Collaborating Smart Solar-powered Microgrids

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D5.3 Report on completed configuration of micro computers, software and hardware installation

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ABSTRACT

This deliverable documents the work related to the installation of measurement and control equipment in the trial buildings, gives the reference to the documentation of the installation of the necessary software and for collecting measurement data during the trials and the training of trial user to operate it. Each trial household will be equipped with a Raspberry PI-2, different smart meters and several smart plugs and further measurement meters that collect data and feed them to the central database.

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Document history

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0.1	2015-07-24	Initiated by JGR
0.2	2015-08-07	PCOS proposed (Planned COntent and Structure)
0.3	**2015-09-10**	**Input from Konstanz**
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1.1	2015-11-11	External proposed (proposed for external release)
1.2	2015-11-13	External approved
2.0	2015-11-27	Released

Table of content

1 About this Document

1.1 Role of the deliverable

This delivery has the role to document the “what and how” of the installed hardware and software at the users trial sites. Additionally to this description of the integration process all restrictions either of technical or legal nature classified by country, type of user or a single user is addressed, discussed and ways to overcome described.

1.2 Relationship to other CoSSMic deliverables

D5.3 is strongly correlated with D5.1 which already describes the trial users of the City of Konstanz in Germany and the Province of Caserta in Italy with their installed PV systems and lists the users and their selected equipment as foreseen for the integration into the trial for each user´s site.
Furthermore D2.1 and D2.2 give overviews how the potential trial users are integrated and what technologies are used and the requirements of the users as worked out in workshops. D2.5 focuses on the community building.
First D3.1 describes the technical architecture and D3.2 its realised implementation.

During the project work it turned out for practical reasons that the documentation of the developed software and the integration of the database for the measured data are much better classified in the deliveries of WP3 and WP6, respectively, where their development has been done.
The software development and implementation is documented in D3.3 section 5 Software modules and the topic database of measured data in D6.1 section 4.1 Handling of the measured data.

1.3 Relationship to other versions of this deliverable

No review of final version foreseen.

1.4 Structure of this document

Chapter 2 describes the system integration at the user sites, chapter 3 the application of the equipment and chapter 4 the installed equipment at the trial sites of the City of Konstanz in Germany and the Province of Caserta in Italy. Chapter 5 summarizes all unforeseen local, facility and technical dependent restrictions and obstacles (and is extended by the report on legal boarders and confinements). Chapter 6 reports on the training of the involved users at the two trial sites and is followed by a final summary.

2 The system integration at the user site

2.1 The Raspberry PI as the home gateway

The procedure for the system integration at the user site with and also without a PV installation is worked out in a common way which can easily be stereotyped for a future third party installation procedure. Once the process is developed it can be applied as a master plan by “copy and paste”.

The user households are equipped with additional hardware for measuring, controlling and optimising their energy consumption and generation. The centrepiece of the developed system is a Raspberry PI embedded computer (Figure 1) installed in the household’s or commonly spoken user´s electric cabinet with connections to the meters of the household, PV and storage, if applicable. The Raspberry PI acts as the data control and management centre inside the local micro grid and is the household’s digital representative, a CoSSMic client, also depicted as user, in the community. Therefore a connection to a local network is needed, to allow the systems visualisation for the households’ user, as well as his instructions. Further, a connection to the internet needs to be established, through which the client is able to communicate with the CoSSMic cloud server. This connection to the neighbourhoods cloud allows the communication and exchange with other CoSSMic users, as well as external services.

Figure 1: Left: The Raspberry PI mounted in a household’s electrical cabinet. Right: As a demonstrator. It is connected to the internet and offers interfaces for a wide range of sensors and actuators, including smart meters, wireless plugs and thermometers.

In a first installation round in the year 2014 with at that time up to date and on the market available version of Raspberry PI-1 we found out during the ongoing project work, that the computing power and the SD-card storage volume could be a limiting factor when it comes to run the entirely developed MAS software routine with the task scheduler on each embedded computer locally. As development on IC hardware equipment obeys very short time periods with the challenge for the next generation to be better and cheaper we could exchange the first generation Raspberry PI-1 by a Raspberry PI-2[1] which came on the market in February 2015. This next generation computer was offered at the same price level of about 30 € but with an increase of the processing frequency from the power of a single processor with 700 MHz to four parallel processors of 900 MHz each and a doubling of RAM up to 1GB.[2]
In a second installation round successively all Raspberry PI-1 have been exchanged by a Raspberry PI-2, i.e. when we are talking about Raspberry PI we mean always a Raspberry PI-2.

[1]https://www.raspberrypi.org/products/raspberry-pi-2-model-b/

[2] http://raspberry.tips/raspberrypi-einsteiger/unterschiede-zischen-raspberry-pi-1-und-raspberry-pi-2-im-detail/

The software installation on the Raspberry PI is described in D3.3 under 6. Installation, deployment and configuration guide and 6.1 Installation of the software on Raspberry PI
Raspberry PI image preparations: https://bitbucket.org/cossmic/developer-guide/wiki/Raspberry%20Pi%20image%20preparations#markdown-header-3-dependencies
And the local installation of the multi-agent system (MAS) at:
https://bitbucket.org/cossmic/mas/wiki/Home

The installation procedure for software running on each Raspberry PI can be applied with small adjustments for the integration of all private, public and industrial users. The selected hardware with all necessary technical details is described in D3.1 section 7.2.2 Device integration, and summarised together with the selected integrated software in document D3.1 section 7.2.8 Technology baseline for CoSSMic, Table 6.

Figure 2 shows a schematic view of the established ICT architecture as implemented into the CoSSMic trials. A variety of integrated devices are managed by the device management, which receives commands from the MAS and hands them over for execution via the task manager. All the three components, the device management, the task management and the multi-agent system are running locally on the Raspberry PI together with the Graphical User Interface (GUI) which acts as the interface and link to the users.

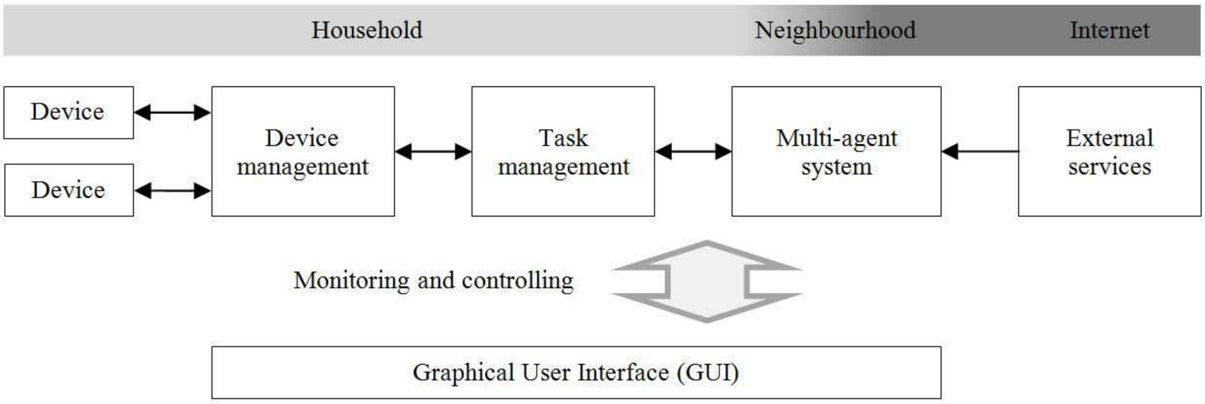

Figure 2: Sketch of the established ICT architecture implemented CoSSMic. The Graphical User Interface (GUI) is the link to the users. Device management, task management and the MAS are running on the Raspberry PI.

2.2 The categories of users

As users we wanted to win at least twelve responsible persons with their facilities for each trial site, with a preference of being already equipped with a running PV system. For the consuming devices we paid special attention that some of them are able to run with respect to their need and availability at preferred periods of time, i.e. that these devices can be regarded as so called shift able loads. Restriction issues related on the trial sites, the class of users or to single users are addresses in section 5 Emerging restrictions and obstacles.

2.2.1 Private users

Private users consist of two ensembles of six households in Konstanz and three in Caserta. They have different PV related electrical power production which is between zero and almost self-sustaining which feed also into the local power grid. And they are very different in self- and local power grid consumption.

The private users in Konstanz (KN-07 – KN-12) and in the Province of Caserta (CS-10 – CS-12) are almost all equipped with a PV installation. Only two users in Konstanz and one user in Caserta are without PV.
The list below describes the roadmap how to install the hardware at a user´s site.

- Check of the internet access either by WLAN or LAN
- Installation of the Raspberry PI as the home gateway with an own power supply either rail mounted and connected via a switch fuse or directly to a power plug.
- Equip the Raspberry PI with the necessary hardware for the communication to the internet, the local area network of the use site and the communication path with the smart plugs by radio frequency and the cable connection to the smart meters by RS485 interface.
- The installation of smart meters of Type Elster AS 1440 or A 1500 for monitoring the generation and feed in of the PV system and the entire household consumption via RS485 has been done in advance already by the DSO.
- Installation of rail mounted smart meters with RS485 interface to Raspberry PI to monitor the energy flow of consuming devices and batteries when available.
- Installation of radio frequency communicating smart plugs for monitoring and switching of consuming devices.
- Installation of radio frequency communicating smart temperature sensors for monitoring of temperatures of heat pumps, refrigerators and freezers.

2.2.2 Public users

The integrated public users mainly include schools in terms of their energy consumption and production - two in Konstanz (KN-05 – KN-06) and eight in Caserta (CS-01-CS-08) and in addition one public swimming pool in Caserta (CS-09). The swimming pool has a large PV installation providing more energy than the demand and the integrated schools in Konstanz produce an average of 28% of their electrical demand.
Some of the PV installations are already monitored by the private company Common-Link which makes the PV-yield data available on public home pages http://www.pvlog.de, with a repetition rate of 15 minutes. See for example:

http://www.pvlog.de/solar.phtml?nav=info&lid=nX26tjCG98R2sTt8&profil=7).

Due to legal regulations and on the appeal of the parents of pupils no WLAN based internet access is available within the school boundaries of the two Konstanz schools KN-05/06. Also the LAN access to internet is restricted to a guest account access by the school authorities running pedagogic network, which allows restricted cable assisted access to the internet.
The location of the installed Elster smart meters is the power distribution cabinet, where for technical reasons also the Raspberry PI should be installed. The available access point to the pedagogic LAN, which is typically in the secretary´s office or in the teacher´s preparation office are rather far away of

at least 50m and must be lockable. So it is rather difficult to realize a LAN access by drawing and maintaining a cable based data connection between the Raspberry PI and the specified LAN access. The internet access of the Raspberry PI as located in the electrical cabinet is now realized by a 3G/UMTS USB stick with a pre-paid SIM card (5€/month/1GB with up to 50Gbit/s data transfer rate)., which is sufficient for the measured data transfer when the necessary installed software is preloaded on the computer before the field installation.

The continuous availability of the gateway, i. e. the Raspberry PI of the users site and the data transfer via the Raspberry PI as installed in the electrical cabinet is not always guaranteed because of the electromagnetic shielding of the door looked electrical cabinet..
We are looking forward to realise the steady user´s internet presence by the following solution: Additional installation of a Raspberry PI with continuous LAN access to the internet. Then the Raspberry PI inside of the electrical cabinet close to the Elster smart meter is used only for the sampling and storage and when available transfer of the data by UMTS technique.

The nine public users of the Province of Caserta are eight schools and one public swimming pool have all internet access.

2.2.3 Industrial users

Konstanz has four industrial users. They have a span of PV production between 4% and above 100% of their own total electrical demand. Some industrial users consume the entire energy which is produced from PV while other industrial users give away a portion of their energy production to either the local public grid or to the neighbouring consumers. To date, Caserta will not include industrial users because none were available with suitable PV installations.

The industrial user sites are all equipped with a Raspberry PI as the gateway with WLAN or LAN access to the internet. All industrial users in Konstanz have PV installations.
It turns out that the industrial users show a higher variety in their technical installations between each other compared to the private users. Because of this fact a short introduction comment is been given in the following for each industrial users. Details of the equipment are given in section 4.1.

KN-01:
1xElster A1500 (#71262) with RS 485 was installed to substitute an A 1500 without RS485 for total energy measure on the 17th June 15, 11am, the right conversion ratio of x50 has been introduced later, a modem interface over which data could be handled by the local DSO “Stadtwerke Konstanz” was switched off.

But it turned out that the SWK needs to have once a day access to the meter data via CL0 interface between 00.00-0200am for 15 minutes. Therefore a 1xElster A1500 (#84659) with two interfaces, RS 485 + CL0 was installed on the 20.08.15. In this way CoSSMic should get data access through the RS485 interface which is open when no data via prioritised CL0 interface is transmitted. The exchange of the Elster A1500 with RS485 by an Elster A1500 with CL0+RS485 led to hierarchical conflicts in the data acquisition.
It needed some effort to bring the system in service as proposed.

KN-02:
At present for the integration CoSSMic uses a user owned smart meter of type Nova 5/1A MID-4L “Wandlerdrehstromzähler” with a RS 485 interface which is connected to a LAN-internet accessed Raspberry PI
Parts of the consumption device system are already foreseen for a user internal optimization together with a third party company this topic is continued in section 4.1, KN-02.

KN-03:
This industrial user has been integrated in the same way like the public users.

KN-04:
At this user site an already existing M-Bus-system is integrated via the sequence M-Bus and RS485 – USB adapters to the Raspberry PI with internet access.

In Caserta no adequate industrial user with an appropriate installed PV system could be integrated up to now.

3 The control and measurement system

3.1 The energy consuming devices

The overall consumption of a single user site in Konstanz is measured by summarizing Elster smart meter of type AS 1440 or A 1500 and in Caserta by a energy meter of type ZR-HMETER3P-EM Energy Meter three-phase from 4-noks s. r. L. with 6 pick-up coils; 3 pick-up coils are installed before and 3 pick-up coils behind the consumer main power cable connection. Thus the difference of the incoming and outgoing power is the user consumption. The PV generated energy flow will be measured by a SDM220-Standard smart meter.

Figure 3: Clockwise from top left: Installed summarizing smart meters in Konstanz, an Elster AS 1440 and an Elster A 1500 smart meter and for Caserta smart meters of type ZR-HMETER3P-EM to measure the entire user consumption and for the PV generation, consumption and feed in a SDM220-Standard smart meter.

The energy flow data of a consuming device, the on and off switching and also the ambient or freezers and refrigerators inside temperatures are measured by rf-controlled and transmitting smart plugs and temperature sensors. In Figure 4 the two types of smart plugs as used in Konstanz and Caserta are shown.

Figure 4: Left: Smart plug of type HomeMatic „Funk-Schaltaktor 1-fach mit Leistungsmessung, Zwischenstecker Typ E“ as used in Konstanz. Right: Smart plug of type 4-noks ZR-PLUG-XX-M, ZigBee electricity meter and remote control plugs as used in Caserta.

At the Caserta trial site an ethernet interface is used to link a ZigBee network with the external environment (i. e. internet access). In order to bridge larger distances a repeater can be used to improve the signal quality and the extension range, both devices are shown in Figure 5.

Figure 5: Left: A gateway ZC-GW-ETH-EM modbus ethernet and right: A repeaterZR-REP-E230M, ZigBee to extend the range and to improve the signal quality, both devices are from 4-noks s.r.l..

When a single device already connected via an own short-circuit switch or a fuse the control then the measurement of the energy flow data can also be done by a smart meter of type DRS110M which is shown in Figure 6 and is equipped with a RS485 interface for communication.

Figure 6: Array of four smart meters of type DRS110M (left) and remote controlled switches (right) in the electrical cabinet of user KN-10.

3.2 The PV installations for self-supply of energy

The following Table 1 gives an overview of the PV-installations only with some technical details necessary to calculate the PV energy yield.

user KN-##	PV System	PV System ID
	70x mc (ex)Shell 88W=6.16kWp	100
	8x Solarworld SW155W = 1,24kWp	101
01	31x Solarworld SW155W = 4,81kWp	102
	Mainauhof - Modulset (1): 63x Aleo Solar A18/240Wp	100
	Mainauhof - Modulset (2): 63x Aleo Solar A18/240Wp	101
	Gärtnern für alle - Moduleset (1): 38x Ersol E6 Blue Power 155A (155Wp)	102
02	Schwedenschänke - Modulset (1): 114x Ersol E6 Blue Power 155A (155Wp)	103
	SST - Modulset (1): 18x MHH MHH plus 180, 175 W	100
	SST - Modulset (2): 24x MHH MHH plus 220, 220W	101
	SST - Modulset (3): 11x Kyocera KC120	102
	SST - Modulset (4): 46x Sunways SM210U, 220Wp	103
	SST - Modulset (5): 70x Solarwatt Orange 60P 255Wp	104
	SST - Modulset (6): 47x Sunways SM210U, 220Wp	105
	SST - Modulset (7): 47x Sunways SM210U, 220Wp	106
	SST - Modulset (8): 18x Sunways SM170U, 170Wp	107
03	SST - Modulset (9): 21x Mitsubishi el. PV-MF130EA2LF	108
	Topproof : 6*9=54x Sunways mc, B-class!	100
04	Fasadenanlage: 14*5=70 old Pelworms mc 5´´	101
	Ellenrieder - Modulset (1): 64x Aleo AVIM A_18P235	100
05	Ellenrieder - Modulset (2): 63x Aleo AVIM A_18P235	101
	Schwaketenstrasse (GSS) - Modulset (1): 24x Aleo Solar S_18/225	100
	Schwaketenstrasse (GSS) - Modulset (2): 24x Aleo Solar S_18/225	101
	Schwaketenstrasse (GSS) - Modulset (3): 24x Aleo Solar S_18/225	102
06	Schwaketenstrasse (GSS) - Modulset (4): 24x Aleo Solar S_18/225	103

	Schwaketenstrasse (GSS) - Modulset (5): 24x Aleo Solar S_18/225	104
07	Modulset (1): 10kWp	100
08	No PV installation	
09	Modulset (1): Suntech mc; STP210-18/Ub-1, 2xString mit je 12 Modulen 24x210Wp=5.04kWp	100
10	Modulset (1): 54 Module Day4-48Zellen ca. 200Wp(189Wp)	100
11	No PV installation	
12	Modulset (1): 3.9kWp: (3x5) Kyocera 167W	100
	Modulset(2): 14x (ex)Shell 88W	101
	Modulset (3): 5.2kWp: (3x14) 100W ASE	102
	Modulset(4): 10x 100W ASE	103

Table 1: Overview of the PV installations at the Konstanz trial site.

An ensemble of PV installations, which are already introduced in D5.1, has been additionally selected during the project for integration. These PV systems act only as energy supplier to deliver only in order to increase the entire PV-yield of the Konstanz trial site.

user KN##	PV Installations	kWp	orientation	inclination
00-01	4/1	67,5	180°	0/3
00-02	3	70,64	180°	13°
00-03	2	49,14	180°	13°
00-04	3/3	106,5	205° west	0°/3°
00-05	3/2/2	99,84	133°/198°/227°	20°

Table 2: Overview of five PV installations owned by the DSO "Stadtwerke Konstanz".

KN-00-01. 67.50kWp 1052.1m² "Stadtwerke Konstanz Fahrzeughalle" 78467 Konstanz
http://www.pvlog.de/solar.phtml?nav=info&lid=aTXC3p4tg5RT901a
KN-00-02. 70.64kWp 404.4m² "Stadtwerke Konstanz Schwaketenbad" 78467 Konstanz
http://www.pvlog.de/solar.phtml?nav=info&lid=YK36s8N628Ei77eM
KN-00-03. 49.14kWp 275.9m² "Stadtwerke Konstanz Max Stromeyer Str.23 Bauteil F" 78467 Konstanz
http://www.pvlog.de/solar.phtml?nav=info&lid=896Rv8H7GMxmXGhk
KN-00-04. 106.50kWp 1640.1m² "Stadtwerke Konstanz Materiallager" 78467 Konstanz
http://www.pvlog.de/solar.phtml?nav=info&lid=6qXP4sD1cvIs5n5b
KN-00-05. 99.84kWp 607.4m² "Stadtwerke Konstanz Landratsamt" 78467 Konstanz
http://www.pvlog.de/solar.phtml?nav=info&lid=VXV0URzdkYQKY5B5

Figure 7: Integrated PV systems of the users KN-01 (left) and KN-00-01 (right).

3.2.1 Direct measurement

The standard way is the direct integration of the user´s local PV-system through an Elster AS 1440 Smart Meter by the RS 485 interface and a cable connection to the Raspberry PI. The smart meter is able to measure both the self consumed energy as well as the feed into the local public power grid.

3.2.2 Data acquisition via PVlog

The PV-systems of public users are already controlled by third party Common-Link AG, see http://www.common-link.de, which distributes the local energy production data every 15´ via PVlog on the public homepages of the PV sites.
In this way CoSSMic has the possibility to grab the measured PV-yield energy data via a parser software tool from the source code of the html internet page as can be seen in the following cut-out in **Fehler! Verweisquelle konnte nicht gefunden werden.** for a PV installation of the user KN-06.

```
<p class="f9">Erträge gesamt: <b>125.430,01 kWh / 49.087,58 EUR</b></p>
<p> </p>
<p class="f9">Überwachung aktiv seit: <b>15.09.2010</b></p>
<p class="f9">Letzte Aktualisierung der Messwerte: <b>4m 44s</b></p>
```

Table 3: Cut-out of the source code of the internet page of the online PV-yield documentation by PVlog.

For a higher time resolution of the measured PV- energy yield of the connected PV systems Common-Link AG has been asked for an offer of 10-11 Systems (for 3x KN-02, 1xKN-05, 2xKN-06, 5xKN-00) with the following response for the investment into hardware as well software of altogether about 10 k€, i. e. about 1000 € for each monitored PV-System:

New System Software:	3800 Euro
API/Interface:	2850 Euro
Hardware Update:	950 Euro
Communication:	216 Euro/unit/2years = 9€/month

<u>The content of the offer of the Common-Link AG:</u>

Current and voltage high precision measurement with an exact time synchronicity via shunt-pick up system technique in order to calculate the power within 80 times/s, to integrated these power values within 1 ´ to get the energy value each minute.

We decided not to go for a higher time resolution of the PV-yield data via PVlog for two reasons:

- We get the weather forecast data every six hours with a one hour resolution from the DWD. These data serve as input to calculate the PV-yield of each PV installation as described in the following paragraph "weather prediction". Therefore it is sufficiently precise enough in time when we get the measured PV-yield value every 15 minute. We can even use the 15 minutes measured PV-yield value to build the averaged over an hour to compare the predicted with the measured PV-yield data.
- The cumulative costs of this third party service are too high to serve in the CoSSMic project.

3.2.3 Weather prediction

The self supply of electrical energy of the integrated users is based on their own PV installation which is a high intermittent energy source and depends among others on the day time, the season and the daily weather conditions.
Therefore it is striking to know the weather conditions already ahead as precisely as possible in order to react on the availability of PV the prospected PV electrical energy amount.

Weather forecasts used for predicting the upcoming PV performance are provided by "Deutscher Wetterdienst" (DWD). The COSMO-EU forecast model covers entire Europe with a mesh size of 7 km. Thus, it also accounts for regionally limited characteristics. The PV yield prediction algorithm is fed with direct and diffused downwards radiation, measured at a horizontal surface level (ASWDIR_S, ASWDIFD_S) as well as temperature at 2 m level (T_2M).

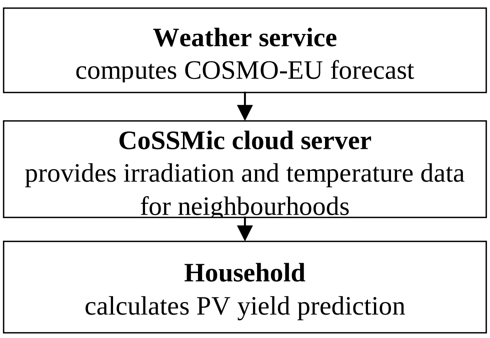

Figure 8: Flow chart of the PV prediction components. The weather forecast is pushed to a cloud server by DWD service every 6 hours.

In order to evaluate the deviation of the PV-yield of energy between the forecasted and the really measured amount, one can simply build the ratio between the every six hours hourly based forecasted PV-yield value with the measured and every 60 minutes summarized one as: PV-yield-Deviation (%) = 100 x (forecasted value - measured value) / measured value to get the relative deviation within every six hours.

3.3 Energy storage devices – i.e. the batteries

3.3.1 The mobile batteries

The mobile batteries are the electrical energy reservoirs, being the fuel tank of the integrated e-Cars. At present the mobile batteries are foreseen as loads and are treated like common consuming devices. At present the batteries can only be charged and may be discharged when disconnected from the electrical net.

The management system to run for example the e-Golf (or any other e-Car) of the user KN-04 comes together with the e-Car management system. In order to have access for the integration of the e-Car in the user´s home grid additional hard- and software is necessary. The preparation for the communication when the e-Car is connected at the charging unit and during the charging process is managed by an embedded “Schletter 261900-005 P-Charge EWS-Box P” driving unit with $P_{standby}$=3W and I_{charge} =13/20/32/63/70A → 3 – 16 $kW_{charging}$

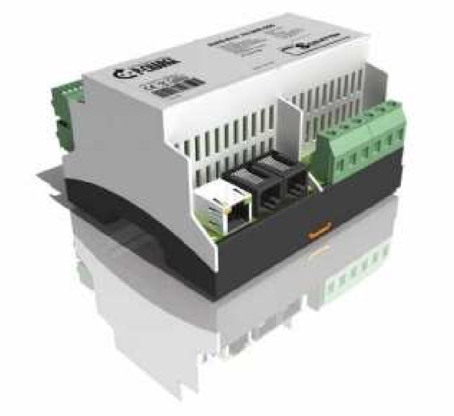

Figure 9: The driving hardware unit from Schletter 261900-005 P-Charge EWS-Box P”.

Figure 10: E-Golf with a 24 kWh Li-Ion battery of KN-04.

3.3.2 *The stationary batteries*

The stationary batteries can be charged and discharged when connected to the user´s household. It has been decided to charge the stationary batteries only by PV generated electrical energy.

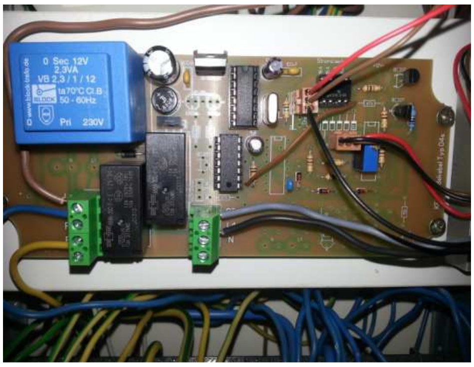

Figure 11: Prototype of a smart battery charger of KN-04.

There is already a variety of different stationary battery systems on the market. One example, which is already integrated into the CoSSMic trials, is the system: “Varta Engion Family Energiespeicher” at KN-03 with a charging capacity of 3.7 kWh. The battery system has its own battery charger already integrated. Thus it can be directly connected over a bidirectional measuring smart meter which monitors both the charging and the discharging energy flow.

4 The users and their equipment at the trial site

4.1 Konstanz (KN)

The users and the devices of the users are already introduced and described in D5.1.

The local distribution system operator (DSO) at the Konstanz trial site is the “Stadtwerke Konstanz GmbH” an enterprise owned by the Stadt Konstanz. The “Stadtwerke Konstanz” is in charge to provide the smart meters of type Elster at each user´s home. Depending on the different users there are two types of smart meters, an Elster AS1440 of single and bidirectional layout always equipped with a RS485 interface for CoSSMic use, and especially for higher loads of public and industrial users the smart meter Elster A 1500 which is differently integrated either by a RS485 or a CLO interface or by an analogous S0 output.
The “Stadtwerke Konstanz” installed the Elster smart meter and still remains their owner. They provide the access to the sealed RS485 interface data output for the data input to the Raspberry PI and provide inside the power distribution cabinet the power supply for the Raspberry PI.

KN-01

- Raspberry PI-2 (ISC#10085) with power supply (ISC#10086), both rail mounted.
- 1xElster A1500 (#84659) with two interfaces, RS 485 + CL0 was installed
- 2xElster AS 1440 (PV1 #77499 + PV2 #77498) for the PV-System with 10kWp which at present feeds directly into the local power net.

Available system components which could be added

- Control of 5-8 single cooling compartments/halls with a time resolution (in the order of magnitude) Δt >1´
- Control of the electrical pre-cooling by power net connected aggregates of 15 cold service trucks
- Office section
- In house entire subsidiary with 2 large consumers
- E-Vehicles (4-5x lifters and 1x e-Smart 17.8kWh loaded from “Schuko”-plug over night; stand alone power-meter measures load) as mobile e-storage

KN-02

- Raspberry PI-2 will be installed in the basement of the Comturey close to LAN with internet access; data cable already prepared; access for power supply for Raspberry PI-2 must be installed.
- Smart meter: (http://www.produktinfo.conrad.com/datenblaetter/500000-524999/516709-an-01-de-TIP_NOVA_5_1_MID_4L_MESSWANDLER_DSZ.pdf)
  see preferred:
  http://shop.enerserve.eu/zubehoer/118/nova-5/1a-mid-4l-wandlerdrehstromzaehler
  already installed together with RS485 IR coupled module, as shown in Figure 12 left the smart meter and on the right the middle module as the RS485 interface hardware. Consult for more details: http://shop.enerserve.eu/zubehoer/119/nova-rs485-mod-bus

Figure 12: Left side shows the already installed smart meter, and on the right side the middle device which is the RS485 interface hardware module.

- Three PV installations with A 1500 CL0 to SWK and So to interlink

The PV-installations are equipped with smart meters of type A 1500 Elster from SWK and are all connected to PVlog data acquisition system via S0 interface and to SWK via CL0 interface and modem:

Solarcomplex Mainau Gärtnern für All (l_120 E(kWh)-l_123 time(min_s))
http://www.pvlog.de/solar.phtml?nav=info&lid=01hi5cklG00RI06Re : 5.89 kWp

Solarcomplex Mainau Schwedenschenke (l_120 E(kWh)-l_123 time(min_s))
http://www.pvlog.de/solar.phtml?nav=info&lid=4bO3e46yF0ih9uoF 17.67 kWp

Stadtwerke Konstanz Heizwerk Mainau (l_119 E(kWh)-l_122 time(min_s))
http://www.pvlog.de/solar.phtml?nav=info&lid=J0n9n88fYp3mDD58 : 30.24 kWp

in total sum 53.80 kWp

Available system components which could be added

- Altogether consists the Mainau of eight (8) island units, at one unit the 20kV medium voltage feed in point for Schwedenschenke and Comturey the incoming energy flow is measured together; all others are Mainau owned
- A back-up battery (lead acid units) with a capacity of 18x40Ahx12V →8.64 kWh is installed in the Comturey basement close to the smart meter.
- CHP / wood gas
- There is already a switchboard (Figure 13) with different consumer devices of the Comturey.

Figure 13: Installation inside the electrical cabinet.

KN-03

- Raspberry Pi-2(ISC#10088) and power supply (ISC #10089) and 3xElster AS 1440 Smart Meters
- 1xElster AS 1440 Smart Meters (#77486) for PV self consumption (of PV_{tot}=58.6 kWp) and feed in
- 1xElster AS 1440 Smart Meters (#72515) only for one 14kWp PV-System for feed in only!
- 1x Elster AS 1440 (#79662) for total consumption
- For 3 phases and 2 directions 1xsmart meter SDM630MDC from B+G E-Technik for an engion 3.7 kWh battery system from Varta Storage GmbH (ISC#100??)
- Via PVlog: http://www.pvlog.de/solar.phtml?nav=data&lid=kn78TU47X22Nuz6f

Available system components which could be added

- Different connected households with appliances
- E-car 16A-charger with switch could be connected as a non-traceable consumer. An additional E3DC-system can be used as benchmark like a “µCoSSMic”

KN-04

- In the nearby MV-LV transformer station is 1xElster A 1500 connected via M-Bus and RS485 –USB adapters to the Raspberry PI-2 (ISC#10087)

Household devices by HomeMatic 868.3MHz for:

- Dishwasher HomeMatic (ISC#100??) not yet tagged
- Refrigerator HomeMatic (ISC#100??) not yet tagged
- T-sensor integrated into the (left) refrigerator HomeMatic (ISC#100??) not yet tagged

Industrial equipment at ISC via M-Bus (EN 13757-2 physical and link layer, EN 13757-3 application layer)

- ct CVD
- ct Diffusion
- ct Firing Oven
- Rena Inline
- Cooling Machine (aggregate)

- Pressured Air Device
- Cooling Water Pumps
- Air Conditioner (Ventilation)
- Printing Room I
- Printing Room II
- Chemistry Room
- Clean Room
- Office Building
- PV roof 12.4 kWp with a Landis& Gyr meter (SWK #S73414)
- PV front 6.9 kWp with 1x Schellcount meter and 1x Enermet meter (SWK #64753)
- The charging of the e-Golf monitored via an own Raspberry PI is active and works, the additional integration of a stationary battery of 2.7kWh/30% will be integrated soon.

KN-05

- Raspberry PI-2 (ISC #100??) with rail mounted power (ISC#10093) supply and Huawei USB-Stick (ISC#100??) with SIM-card O2-1GB-50Gbit/s provided by maXXim for 3G/UMTS internet connection is installed on the 21.10.15 but the USB/UMTS-unit has to be shifted outside the cabinet because of no internet access inside the cabinet.
- Exchange of 1x mechanical meter and 2x Landis & Gyr by 3x AS 1440 with RS485 interfaces
- Elster AS 1440 for total energy (#77510) of school house
- Elster AS 1440 for PV-panel (#77512 feed in only)

The PV-installation on the gymnasium roof is shared with Ellenrieder High School: http://www.pvlog.de/solar.phtml?nav=info&lid=cq6jIBs1McnYbzM9

With parser take energy in line 119
<p class="f9">Erträge gesamt: 96.501,19 kWh / 23.585,96 EUR</p
and time print in line 122
<p class="f9">Letzte Aktualisierung der Messwerte: 6m 41s</p>

- Elster AS 1440 for the gymnasium (#77511)

Available system components which can be added

- Teachers room LAN-access possible → Comformatik →open guest access
- Lighting of the class rooms, best separated from other consumers
- Emergency battery systems (one at gymnasium and one close to cantina kitchen)
- Hot water provider in the basement
- School kitchen cantina
- Teacher preparation room

KN-06

- Raspberry PI-2 (ISC #10090) with standard plug power supply and Huawei USB-Stick (ISC#10091) with SIM-card O2-1GB-50Gbit/s provided by maXXim for 3G/UMTS internet connection is installed
- An Elster A 1500 with CL0 w/o RS485 (#71438) in the MV transformer station about 100 m off access point to pedagogic LAN is exchanged on the 20.8.15 by 1x Elster A1500 (#84639) with RS 485 + CL0 interfaces and a conversion ratio of x2000 (50/5A) is installed.

- Access to internet via guest access possible → Comformatik to open port #3/#4 or alternatively to connect the Raspberry PI-2 as feed via RS485 of the A1500 Elster by tethering smart mobile access to the internet.
- 1 PV Systems 2.1 kWp (GSS)
- 1 PV Systems 27 kWp (http://www.pvlog.de/solar.phtml?nav=data&lid=nX26tjCG98R2sTt8 , 5 owners)

With parser take line 119
<p class="f9">Erträge gesamt: 125.430,01 kWh / 49.087,58 EUR</p>
And Time print line 122:
<p class="f9">Letzte Aktualisierung der Messwerte: 4m 44s</p>

- 1 PV Systems 30 kWp (owners administrated by: sun4six GbR)

Available system components which can be added

- Cooling System (so called air conditioning)
- Back-up Battery-to back up and substitute 48kW Gasoline Generator for 1h → 50 kWh
- School education kitchen and/or cantina
- Select heavy duty electrical tool, e. g. the circular saw
- Cooling System (so called air conditioning)

KN-07
- Raspberry PI-2 (ISC#10079) power supply (ISC#10078) and circuit breaker (#10052)
- Fritzbox #7490 available iphone/tablet, WLAN/LAN
- 1xElster AS 1440 for PV 10kWp (#72469)
- 1xElster AS 1440 for HP (in the past two now one tariff) (#72746)
- 1xElster AS 1440 bi-directional for remaining entire consumption (#76344)
- Refrigerator (not yet connected)
- Dish Washer HomeMatic (ISC#10082)
- Washing Machine HomeMatic (ISC#10081)
- Freezer HomeMatic (ISC#10080)
- T-sensor in freezer and transmitter outside nearby HomeMatic (ISC#10083)

KN-08
- Raspberry PI (ISC#10071) power supply for standard plug with loose connection exchanged
- 1xElster AS 1440 (#77492)
- 10kW Heating System Pump (Pmax < 100W) with about 1kW fresh air ventilation – via DRS110M (ISC#10023)
- Dish Washer (HomeMatic ISC#10074)
- Freezer (HomeMatic ISC#10073)
- T-sensor and transmitter inside freezer HomeMatic (ISC#10075)
- Washing Machine (HomeMatic ISC#10072)
- Refrigerator not integrated

KN-09
- Raspberry PI-2 (ISC#100??) power supply (ISC#100??)
- 1x Elster 1440 for total energy consumption (#72544) right one

- 1x Elster 1440 for the PV 5.04kWp panel (#72761) left one
- Freezer: A0004 HomeMatic (ISC#100??)
- T-Sensor HomeMatic (ISC#10019)
- Refrigerator: A0005, (HomeMatic ISC#100??)
- T-Sensor refrigerator HomeMatic (ISC#10020)
- Washing Machine (with Dryer): A0003 HomeMatic (ISC#100??)
- Heating System Pump (Pmax=60-100W) smart meters DRS110M (ISC#...235)
- Dish Washer, smart meters DRS110M (ISC#....234)

KN-10

- PV (1xElster AS 1440) (#_____)
- HP (1xElster AS 1440) (#72490?)
- Remaining consumption (1xElster AS 1440) (#_____)
- EV (charging control) soon via rail mounted smart meters DRS110M (ISC#_____)
- Refrigerator 1 (ground floor) (smart meters DRS110M) (ISC#_____)
- Refrigerator 2 (basement) (HomeMatic) (ISC#_____)
- Freezer (basement) (smart meters DRS110M) (ISC#_____)
- Dish washer (smart meters DRS110M) (ISC#_____)
- Washing machine (smart meters DRS110M) (ISC#_____)

Available system components which can be added

- Ventilation (ground floor) requirement when HP on → vent max to warm up fresh air

KN-11

- Raspberry PI-2 (ISC#100~~51~~old→10092new) power supply (ISC#10053) with rf transmitter ISC10050) and Logilink (ISC#10054)
- 1xElster AS 1440 (#_@ground floor)
- Between the Raspberry PI in the 3rd floor and the smart meter in the ground floor is a long cable data connection
- Refrigerator + Freezer HomeMatic (ISC#100??)
- Washing Machine HomeMatic (ISC#100??)
- Dish Washer HomeMatic (ISC#100??)

KN-12

- Raspberry PI-2 (ISC#10070) with power supply (ISC#10061)
- 1xElster AS 1440 total supply (#77493)
- 1xElster AS 1440 for PV 3.9kWp + 5.2kWp (#77494)
- Pellet heating pump via smart meter DRS110M (ISC#10027)
- Dish washer HomeMatic (ISC#100??)
- Freezer HomeMatic (ISC#10076)
- Washing Machine HomeMatic (ISC#10077)
- T-sensor HomeMatic inside freezer with transmitter outside (ISC#10059)

Available system components which can be added

- Own not controlled battery charger, large aquaria.

KN-User →	KN-01	KN-02	KN-03	KN-04	KN-05	KN-06	KN-07	KN-08	KN-09	KN-10	KN-11	KN-12
Device | items	industry	industry	industry	industry	public	public	private	private	private	private	private	private
since	13.05.15	22.09.15	02.09.14	Aug 14	1uly15	Aug 15	15.04.15	17.03.15	11.12.14	Aug 14	21.01.15	18.03.15
Elster sm/Devices/T-sensor	3/-/-	-/1/-	3/1/-	1/16/1	3/-/-	1/-/-	3/3/1	1/4/1	2/5/2	3/5/1	1/3/-	2/4/1
Elster sm tot	1 x A 1500	8 x diff meters	1x AS1440	1x A1500	1 x AS1440	1 x A 1500	1 x AS1440	1 x AS1440	1 x AS1440	1 x AS1440	1 x AS1440	1 x AS1440
for PV	2 x AS1440	4 x A 1500	2 x AS1440	different	1 x AS1440	some	1 x AS1440	noPV	1 x AS1440	1 x AS1440	noPV	1 x AS1440
add. sm	-	Nova5// 1A	yes for battery	yes for Mbus	1 x AS1440	no	yes	yes	yes	yes	no	yes
T-sensor	-	-	-	yes			yes	yes	yes(2)	yes	?	yes
refrigerator	-	-	-	SP			no	no	SP	SM+SP	SP-combi	no
freezer	-	-	-	-			SP	SP	SP	SM	SP-combi	SP
dish washer	-	-	-	SP			SP	SP	SM	SM	SP	SP
washing machine	-	-	-	-			SP	SP	SP	SM	SP	SP
heat pump (=hp) / pump (=p)	-	-	-	-			AS1440 (hp)	SM for (p)	SM for (p)	AS1440 (hp)	-	SM for (p)
storage device	eCar (17.8kWh)+ 5+1lifters	18*12V *40Ah= 8,65kWh	stationary battery (3.7kWh)	eCar(24 kWh) + stationary battery (2.3kWh)	back-up safety batt.	back-up safety batt.	-	-	-	eCar (15kWh)	-	-
add. Devices			16A open charger for 4 employees eCars+all	14 industrial dev. via SM (Mbus)			-	-	-	second refrigerator ventilation	-	aquarium, car-charger at home?

Table 4: Overview of the installations at the different users in Konstanz. Abbreviations as used in this table are: sm for smart meter, hp for heat pump and SP for smart plug.

4.2 Province of Caserta (CS)

The province of Caserta will integrate for the CoSSMic trial three private users, and nine public users, i.e. one public swimming pool and eight schools. The following text is an excerpt from a contribution of Province of Caserta officials.

4.2.1 PV installations at the schools

So as to forecast electric energy production of a PV plant installed onto a school building with a rated power of 3.00 kWp, solar radiation value on module level is calculated , on the basis of ground solar radiation value in Caserta (Lat. 41.07 N , Long. 14.33 E, 68 m above sea level), in accordance with UNI 8477/1.

The annual value of radiation of solar energy on module level, as mounted parallel to the surface for the installation of the photovoltaic generator module, is considered equivalent to 1673 kWh/kWp/year. The annual energy produced by a 3 kWp PV installation is estimated when achieving a yearly 85% average operative system efficiency with 0.85 x 1673kWh/kWp x 3kWp = 4266kWh/year.

All integrated school buildings have an energy supply contract that amounts up to about 40 kW three-phase and thus the energy produced by PV is totally absorbed by the building itself.

4.2.2 Intermittent consuming devices

Intermittent consuming devices have been individuated on the sites along with project partners, as follows:

- Forced air systems (air conditioner)
- Washing machines and dishwashers
- Hot water boilers
- Heat pumps

The above mentioned appliances are used during the whole year, at regular intervals, almost continuously, except for short periods of the year.

4.2.3 Installations for monitoring

An experimentation of the chosen meter applied to one of the plants of the project was made for error tolerance. As a result of the on-the-spot investigation with CoSSMic partners and of various meetings we individuated the appliances to be installed onto the plants for monitoring purposes, both for produced and consumed energy, as well as for input energy.

The appliances given to be installed are:

- mono-phase meter
- three-phase meter
- WIFI transmitter or LAN net
- operational software

The Province of Caserta, together with the Aversa Engineering Department of the local University, agreed to buy the type SDM220-Standard type smart meter for PV plant monitoring.
For verification a SDM220-Standard type smart meter was installed into the electrical cabinet of the PV installation of the user CS-11, situated in Macerata Campania, in the territory of the Province of Caserta.

Figure 14: Image of the electrical cabinet of user CS-11 with an integrated SDM220-Standard type smart meter (compare with Figure 3, bottom left) for the measurement of PV energy flow depicted with meter.

As we see in from Figure 14, the smart meter was placed in series with the main (contatore di scambio) and the PV (contatore di produzione) smart meter. During the installation both the main electric and the photovoltaic meter were disconnected, then the PV installation was connected in series with the integrated SDM220-Standard type smart meter by the blue and brown electric wires.
The installed meter monitored the produced energy, the consumed energy and the input energy during the period of April 29th 2015 – May 5th 2015, with a manual data survey every 24 hours as from the date of installation.
The measurement of the produced, consumed and feed in energy by the integrated SDM220-Standard type smart meter was compared with the one measured by ENEL of the DSO (official energy supplier) smart meters.
The measured data show a daily deviation of about 0.5 kWh, which is about 1% of the total measured amount of energy.

5 Emerging restrictions and obstacles

5.1 By country of trial site

5.1.1 Italy

Due to legal confinements as explained by our Italian CoSSMic partners of the Province of Caserta, Giulio Salzillo and Rosita Caiazzo, there are no consumption and feed in data available online via the already installed smart meters which are owned by the DSO ENEL. The customers get still a paper bill once a year

There is a letter of confirmation from Giulio Salzillo dated from the 9th July 2015, and the text is given without any changes in the following:

Alla c.a.
Svein
ISC
Proff. Di Martino
Venticinque

After several technical meetings and exchanging e-mail with prof. Venticinque of the SUN of Aversa, the following table shows the reasons for the choice of devices to be installed on the systems selected for the project CoSSmic.

All electrical systems of buildings proposed for the testing project CoSSmic are in possession of the certificate of conformity to the provisions of the Decree of the Ministry of Economic Development 22 January 2008, n. 37.

The installation of the equipment indicated by the partner SAI, for the testing of the project, would make the electrical system does not conform to the above regulations. Indeed, to enter the new device, it is necessary to rewire the electrical panel. Moreover, installing this device in the electrical certificate, change the wiring diagram of the same by altering the projects secured for planning permissions.

Therefore, we recommend devices equipped with TA (clamp meters) that would have no impact on the system without modifying existing wiring in the control cabinet and without altering its certification.

Please note that the power plants with a peak of more than 6 kW are subject to an adjustment required by resolution 243/2013 / R / EE Authority for Electricity and Gas.

The insertion of the device indicated by the partners would amend the provisions in the wiring diagram of the PV system presented to the Management network (ENEL) and GSE.

As a result of the adjustment of the Enel Distribuzione SpA, the grid operator, is required to verify conformance to the statement; In case of negative feedback will abort the contribution GSE (Energy Services) until the system will not conform to the Resolution no. 243/2013 / R / EE Authority.

By virtue of what has been reported, the choice of the equipment indicated in the draft specifications for the race turns out to be more advantageous since they will not be an integral part of the electrical installation since they are external and, therefore:

- ✓ not violate the Italian legislation concerning the certificate of conformity of the electrical system;
- ✓ not violate the resolution 243/2013/R/EE Authority for the adaptation of the production facilities.

Caserta li, 09/07/2015

f. to Ing. Tommaso Gazzillo

f. to Dott. Giulio Salzillo

5.1.2 Germany

In Konstanz there is no WLAN allowed within a public school area and also no direct free internet access is available. However, a LAN access to the internet is possible but only via a guest account through a pedagogic intranet verified by a third party company.

5.2 By class of user

5.2.1 Consumer above a consumption threshold

There are already smart meters of type A 1500 Elster installed without RS485 interface.
Monitoring of facility power flow by local DSO (Stadtwerke Konstanz) either through a digital CL0 or analogous S0 interface.
There are rising conflicts between CL0 and RS485 interface data acquisition when both interfaces are in parallel installed.

5.2.2 The two selected schools as the public users in KN

During the integration work at the regarded schools as the public users some practical obstacles came up while the hardware and software installation continuation.

<u>The restrictions:</u>

- There is no direct public internet available as already mentioned neither by WLAN nor by LAN access at the school sites
- It is not allowed to create an own/private even hidden WLAN for the CoSSMic data exchange
- The main smart meter of the school to measure the energy consumption is far away from the other facilities and devices
- The installed PV-systems at the school sites do not belong to the schools but are privately owned with private smart meters. The owners are not participating in the CoSSMic trial.
- Ergo: The physical distances between the main smart meter and the internet access, the consumer devices, the PV-systems are too large for applying rf smart plugs Connections can only realised with long (up to 100 m) freely installed data transfer cables, coming together with permanent changes in the wall construction of the facilities.

The possible solutions:

- The access to the public internet could be realized by a guest internet access via the pedagogic internet system and the external third party company comformatik AG.

- By tethering technique, an internet access of the Raspberry PI through a SIM-card equipped USB-stick could be realised. This way could also be used to integrate the main smart meter from its own remotely cabinet.

5.3 By single users

5.3.1 Local and facility related technical restrictions and obstacles

In the following Table 5 observations are listed which have been recognised during the installation of the hardware and influence the installation in a non desired manner.

trial user	**observation**	**solutions**
KN-01	Large temperature controlled food storage halls have to be safely controlled. The food is sensitive to longer lasting temperature increases.	Therefore after a trial ramp up learning time period with smaller cooling device like freezers and refrigerators of private users we will integrate more of these larger devices.
KN-02	A third party company already started a smart integration and control program of several devices and will finish the setup by the end of 2015. Then the devices are also available for the integration into the CoSSMic trial. Third party private owned installed PV systems at this CoSSMic trial user site.	There is already a Comturey owned summarizing smart meter with RS485 available for starting the integration. As proposed use of PVlog access for the measured data with a 15 minutes repetition rate.
KN-03	- ok	- ok
KN-04	- ok	- ok
KN-05	No open internet available. No WLAN allowed, LAN is restricted to the internal pedagogic network on which we could get limited guest	Our solution is to use 3G/UMTS internet access by USB/SIM-card tethering access. Then we need for each device an own access with a

	access via a third party company. Third party private owned installed PV systems at this CoSSMic trial user site.	Raspberry PI-2. Or alternative to this: 40 m long indoor data cable from the Raspberry PI to the LAN router in the teacher´s room and one 30m long indoor/outdoor data cable from the PV system to the Raspberry PI at the electrical cabinet. As proposed use of PVlog access for the measured data with a 15 minutes repetition rate.
KN-06	No open internet available. No WLAN allowed, LAN is restricted to the internal pedagogic network on which we could get limited guest access via a third party company. Third party private owned installed PV systems at this CoSSMic trial user site.	Our solution is to use 3G/UMTS internet access by USB/SIM-card tethering access. Then we need for each device an own access with a Raspberry PI-2. Or as an alternative: At least a 100 m long outdoor data cable As proposed use PVlog access for the measured data with 15 minutes repetition rate.
KN-07-ok	- ok	- ok
KN-08 -ok	- ok	RP1→RP2 not yet done
KN-09 -ok	unstable WLAN	Check it again
KN-10 -ok	- ok	- ok
KN-11 -ok	- ok	- ok
KN-12 -ok	- ok	- ok

Table 5: Observations during the hardware installation, which influenced the installation in a negative way.

6 Training of the users

The introduction of the trial users into the project target and into the "Spirit of CoSSMic" was started already during the workshops carried out within WP2 in the first six months of the project period and was followed up by face to face meetings and interviews and finally in the two days lasting Smart Energy Workshop in Konstanz on the 13th and 14th July 2015.

Further face to face meetings with the users are ongoing and are planned and will be arranged whenever necessary and also immediately before the official trial start in order to:

- Introduce the trial users practically into the used equipment.
- Introduce the trial users into the software especially how to handle the GUI on a common communication and activation base.
- Introduce the trial users into the graphical user interface (GUI) in details about how to
  - Get an overview of the own household with all connected devices
  - Control the own household, schedule, reschedule and skip tasks, etc.
  - Get an overview about the entire neighbourhood behaviour
  - Set preferences and constraints for the energy management with respect to the own PV generation, the supply by the neighbourhood or the external power net, the own and overall demand and use and the storage of the electrical energy via GUI

7 Summary

The installation of the hardware and the software development and installation process is now at its final stage and ready for the application at the trials in the City of Konstanz in Germany and the Province of Caserta in Italy running until the end of 2016.

Almost all foreseen users have been integrated into the ICT energy managing CoSSMic system by a Raspberry PI as the gateway to the collaborating neighbourhoods with the integrated software to communicate among the integrated trial users with their connected devices and to the remote CoSSMic server, all by internet access.

The software was created to measure and store continuously power and energy data of consumption and production and additionally temperature data for control reasons.
Furthermore these collected data serve additionally as a basic for further evaluations and simulations for future system development beyond the actual trials.
Based on these measured data the CoSSMic ICT system is able to act autonomous after given and set preferences and restrictions of the users via GUI to execute the tasks as scheduled and re-planed by the user.

During these field tests, we are able to create local smart grids under real-world conditions to investigate how an ICT assisted smart community can be influenced and will behave, in order to optimise the self-consumption of PV generated power. The main target is to focus not only on the optimisation of the behaviour of a single household but in the improvement of the entire neighbourhood self-consumption. While the continuation of the trials we want to demonstrate, that information technology and the resulting enablement to shift a part of the energy consumption to match the more and more fluctuating production, will contribute towards an overall lower need for fossil fuel based power. We intend to show, that the collaboration of regional neighbourhoods will result also in a reduced need of storage systems with large capacities, in order to minimise the exchange with the public grid.

8 Appendix The energy consumption of installed smart devices

When using additional electronic equipment for the optimisation of the electrical energy supplying system by an increase of PV and a decrease of public grid energy consumption, it must be allowed to raise the following question:

How much additional electrical energy does the applied hardware consume, for example, in average in the regarded time period of one year. Take into account that a 1 W stand-by consumption ends up in 8.76 kWh/year! For the single devices see the demand as listed in Table 6: Average energy consumption of installed hardware components at the user sites of the trial. For a private user in Konstanz with two Elster smart meters (18 kWh) for PV and total consumption, three smart plugs (15 kWh) two additional smart meters (7 kWh) and one Raspberry PI-2 (35 kWh) the additional stand by energy demand is about 75 kWh/user and year.

Device	Continuous consumption (W)	kWh/a
Smart rf-controlled plug	0.6	≈ 5
Raspberry PI-2	4.0	≈ 35
Smart Meter DRS110M	0.4	≈ 3.5
Smart Meter Elster	1/phase	≈ 9/phase

Table 6: Average energy consumption of installed hardware components at the user sites of the trial.