

ENPOS – Energy Positive Farm

Monitoring energy use on farms – measurements,
bookkeeping forms

Electricity consumption

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Main topics

- Electric energy
- What to measure
- Where to measure
- How to measure
- Differences between measurement and logging
- Instrumentation
- Measurement environment

Electric energy

If W is work of electric current

U – voltage

I – current strength

t – time of current existence

R – resistance of the circuit

Q – electric charge transported by the current ($Q = It$)

then the amount of work in case of direct current (DC) is $W = UQ$
and from that

$$W = UI t = \frac{U^2 t}{R} = I^2 R t$$

On the other hand, we know that the power of electric current

$$P = UI = \frac{U^2}{R} = I^2 R.$$

So, the energy consumed by some electric circuit or device in time t

$$W = Pt .$$

The unit of energy is Joule. The unit of power is Watt. In case of electric energy for large amounts of consumed energy kW·h are used:

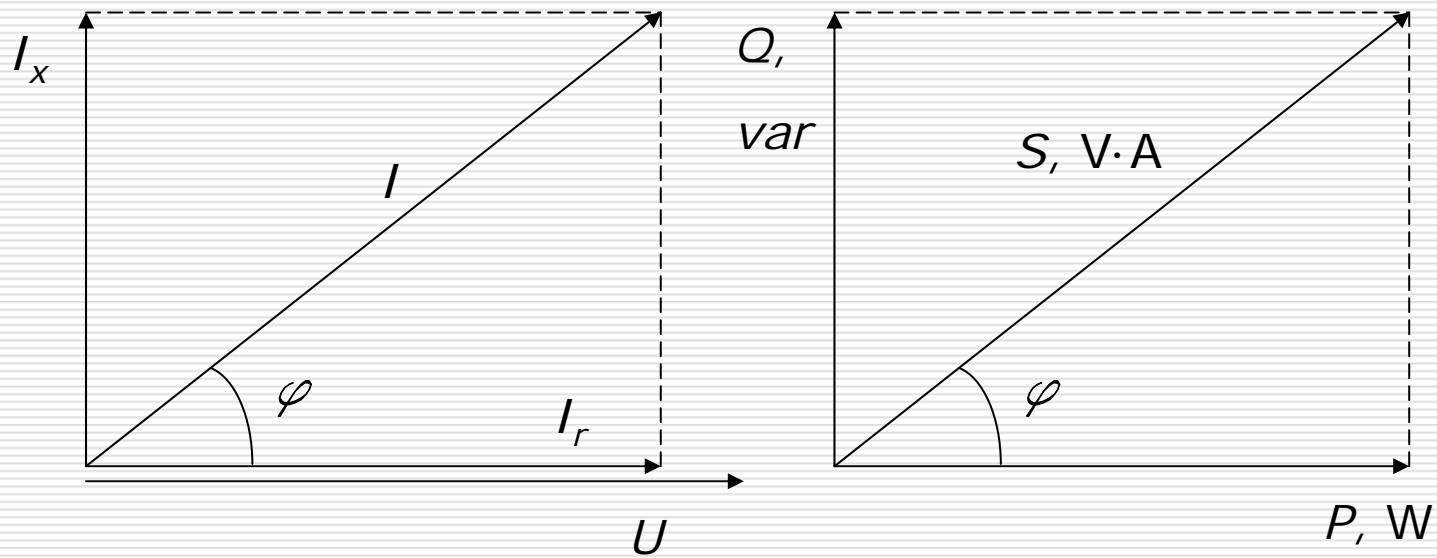
$$1 \text{ kW}\cdot\text{h} = 3.6 \cdot 10^6 \text{ J}.$$

In case of alternating current (AC) some electric consumers (mostly electric motors) have inductive or capacitive (reactive) resistances. Because of that the current and voltage have different phases and in this case

Active power $P = UI \cos \varphi$

Reactive power $Q = UI \sin \varphi$

Full power $S = UI$



What to measure

To register energy consumed we can measure:

- In case of 1_{ph} purely active loads: W_1 or P and t or U, I and t or ON/OFF state if the load is constant.
- In case of 1_{ph} reactive loads: W_1 or P, t and φ or U, I, t and φ or ON/OFF state if the load is constant.
- In case of 3_{ph} active loads: W_3 or $3P, t$ and φ or $U, 3I, t$ and φ or ON/OFF state if the load is constant.
- In case of 3_{ph} reactive loads: W_3 or $3P, t$ and φ or $U, 3I, t$ and φ or ON/OFF state if the load is constant.

Where to measure

- At the electric energy substation
- Inside the distribution boards
- Near the machines (electric motors, heating or cooling devices) with largest consumption

How to measure

If the measurements are done by loggers, we need

- To distinguish all relevant points in the electric grid to be able to get the electric energy consumption by specific technological process
- To get access to electrical wiring at these points.
- Depending on the equipment available, connect loggers at these points
- To choose the logging interval
- To choose logging period
- To draw a plan with logging points and loggers' numbers
- To check the loggers state during logging period
- To download data to PC or shuttle or to disconnect logger in the end of the logging period

Differences between measurement and logging

Measurement

- Measurement may be done by devices without onboard memory or remote data saving capability – every time we read the value, we get the integrated energy consumption (energy meter)
- Measurement may be done for getting results for specific load estimation at given time for short interval

Differences between measurement and logging

Logging

- Measurement is done by devices with onboard memory or remote data saving capability – all values are saved with specific interval (frequency) for long period – days, weeks
- Measurement may be done by devices without onboard memory or remote data saving capability – energy meters with data recording by hand. Difficult to use for shorter than 24 h logging interval

Instrumentation

Most suitable devices are loggers with large memory and built-in power supply.

Some examples

DENT INSTRUMENTS PRO SERIES

ELITEpro™
RECORDING POLY PHASE POWER METER

- Measures up to four channels of current (4 200 amps) and three channels of voltage (0-690V AC or DC)
- Low-ohm shunt rated up to 1, 10, 50 amps or 1, 1.5, 10, 20, 50 Amps or 1, 1.5, 10, 20 Amps
- Expandable memory: from 10,000 records demanded to 500,000 records with the high-memory option, allows for years of recording time
- Radio uses 433MHz or 433.92MHz
- Communications via direct RS232 connection or optional internet option or Ethernet port. Can read from access for multiple higher resolutions
- eASIC™ (integrated software package for programming set-up, communications, data retrieval and analysis. Easy, with nothing to install and simple programs such as E-Grid and e-report™)
- Ready to install
- Powered by battery, external power, or from the phase of current being measured (non-Powered Option)
- Rugged and compact-size: 9.1 x 3.8 x 2.7" (3.7" x 2.7" and 2.0" deep) (10" required to reach the end of 480V breaker panel and auto-gen.)
- Multiple high resolutions available for addition or built-in channels
- UL Listed and CE Compliant for added safety.

e2 wireless electricity monitor **new**

Wireless electricity monitor displaying instant power, costs and estimated CO2 emissions. It can also show historical and average data.

- Take control of your energy use
- Monitor the cost of using your home appliances and lights
- Discover and reduce the size of your carbon footprint
- Fun and educational for the whole family

efficient energy through technology... **energy**

Single Phase Voltage & Current Logger Electrorecorder – EC-2VA

- Enables voltage and current monitoring to be highlighted for further investigation
- Monitor equipment operation & receive single phase voltage and current
- One Voltage input (0, 5, 10, 250V AC/DC)
- Records V_{rms} , V_{avg} , R_{rms} and V_{avg} to 8-bit resolution
- Free software: ElectroGrid
- Record resolution is selectable in 1 Hz for accuracy with ElectroGrid
- Memory capacity of 50,000 from 0000 records per channel (50 Hz), up to 75 years continuous recording
- Records channel input V_{rms} , V_{avg} , R_{rms} and V_{avg} to 8-bit resolution
- Relatively averaging period for current measurement, accurate to 0.1% of recording
- AC resolution: 0.1 (200V range), ElectroGrid voltage level: 2000 (current sensor) & 2000 (no sensor)
- Features:
 - On-board: RS-232 (USB option)
 - On-board: RS-485 (RS-485 option)

ELECTRORECORDER
www.electrorecorder.com

3 Phase Voltage & Current Logger Electrorecorder – EC-6VA

- Enables voltage and current monitoring to be highlighted for further investigation
- Monitor equipment operation & receive three phase voltage and current
- Three Voltage inputs (0, 5, 10, 250V AC/DC)
- Records V_{rms} , V_{avg} , R_{rms} and V_{avg} to 8-bit resolution
- Free software: ElectroGrid
- Record resolution is selectable in 1 Hz for accuracy with ElectroGrid
- Memory capacity of 200,000 from 0000 records per channel (50 Hz), up to 75 years continuous recording
- Records channel input V_{rms} , V_{avg} , R_{rms} and V_{avg} to 8-bit resolution
- Relatively averaging period for current measurement, accurate to 0.1% of recording
- AC resolution: 0.1 (200V range), ElectroGrid voltage level: 2000 (current sensor) & 2000 (no sensor)
- Features:
 - On-board: RS-232 (USB option)
 - On-board: RS-485 (RS-485 option)

ELECTRORECORDER
www.electrorecorder.com

Product specifications PROVEN DATA LOGGING SOLUTIONS

SmartReader Plus 3
Eight-Channel AC Current, Voltage and Temperature Data Logger

• The SmartReader Plus 3 features eight channels of AC current and voltage. Three channels of AC current (up to 100A) are sampled around the phase main(s) and voltage transformer and logic monitoring. Three channels are for three-line energy consumption (3-wire 3-phase, 3-wire 3-phase, 3-wire 3-phase)

APPLICATIONS
Determining energy consumption, including 3-phase voltage and current, short-run or long-term load analysis, demand side management, active meter maintenance scheduling, etc.

GENERAL SPECIFICATIONS

Date:	05/2011
Weight:	1.8 kg (4.0 lbs)
Height:	130 mm (5.1 in)
Width:	130 mm (5.1 in)
Depth:	50 mm (2.0 in)
Operating Temperature:	0°C to 50°C (32°F to 122°F)
Relative Humidity:	5% to 95% (non-condensing)
Storage Temperature:	-40°C to 70°C (-40°F to 158°F)
Storage Humidity:	5% to 95% (non-condensing)
Power Consumption:	1.5W (typical)
Power Supply:	1.5W (typical)
Power Output:	1.5W (typical)
Power Input:	1.5W (typical)

ORDERING INFORMATION

Model	Case	Blade	Case
SRP-001	SRP-001-1.00	SRP-001-1.00	SRP-001-1.00
SRP-002	SRP-002-1.00	SRP-002-1.00	SRP-002-1.00

www.dentstruments.com

Resistor poteri para industria resistentes / Durables resistentes para energia solar

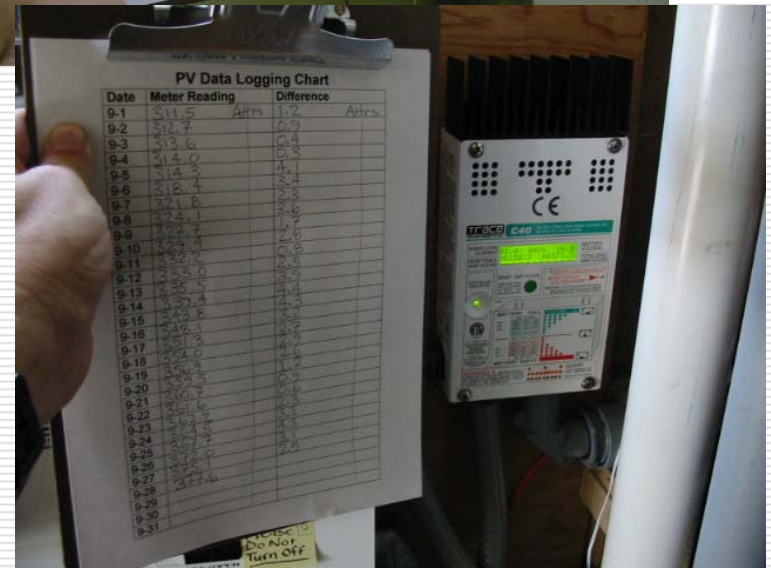
CIR-e³

"E1 auditor"
"The auditor"

CIRCUTOR
La medida que cuenta. *Measuring with accuracy also*



Manual data logging



CURRENT SENSORS

Deltec Shunts
www.deltecco.com

Shunts (low value resistors)

Good for AC or DC.
Relatively low cost (\$20 - \$50).
Direct conversion to voltage (no extra stuff required).
Must be spliced in series with the circuit.
No electrical isolation.



Hall Effect (m-field) sensors

Good for AC or DC.
Relatively low cost (\$12 to \$72).
Requires regulated power for the sensor.
Must be threaded over a disconnected wire but no splice is needed.
Provides electrical isolation.

Amploc Hall
Effect Sensors
amploc.com
See HP85

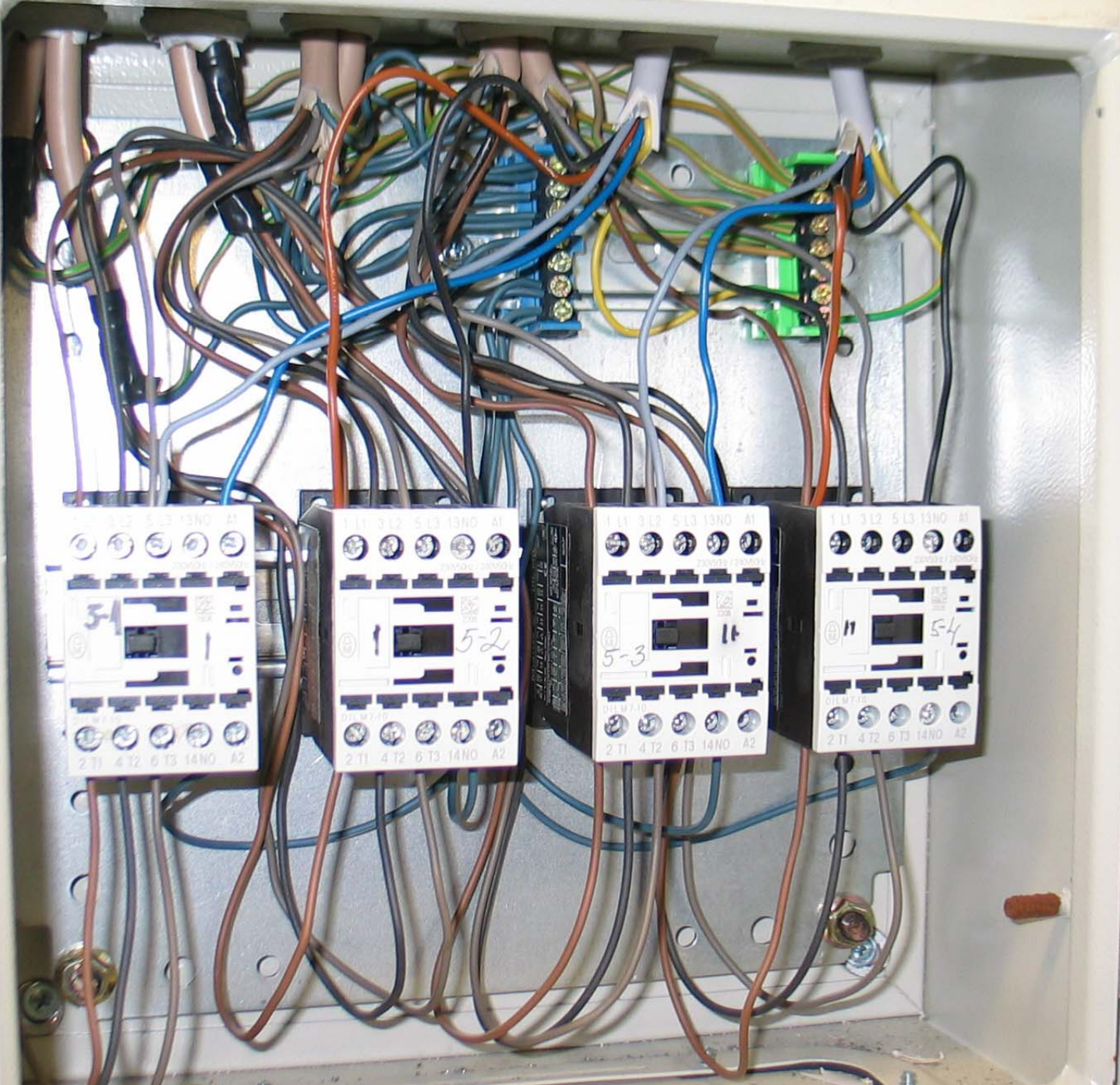


Current Transformer

Good for AC only.
Relatively low cost (\$15 to \$75).
Clamps over the wire. Usually no disconnection or splicing required.
Provides electrical isolation.

Onset
Clamp-on current transformer
onsetcomp.com





OMESTO
WATERPROOF SERIES
ELECTRICAL ENCLOSURE
Designed to BS EN 60529
ATEX Certificate No. 107740



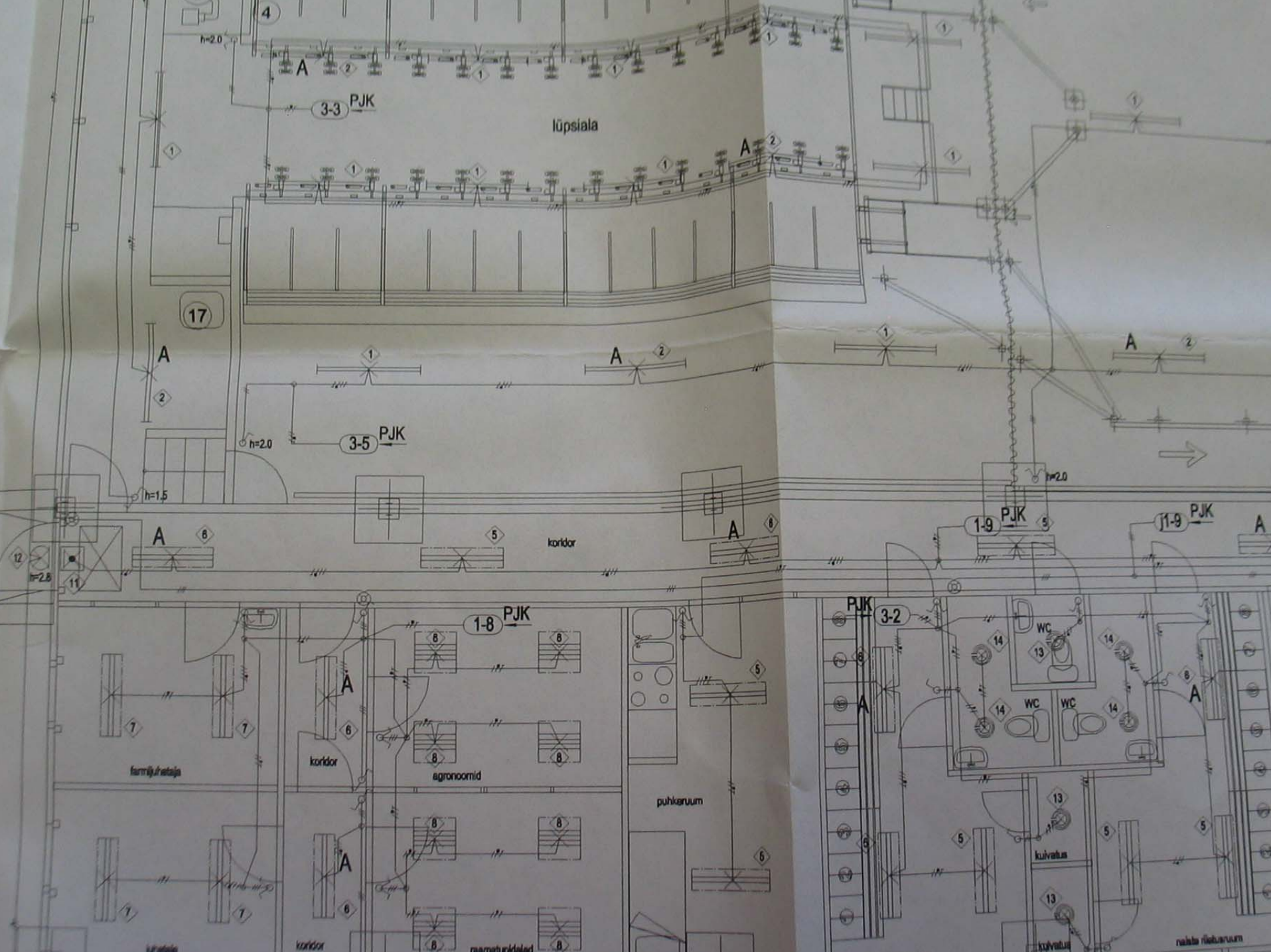
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RVK1
PJK

RVK2

RVK3
JK-1

25 26 27 28 29 30 31 32 33 34



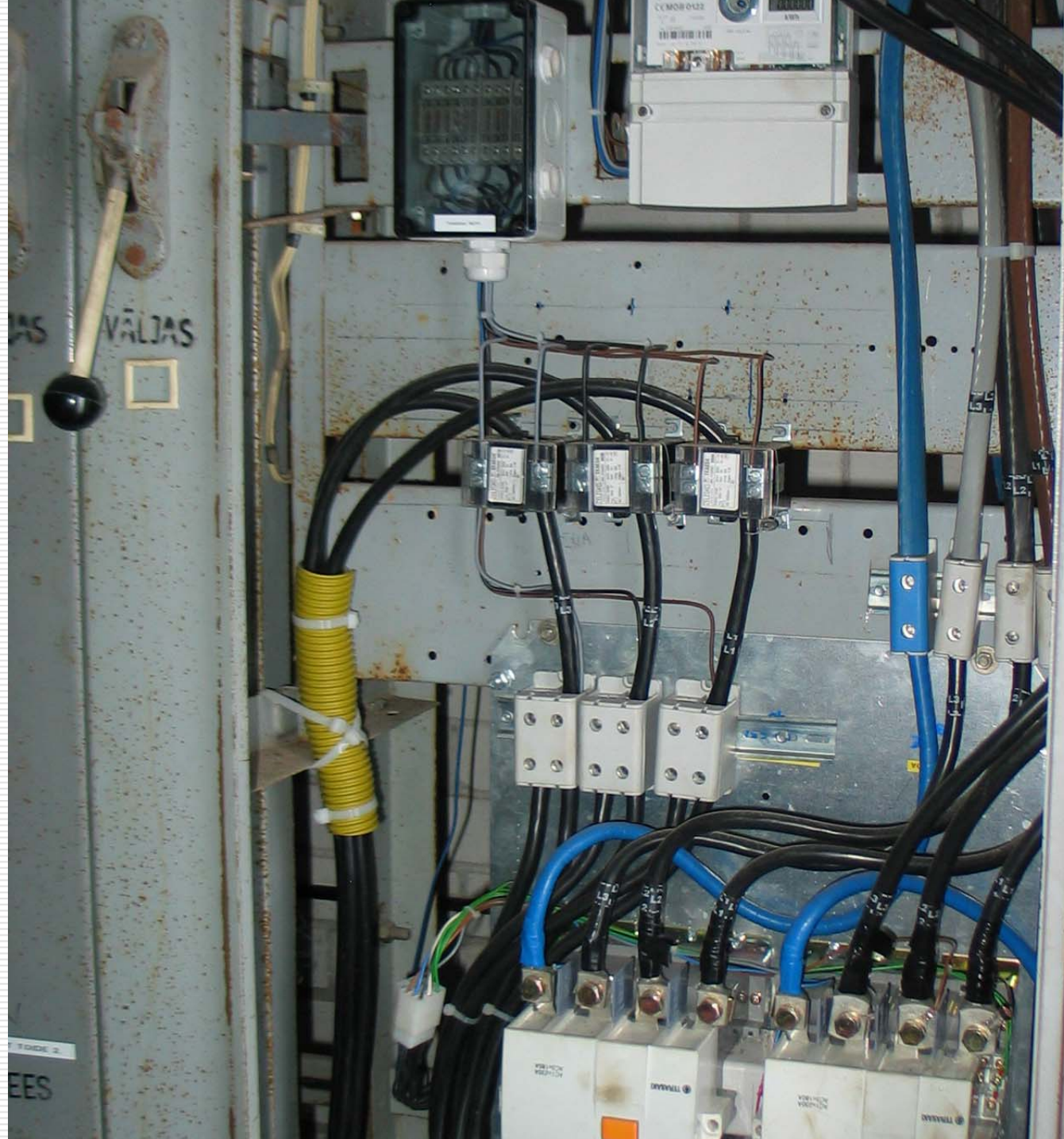
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RVK1
PJK

RVK2

RVK3
JK-1

25 26 27 28 29 30 31 32 33 34



VALJAS

EES

Voltas
TRAF









This material has been produced in ENPOS project. ENPOS is acronym for *Energy Positive Farm*.

The project partners are

- University of Helsinki, department of Agricultural Sciences – Agrotechnology
- MTT Agrifood Research Finland - Agricultural Engineering
- Estonian University of Life Sciences

Project home page is at <http://enpos.weebly.com/>

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ENPOS Energy Positive Farm



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EUROPEAN REGIONAL DEVELOPMENT FUND
INVESTING IN YOUR FUTURE



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PROGRAMME
2007-2013