroz svoje svakodnevne operacije farme mliječnih krava predstavljaju velike potrošače energije. Upravo zbog toga promatrana je pojedinačna potrošnja energije na farmama kako bi se došlo do spoznaje na kojim dijelovima, odnosno procesima se mogu ostvariti eventualne uštede te povećati energetska efikasnost. Procesi i metode korištene u ovim razmatranjima mogu se koristiti i kod razmatranja energetske učinkovitosti i ostalih malih i srednjih poduzetništva. Procesi na farmi su promatrani zasebno te su predložene mjere, eventualne, uštede energije za svaki segment proizvodnje. Procesi su snimani putem energetskog audita. Eventualna poboljšanja su predlagana na temelju postojeće energetske opreme na tržištu. Za svaki od promatranih segmenata rađeni su proračuni eventualnih energetskih ušteda nakon uvođenja novih i modernijih rješenja. Uz povećanje energetske učinkovitosti razmatrane su mogućnosti ugradnje određenih oblika obnovljivih izvora energije. Najviše prostora posvećeno je mogućnosti proizvodnje bioplina i zagrijavanju vode putem solarnih kolektora. Krajnji rezultat je egzaktna količina uštođenih kWh odnosno količina uštođene emisije CO_2.

Abstract:
Dairy farms today are significant energy consumers in their everyday operations**:** water heaters, milk coolers, vacuum pumps, lighting, irrigation pumps, fodder dryers, ventilation etc. Dairy farms are a typical SME (small and medium sized enterprise) but the methods and operations used in this research could be applied to all the other SME s concerning energy efficiency and energy management. Usually dairy farmers lack the time, resources and knowledge to effectively address on-farm energy issues. So there is a big opportunity to investigate and bring some new solutions and methods in this field in order to increase energy efficiency awareness among farmers. Also calculation and investigation of energy saving possibilities on an average dairy farm was a significant part of the studies. See the possible savings through modernizing and upgrading the equipment and processes that are already on the farm, by suggesting new solutions and methods. That work was done through energy farm audits, energy calculators and case studies on dairy farms in Croatia but also dairy farms in Europe. The main processes and main energy flows were dismembered. That was the best way to determine energy potentials for each of the energy consumer on a farm. By comparing the present situation with possible improvements we could calculate exact savings for each of the farm section. Final major issue was the possibilities of renewable energy sources implementation on a dairy farm. Biggest attention went to possibilities of a biogas

production. Since there isn't any biogas production site in Croatia this was quite challenging. A full techno-economic calculation was done for a small biogas plant that the farmers could use in their future biogas plant planning. Other renewable energy potentials were considered depending on the farms size, geographical position etc. (solar systems, biomass, biodiesel production etc.). For every farm section and potential renewable energy source implementation we made detailed calculation and calculators online so the farmers could use it for free and calculate their potential savings and possibilities of introducing renewable energy sources. Our final goal is to have exact measurable savings in kWh per a cow so we could know exactly how much energy, money and CO_2 we could save.

Key words:
Biogas, CO_2 reduction, energy efficiency, renewable energy sources, solar panels

1. Introduction

In a time where we are faced with constant increase in fossil fuel prices, energy efficiency and possibilities of using some form of renewable energy sources becomes crucial in an every day industrial process. For our research we decided to observe a typical dairy farm and to see the possibilities for basic savings in increasing energy efficiency and implementing some type of renewable energy technologies. This kind of approach means that for the same amount of milk we would use less energy. This would lead to cheaper milk production. Of course economic benefits are not the only one. We could also look the ecologic impact from increasing energy efficiency and introducing renewable energy on a dairy farm. Dairy farms are chosen since they represent typical small and medium enterprise with characteristic manufacturing processes. It was already mentioned, dairy farms are big consumers of energy, primarily electrical, and the potentials in reducing that consumption are significant. Beside electrical energy, significant part of total energy used on a dairy farm goes to fossil fuels (gas, coal….). With the tougher competition on the dairy market, producing milk as cheap as possible would make all the difference. And since production (including energy) costs determine the final milk price, reduction of energy costs becomes more and more important.

2. Scope of research

First intention was to determine and see the possibilities of making a dairy farm more energy efficient and introduce possibilities of renewable energy technologies. First we tried to see the biggest electrical energy and fossil fuel consumers. Biggest electrical energy consumers on a dairy farm are the following systems:

- Milk cooling system
- Vacuum pump system
- Washing system
- Lightning
- Ventilation
- Water heating
- Other electrical devices

Since it is not possible to eliminate some of this systems since they are necessary for a functional farm operation we have to optimize their work, regarding energy consumption.
All of these systems were investigated with the intent of possible improvements regarding

energy efficiency. Other major issue was the possibilities of implementing some form of renewable energy source. Our first choice was to see the possibilities of a biogas plant on a dairy farm and possibilities of solar water heating. Intention was to show the economic benefits of investing into energy efficiency and renewable technologies since the average farmers would be most interested about that.

3. Methods used

In our work we used data and information collected from various EU countries but our primary objective was to analyze data collected from a farm audit done in Croatia. After we selected a relative new and modern farm with around 70 cows we dismember all the main farm processes. Through an audit, we collected most important information about the consumption, equipment, manufacturing process and the current market situation. All the data was analyzed and based on the information gathered, techno-economic calculations were made for recommended improvements.

4. Results

After an initial analysis we concluded that the best areas for improvement would be

- Milk chilling system
- Vacuum pump system
- Ventilation system

And for renewable energy sources most suitable for analyses would be to calculate cost effectiveness of biogas production on a dairy farm.

4.1 Milk chilling system

Before starting any equipment replacement the best way to increase energy efficiency would be to have basic insulation of pipes and cooling tanks and have all the equipment regularly maintained. With these simple actions, which don t cost so much, a lot can be done.
Effective milk cooling is essential to ensure the quality of the product. Surveys show that milk cooling accounts for 20 to 40% of the total electricity consumption on a dairy farm, so designing and operating an efficient milk cooling system can significantly reduce energy demand and shed operating costs. Installing a precooler would be the best way to save money and energy but also increase the quality of milk. With the direct pumping to the cooler the milk is being cooled in the tank. That way we increase the possibilities of bacteria appearance. The best way is to cool the milk as fast as possible. With a precooling the milk is entering the tank already chilled, saving energy and time. Pre cooling of milk in most cases will significantly reduce milk cooling cost. The power rating of your cooling compressor will be reduced. The heated water that is produced in the precooling process can be used for other processes (washing, drinking water for the cows).

4.2 Vacuum pumps

With vacuum systems it is very important to know the exact needs for vacuum (depending on the parlor type and number of cows. Most common mistakes are over dimension of the vacuum systems. That way farmer is consuming more energy than necessary. Vacuum pump is the most important part of the milking system and reducing its cost would be most important. The vacuum pumps are used to balance between the vacuum and airflow. Most of

the normal milking systems are intentionally oversized so they could handle the biggest anticipated vacuum capacity. The best solution would be switching to variable speed drive vacuum pumps. Regular vacuum pumps run at full capacity and the variable speed pumps modulate the speed and energy consumption to match the actual vacuum needed. They can do so by monitoring actual vacuum in the milking system. Variable speed drive vacuum pumps are:

- Reliable as regular vacuum pumps
- They do not increase milking time
- No impact on cow's health

By most of the manufacture specification and by the experience gathered from the farmers installing a variable vacuum speed drive farmers could save from 40 to 70% energy in the milking process.

4.3 Ventilation system

With the proper type of ventilation we reduce gases and dust in the farm, regulate the degree of humidity in the air and contribute to the cow's healthcare. Ventilation system is highly recommended if:

- There is a strong ammoniac odor in the stall
- The cows have any kind of respiratory problems
- You have strong warm/cold zones in the stall
- You notice a condensation on the walls and ceiling

When choosing a ventilation system, things needed to taken into consideration: the number of cows on the farm and their age, investment and mounting costs, noise, maintenance, cleaning, diameter of the fan, spare parts, putting the fans over the feeding area, autonomy for each of the fans, one "big" fan is always better than more "small" ones! Today we have models of fans that use energy efficient motors. The savings could go up to 20% of electrical energy. The fan speed is not crucial because with the increase of speed we also increase the turbulence and noise, and efficiency decreases. The fan doesn't t need to be noise to be efficient! The best solution for ventilation is **High volume low speed ventilators (HVLS)**. This is quite new approach for farms. These ventilators allows air circulation on a very energy efficient way. They work on relatively low speeds but have a big air flow. They are very similar to house ventilators, the difference is their diameter (2,5 to 7,5 meters).
The speed is between 120 to 50 rpm. HVLS ventilators are steering the air vertically to the floor and than it spreads horizontally. For this system the maintenance costs are smaller and the system uses less electrical energy. We need fewer ventilators to have the same effect. We can t exactly measure the HVLS impact on milk production but the farmers agree that the air quality is much better on the farm because of the constant air circulation. It is noticed that the floors are much less wet and there in less noise. HVLS s biggest advantage is in the summer periods. If the cows are too hot, the milk production can decrease. That is why we have to cool down the stall during hot periods. In the summer we use the ventilators for cooling and during winter we use them to shift the dry air from the ceiling to the lower zones. High speed ventilators impact on a small area and leave more "bad" air in the stall; HVLS ventilators have a much better volume flow impacting much bigger area.

4.4 Biogas production

Biogas production is the most logical solution for farms. Biogas, as a final product, can be

used to produce electrical energy, heat or can be sold to the gas grid. The last solution is not possible in every country and the biogas needs some “purification” process to be distributed in the gas grid. For the farm studied in Croatia the basic biogas potential calculation was made. Biogas production in Croatia is still not developed enough so the biggest problems in cost effectiveness calculations were the real equipment and installment prices and the lack of experience in this field. By some initial calculation a biogas plant won t be payable for our 70 cow farm. Biogas plant would be payable on farms that have more than 300 cows, but on cost effectiveness influences a lot of parameters. One of the most important parameters would be possible government subventions for the electricity produce from biogas. This also depends from country to country. In Croatia the electricity produced from biogas has defined price of 1.2 HRK for kWh. Other important thing is to produce energy efficient biogas (more methane ratio). And finally it is important to minimize investment costs by optimizing correctly the biogas production plant. However there are some more benefits in biogas production like waste and manure management and producing fertilizer material.

5 Conclusions

Energy processes on dairy farms gives us a lot of room for improvement since there weren’t a lot of research and studies in these field. But with the increase of energy prices energy efficiency on a farm becomes a major issue. It is important to determine all the major energy flows on a dairy farm so they could be dismembered and studied closely. With basic and cheep improvements, like switching to energy efficient light bulbs, a lot can be done. For more serious improvements and replacements more complex analysis is needed.

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