



**Prometec**

Energy  
Efficiency  
Solutions



**Robot**

# Case study Kuopion Energia





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# 1 Automated Sampling Brings Accuracy to Fuel Invoicing

How Automated Sampling helped Kuopion Energia **drive their Fuel Energy Balance Error down** to almost nothing and put them on track to **save more than 5 million euros** over the next 5 years.

## 2 Executive Summary

Based on several studies sampling is causing error (80%) in biomass quality controlling process. The rest of the error is coming from sample handling (15%) and from measurement (5%). For power plants this means that the error can be responsible for 5-10% of unnecessary cost related to fuel purchases.

Like many others, Kuopion Energia wanted to base their payments of the fuel to the energy content of biomass and that's why regular sampling was started. After a while, recognizing the shortcomings of sampling by humans, Kuopion Energia went through a couple of automated sampler options, but could not find a suitable solution.

Kuopion Energia took Prometec's Q-Robot into commercial use in June of 2017, after agreeing to pilot (2016) the Q-Robot and start sampling the fuel before it is unloaded.

Since Q-Robot's commercial launch, Kuopion Energia have seen a sharp drop to almost 0% difference between boiler-side calculations and their invoicing. For a power plant operation of their size, this means over 1 million euros saved annually from fuels– and a very satisfied plant manager.

## 3 Genuinely Kuopion Energia

Kuopion Energia is a versatile and modern energy service company, owned by the City of Kuopio. Kuopio is a city of just over 117 000 residents in the municipality of Northern Savonia in Finland, 18th largest municipality in Finland.



Kuopion Energia cogenerate electricity and district heating at their Haapaniemi Power Plant and their Pitkälähti biogas power plant. Fuel that is sent to the boilers at Haapaniemi is harvested primarily from Northern Savonian sources. Using local fuel guarantees jobs and wellbeing for the entire municipality.



Kuopion Energia strives to offer their customers competitive and reliable energy services in consideration of environmental concerns and responsibility towards their personnel.

**Kuopion Energia Company Details:**

	2013	2014	2015	2016
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Revenue (tEUR)	72035	73942	83449	86280
Growth	-0,1%	2,6%	12,9%	3,4%
Result (tEUR)	-1463	-591	-2254	1597
Profit	6,5%	7,7%	11%	14,4%
Personnel	108	161	125	134

#### Sales (Annual)

Electricity: 700 GWh

Heat: 900 GWh

#### Customers

Electricity: 50 000

Heat: 6 000

#### Annual Fuel Volume:

1,5 million cubic meters

#### Daily Fuel Truck throughput:

Over 100

#### Energy Source Distribution (October 2017):

Biomass: 52%

Peat: 48%

Other: 0%

## 4 Energy Error

Sampling is a major problem with solid biofuel quality control. According to studies, deficiencies in sampling methodology cause approximately a 5% *Energy Error* in biofuel energy content calculation.





Energy Error is most commonly caused by sampling which is not done in representative way. These wrongly taken samples are being analyzed and measured. The results from these samples gives wrong information about the energy content. And when material is finally burned in the boiler the energy output is different what was fed to boiler. The payment is still done based on the samples that have been collected in unrepresentative way.





## 5 Significant Impact on Operations

Normally, the energy Error varies between 5%-10%, depending on geographical factors among others. This amount of money can be saved if the sampling would be arranged properly.

*"We started comparing the energy that we paid for the suppliers and what the calculations told us how much fuel energy is fed to the boiler.*

*There always was quite a big difference, few percents. But when your fuel costs are high like 25 million or so, even a couple of percents means a lot of money annually."*

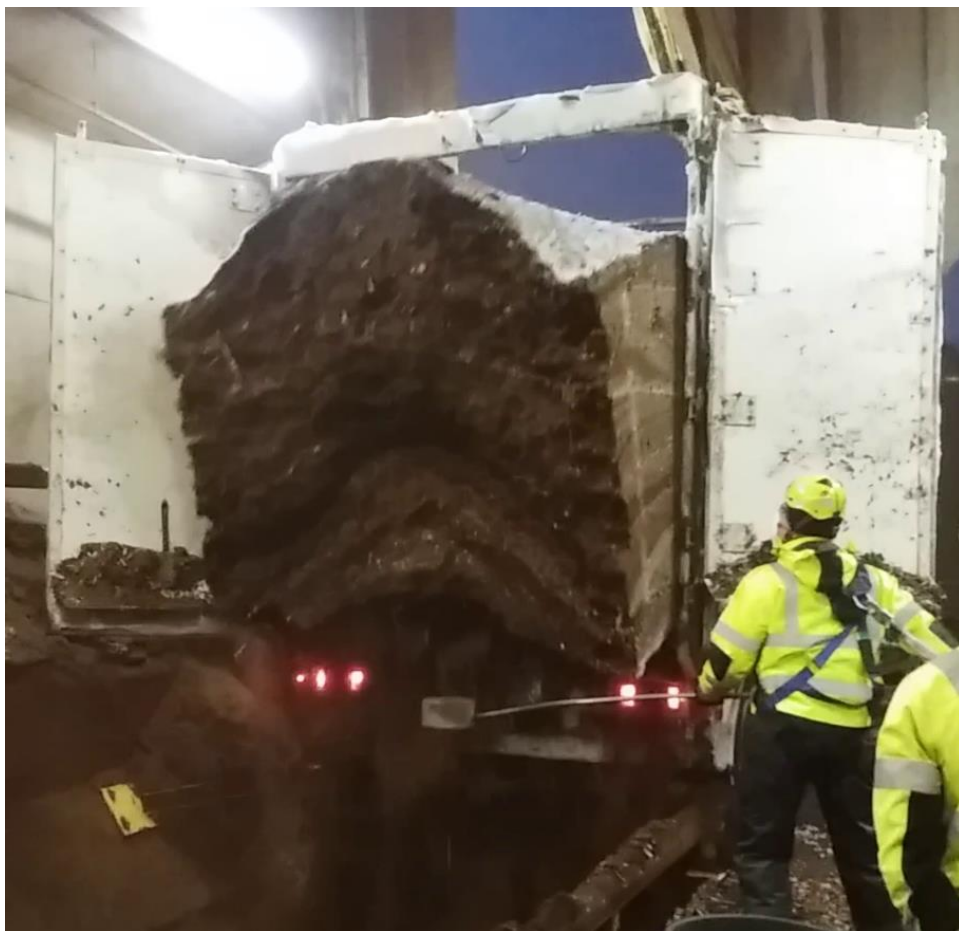
Samuli Räisänen,  
**Kuopion Energia**





## 6 Manual Sampling

Usually, the fuel load has been manually sampled after unloading, either by the truck driver or Power Plant personnel or a person from a third party.



*"Before the Q-Robot investment the lorry drivers took the samples manually. We always knew there was a problem that they're not motivated to get the sample as it should be taken carefully."*

**Samuli Räisänen**  
Kuopion Energia





## 6.1 Inaccuracy

Humans make errors. Our cognition is an optimized engine, but it doesn't always connect with the surrounding context very well. This is called intuition; we are operating on autopilot relying on our intuition to get us through any immediate tasks while our brains either save energy or work on something else entirely.

For sampling biomass, this can mean we are unlikely to pick representative samples for the laboratory. We see snow, and intuitively know it is not a fuel, so it never makes it to the sample.

Our brains also wish to conserve energy, and the required diligence to distribute our manual sampling evenly throughout the load is much greater than exerting a little less effort and sampling only a limited portion

Sometimes it is just not possible for a human to take a representative sample. Fuel loads that are clearly layered provide a challenge as the required depth for representative sampling is unreachable by a sampling scoop before or after unloading.

Lastly, there is of course the challenge of conscious bias. Conflicts of interest can tilt the samples towards either end of the scale, away from being representative of the whole load.

## 6.2 Occupational Safety Concerns

Additional challenges to manual sampling is that the drivers have to get out of their vehicle and into the unloading area. Unloading area has pits, crevices, cross-irons and beams that drivers need to balance on and be mindful of as they try to reach the fuel with their sampling scoop. All the while the driver is trying to move around in places where a wrong move can cost a limb or more.

The small-particle dust involved at times can get overwhelming. Breathing in the small particles launched into the air from unloading biomass can cause acute respiratory ailments and momentarily disable the employee from continuing the sampling. Long-term effect of breathing in these small particles at this stage of the process is unnecessary because this job could be done automatically.



### 6.3 Low Efficiency

Turning the trucks over quickly is vital to process efficiency at the power plants unloading area. Turnover times can get excruciatingly long if drivers are required to exit their vehicles and manually sample their cargo before or while unloading, given all the probable delays related to manual sampling.



## 7 Kuopion Energia Pilots the Q-Robot

We had problems with measuring the energy coming in with the trucks. Every time, every month what we paid for was more than what we gained.

Prometec came to us and asked if we are willing to start a pilot project with them with this sample taking system where nobody touches it, a robot will take it and so on and we were interested and that's how it started.

**Peter Seppälä**  
Kuopion Energia

We were already providing our quality control service to Kuopion Energia prior to the Q-Robot pilot. We were taking the samples manually and analyzing samples in our customized Q-Link laboratory container with dedicated personnel.





## 8 Entering the Pilot



Taking samples manually has its problems. Conflicts of interest and even human cognitive biases come into play and with large enough numbers they can add up to a big sum.

During discussions around this shortcoming, we asked Kuopion Energia their ideal fuel sampling process. Their answer was that sampling should happen prior to unloading, and in a place where the trucks could just drive through, and all human effort would be minimized.

After a month of intense product design, we proposed Kuopion Energia to pilot an Automated Sampling Robot. The *Q-Robot* would be operated inside a dedicated sampling hall and it would process all incoming trucks prior to unloading. Kuopion Energia found this highly interesting and agreed to enter the pilot project with us.



## 9 Automated Sampling

Automated Sampling is a robot-aided methodology that introduces a single point of sampling for all incoming granular fuel providing real-time, truck-by-truck representative samples.

## 10 Automatic vs. Manual Sampling

Manual sampling is performed either by the fuel provider, or by power plant personnel, or third party personnel. The common denominator is, that it is always done by humans.

Automated Sampling is performed by a state-of-the-art system combining learning algorithms and precision automation.

Each truck coming in will have their cargo precisely sampled, the sample labeled and categorized meticulously. The truck enters and leaves from the sampling area within 10 minutes.







## 11 Precision

As the samples are produced by automation, they will always be representative, include any impurities such as snow and sand as well as content from previously hard-to-access depths.

### 11.1 Cost-effective

Automated Sampling allows to take representative samples from any incoming granular fuel with the help of on sampler.

### 11.2 Standard-compliant

Q-Robot sampling increments comply with the ISO 18135 and ISO 14780 standards.

### 11.3 Instant Measurements

Automated Sampling can provide real-time information on volume of the load and moisture content by calculated moisture model. Also, fast moisture analyzer can be integrated to Q-robot sampling system.

### 11.4 Occupational Safety

Only personnel involved in automated sampling is the truck driver. Their responsibilities are limited to driving the truck in and out of the sampling hall and initiating the automated sampling process by pressing a single button.





## 12 Requirements

### 12.1 Sampling hall and sample handling station

Truck cargo is sampled inside a specialized Sampling Hall, which houses the automated sampling robot. Q-Robot can also be installed outdoors. Sampling hall can also optionally be equipped with a separate sample handling station and mixing tanks (Q-Mixers). Truck specific samples can be stored into a supplier and material-specific Q-Mixer mixing tank, in which a day combined sample is automatically formed and prepared for laboratory analysis.









## 12.2 Automated sampler

The Q-Robot Automated Sampler is specialized equipment developed by Prometec. It houses instruments required for machine vision and sampling and can produce representative samples from a fuel truck within 10 minutes.





### 12.3 Sample analysis

Estimated moisture information from the fuel can be calculated right after sampling. This estimated real-time moisture information can be used for logistic purposes and process optimization. For the payment purposes samples is measured in the power plant's own laboratory.







## 13 Automated Sampling Process

### Truck Arrives

The traffic light outside will show when the driver can drive their truck in. After recognition of truck by register plate camera or RFID automated doors will open. After they have cleared the door the door will close automatically and the traffic light will indicate the hall is in use. Next driver will move into the position to wait until sampling procedure is finished.



### Truck is stopped

Driver will drive their truck until the guiding lights inside the hall will tell them to stop. This happens at a precise location in the hall so the Q-Robot will have full use of its reach available. Driver will then exit the truck cabin and move into the designated safety area to operate from control panel or the truck driver can stay in the cabin and start sampler from there.





## Sampling begins

### Truck is under sampler for first time

If this is the first time the truck is under the sampler, the driver will be instructed to unload the fuel at the proper station and return to the sampling station for a scanning of the empty truck. The scanning needs to be done only once. The truck-specific information is automatically saved to the truck database.

### Adaptive Machine Vision and Sampling Depth

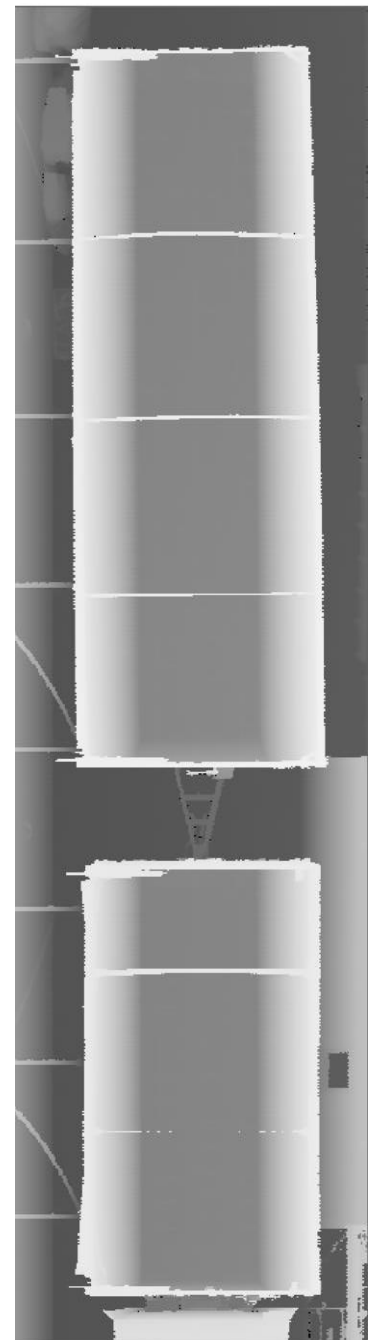
Machine vision (lidar) scans of empty trucks are used to determine the optimal, randomized sampling positions and depth perception in the machine vision will help determine proper sampling depth for each round of sampling. Also, lidar enables to receive information about the truck-specific volume.

### 10-minute Turnaround

Sampling takes around 10 minutes (6 increments), during which time Q-Robot will have determined the correct amount of samples to take and proper variables for each individual sample, such as position and depth.

### Sampling is Completed

Once the sampling is complete, the Q-Robot will unload the sample automatically to the correct sample tube. Under the sample tube there is a plastic bucket for collecting a truck-specific sample, which is ready for laboratory analyses. Alternatively, samples can be collected into a supplier and material-specific Q-Mixer mixing tank, in which a day combined sample is automatically formed and prepared for laboratory analysis.





### Truck Proceeds to Unloading Area

Once the sampling is complete, the driver can proceed to unload the fuel at the proper unloading area. Exiting the vehicle is not required anymore as the sampling is done, resulting in greater workplace safety.



### When the Fuel Has Too Much Moisture

If in sampling it turns out the calculated moisture content in the fuel is beyond an actionable threshold, the truck can be instructed to not unload the fuel and take it back.



## 14 Results



### Energy Error down to 0%

After launching the Q-Robot into full commercial use, Kuopion Energia has seen an almost vertical drop in the graph representing their energy error.

“Before june, when we compared the boiler calculations and the energy going out that we paid money for we always paid more.

In June we started using the Q-Robot. June, July, August energy error was almost 0%.”

**Samuli Räisänen**  
Kuopion Energia





## Projected Savings

Compared to the former way Energy error of 5%, Kuopion Energia is now on track to save over 1 Million Euros annually through the use of the Q-Robot.

Kuopion Energia processes 1400 Gigawatts of energy every year, and the fuel prices in Finland are low due to highly competitive market. Even still, fuel costs are the highest single expense in the power plant and any savings there will make a sizable difference in the bottom line.

*Our yearly fuel cost is around 22 million euros. If there is a 5% mistake, you can calculate 5% of*

*that is 1 million, more or less. That's a big thing.*

**Peter Seppälä**  
Kuopion Energia

## Kuopion Energia Warmly Recommends

As a pilot customer, Kuopion Energia has been very happy with the responsiveness and close proximity of the Prometec team.







Education requirement of personnel is low due to our extensive documentation and guides, and this is appreciated by Kuopion Energia.

They have already recommended Q-Robot to a number of their peers and are happy to do so moving forward. Kuopion Energia are proud to be directly responsible for a number of their peers moving forward with us. That makes us very humble and we could not have asked for a better partner to cooperate with on the Q-Robot pilot.



*It's been quite easy working with Prometec. There hasn't been that much hassle and it's been quite straight forward working with them.*

*We have a couple of persons that we know to contact so it's quite easy.*

**Samuli Räisänen**  
Kuopion Energia

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*I've been liking Prometec quite a lot, we started working with Prometec I think 5 years ago when they were taking samples from our trucks we received over here. So far I've been very satisfied with them.*

*It's easy to work with them and you are talking with the persons who are making the decisions.*

**Peter Seppälä**  
Kuopion Energia



## 15 Prometec

Prometec Solutions was founded in 2012 as a service business helping power plants to improve their quality control manners. 2 years after that, after Kuopion Energia agreed to a pilot project with them, Prometec Tools was spun off. At the moment, Prometec operates in three countries and has 7 automated samplers in commercial use. Now, there are also semi-automated sampler, Q-Data fuel information system and several different types of services available.

Prometec is fully owned by its employee founders, and funding for the development of Q-Robot has been provided by ELY and Leverage from EU fund.





## 16 Get in Touch

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