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RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

Utilizing energy auditing in intensive livestock farming facilities

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Introduction
Energy audits as an energy efficiency tool

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- In 2007, the EU leaders set 3 key targets for 2020:
  - (a) 20% cut in greenhouse emissions from the 1990 levels
  - (b) 20% of EU energy to derive from RES
  - (c) 20% improvement in energy efficiency
- The last was enacted with the **2012 Energy Efficiency Directive (2012/27/EU)**
- The new, recast **Energy Efficiency Directive (EU) 2023/1791**
  - The new directive introduces a series of measures to help accelerate energy efficiency, including embracing the "**energy efficiency first**" principle in the energy and non-energy policies

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Introduction
Energy audits as an energy efficiency tool

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- "Energy audit" means a systematic procedure with the purpose of obtaining adequate knowledge of the energy consumption profile of a building or group of buildings, an industrial or commercial operation or installation or a private or public service, identifying and quantifying **opportunities** for **cost-effective energy savings**, identifying the **potential** for **cost-effective use** or **production** of **renewable energy** and reporting the findings
- Energy audits should be mandatory and regular for enterprises with an average annual energy consumption above a certain threshold, as energy savings can be significant
- A specific European standard on energy audits is currently under development

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Introduction
Minimum criteria for energy audits

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(a) be based on **up-to-date, measured, traceable operational data** on energy consumption and (for electricity) load profiles

(b) comprise a **detailed review of the energy consumption profile** of buildings or groups of buildings, industrial operations or installations, including transportation

(c) **identify energy efficiency measures** to decrease energy consumption

(d) identify **the potential for cost-effective use or production of renewable energy**

(e) **build, whenever possible, on life-cycle cost analysis** instead of simple payback periods in order to take account of long- term savings, residual values of long-term investments and discount rates

(f) be **proportionate**, and **sufficiently representative** to permit the drawing of a reliable picture of overall energy performance and the reliable identification of the most significant opportunities for improvement

The data used in energy audits shall be storable for historical analysis and tracking performance

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Introduction
Types of energy audits

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Level I. Walk-through energy audit

- Via energy bills and the results of a short autopsy
- Visual verifications, study of installed equipment and operating data and detailed analysis of recorded energy consumption
- A candidate list of interventions or investment is provided

Level II. Comprehensive energy audit

- Energy use survey
- A first quantitative evaluation of the interventions and investment selected to correct the defects or improve the existing installation
- On-site measurements and computer-based simulation tools to precisely evaluate the selected energy efficiency measures

Level III. Detailed energy audit

- The detailed energy audit (energy study) includes a detailed analysis of capital-intensive modifications focusing on potential costly interventions and investments requiring thorough engineering studies

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Methodology
Work carried out within RES4LIVE

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- Specific buildings and not the 4 pilot farms as whole units
- **Descriptions and schematics of the buildings**
  - Dimensions, construction materials, openings, insulation and intended usage (animal type and population)
- **Consumption data** classified in 4 levels of detail
  - 1st: Different types of energy (electrical, diesel fuel, biogas, natural gas)
  - 2nd: Assignment of the consumption data to each specific building of interest
  - 3rd: Assignment of the consumptions to specific devices/device types
  - 4th: Devices' working time in hours per month, for a full year cycle
- Estimations had to be done

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GOLINELLI swine farm

1. General notes

- In Buildings' characteristics, some already filled in data serve as an example and can be deleted. In case there is more than one type of doors/windows, the related table can be copied and filled in accordingly.
- The estimation of the energy consumption of each device should be connected to one of the buildings that are being of interest for the Project and the correlation should be scientifically explained. For example, out of x liters/year of Tractor's diesel fuel, the y quantity is connected to Building 12 for the z purpose.
- It is preferable to explain the use of each device but in case of common use there is no need to be repeated (e.g. LED lamps = lighting).
- The *Estimated annual consumption* (3.a) can be filled in based on an already existing assumption and then it will be compared with the data acquired from the detailed tables.
- For any inquiry contact m.maraitis@certh.gr.

2. Buildings' characteristics

a. Buildings' list

Building number	Usage	Dimensions (m)	T
12	Hog barn (number of animals: 400 hogs)	13.00 x 51.00	
16	Nursery barn (no. of animals: 2400 weaners)	16.10 x 62.26	
Other, please specify	-	-	

b. Building 12

External wall		
Building Materials	Type (Inside->Outside)	Mat. Thickness (m)
	Precast concrete walls (W, S, E):	
	concrete	0.05
	polystyrene insulation	0.05
	concrete	0.07
	brick wall (N)	0.14

Building frame		
Building Materials	Type (Inside->)	Mat. Thickness (m)
	Building frame in reinforced concrete	Pillars: 0.29x0.29

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Floor		
Building Materials	Type (Upper->Lower)	Mat. Thickness (m)
	concrete slatted floor	0.05
	concrete	0.15

Roof		
Characteristics	Rise (m)	
	2.2	
Building Mat.	Type (Inside->Outside)	Mat. Thickness (m)
	precast concrete panels	0.05
	polystyrene insulation	0.05
	sandwich panel	0.05

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c. Building 16

External wall		
Building Materials	Type (Inside->Outside)	Mat. Thickness (m)
	Precast walls in vibrated reinforced concrete	0.36

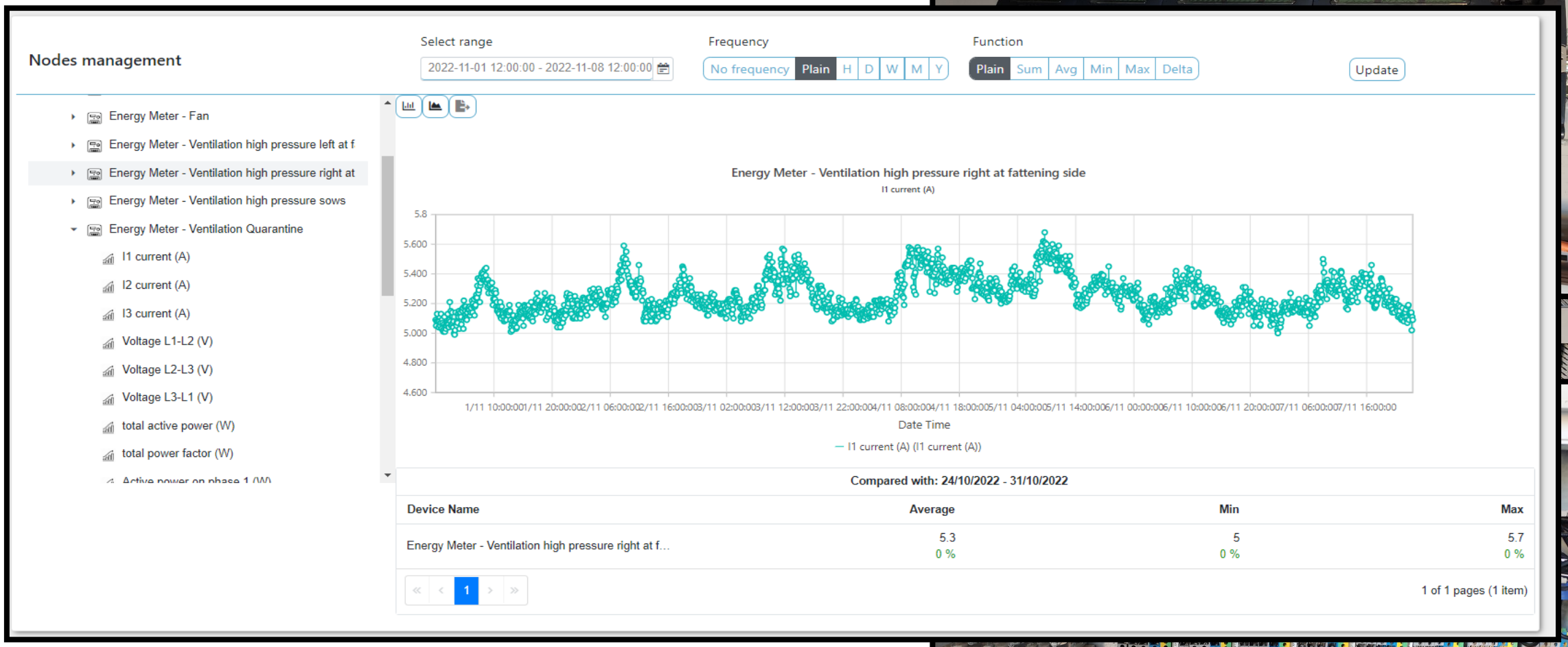
Building frame		
Building Materials	Type (Inside->)	Mat. Thickness (m)
	Precast walls in vibrated reinforced concrete	0.36

Building 29

Device type (usage)	Power (W)	Quantity	Working time (hours)												KWh/ year
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
LED lamps (lighting)	30	8	3968	3584	3472	2880	2480	1920	1984	1984	2400	2976	3360	3968	1.051,20
A4 Lely milking robot (water treatment)	120	1	520	480	520	520	520	520	520	520	520	520	520	520	1.051,20
A4 Lely milking robot (single box)	1895	1	520	480	520	520	520	520	520	520	520	520	520	520	11.826,00
boiler	7000	1	91	91	91	91	91	91	91	91	91	91	91	91	7.665,00
circulation heating watering place	3000	1	360	360	25	0	0	0	0	0	0	0	25	250	3.060,00
compressor	3700	1	182	182	182	182	182	182	182	182	182	182	182	182	8.103,00
SmartVet ventilation	1000	3			100	200	500	800	1800	1800	200	100			5.500,00
ventilation	1200	1						200	400	400	200				1.728,00
ventilation	1800	1						200	400	400	200				2.592,00
manure scraper	550	2	365	365	365	365	365	365	365	365	365	365	365	365	2.409,00
concentrate feed snail (milking robot)	550	2	31	28	31	30	31	30	31	31	30	31	30	31	200,75
heating control gas heater	30	1	360	360	25	0	0	0	0	0	0	0	25	250	31,00
automatic dringer Urban (calves)	3500	1	60	60	60	60	60	60	60	60	60	60	60	60	2.555,00
trough heater	80	2	720	720	50								50	500	163,00
thermal boiler (heat accumulator 5 l)	2000	1	31	28	31	30	31	30	31	31	30	31	30	31	730,00
transformer (drough)	80	3	1080	1080	75	0	0	0	0	0	0	0	75	750	240,00
neon tubes (calves)	60	3	1488	1344	1302	1080	930	720	744	744	900	1116	1260	1488	1.576,80
HQI lamps (silo)	120	1	400	350	200	80	20		30	50	100	200	400	400	262,80
neon tubes	40	3	1488	1344	1302	1080	930	720	744	744	900	1116	1260	1488	43,80
slurry mixer	5000	1	23	22	23	23	23	23	23	23	23	23	23	23	1.368,75
slurry pump	15000	1	23	22	23	23	23	23	23	23	23	23	23	23	4.106,25

Methodology

Work carried out within RES4LIVE



www.res4live.eu

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Results
Comparison between energy audits and metered values

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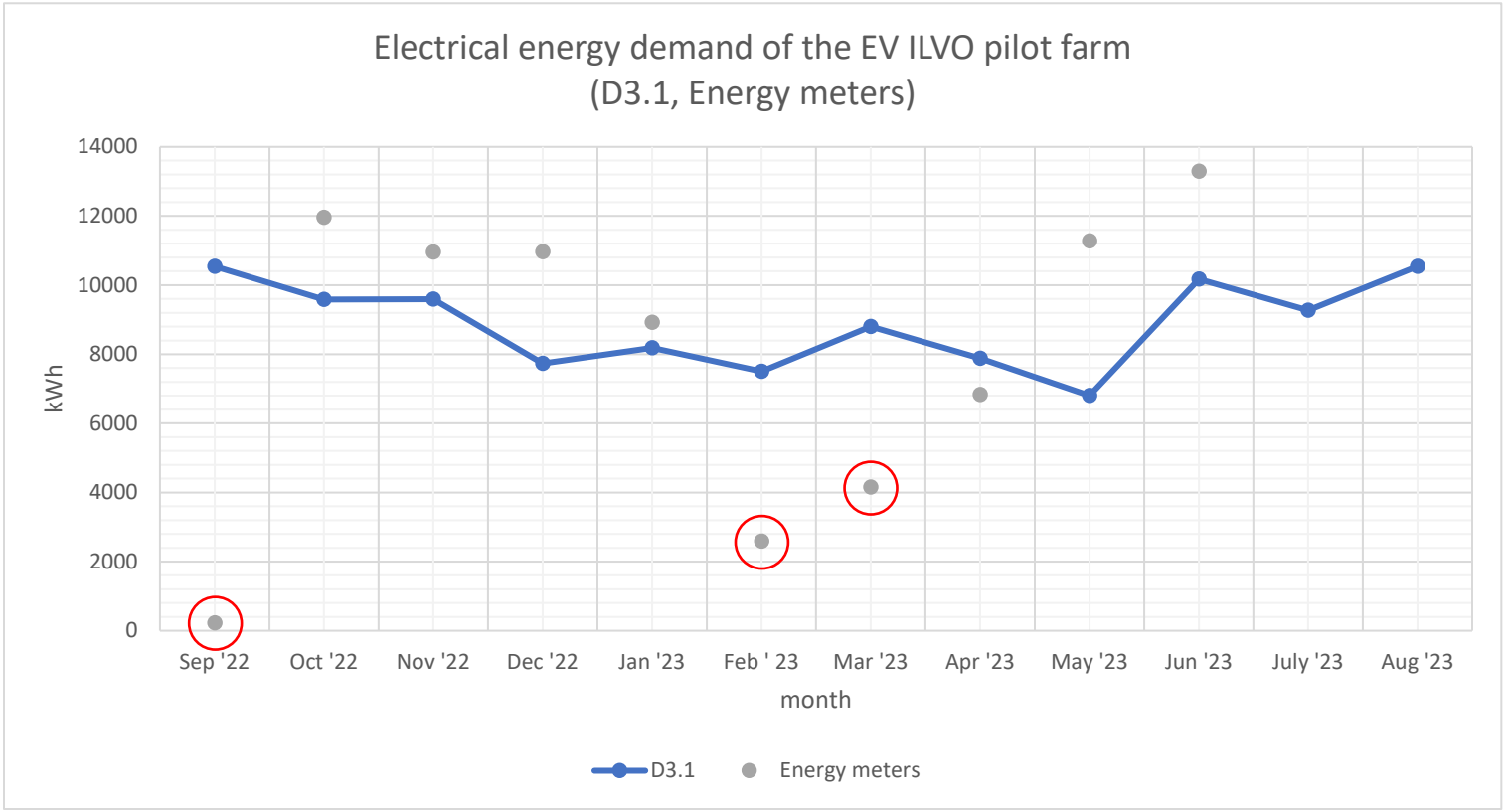
EV ILVO

- September: first month of meters' operation, depicts only the last few days
- February, March: malfunctions of the meters



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Results
Comparison between energy audits and metered values

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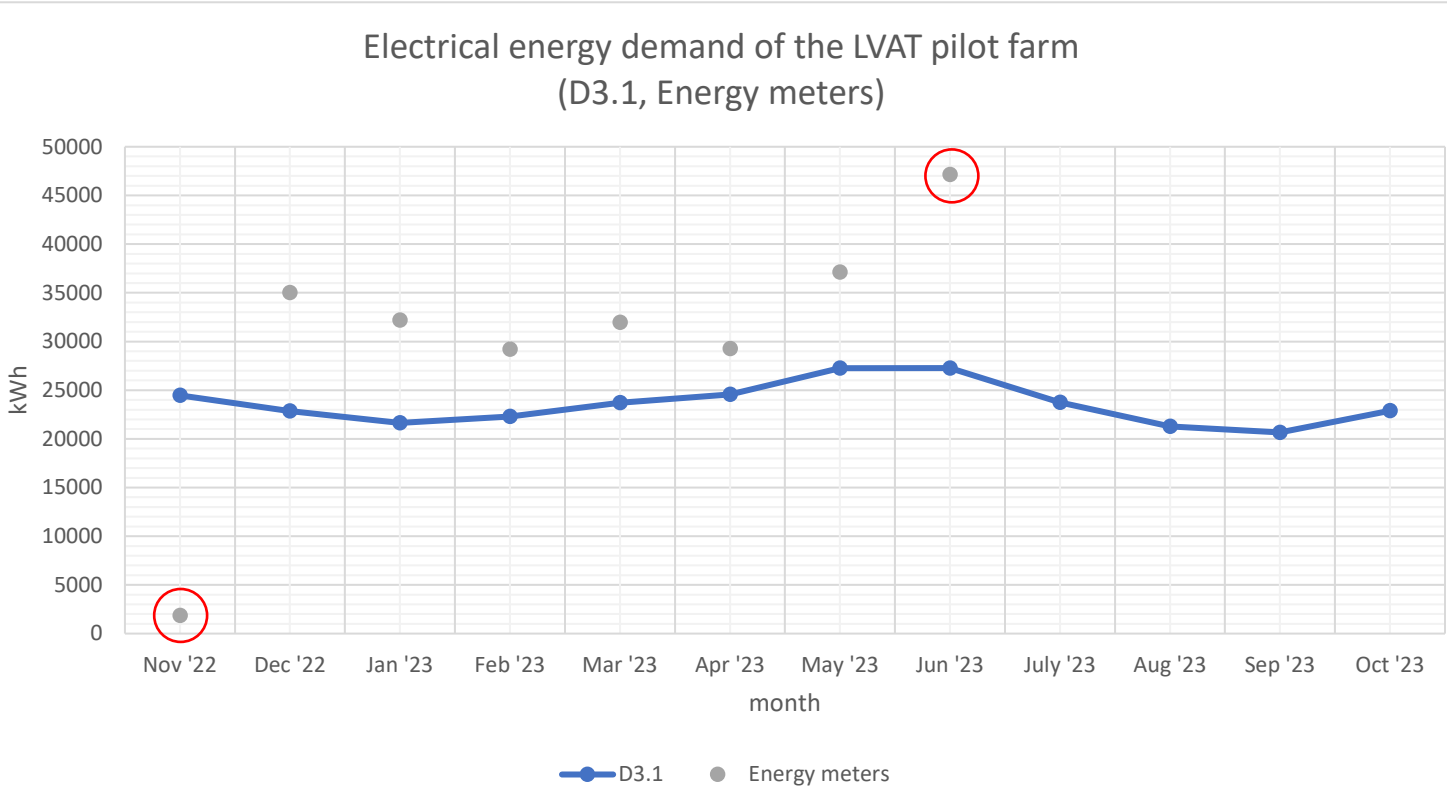
LVAT

- First readings in late November ‘22
- Malfunction of some nodes (energy meters) that were later fixed



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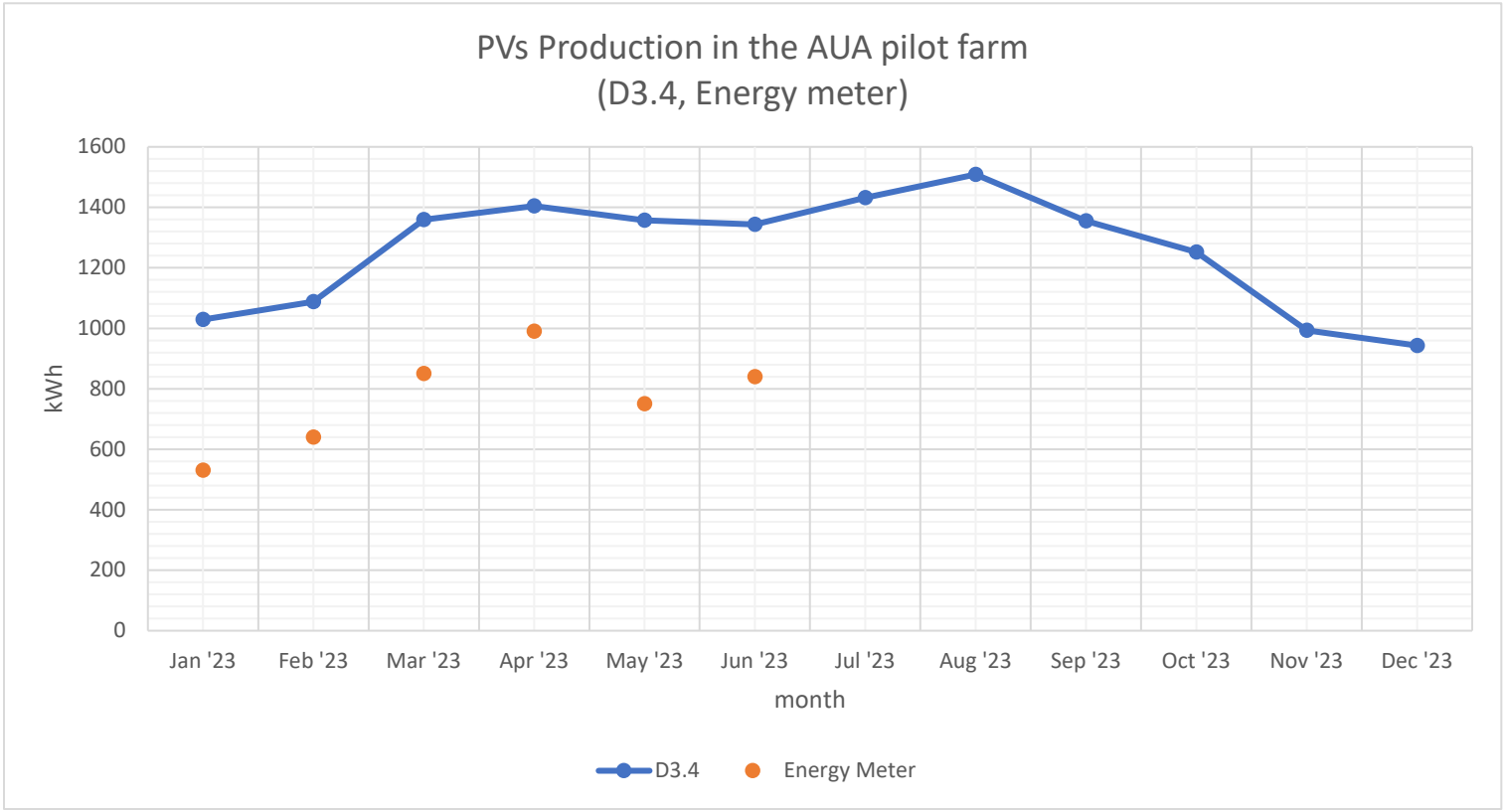
AUA – PVs PRODUCTION

- The estimations occurred over a 5-year period and the average values were calculated
- Produced energy appears to be less than the estimated



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Results

Comparison between energy audits and metered values

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- In the EV ILVO experimental pilot farm (swine) the estimations were very close to the measured values
- In the LVAT experimental pilot farm (dairy), the estimations were to some extent accurate, some malfunctions altered the logged data but as in the EV ILVO farm, a well executed energy audit can provide an adequate first picture
- In the GOLINELLI commercial pilot farm (swine) the energy demand estimations were not accurate, something which was expected mostly due to the limited existing data during the audits

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Conclusions

- Energy audits will be as accurate as the data retrieved
- Sufficient for a general estimation where the installation of energy meters is not feasible
- Initial depiction of the farms' energy consumption and potential to identify the most promising RES
- A number of factors such as farm location, local environment, buildings' characteristics, special farm needs (i.e. milking needs) & policies
- https://res4live.eu/public-deliverables/
  - D3.1: Report on the analysis of energy demand-consumption and RES availability in typical livestock farms

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Thank you!

https://res4live.eu/

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