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Cologne Institute for Renewable Energy

Possibilities of Energy and CO2 savings and modification options in energy demand of agriculture in times of rapidly changing electricity prices

(Short title: Intelligent (smart) energy in agriculture)

Cologne, 01.07.2016

Patrick Beuel, M. Sc.

Agenda

- Intelligent (smart) energy in agriculture – Project partners
- What do we want to achieve?
- How do we achieve it?
- Exemplary analysis regarding the project goals
- Results so far
- Outlook for the remaining duration of the project

IE in agriculture – project partners

Association for the promotion of renewable resources and development of technical solutions

Chamber of Agriculture Nordrhein-Westfalen

Machinery Ring Höxter-Warburg e.V.

Technische Hochschule Köln
Cologne University of Applied Sciences

duration of the project:

30. Sept. 2013 - 31. Okt. 2016

The project is supported by:
Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen
funding reference number: 17-02.04.01-18/13

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What do we want to achieve?

- **Adaptation to energy transition**
  - Response to fluctuating electricity supply throughout the day
  - Identify variable load shifting options
  - Increase own electricity use, electricity storage

- **Energy and CO_2 savings**
  - Efficiency improvement
  - Optimize settings and terms of the electrical load

➢ **Counseling recommendations for energy optimization of livestock farming enterprises**

How do we achieve it? – Basic requirements

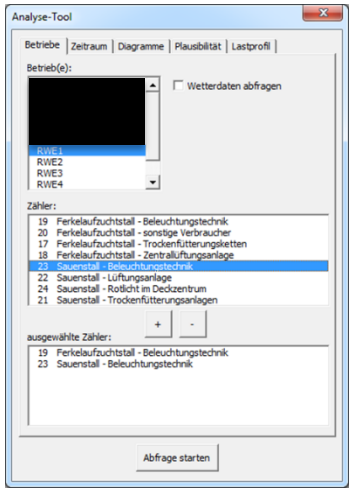
- **Production data acquisition of pig and dairy farms**
  - Resources (Type, quantity, power class,…)
  - Number of animals
  - Average energy consumption
- **SmartMeter with automatic transmission**
  - Installed in subunits
    - Ventilation,
    - Feeding,
    - Milking, light, …

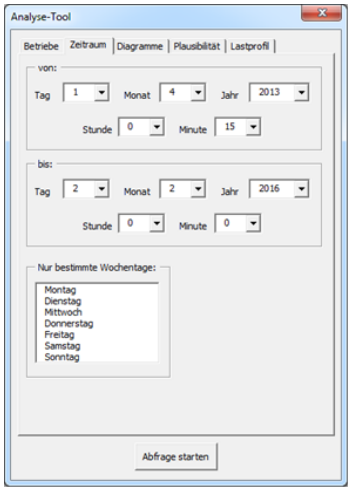
How do we achieve it? - Used and developed tools

Source: www.evb.net

CSV-Data

MySQL
DATABASE

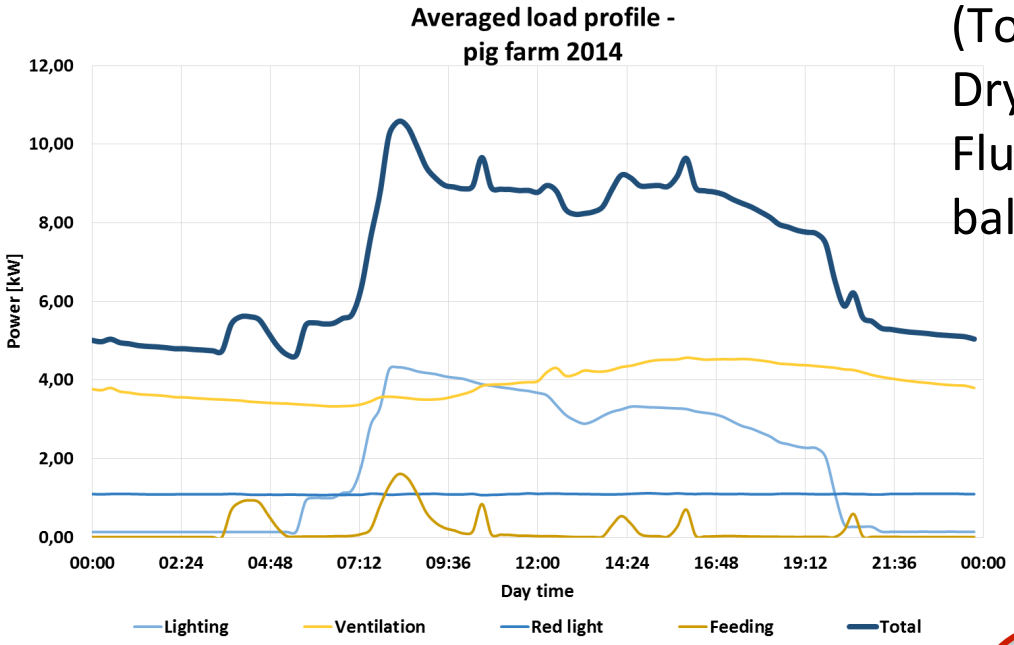




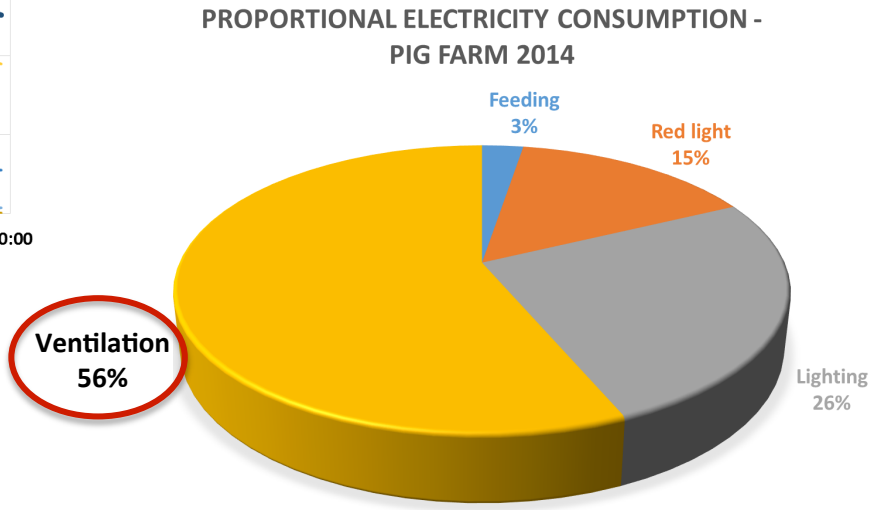
12 Farms (pig and dairy)
45 Measuring points

35.049 data sets
per SmartMeter and year
= 3.504.900 data sets

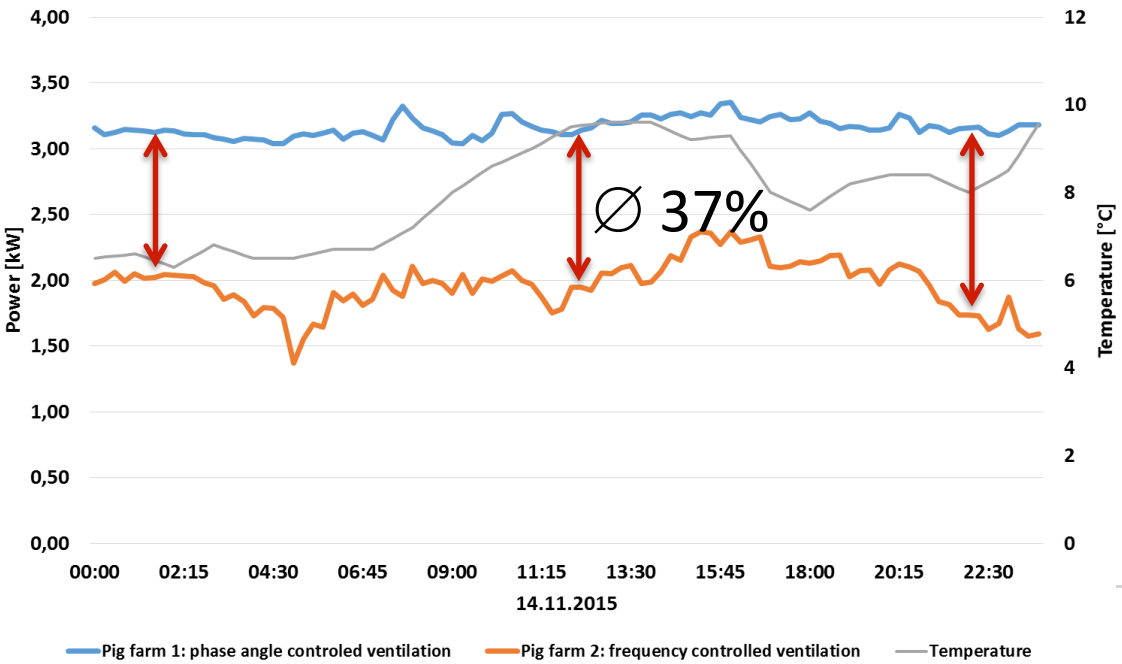
Exemplary analysis – pig farm



822 Animal places
Phase angled controlled Ventilation (Total: 8 kW)
Dry Feeding System (Total: 4,4 kW)
Fluorescent tubes with conventional ballast



Exemplary analysis– key indicators and efficiency improvement



- Ventilation systems run with less than 40% of its total installed capacity most of the time
- Partial load efficiency is very important

	Pig Farm 1 2015 [kWh/TP*a]	Pig Farm 2 2015 [kWh/TP*a]	nach KTBL Heft 103 [kWh/TP*a]
Consumer			
Ventilation	38,0	29,8	51,2
Feeding preparation	-	-	20,5
Feeding	1,8	12,6	3,4 (20,5)
Lighting (incl. Red light)	17,4 (23,8)	12,7	30,7
Others (Cleaning , removal of manure)	-	6,8	6,8
Total	63,7	61,9	109,2

Frequency converters can reduce energy consumption up to 35% per year – 21% in this case!

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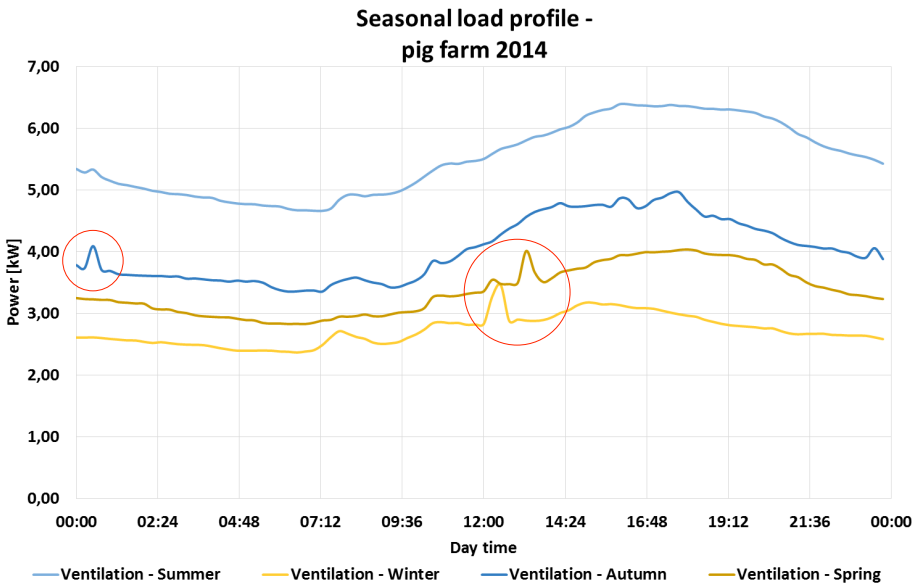
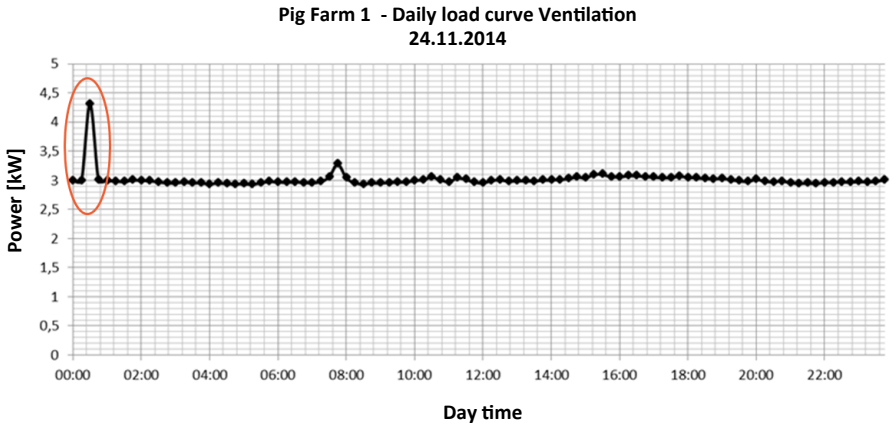
Exemplary analysis - Optimize settings and terms of the electrical load



3.488 kWh higher energy consumption due to load jumps in 2 years!

Not optimally adjusted and outdated ventilationsystem!



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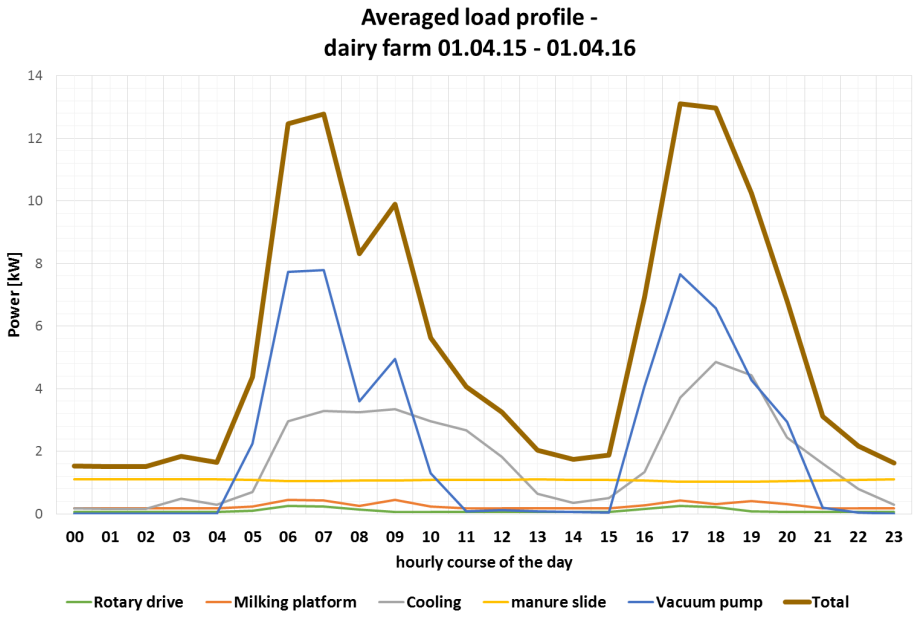
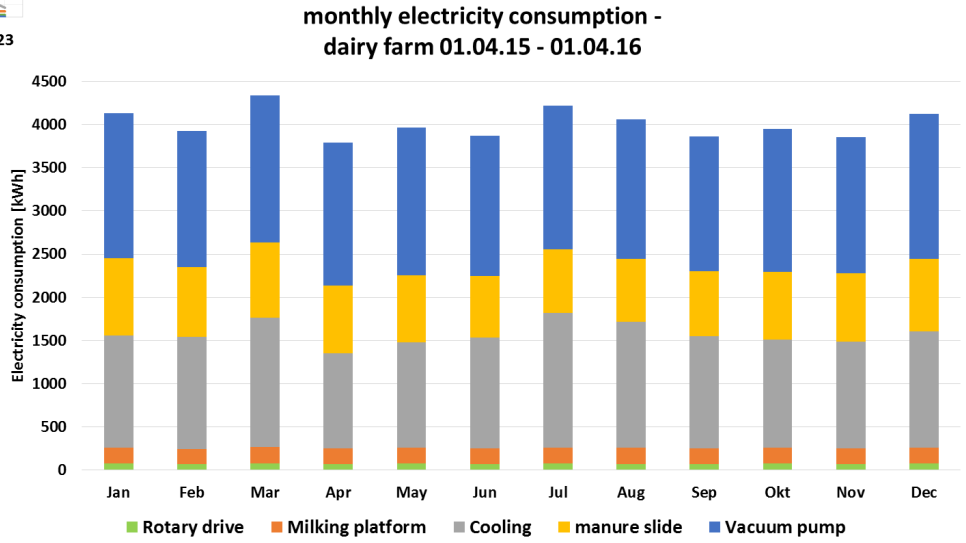
Exemplary analysis – dairy farm



180 cows / ∅ 9.500 liter milk per cow and year
∅ Daily production ~ 4.600 liter
Milk tank volume 11.000 liter
Rotary milking platform
Frequency controlled vacuum pump

Source: www.packocooling.com



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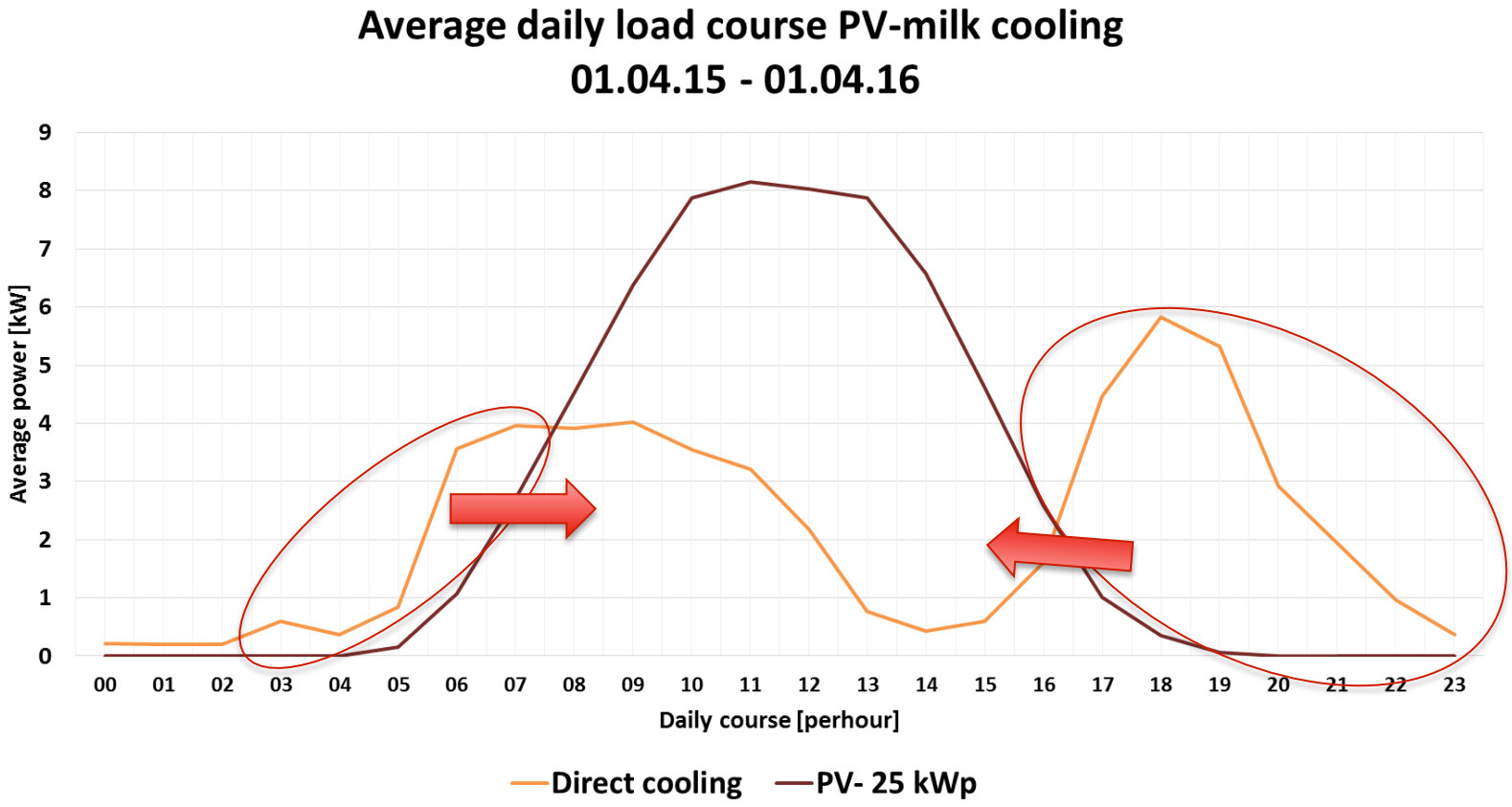
Exemplary analysis – Load shifting



PV-System	Direct cooling - Consumption share [%]	Direct cooling - Degree of self- sufficiency	Ice-water cooling - Consumption share [%]	Ice-water cooling - degree of self- sufficiency
25 kWp	52,07	18,15	66,43	22,08
50 kWp	35,96	25,07	45,9	30,50
250 kWp	11,27	39,29	13,87	46,09

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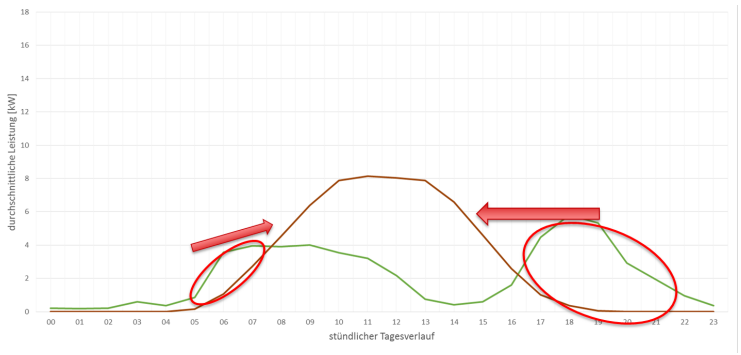
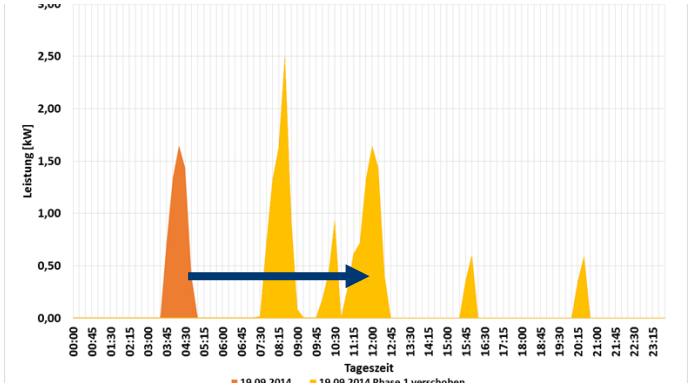
Results so far

- Recommendation for energy-efficient components:
  - Ventilation: e.g. Frequency technology
  - Lighting: e.g. Electronic ballast or LED

- Load shifting potentials:
  - Decoupling of consuming processes by storage to increase own consumption
  - **Total potential in our 12 agriculture holdings approximately 153 kW**





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Outlook

- Duration of the project till october, deadline for the final report is february 2017
  - **Still lots of work to do:**
    - Evaluating the other agriculture holdings
    - Discussing key figures and production systems of the investigated agriculture holdings
    - Developing renewable energy concepts with high self-consumption share
    - Check further possibilities of data access and analysis with the help of Microsoft PowerTools (e.g. PowerPivot, Powerquery ect.)

Thank you for your attention!

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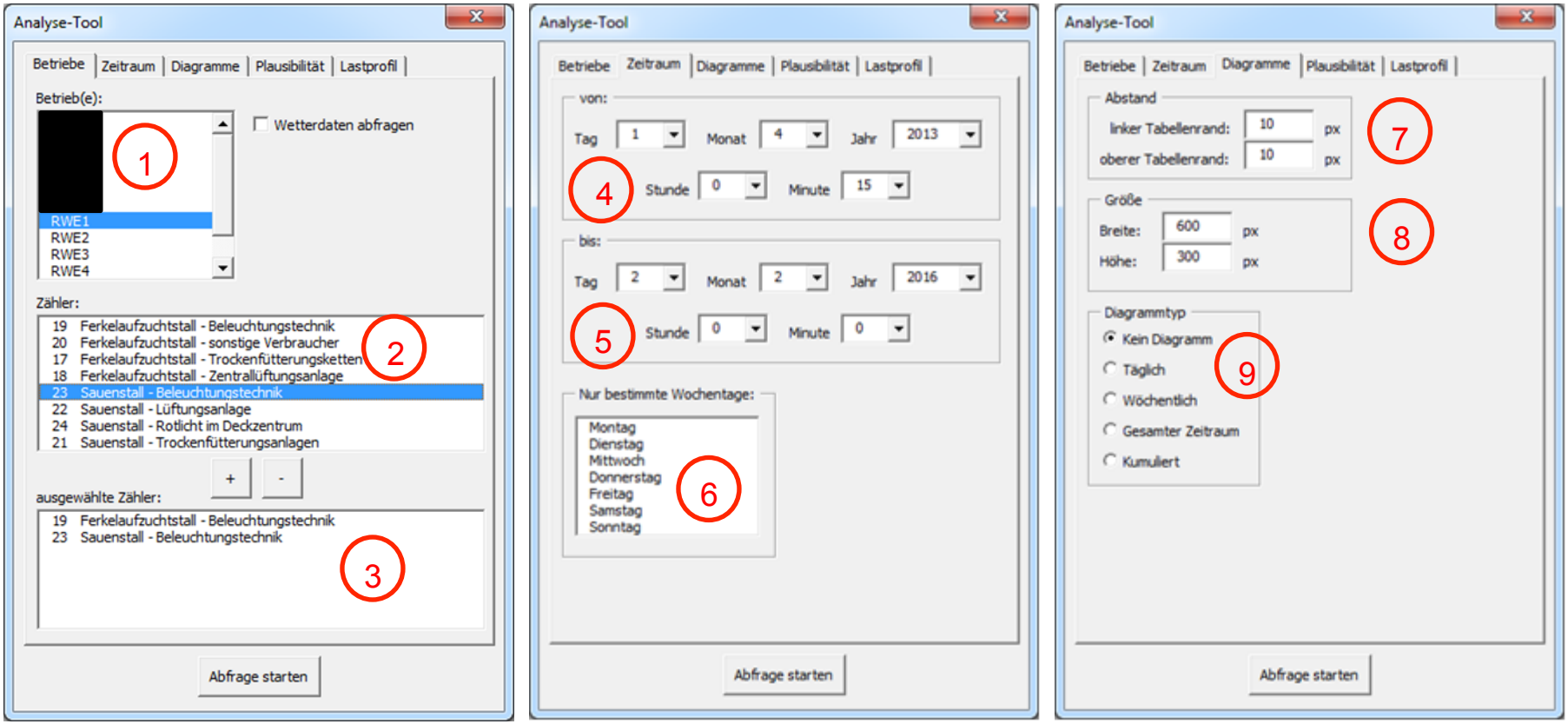
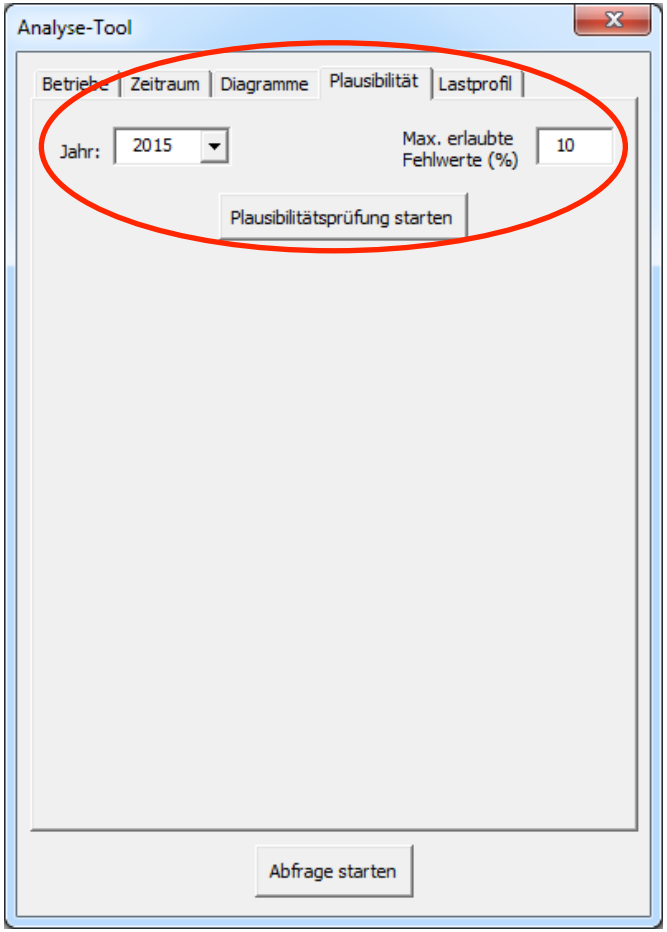
Analysis-Tool

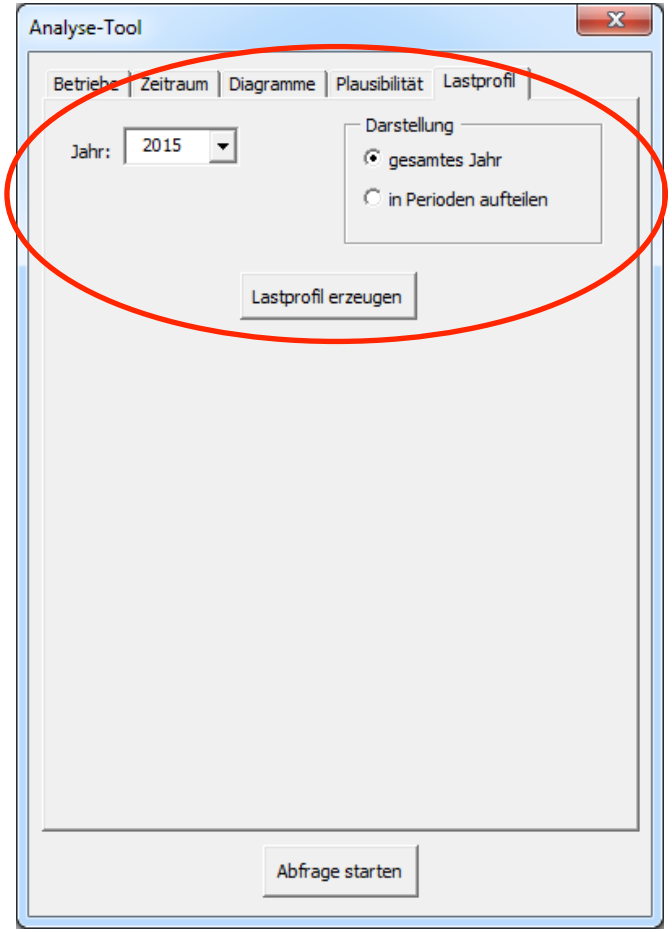
User Interface (General Requirements)



Analysis-Tool

User Interface (Advanced)





Plausibility check

Betriebe	Zählerbezeichnung	Zählergenauigkeit	
		2014	2015
BESTE1	Fütterung	40,17%	98,48%
BESTE1	Fütterung 2	56,44%	98,09%
BESTE1	Lüftung	40,17%	98,54%
BESTE1	Lüftung 2	56,44%	98,09%
BESTE2	Fütterung	42,02%	99,26%
BESTE2	Fütterung 2	31,48%	77,81%
BESTE2	Lüftung	42,02%	99,26%
BESTE2	Lüftung 2	31,48%	83,18%
BESTE3	Chargenmischer	5,59%	78,99%
BESTE3	Lüftung	5,59%	75,30%
BESTE4	Kühlung	48,17%	79,67%
BESTE4	Melkroboter	48,17%	79,67%
BESTE5	Fütterung	90,86%	93,92%
BESTE5	Mühle	90,85%	94,67%
BESTE6	Kühlung	9,32%	79,49%
BESTE7	Kühlung	0,00%	83,44%
BESTE8	Karussellantrieb	0,00%	82,45%
BESTE8	Melkstand	0,00%	82,76%
BESTE8	Milchkuehlung	0,00%	76,00%
BESTE8	Mistschieber	0,00%	77,17%
BESTE8	Vakuumpumpe	0,00%	83,20%

BeSte-farm

RWE-farm

Betriebe	Zählerbezeichnung	Zählergenauigkeit	
		2014	2015
RWE1	Ferkelaufzuchtstall - Trockenfütterungsketten	99,14%	99,91%
RWE1	Ferkelaufzuchtstall - Zentrallüftungsanlage	99,55%	99,87%
RWE1	Ferkelaufzuchtstall - Beleuchtungstechnik	98,90%	99,89%
RWE1	Ferkelaufzuchtstall - sonstige Verbraucher	99,10%	99,92%
RWE1	Sauenstall - Trockenfütterungsanlagen	99,17%	99,92%
RWE1	Sauenstall - Lüftungsanlage	98,96%	99,88%
RWE1	Sauenstall - Beleuchtungstechnik	99,16%	99,65%
RWE1	Sauenstall - Rotlicht im Deckzentrum	98,97%	92,14%
RWE2	Ferkelaufzuchtstall - Fütterung	99,01%	99,87%
RWE2	Ferkelaufzuchtstall - Lüftung	99,00%	99,90%
RWE2	Ferkelaufzuchtstall - Licht	99,14%	99,94%
RWE2	Ferkelaufzuchtstall - Nebenverbraucher	42,29%	17,40%
RWE2	Sauenstall - Fütterung	99,04%	99,90%
RWE2	Sauenstall - Lüftung	99,10%	99,91%
RWE2	Sauenstall - Licht	98,19%	99,89%
RWE2	Sauenstall - Nebenverbraucher	99,61%	92,03%
RWE4	Ferkelaufzucht - Fütterung	98,47%	99,86%
RWE4	Ferkelaufzucht - Lüftung	98,91%	99,84%
RWE4	Sauenstall - Fütterung	98,44%	99,84%
RWE4	Sauenstall - Lüftung	99,16%	99,88%

Averaged load profile generation

Breakdown of periods:

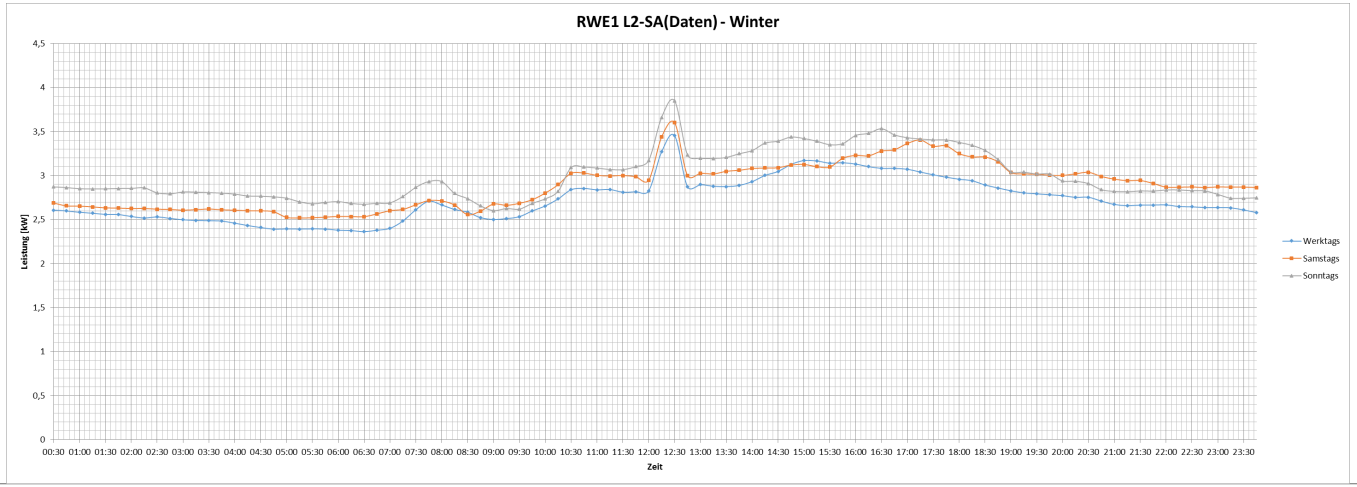
Spring 21.3. - 14.5.

Summer 15.5. - 14.9.

Autumn 15.9. - 31.10.

Winter 1.1. - 20.3. und 1.11. - 31.12.

	RWE1 L2-SA(Daten) - Sommer			RWE1 L2-SA(Daten) - Winter		
Uhrzeit	Werktags	Samstags	Sonntags	Werktags	Samstags	Sonntags
00:00	5,33833563	5,50297778	5,67813333	2,604444	2,7467	2,86388
00:15	5,27970115	5,40004444	5,63544444	2,6047	2,72534	2,8688
00:30	5,3275954	5,32548889	5,63882222	2,60768	2,68932	2,87162
00:45	5,20705747	5,24711111	5,41293333	2,597952	2,65612	2,86408
01:00	5,14598621	5,23933333	5,39717778	2,583364	2,65346	2,85114
01:15	5,0964	5,15391111	5,37288889	2,5724	2,64504	2,84908
01:30	5,0743814	5,10562222	5,34593333	2,560072	2,6334	2,84982
01:45	5,04493488	5,10673333	5,31891111	2,557772	2,631	2,85372
02:00	5,01835349	5,10991111	5,18888889	2,53578	2,62666	2,85518
02:15	4,98300465	5,0734	5,12686667	2,518428	2,62708	2,8606
02:30	4,9639907	4,98384444	5,13817778	2,530404	2,61876	2,80456
02:45	4,93594884	4,94215556	5,10535556	2,513908	2,61564	2,79366



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