GREEN DROP

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DELIVERABLE 2.2:

Constructed and installed system parts

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Workpackage 2

Deliverable D2.2

Constructed and installed system parts

February 2020

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1. Introduction

In this deliverable, the construction of the Green-Drop demo-site in Beerfelde (Germany) is presented. Due to the necessary change of the test site from Czech Republic to Poland, a delay in the whole work package 2 has taken place. The following figures and pictures as well as explanations, are meant to give an overview of the work done until now.

2. Adaptation and up-scaling of the Green-DROP prototype components

2.1. First demo site description

The first demo site is located in Germany, approximately 40 km east of Berlin and it is characterized by heterogenous soils, according to the soil location mapping with soil-points from <20 to <50. With a water deficit of over 150mm during the vegetation period (April-September), see figure 1. Fertilizer is still applied equally and traditionally using ordinary manure distributes. The irrigated area has an established crop rotation of Triticale – Corn – Corn – Rape. Due to the heterogenous soils, this is a preferable location for soil and plant specific irrigation and fertilization.

The irrigated area itself is having slopes and elevation differences. Maximum slopes reach 10% while elevation differences stay below 5m. Two gaps have to be crossed and spared out of the irrigation process. The field has already been surveyed, using our GPS-RTK system, with an accuracy of 50cm, in addition to the free available elevation model from google.

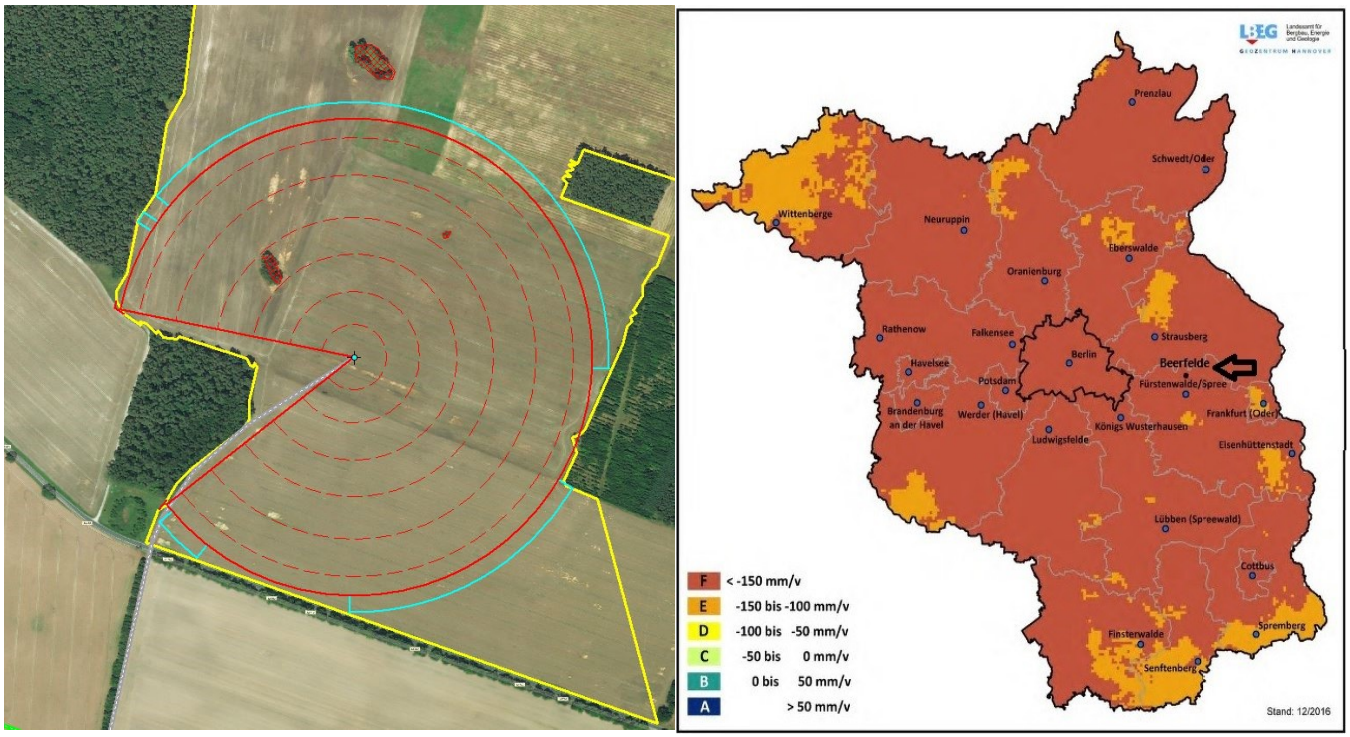


Figure 1 Overview of the center-pivot system Beerfelde and location on the climatic water balance map (DWA Merkblatt 590)

Figure 2 Green-Drop Demo site in Beerfelde, Germany (viewing direction west, towards central point)

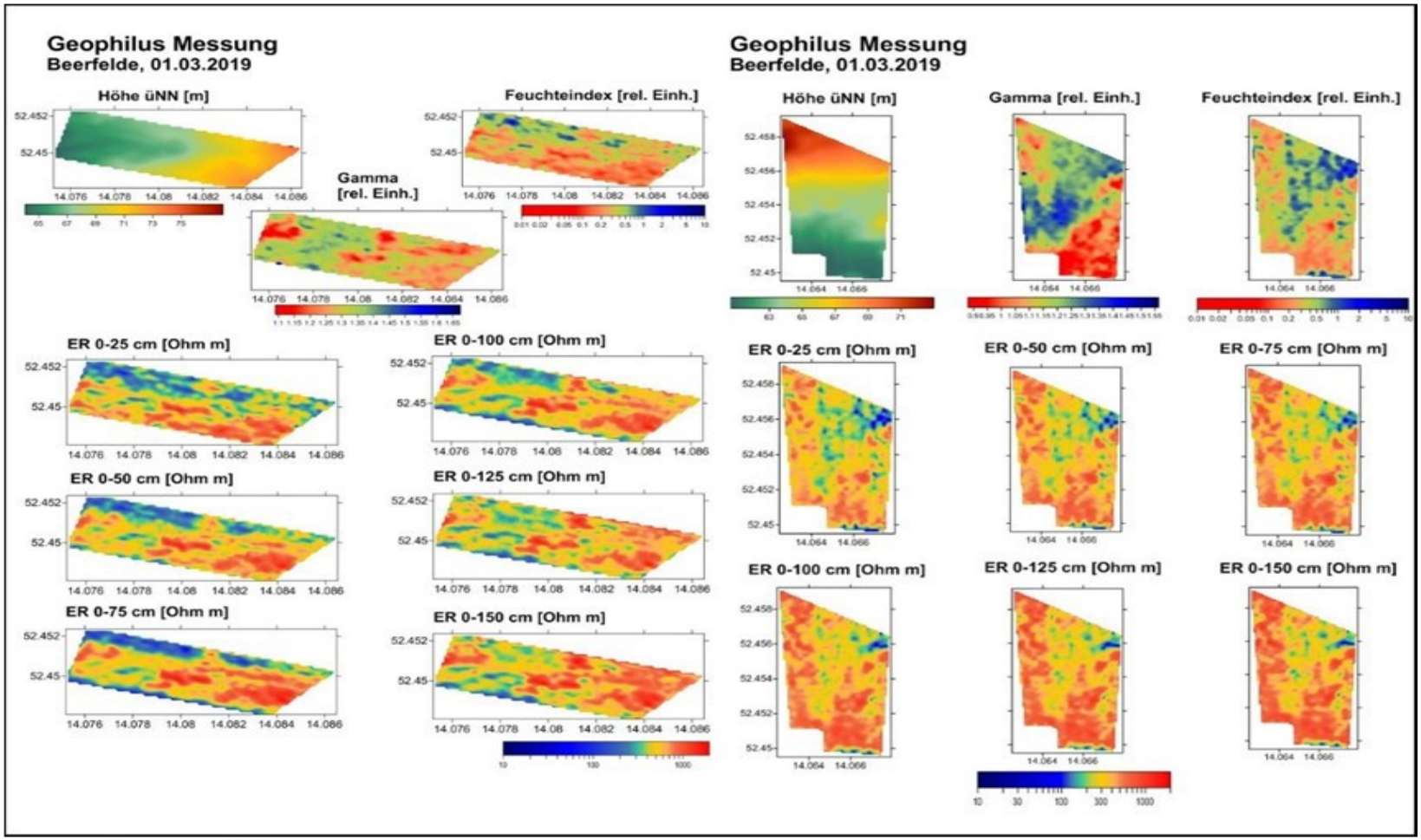
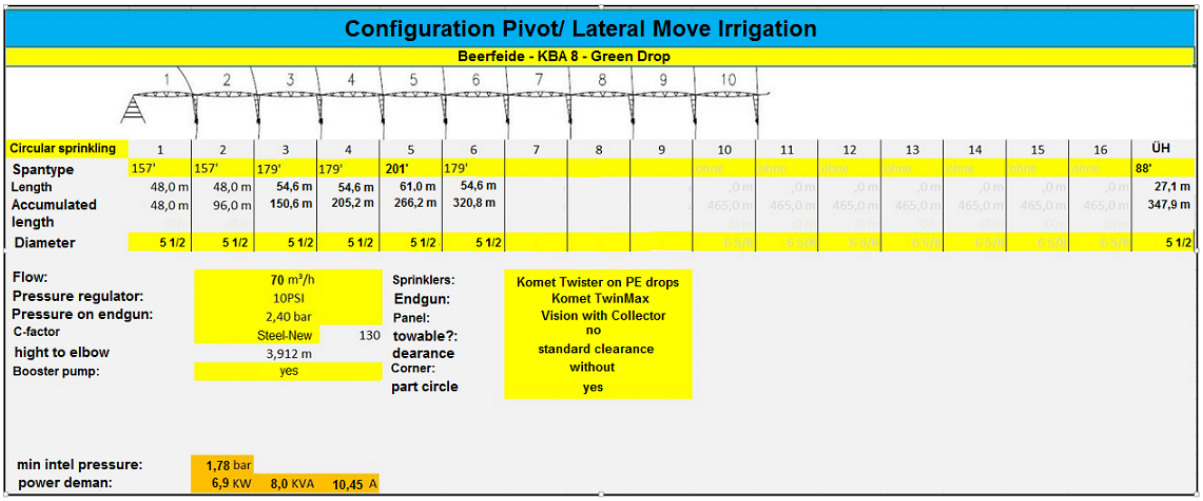


Figure 3- Soil mapping demo site in Germany

2.1.1. Description of the German prototype

The German prototype was designed as a pivot irrigation system covering an irrigation area of 34 ha as a part circle system. Its flow demand is calculated to 70m³/h, accordingly it is designed to use 5 9/16" diameter pipe. The different span lengths are a consequence of slope, elevation difference and obstacles on the test site. In order to keep variable costs as low as possible the system is operating with only 0,7 bar on each nozzle which in addition keeps droplets on a medium size minimizing also wind drift. The system is fitted to a new installed well with a variable frequency drive (VFD) controlled pump maintaining a constant pressure during variable flows of the system due to the pulsing of its nozzles. To maintain proper cooling of the pump, whose only cooling is achieved by its flow, the software simulation is used before each run ensuring a minimum flow. To increase the irrigated area the system is using an end gun, which is in need for higher pressure. The needed pressure is provided by a booster pump feeding the end gun. That way, the inlet pressure can be reduced to only 1,8bars without taking any elevation differences into account.



Configuration Pivot/ Lateral Move Irrigation

Beerfeide - KBA 8 - Green Drop

Circular sprinkling	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ÜH
Spantype	157'	157'	179'	179'	201'	179'											88'
Length	48,0 m	48,0 m	54,6 m	54,6 m	61,0 m	54,6 m				,0 m	,0 m	,0 m	,0 m	,0 m	,0 m	,0 m	27,1 m
Accumulated length	48,0 m	96,0 m	150,6 m	205,2 m	266,2 m	320,8 m				465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	347,9 m
Diameter	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2											5 1/2

Flow:	70 m³/h	Sprinklers:	Komet Twister on PE drops
Pressure regulator:	10PSI	Endgun:	Komet TwinMax
Pressure on endgun:	2,40 bar	Panel:	Vision with Collector
C-factor	Steel-New 130	towable?:	no
hight to elbow	3,912 m	dearance	standard clearance
Booster pump:	yes	Corner:	without
		part circle	yes

min intel pressure:	1,78 bar			
power deman:	6,9 KW	8,0 KVA	10,45 A	

Figure 4 - Data sheet Germany

Including elevation differences, its inlet pressure should be at around 2 bars minimum which is ensured by our pump control system. A VFD controlled piston pump for injecting liquid fertilizer is fitted to the centre point. Flow is measured continuously and the injection pump regulated to maintain a constant fertilizer / water mixture. In Addition, the system is connected to a Biogas plant. Its digestate will be separated and filtrated according to previous test and mixed to the irrigation water giving the customer the possibility to apply digestate

according his plants demand during the entire growing season. Electrical power for driving the center drives and booster pump is provided by a local infrastructure brought to the systems center-point along with the pipeline from the well which is next to a local power transformer.

2.2. Second test site in Poland

Site survey / Test site **Gniewowo Poland**

The second test site in **Poland** is near **Koscian**, 40km south east of Poznan. Here the customer is already irrigating several areas. Therefore, a pumping station is already built but still has to be equipped with pumps and a control system to fit the needs of the Pivot system. In addition to the Pivot system the use of hose-reels is planned, the Pumps can be used for both operations and a system for pressure regulation is unnecessary.

Figure 5 - view of the planned test field showing only minor elevations

Figure 6 – current pumping station with PVC-Pipe for connection and space for the pumps

A survey of the construction site hasn´t shown any points of unexpected problematics. The homogenic soil without any slopes or any bigger elevation differences does not require any detailed site survey.

Figure 7 - 2D planning Indicating needed supply pipe

Figure 8 - Elevation model showing only mild elevation changes and slopes. Biggest difference in elevation above sea level is 6m.

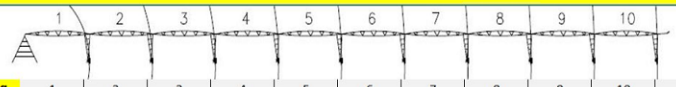
The topography doesn´t inflict any structural complications within the Pivot systems limitations. Site survey has been performed by Mr Scholz.

2.2.1. Description of the polish prototype

The polish prototype is designed as a pivot irrigation system covering an irrigation area of 75ha as a full circle system. Its flow demand is calculated to 150m³/h, accordingly it is designed to use 6-5/8" diameter pipe. In order to keep variable costs as low as possible the system is operating with only 0,7 bar (10psi) on each nozzle which in addition keeps droplets on a medium size minimizing also wind drift. To minimise the needed inlet pressure the Pivot is equipped with a booster pump, so the End-gun receives its 2,4bar pressure to ensure functionality and throwing range. The system will be fitted to an existing irrigation pipeline. This pipeline will be extended and near the border of the field, a hydrant is to be added, to connect a hose-reel system. The characteristics of the two pumps are fitted to fulfil the needs of the hose-reel and the Pivot system. In addition, cooling of both pumps is calculated by running simulations before each run, indicating minimum flow. If the hose-reels are in use, the pumps are able to achieve higher pressure, to ensure functionality. To apply fertilizer an injection pump controlled by a variable frequency drive will be fitted to the centre point. Flow is constantly measured at the inlet and the injection pump driven accordingly to maintain a constant nitrogen concentration. Electrical power for driving the centre drives and dosing pump is provided by a local genset at the centre point. The systems design has been performed by Mr Scholz.

Configuration circular sprinklers

Koscian VRI



Circular sprinkling	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ÜH
Spantype	157'	157'	157'	157'	179'	179'	179'	179'	179'								11'
Length	48,0 m	48,0 m	48,0 m	48,0 m	54,6 m	54,6 m	54,6 m	54,6 m	54,6 m	,0 m	,0 m	,0 m	,0 m	,0 m	,0 m	,0 m	3,6 m
Partial length	48,0 m	96,0 m	144,0 m	192,0 m	246,6 m	301,2 m	355,8 m	410,4 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	465,0 m	468,6 m
Cross section	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	6 5/8	5 1/2

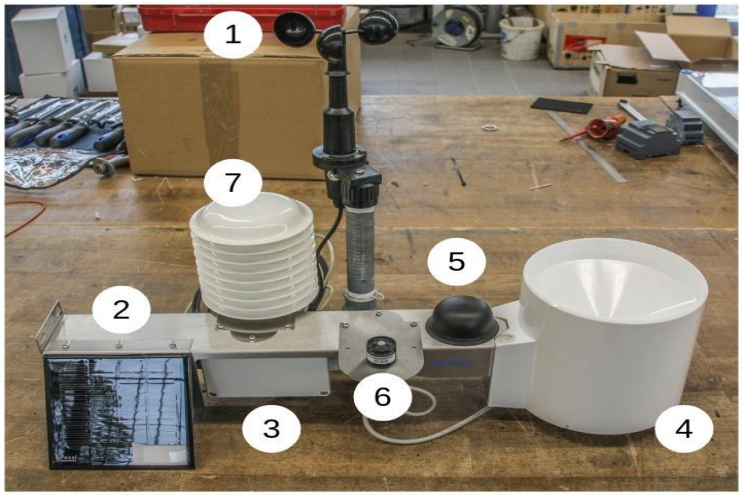
Flow:	150 m³/h		Sprinklers:	Comet Twister on PE drops	
Pressure reducer:	10PSI		Final sprinkler:	Comet TwinMax	
Pressure at the final sprinkler:	2,40 bar		Panel:	Vision with Collector	
C-factor	Steel-New	130	Movable?:	no	
Height to arch	3,912 m		Height:	standard clearance	
Booster pump:	yes		Corner:	without	
			Piece circle:	no	
Required inlet pressure:	2,18 bar				
Power consumption:	9,0 KW	10,5 KVA	13,69 A		

Figure 9 - data sheet Koscian, Poland

3. Construction of the two Green-DROP systems

3.1. Construction of the environmental management systems including the soil management systems

The construction, optimization and configuration of the weather station (based on the design and simulations in work package 2) is now finished as well as the integration of the selected environmental management systems into Green-DROP. The integral part for this management system is, that the systems are able to measure the most important parameters of arable land such as soil type, soil moisture, etc. All relevant soil data are archived in the management system. The actual daily weather-conditions accumulated with the weather station will be used to calculate the effective-needed amount of water for every specific area. How these calculations are performed, is to be read under point 3.2.



Liste of the individual components and their function	
Nr.	Component and function
1.	Wind speed sensor
2.	Power supply (solar panel and battery)
3.	Logger and modem
4.	Rain gauge
5	Dual antenna (GPS/communication)
6.	Global radiation sensor
7.	Temperature and relative humidity sensor with radiaton shield

Figure 10 Weather station.

3.2. Set up of the monitoring and control unit

The construction of the monitoring unit is completed. The optimisation of the software of magnetic pulsation has also being completed.

The monitoring and control systems have integrated communication and processing via GPS and GIS technologies as well as soil management systems. With these tools it is possible to obtain the optimal agricultural conditions for each specific zone and each type of crop. The

calculations are based on the ratio of actual evapotranspiration-rate (AET) and potential evapotranspiration-rate (PET).

The AET is a function of the water content in the soil, leaf surface and atmospheric evaporation demand. PET is a function of meteorological factors, type of fruit and stage of plant development. For the irrigation control, a fruit specific and growth stage specific optimal AET-PET ratio baseline is established. Weather services publish daily PET data called “Grass reference evaporation”. These references will be adapted for the actual agricultural crops, PET -> PET_{corr}. Normally before the plants have completely covered the ground, PET/PET_{corr} will be < 1, during the vegetational phase it will rise to values > 1 and sink back after the plants have exceeded the generative phase. “IRRIGAMA steering” can access these data and formulate a $PET_{optimal}$ for the given situation. The course of $PET_{optimal}$ through the irrigation season was determined with lysimeter-studies. The AET is calculated daily and compared to the $PET_{optimal}$. If the AET-PET ratio for the forecasted timeline falls below the $PET_{optimal}$ an irrigation is recommended. The figure below shows the optimal AET/PET ratio and the actual ratio. On the 7th of August for example, the actual measuring is below the optimal AET/PET ratio, but rainfall is forecasted and no irrigation is started. Without the forecasted rainfall, an irrigation-cycle would have been recommended. The amount of irrigated water is calculated to reach the optimal AET-PET-ratio, without risking a surface runoff and keeping the irrigation system inside its limitations (maximum waterflow). The weather-station on site measures all relevant data, such as temperature, wind speed, humidity and global radiation to calculate the evapotranspiration rate.

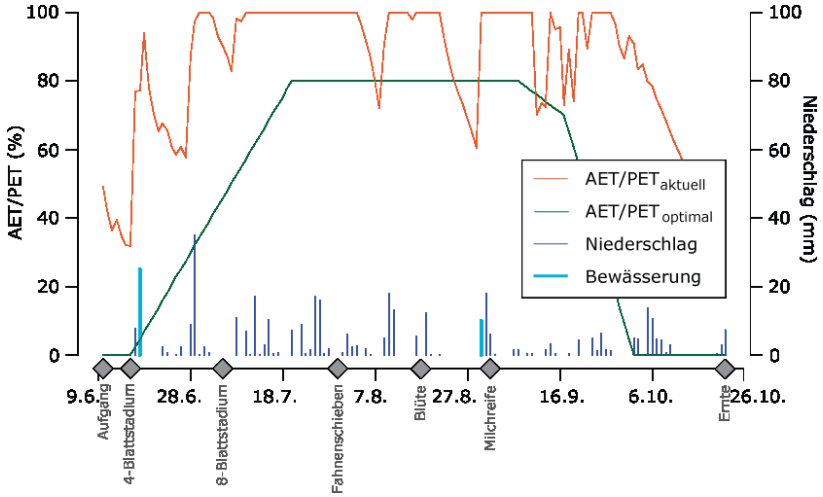


Figure 11 calculation for the irrigation recommendation (FIB IRRIGAMA steering)

The actual conditions will be transmitted and according to previous irrigations, an irrigation recommendation will be compiled. An updated irrigation-plan will contain the information necessary to react according to the actual weather- and soil conditions.

This updated irrigation-plan is to be send to the irrigation-control unit, where the user gets informed about the new irrigation-recommendation and can respond accordingly.

The transmission of the weather conditions, gathered by the weather station, is released using an API-interface inside the control-unit. The data will be transmitted via the internet to the "IRRIGAMA" server and if an irrigation is recommended, the updated irrigation-plan is send back to the controller. As mentioned, this is only a recommendation, so the user will receive the new information and has to start the irrigation-process. The figure below shows one such information, send via e-mail to the operator. The corresponding irrigation-plan is to be send separately to the operator and it just has to be activated to start the irrigation, modulated to the plant and soil specific needs.

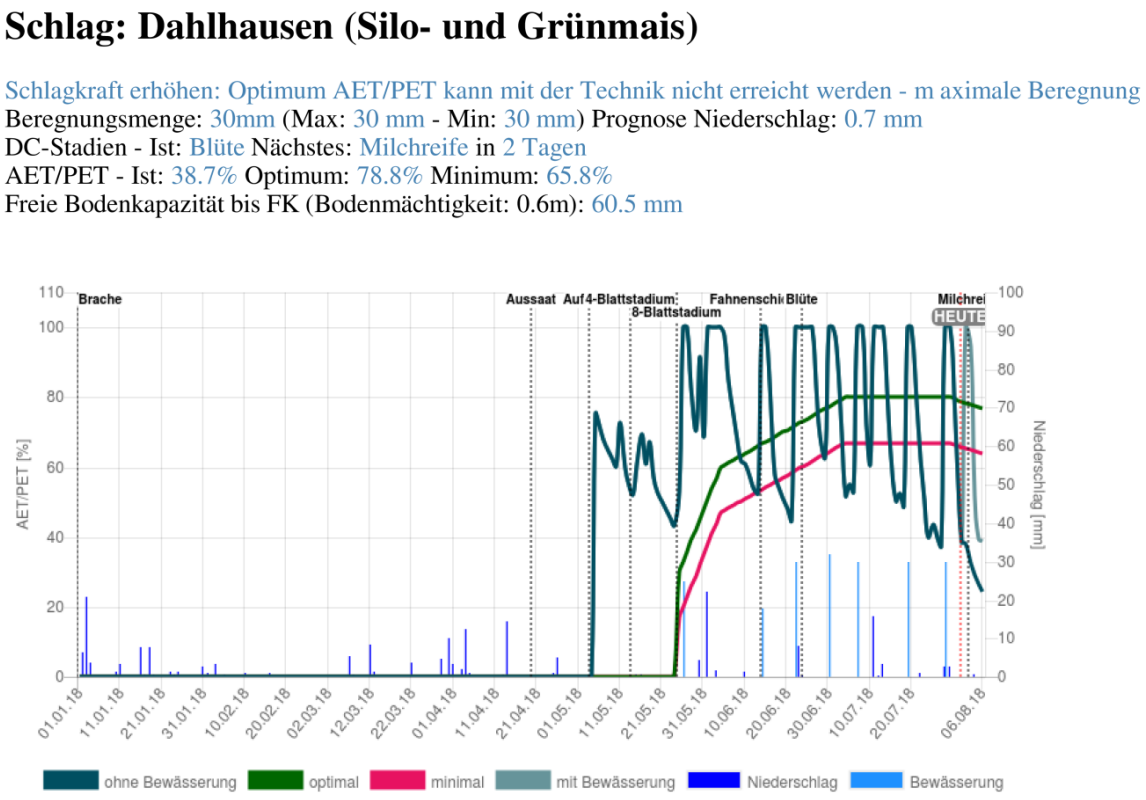


Figure 12 Example of an information e-mail with irrigation-recommendation (FIB IRRIGAMA steering)

3.3. Construction of the liquid fertilizer module

The optimized and adapted liquid fertilizer module was designed and manufactured for the Green-DROP system. After completion of the test phase, the module was optimally integrated. By means of the module, nutrient-rich waste from arable land, biogas plants and livestock breeding can be used. Both liquid manure and fermentation residues are suitable for use. The medium is prepared by means of a mixing plant and technical treatment and can be added optimally to the irrigation water. During the test phase different sieve sizes were tested. These different sizes have a direct influence on the particle size of the individual components in the medium. Various mechanical processing methods were also carried out and evaluated from a technical and economic point of view.

Technical implementation of an equal fertilizer concentration

Liquid fertilizer is added to the water quantity by means of a piston pump. It is necessary to variate the fertilizer dosage, because the flowrate is not always constant. Due to the nozzles, which open and close differently, to react accordingly to different soil-structures with specific water contents left in the soil and the resulting usable-FK or different water demands of the planted culture and the resulting AET, different flow rates are obtained as a result. These result in different concentrations of fertilizer at the nozzles. The aim was to achieve the same amount of fertilizer at each individual nozzle. The mixing ratio must remain constant at the inlet of the system. Inside the pivot pipe, a flowmeter is installed to measure the actual flowrate, which allows an exact adjustment of the amount of fertilizer. If the water quantity is low, the performance of the piston pump can be adjusted by a frequency converter. This enables the output of the pump to be adjusted precisely to the flow rates and to ensure constant dosing of the fertilizer throughout the entire irrigation system.

Under field conditions, a portable Tank with liquid fertilizer is positioned aside the pivot center-point. Mounted to this tank is the fertilizer module, which receives the data from the flowmeter installed into the rising-pipe of the pivot-tower. According to the actual flow, the module controls the piston-pump to adjust the fertilizer quantity.

Figure 13 Liquid fertilizer module

Liquid fertilizer Injection system with the following parts:

Piston pump, VFD (variable frequency drive), Water meter with signal converter, Connection hoses and filter Connectors for power and analogue/digital signals.

3.4. Construction of the pivot fertigation system

A precise control-unit for the pivot irrigation system was built with a capacity to manage up to 50,000 sub-areas in arable land of 80 ha and 100 ha, allowing independent treatment of a variety of soil and plant species, preventing surface runoff and eutrophication. The control-system production also included the implementation of routines to control the selectable magnetic- valves, waterflow, the FIELD NET GSM module and an alarm system. During the installation phase a detailed GPS- and RTK survey was performed. Using this data-set, the entire field is divided into polygons to calculate the precise positioning of the system during its pathway. Referring to the underlying Soil data (see 3.2.), the control system signals the corresponding magnetic valves to open or close, so only the necessary areas will be irrigated/fertigated. If the amount of water needed for an area is reduced due to soil or plant conditions, the magnetic-valves are pulsating to reduce the water quantity. Additional

equipment includes: additional valve controls, pipes, main plate, cables, extensions, circuits, etc.

Figure 14 shows the control-unit for the magnetic valves of the Green-drop system. Essential for this system is a router and its antenna to communicate with the wireless signal-nodes distributed along the pivot-system, to send weather-conditions and to receive updated irrigation-plans from the IRRIGAMA server. In addition an alarm-system was installed to avoid possible damage or theft of system parts.

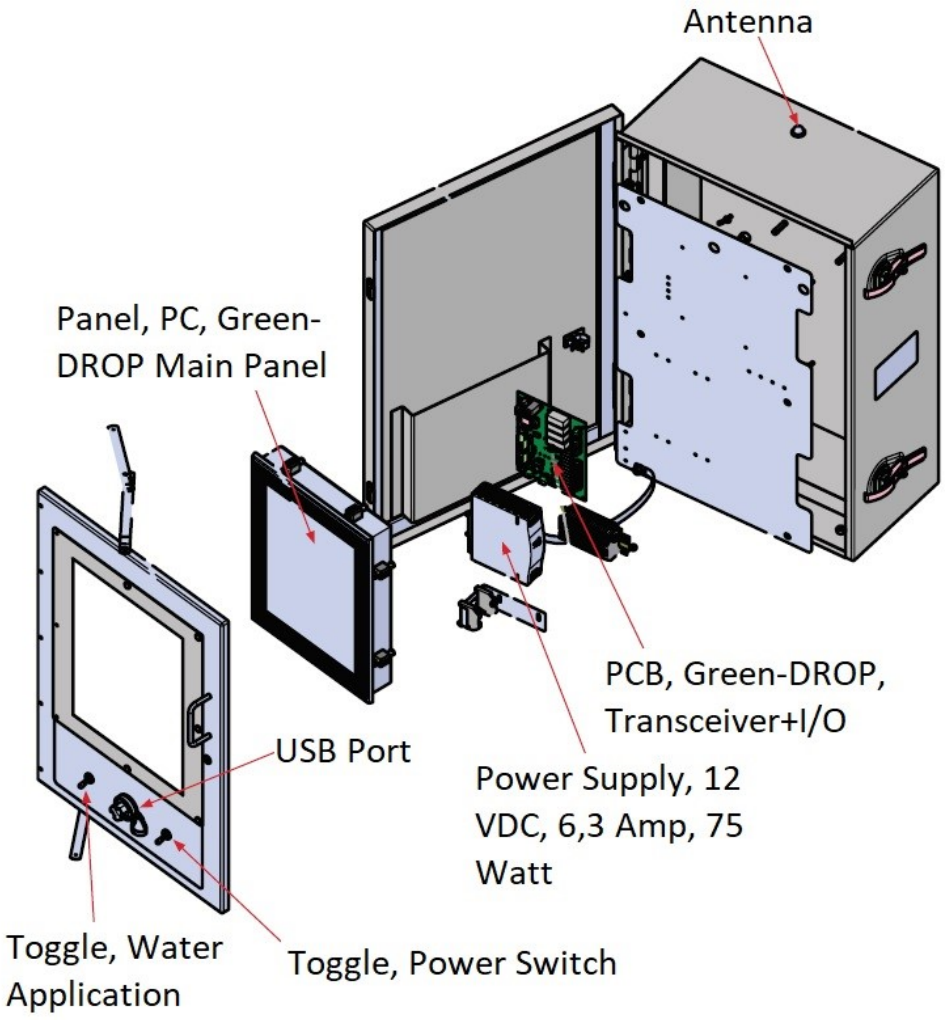


Figure 14 GreenDROP irrigation system controller

Wiring, programming and testing of the control system for controlling the nozzles

According to the wiring plan, all components have been installed and tested for connectivity. On the display sub-area specific options can be adjusted, and new irrigation-plans can be selected. Additionally, a self-testing option is implemented. All components and functions have been tested by our electricians, Mr Heckendorf and Mr Kaschel. See figures 15 – 17.

Figure 15 Wiring of the irrigation system

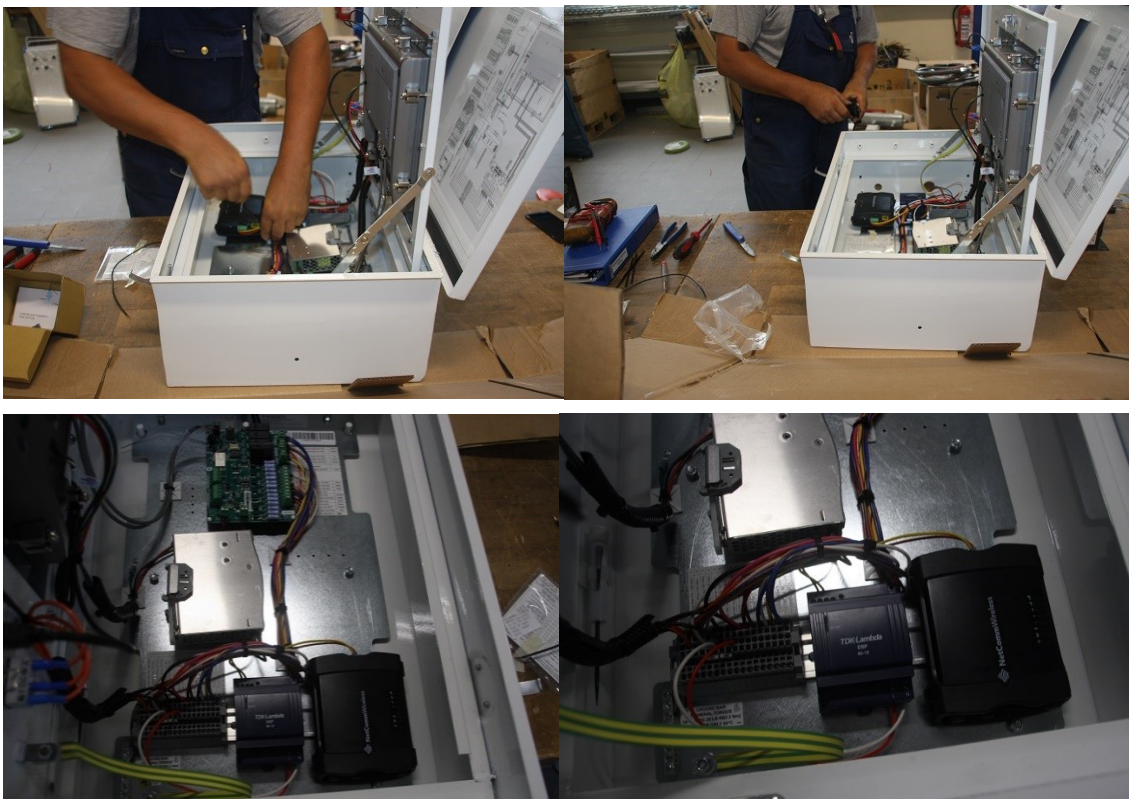


Figure 16 Irrigation system with the power supply and router

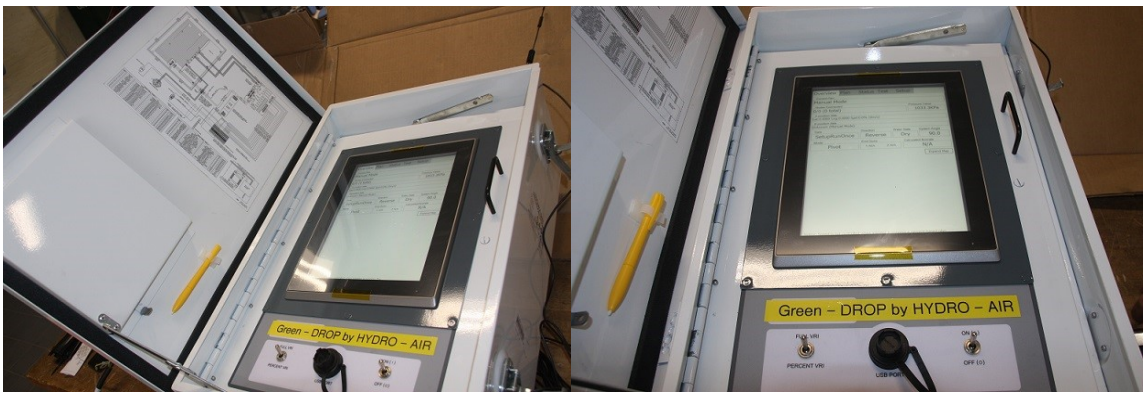


Figure 17 Testing of the irrigation system

Reprograming of the main controller for coming in action with the sub-area specific control

For the control-system to operate the magnetic-valves correctly, it is important to transmit essential information from the main controller (information such as moving-speed, moving-direction). Normally, the main controller only receives this data, therefore it was necessary to reprogram some subroutines, that these information are processable and get transmitted to the sub-area specific control-panel. The standard main control-panel is responsible for the

basic operations of the system, the operator defines the water amount and the direction. With the archived soil- and irrigation plan, the sub-area specific control panel, gives the signals to the magnetic-valves to open and close or to pulsate while the pivot system is driving over the area. For the test site in Beerfelde we also installed a German language-pack, as well as the latest firmware updates.

Figure 18 Reprograming of the main controller

3.5. Construction of additional equipment

Wireless node mount

Due to the optimization of the previous node mount, the new assembly allows a more flexible mounting between pipe flanges and saves cable meters as far as an optimized position in between the solenoids can be used. In addition, the range of suitable pipe diameters grew from 4 ½" to 8 5/8". The wireless node is positioned in the middle of four magnetic valves, receives the signal and splits this signal to control these four Valves. Figure 19 shows one such node with the central energy-cable and its four, outgoing control-cables installed on the pivot system. These mount position opens the option to save cable-meters and pre-assemble the nodes with the specific cable-length according to the span-length.

Figure 19 wireless node mounted

The figure 20 shows the positions of the nodes and the power supply-unit in the middle of the system to supply the nodes. These power supply-unit is part of the additional equipment and can be pre-assembled as well.

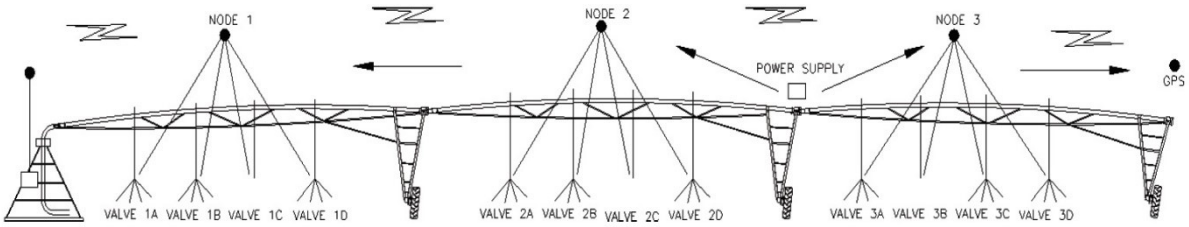


Figure 20 wireless node positioning

Pre-wiring and assembly of radio nodes

As mentioned before due to the new signal nodes, it is possible to pre-assemble specific parts of the signal transmitting. The figures below show the assembly and wiring of these Nodes and power-supply units. The Electrician Mr Heckendorf performed the assembly and added the specific cable-length onto each node for its specific position on the Center-Pivot system. The power supply of the nodes is set in the middle of the pivot-system and powers all nodes to the left and right. Therefore, a 24V cable is looped through all nodes at one side. The nodes

are numbered to ensure the correct positioning during the assembly of the system. The figure 22 shows one such power-supply unit connected to two signal-nodes, on these nodes again are the cables to connect 4 magnetic valves.

Figure 21 Pre-wiring of the signal nodes

Figure 22 Assembly of radio nodes

4. Transport and installation

The following pictures show different stages during the construction of the pivot irrigation system in Beerfelde. The system is always built from the center-point outwards. After the tower is assembled, the first span is lifted up to fit the pipe into the tower. All following spans get assembled on the ground, so the magnetic valves, cables, PE-drops und sprinklers can be installed without climbing onto the system or the need of a lift. After all these steps are executed, the span´s will be lifted and mounted onto the supporting wheel axels one after the other. The assembly has been performed by one of our construction-teams, consisting of Mr Herrmann, Mr Yarmukhamedov and Mr Sidko. Only the final electrical wiring on the wheel towers has to be fulfilled onside the system after construction. For the irrigation system to work correctly, a precise GPS-survey of the field and center-point of the pivot-system is essential. A normal Pivot system is operated using one control panel. To integrate the new magnetic valves, a second control unit is needed. This control-panel is installed aside the first one, at the tower.

Figure 24 installation of the last tower and overhang stabilization

Figure 25 shows the electrical work on the main control system for the operation of the pivot-system, performed by Mr Hödt. The basic settings are given using this controller like: position on the 360° circle, running speed, direction, water quantity etc. Those settings and measurements will be transferred to the sub-area controller (see figure 26) which will control the magnetic-valves and the sprinklers.

Figure 25 wiring of the main control system

Figure 26 connecting the sub-area controller

5. Handover certificates, testing and controlling

After the completed assembly of the system with its electrical installations, the whole System was subjected to a detailed inspection following a specific checklist according to the standards of “DIN VDE 0100-600” and the “DGUV” for personal safety and switch-off conditions in case of a malfunction. After the successful inspection of cables and installations, the magnetic valves were checked by running a pulsation test, during this test the valves open and close with a distinctive sound, that indicate the functionality. Protocolisation for the DIN and DGUV as well as the magnetic valves is to be found in the annex. To check the accurate distribution of the nozzle and valve function, a test run under working conditions was started. For the purpose of checking the distribution measuring pans are placed under the nozzles to collect the water. The expected quantity is compared with the actual amount of water (see figure 27).

Datenblatt Test Beerfelde Green Drop

Datum	30.09.2019	09.10.2019
Windgeschwindigkeit (m s^{-1})	0,74-1,34	2,8 - 4,2
Windrichtung	S-SW	O-SO
Anlagenausrichtung	Süd-Nord	Süd-Nord

Kollektor-Nr.	Kollektor-Standort (Entf. zu Düse 128 (m))	Kollektor-Standort (Entf. zu Zentralturm (m))	zugeordnete Düsen	Gabe (mm)	Gabe (ml)	Erwartete Menge (ml)	Gesammelte Menge (ml)	Gesammelte Menge (mm)	Abweichung (mm)	Bewertung 30.09.2019	Bewertung 09.10.2019	Kommentar
1	5	216,7	100	0	0	0-262	170	15,03130018	15,03	ok	ok	
2	10	221,7	102	0	0	0-262	42	3,713615339	3,71	ok	ok	
3	15	226,7	104, 106	0	0	0	2	0,176838826	0,18	ok	ok	
4	20	231,7	106, 108	0	0	0	0	0	0,00	ok	ok	
5	25	236,7	108, 110	0	0	0	0	0	0,00	ok	ok	
6	30	241,7	110, 112	0	0	0	0	0	0,00	ok	ok	
7	35	246,7	112, 114	0	0	0	2	0,176838826	0,18	ok	zu viel	evtl. Winddrift von Düse 118
8	40	251,7	114, 116	0	0	0-131	75	6,631455962	6,63	ok	ok	
9	45	256,7	116, 118	0	0	0-131	130	11,49452367	11,49	ok	zu viel	Düse 118 hat nicht gepulst
10	50	261,7	120	10	109	0-131	300	26,52582385	16,53	zu viel	zu viel	Düse 118 hat nicht gepulst
11	55	266,7	122, 125	10	109	66-131	100	8,841941283	-1,16	ok	zu viel	Düse 118 hat nicht gepulst
12	60	271,7	125	10	109	66-131	210	18,56807669	8,57	zu viel	zu viel	evtl. Winddrift von Düse 118
13	65	276,7	125, 127	10	109	66-131	165	14,58920312	4,59	zu viel	ok	
14	70	281,7	127, 129	10	109	66-131	80	7,073553026	-2,93	ok	ok	
15	75	286,7	129, 131	10	109	66-131	100	8,841941283	-1,16	ok	ok	
16	80	291,7	131, 133	10	109	131-262	120	10,61032954	0,61	ok	zu wenig	?
17	85	296,7	133, 135	10	109	131-262	295	26,08372678	16,08	zu viel	ok	
18	90	301,7	135, 137	20	219	131-262	245	21,66275614	1,66	ok	zu wenig	Düse 137 hat nicht geregnet
19	95	306,7	137, 139	20	219	175-262	215	19,01017376	-0,99	ok	zu wenig	Düse 137 hat nicht geregnet
20	100	311,7	141	20	219	175-262	380	33,59937687	13,60	zu viel	ok	
21	105	316,7	143	20	219	175-262	400	35,36776513	15,37	zu viel	zu viel	?
22	110	321,7	145, 147	20	219	175-262	475	41,99922109	22,00	zu viel	zu viel	?
23	115	326,7	147, 149	20	219	175-262	215	19,01017376	-0,99	ok	ok	

Figure 27 first test results water distribution

During this first testing several errors occurred. Some could be explained through severe wind drift. Also, some magnetic valves didn´t work properly, possibly because of poor signal transmission. A second test revealed additional errors, a complete software update and system check was undertaken. The following testing didn´t reveal any errors, all magnetic valves worked as expected and the distribution was within the tolerance (see figure 28).

Datenblatt Test Beerfelde Green Drop	
Datum	04.11.2019
Windgeschwindigkeit (m s^{-1})	3,1 - 4,6
Windrichtung	S-SW
Anlagenausrichtung	Süd-Nord

Kollektor-Nr.	Kollektor-Standort (Entf. zu Düse 128 (m))	Kollektor-Standort (Entf. zu Zentralturm (m))	zugeordnete Düsen	Gabe (mm)	Gabe (ml)	Erwartete Menge (ml)	Gesammelte Menge (ml)	Gesammelte Menge (mm)	Abweichung (mm)	Bewertung 04.11.2019	Kommentar
1	5	216,7	100	0	0	0-262	170	15,03130018	15,03	ok	
2	10	221,7	102	0	0	0-262	42	3,713615339	3,71	ok	
3	15	226,7	104, 106	0	0	0	2	0,176838826	0,18	ok	
4	20	231,7	106, 108	0	0	0	0	0	0,00	ok	
5	25	236,7	108, 110	0	0	0	0	0	0,00	ok	
6	30	241,7	110, 112	0	0	0	0	0	0,00	ok	
7	35	246,7	112, 114	0	0	0	2	0,176838826	0,18	ok	
8	40	251,7	114, 116	0	0	0-131	75	6,631455962	6,63	ok	
9	45	256,7	116, 118	0	0	0-131	80	7,073553026	7,07	ok	
10	50	261,7	120	10	109	0-131	140	12,3787178	2,38	ok	
11	55	266,7	122, 125	10	109	66-131	100	8,841941283	-1,16	ok	
12	60	271,7	125	10	109	66-131	120	10,61032954	0,61	ok	
13	65	276,7	125, 127	10	109	66-131	135	11,93662073	1,94	ok	
14	70	281,7	127, 129	10	109	66-131	125	11,0524266	1,05	ok	
15	75	286,7	129, 131	10	109	66-131	115	10,16823248	0,17	ok	
16	80	291,7	131, 133	10	109	131-262	147	12,99765369	3,00	ok	
17	85	296,7	133, 135	10	109	131-262	180	15,91549431	5,92	ok	
18	90	301,7	135, 137	20	219	131-262	245	21,66275614	1,66	ok	
19	95	306,7	137, 139	20	219	175-262	215	19,01017376	-0,99	ok	
20	100	311,7	141	20	219	175-262	245	21,66275614	1,66	ok	
21	105	316,7	143	20	219	175-262	230	20,33646495	0,34	ok	
22	110	321,7	145, 147	20	219	175-262	250	22,10485321	2,10	ok	
23	115	326,7	147, 149	20	219	175-262	215	19,01017376	-0,99	ok	

Figure 28 final test results after software update and checking procedure

6. Conclusion

As documented in this deliverable, the installation of the demo site in Germany have been completed and took place this summer 2019. With the second demo site we have experienced a delay due to the change from Czech Republic to Poland.

Current situation: It is planned to run more tests with the system in Beerfelde during the irrigation season of 2020. Also, the proper function and implementation of the weather-data and irrigation plans. Moreover, several tests of the fertilizer injection are planned to be performed. With the complete vegetation season under irrigation, we hope to get more material for some advertising work to gain more publicity for this project and its capabilities. The installation of a new Green-Drop system in Gniewowo (Poland), is in the planning stage. The final survey before the pivot-system can be assembled was performed by Mr Brachwitz and Mr Bergholz in December 2019. The complete area was measured with GPS as well as the RTK-system, like in Beerfelde, these measuring's are important for the system to work with the correct positioning and data-sets. We expect to start with the installation of all system parts in February. The installation of the pipes and the pumping station are planned for the time shortly after the pivot-system is build. For this work and installation its necessary that the temperatures are above 0° Celsius. In spring-time, it is planned to establish a soil-profile

to gather the soil data for the calculation of the needed water and fertilizer dosage. Furthermore, the weather station to collect actual weather data for the “Irrigama-system” will be prepared at the test site soon. We expect to start with initial testing’s as soon as possible at latest with the start of the vegetational season. If we can follow the timeline without major displacements, we hope it will be possible to bring the system to its full use before the irrigation season of 2020 has passed.

7. Annex

1. Inspection report according to DIN VDE 0100-600 and DGUV standards

HYDRO – AIR
international irrigation systems GmbH

Fachbetrieb nach Wasserhaushaltsgesetz
Beregnungstechnik Filteranlagenbau
Gülletechnik Separationstechnik

Flugplatzweg 1 · 14913 Niedergörsdorf / OT Altes Lager

Servicebetrieb für Pumpen, Kompressoren und Steuertechnik

Erst- und Wiederholungsprüfung elektrischer Anlagen

Prüf- und Messprotokoll

Betrieb:	Fürstenwalder Agraproduktion GmbH Beerfelde	Standort:	Jänickendorfer Str. 17 15518 Steinhöfel
Projektnummer:	1700139	Anlagenbezeichnung:	KBA TA 3034

Prüfung nach: DIN VDE 0100-600 ☑ DIN VDE 0105 ☐ DGUV ☑

Neuanlage ☑ Erweiterung ☐ Änderung ☐ Instandsetzung ☐ Wiederholungsprüfung ☐

Netz: 230 / 400 V 50 Hz Netzsystem: TN-C ☑ TN-S ☐ TN-C-S ☐ T ☐ ☐

Besichtigen	i.O.	n.i.O.		i.O.	n.i.O.		i.O.	n.i.O.
Auswahl der Betriebsmittel	☒	☐	Kennzeichnung N- und PE-Leiter	☒	☐	Zugänglichkeit der Betriebsmittel	☒	☐
Trenn- und Schaltgeräte	☒	☐	Schutz- und Überwachungsgeräte	☒	☐	Hauptpotenzialausgleich	☒	☐
Kabel, Leitungen, Stromschienen	☒	☐	Kennzeichnung der Stromkreise und Betriebsmittel	☒	☐	Zus. Örtl. Potenzialausgleich	☒	☐
Leiterverbindungen	☒	☐	Schutz gegen direktes Berühren	☒	☐	Dokumentation/Warnhinweise	☒	☐
Erproben	i.O.	n.i.O.		i.O.	n.i.O.		i.O.	n.i.O.
Funktion der Anlage	☒	☐	Drehrichtung der Motoren	☒	☐		☐	☐
Funktion der Schutz-, Sicherheits- und Überwachungseinrichtung	☒	☐	~~Rechtsdrehfeld der Drehstromsteckdosen~~	☐	☐		☐	☐

Messen Stromkreisverteiler-Nr.:

Sicherung/ Stromkreis		Leitung/Kabel		Überstrom - Schutzein- richtungen		Schleifen- widerstand Toleranz ±6%		Isolations- widerstand		Fehlerstrom - Schutzeinrichtung (RCD)				Berühr ungs- spannung		Schutz- leiter- widerst.	
Nr.	Ziel- bezeichnung	Typ	Leiter An- zahl	Quer- schnitt (mm²)	Art/Typ Charak- teristik	I_n (A)	Kurzschluss- strom Z_s (Ω)	I_k (A)	R_{iso} (MΩ) ohne ① mit ② Verbraucher		I_n/ Art (A)	$I_{\Delta n}$ (mA)	I_{mess} (mA)	Aus- löse- zeit t_A<300 ms (ms)	$U_L \leq 50$ V U_{mess} (V)		R_{PE} low max 1 Ω	
1	KBA 1	NYY	4	50	NH	35	0,08	4,28A	>500	1	—	—	—	—	0,1	0,2	0,07	0,09
										2								
2										1								
										2								
3										1								
										2								
4										1								
										2								
5										1								
										2								
										1								
										2								
										1								
										2								
										1								
										2								
										1								
										2								
										1								
										2								

Durchgängigkeit des Potenzialausgleichs				Erdungswiderstand: R_E = <0,1 Ω
Fundamenterder	☒	Hauptschutzleiter	☒	Gebäudekonstruktion ❒
Potentialausgleichsschiene	☒	Antennenanlage/BK	❒	❒

Verwendete Messgeräte		
Fabrikat: Fluke	Fabrikat:	Fabrikat:
Typ: 1654B	Typ:	Typ:

Prüfergebnis:				
keine Mängel festgestellt	☒	Prüfplakette erteilt:	ja ☒	Nächster Prüftermin:
Mängel festgestellt	❒		nein ❒	Monat: 11 Jahr: 21

Mängel/Bemerkungen:

Die elektrische Anlage entspricht den anerkannten Regeln der Elektrotechnik. Ein sicherer Gebrauch bei bestimmungsgemäßer Anwedung ist gewährleistet.	ja	☒
	nein	❒

Beerfelde 10.10.19 P.A.
Ort, Datum, Stempel/Unterschrift Prüfer
Name in Druckbuchstaben: Hödt, Patrick

04.11.19
Datum, Stempel/Unterschrift Betreiber

2. Handover certificate for a functional pivot-system

Flugplatzweg 1 · 14913 Niedergörsdorf / OT Altes Lager

HYDRO – AIR
international irrigation systems GmbH

Fachbetrieb nach Wasserhaushaltsgesetz
Beregnungstechnik · Filteranlagenbau
Gülletechnik · Separationstechnik
Servicebetrieb für Pumpen, Kompressoren und Steuertechnik

Übergabeprotokoll

Kunde:	Fürstenwalder Agrarprodukte GmbH Beerfelde, Jänickendorfer Str. 17, 15518 Steinhöfel
Projektnummer:	1700139
Anlagentyp:	Kreisberegnungsanlage, 349m, 2 Span`s 47,9m, 3 Span`s 54,5m, 1 Span`s 61,3m - 5-1/2"
Maschinen-Nr.:	TA3034
Standort:	Beerfelde

Die Anlage wurde frei von Mängeln übergeben.

Übergeben wurden folgende Anlagen:

- ☑ Checkliste Kreisberegnungsanlage
- ☐ Checkliste Schlauchtrommel
- ☐ Checkliste Steuerung
- ☐ Checkliste Bohrlochwellenpumpe
- ☐ Checkliste Pumpe
- ☐ Checkliste Kupplungsaggregat
- ☐ Düsenpläne
- ☐ Checkliste Stromerzeuger
- ☐ Checkliste Lampo
- ☑ Protokoll zur Prüfung elektr. Anlagen
- ☑ original EG-Konformitätserklärung
- ☑ original Bedienungsanleitung
- ☐ Garantiezertifikate
- ☐ _____

Im Falle von Funktionsstörungen an der gelieferten bzw. erstellten Anlage ist die HYDRO-AIR international irrigation systems GmbH sofort zu unterrichten. Eigenmächtige Reparaturen, Ausbau oder Veränderungen an der Anlage führen zu Garantieverlust.

Bemerkungen: _____

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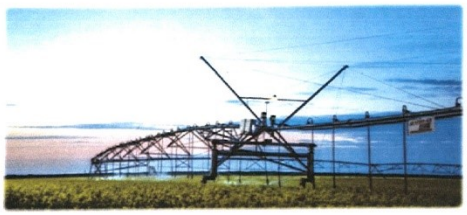
Datum, Stempel/Unterschrift Lieferant
Name in Druckbuchstaben: _____

04.11.19
Datum, Stempel/Unterschrift Betreiber



Flugplatzweg 1 · 14913 Niedergörsdorf / OT Altes Lager

HYDRO – AIR

international irrigation systems GmbH

Fachbetrieb nach Wasserhaushaltsgesetz
Beregnungstechnik · Filteranlagenbau
Gülletechnik · Separationstechnik

Servicebetrieb für Pumpen, Kompressoren und Steuertechnik

Checkliste Kreisberegnungsanlage

1.	Betrieb:	Fürstenwalder Agrarprodukte GmbH Beerfelde, Jänickendorfer Str. 17, 15518 Steinhöfel	
2.	Standort:	Beerfelde	
3.	Projektnummer:	1700139	
4.	Typenbezeichnung:	KBA, Länge 349m, 2 Span`s 47,9m, 3 Span`s 54,5m, 1 Span`S 61,3m - 5-1/2"	
5.	Seriennummer Panel:	TA3034	
6.	Adresse FieldNET:		
7.	Einnordung FieldNET:		
8.	Kontrolle Festsitz aller Kabel und Leitungen:	am Turm: Ja ☒ Nein ☐	am Fahrwerk: Ja ☒ Nein ☐
9.	Fünktionsüberprüfung:	Endregner	☒
10.		Quetschventil	☒
11.		vorwärts	☒
12.		rückwärts	☒
13.		Barrikadeabschaltung	☐
14.		Pumpenstart	☐
15.	Eingangsspannung bei 100% Fahrgeschwindigkeit:	406	V
16.	Betriebsdruck lt. Düsenplan:	1,5	bar
17.	Betriebsdruck bei Beregnung	1,8	bar
18.	Einstellungen im Menü und Eingabe der Daten laut Düsenplan:		
19.		Beregnungslänge:	399 m
20.		Umrundungszeit:	min

21.	Einstellungen im Menü und Eingabe der Daten laut Düsenplan:	Wassermenge:	m³/h
22.		Temperaturabschaltung bei /	°C
23.		Unterdruckabschaltung bei 1,5	bar
24.		Unterspannungsabschaltung bei 380	V
25.		Überspannungsabschaltung bei 420	V
26.	Zusatzmaterial im Turm:	FI (Festnetz) ☒	
27.		Relais für Pumpenstart ☑	
28.		Relais für Störung ☐	
29.	PE-Verschraubung:	Kennzeichnung/Markierung im Düsenplan	
30.	Bemerkungen:		

3. Test for functionality of the magnetic valves and the signal nodes

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----OUTLET---- No	Loc	Sep	GPM Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---		---- VRI ---- VALVE	NODE
-x-							PLUG 3			
4	22.6	22.6	0.7	O3000	Black	1	#11 Beige w/gld	√	A	
5	29.9						PLUG			
6	37.3	14.7	0.7	O3000	Black	2	#11 Beige w/gld	√	B	1
7	44.8						PLUG			
8	51.8	14.5	0.7	O3000	Black	3	#11 Beige w/gld	√	C	
9	59.3						PLUG			
10	66.6	14.8	0.7	O3000	Black	4	#11 Beige w/gld	√	D	
11	73.8						PLUG			
12	81.3	14.7	0.7	O3000	Black	5	#11 Beige w/gld	√	A	
13	88.6						PLUG			
14	95.9	14.7	0.7	O3000	Black	6	#11 Beige w/gld	√	B	2
15	103.3						PLUG			
16	110.8	14.8	0.7	O3000	Black	7	#11 Beige w/gld	√	C	
17	117.8						PLUG			
18	125.3	14.5	0.7	O3000	Black	8	#11 Beige w/gld	√	D	
19	132.6						PLUG			
20	139.9	14.7	0.8	O3000	Black	9	#12 Gold	√	A	
21	147.3						PLUG			
22	154.8	14.8	1.1	O3000	Black	10	#14 Lime	√	B	3
	159.6	TOWER NO. 1			INLINE PRESSURE: 21.1 psi					
-x-							PLUG 2			
25	172.3	17.5	1.1	O3000	Black	11	#14 Lime	√	C	
26	179.6						PLUG			
27	186.9	14.7	1.1	O3000	Black	12	#14 Lime	√	D	
28	194.3						PLUG			
29	201.8	14.8	1.3	O3000	Black	13	#15 Lime w/lav	√	A	
30	208.8						PLUG			
31	216.3	14.5	1.3	O3000	Black	14	#15 Lime w/lav	√	B	4
32	223.6						PLUG			
33	230.8	14.5	1.3	O3000	Black	15	#15 Lime w/lav	√	C	
34	238.3						PLUG			
35	245.6	14.8	1.5	O3000	Black	16	#16 Lavender	√	D	
36	252.9						PLUG			
37	260.3	14.7	1.7	O3000	Black	17	#17 Lvndr w/gra	√	A	
38	267.8						PLUG			
39	274.8	14.5	1.7	O3000	Black	18	#17 Lvndr w/gra	√	B	5
40	282.3						PLUG			
41	289.6	14.8	1.8	O3000	Black	19	#18 Gray	√	C	
42	296.9						PLUG			
43	304.3	14.7	2.1	O3000	Black	20	#19 Gray w/trqu	√	D	
44	311.8						PLUG			
	316.6	TOWER NO. 2			INLINE PRESSURE: 20.3 psi					
45	317.6						PLUG			
46	321.8	17.5	2.1	O3000	Black	21	#19 Gray w/trqu	√	A	
47	329.3						PLUG			
48	336.6	14.8	2.1	O3000	Black	22	#19 Gray w/trqu	√	B	6
49	343.9						PLUG			
50	351.3	14.7	2.1	O3000	Black	23	#19 Gray w/trqu	√	C	
51	358.8						PLUG			

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----OUTLET---- No	Loc	Sep	GPM Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---		VRI VALVE	VRI NODE
52	365.8	14.5	2.3	O3000	Black	24	#20 Turquoise	✓	D	
53	373.3						PLUG			
54	380.6	14.8	2.3	O3000	Black	25	#20 Turquoise	✓	A	
55	387.9						PLUG			
56	395.3	14.7	2.5	O3000	Black	26	#21 Trqu w/yllw	✓	B	7
57	402.8						PLUG			
58	409.8	14.5	2.5	O3000	Black	27	#21 Trqu w/yllw	✓	C	
59	417.3						PLUG			
60	424.6	14.8	2.5	O3000	Black	28	#21 Trqu w/yllw	✓	D	
61	431.9						PLUG			
62	439.3	14.7	2.7	O3000	Black	29	#22 Yellow	✓	A	
63	446.8						PLUG			
64	453.8	14.5	2.7	O3000	Black	30	#22 Yellow	✓	B	8
65	461.3						PLUG			
66	468.6	14.8	2.7	O3000	Black	31	#22 Yellow	✓	C	
67	475.9						PLUG			
68	483.3	14.7	3.3	O3000	Black	32	#24 Red	✓	D	
69	490.8						PLUG			
	495.6	TOWER NO. 3			INLINE PRESSURE: 19.5 psi					
70	496.6						PLUG			
71	500.8	17.5	3.3	O3000	Black	33	#24 Red	✓	A	
72	508.3						PLUG			
73	515.6	14.8	3.3	O3000	Black	34	#24 Red	✓	B	9
74	522.9						PLUG			
75	530.3	14.7	3.3	O3000	Black	35	#24 Red	✓	C	
76	537.8						PLUG			
77	544.8	14.5	3.3	O3000	Black	36	#24 Red	✓	D	
78	552.3						PLUG			
79	559.6	14.8	3.5	O3000	Black	37	#25 Red w/white	✓	A	
80	566.9						PLUG			
81	574.3	14.7	3.5	O3000	Black	38	#25 Red w/white	✓	B	10
82	581.8						PLUG			
83	588.8	14.5	3.5	O3000	Black	39	#25 Red w/white	✓	C	
84	596.3						PLUG			
85	603.6	14.8	3.8	O3000	Black	40	#26 White	✓	D	
86	610.9						PLUG			
87	618.3	14.7	3.8	O3000	Black	41	#26 White	✓	A	
88	625.8						PLUG			
89	632.8	14.5	3.8	O3000	Black	42	#26 White	✓	B	11
90	640.3						PLUG			
91	647.6	14.8	3.8	O3000	Black	43	#26 White	✓	C	
92	654.9						PLUG			
93	662.3	14.7	4.4	O3000	Black	44	#28 Blue	✓	D	
	669.3									POWER SOURCE 1
94	669.8						PLUG			
	674.6	TOWER NO. 4			INLINE PRESSURE: 19.0 psi					
95	675.6						PLUG			
96	679.8	17.5	4.7	O3000	Black	45	#29 Blue w/brn	✓	A	
97	687.3						PLUG			
98	694.6	14.8	4.1	O3000	Black	46	#27 White w/blu	✓	B	12
99	701.9						PLUG			

EH2913 14 May 2019 LINDSAY , 6 TOWER, 308 gpm, 28 psi VRI page 4

----OUTLET---- No	Loc	GPM Sep	Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---	---- VRI ---- VALVE	NODE
100	709.3	14.7	4.4	O3000	Black	47	#28 Blue	C	
101	716.8						PLUG		
102	723.8	14.5	4.4	O3000	Black	48	#28 Blue	D	
103	731.3						PLUG		
104	738.6	14.8	4.4	O3000	Black	49	#28 Blue	A	
105	745.9						PLUG		
106	753.3	14.7	4.7	O3000	Black	50	#29 Blue w/brn	B	13
107	760.8						PLUG		
108	767.8	14.5	4.7	O3000	Black	51	#29 Blue w/brn	C	
109	775.3						PLUG		
110	782.6	14.8	4.7	O3000	Black	52	#29 Blue w/brn	D	
111	789.8						PLUG		
112	797.3	14.7	5.0	O3000	Black	53	#30 Drk Brown	A	
113	804.6						PLUG		
114	811.9	14.7	5.0	O3000	Black	54	#30 Drk Brown	B	14
115	819.3						PLUG		
116	826.8	14.8	5.0	O3000	Black	55	#30 Drk Brown	C	
117	833.8						PLUG		
118	841.3	14.5	5.0	O3000	Black	56	#30 Drk Brown	D	
119	848.6						PLUG		
120	855.9	14.7	5.3	O3000	Black	57	#31 Brwn w/orng	A	
121	863.3						PLUG		
122	870.8	14.8	6.0	O3000	Black	58	#33 Ornge w/grn	B	15
	875.6	TOWER NO. 5			INLINE PRESSURE: 18.5 psi				
-x-							PLUG 2		
125	888.3	17.5	6.0	O3000	Black	59	#33 Ornge w/grn	C	
126	895.6						PLUG		
127	902.9	14.7	5.3	O3000	Black	60	#31 Brwn w/orng	D	
128	910.3						PLUG		
129	917.8	14.8	5.6	O3000	Black	61	#32 Orange	A	
130	924.8						PLUG		
131	932.3	14.5	5.6	O3000	Black	62	#32 Orange	B	16
132	939.6						PLUG		
133	946.9	14.7	6.0	O3000	Black	63	#33 Ornge w/grn	C	
134	954.3						PLUG		
135	961.8	14.8	6.0	O3000	Black	64	#33 Ornge w/grn	D	
136	968.8						PLUG		
137	976.3	14.5	6.0	O3000	Black	65	#33 Ornge w/grn	A	
138	983.6						PLUG		
139	990.9	14.7	6.0	O3000	Black	66	#33 Ornge w/grn	B	17
140	998.3						PLUG		
141	1005.8	14.8	6.0	O3000	Black	67	#33 Ornge w/grn	C	
142	1012.8						PLUG		
143	1020.3	14.5	6.3	O3000	Black	68	#34 Drk Green	D	
144	1027.6						PLUG		
145	1034.9	14.7	6.3	O3000	Black	69	#34 Drk Green	A	
146	1042.3						PLUG		
147	1049.8	14.8	7.0	O3000	Black	70	#36 Purple	B	18
	1054.6	TOWER NO. 6			INLINE PRESSURE: 18.4 psi				
148	1059.0						PLUG		

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----OUTLET---- No	Loc	Sep	GPM Del	----SPRINKLER----- Model	Plate	SpNo.	---NOZZLE---		---- VRI ---- VALVE	NODE
149	1066.5	16.7	7.0	O3000	Black	71	#36 Purple	✓	C	
150	1073.8						PLUG			
151	1081.1	14.7	6.6	O3000	Black	72	#35 Green w/prp	✓	D	
152	1088.5						PLUG			
153	1096.0	14.8	6.6	O3000	Black	73	#35 Green w/prp	✓	A	
154	1103.1						PLUG			
155	1110.5	14.5	6.6	O3000	Black	74	#35 Green w/prp	✓	B	19
156	1117.8						PLUG			
157	1125.1	14.7	5.3	O3000	Black	75	#31 Brwn w/orng	✓	C	
158	1132.5	7.3	3.5	O3000	Black	76	#25 Red w/white	✓	D	
159	1139.8	7.3	5.0	O3000	Black	77	#30 Drk Brown	✓	A	20

VRI Totals: Nodes 20 Sprinklers 77