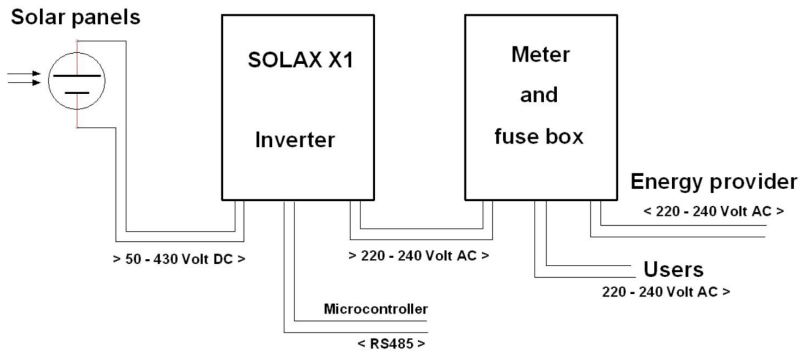
Solarpower controlled sockets - Boiler as “home battery”

The purpose and users
Heating your electric boiler, while your solar panels are delivering the power for it, saves generating the power and brings down the waste of unused solar power during peak production periods. As a consumer it will probably save you money.
As an idea: The heating of 50l. of water from 20° to 70° will consume 2.9 kW.
Apart from an electric boiler, other items can be used or charged while your panels are delivering power, like for instance car-, bike- , computer- or other batteries. The same counts for the use of an air-conditioning or lawn mower.

Power supply to the boiler:
Power supply remains as usual but via a switchable socket. We use remote controlled sockets which are regulated by a programmable microprocessor. (Arduino UNO)**.**

Controlling the sockets and finding the correct codes are explained in detail on this page:
https://www.bootprojecten.nl/solar-energy/programming-rc-sockets-433mhz



Another option is to use a cable between microprocessor and socket. This saves you finding the right codes for the socket(s) but you have to run a cable for each socket. We used this earlier in our try-out period.
We used a defect RCsocket and put a somewhat heavier relay in it.
To switch the socket “on” the processor puts 5V on the cable to the relay.
The blue LED indicates that the socket is “on”
The white plug of the boiler is plugged in. The red/black wire run to the microprocessor.

The boiler remains also switched by it's thermostatic switch.

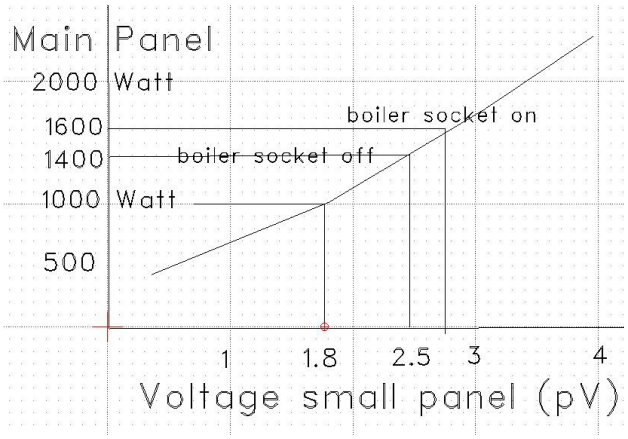
The switching
To know when to switch we use the data of the inverter. In our case we can access it via a RS485 connection. When the power reaches 1600 watts the processor switches the socket “on” and when the power gets below 1550 watts it switches the socket “off”. This way our 1450 watts boiler doesn't use power from the grid.

Connecting to and getting the **data from the inverter** is explained in detail on:
https://www.bootprojecten.nl/solar-energy/getting-data-from-a-solar-panel-inverter

An **alternative method**, in case you can't use the inverter's data, you can also monitor the voltage of a small solar panel, mounted next to the main solar panels.

We compared it's voltage with the power on the inverters display and put it in a graph.
From 2.5V and up the main panels produce the 1450 watts needed by our 50 l. boiler. So the processor switches it's socket “on” at 2.75 V and “off” at 2.5V.

Mounted on a baton



This method needs some re-adjusting during the different seasons. Using the data of the inverter is the most accurate source of course.

Our boiler is a simple 50 litre type, connected with “T”connectors near the piping of the kitchen sink. The warm water system of the central(gas) heating system is switched of in its menu and the physical valve is closed. Because we cook electrical (induction), we closed our main gas supply. We only keep the gas connection for a winter situation we need gas for heating our home.

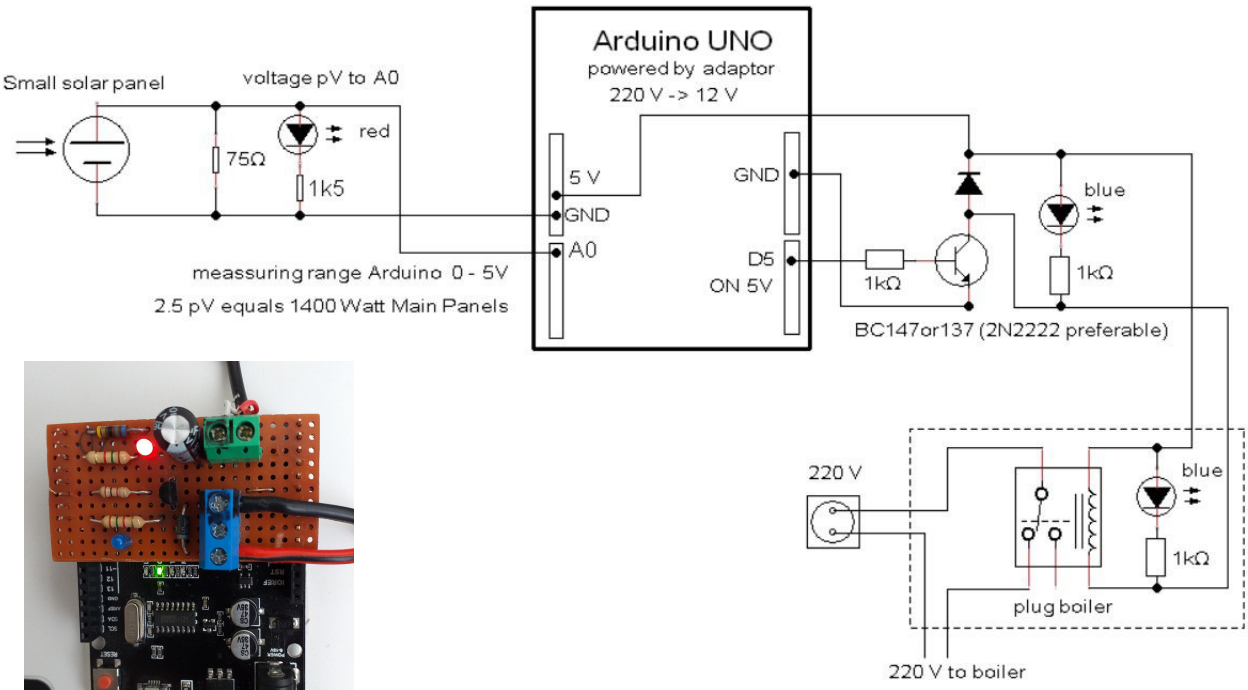
The, during the heating, expanding water is collected in the vase for re-cycling and as boiler-use indication.

De microprocessor.
As microprocessor we use an Arduino Uno.

Our most recent set-up using the inverter's data and remote controlled sockets:
https://www.bootprojecten.nl/solar-energy/solar-controlled-socket-shield-for-arduino

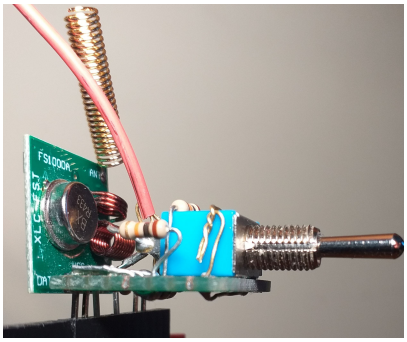
Our first set-up, with the cable connection between socket and processor and voltage regulated is described on this page.

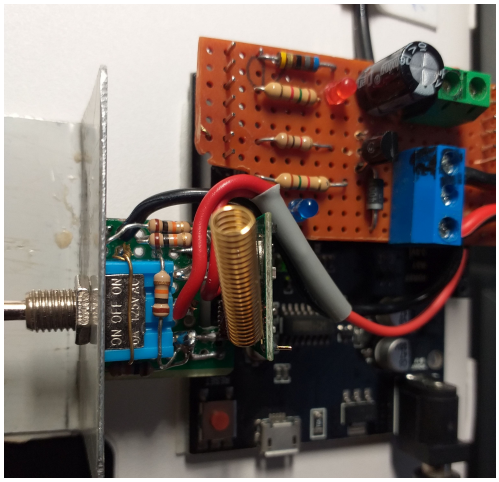
The small solar panel – Panel voltage (pV) version:



The analogue input of the Arduino microcontroller can handle 0 -5 V. Therefore the maximum pV is adjusted in order not to exceed 5V. A red LED light will show when the pV reaches 1.8 Volt.
In this situation, the main panels deliver 1000 Watt.
When digital output D5 triggers the relay of the boiler's socket, the blue LEDs on the print and in the sockethousing light up.

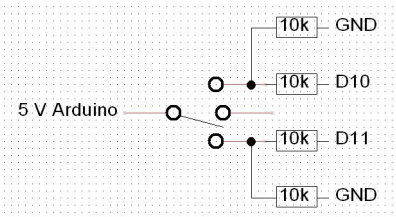
Adding a transmitter to this setup (to switch extra RC sockets)
After straightening the 5V-pin of the little transmitter shield, its GND and data pin fit straight into GND and D12 of the Arduino. The 5V-in of the transmitter is led to the 5V-out of the Arduino.
I also added a 3 way switch, to let me choose between “always on”, “solar controlled” or ” always off”. 5V is put on digital inputs D10 or D11 (via a 10k resistor and with a 10k pull-down resistor to GND). to let the program know what choice is made. The relay in the socket remains controlled via output D5





Not pushed in yet to make the pins visible -
The two pins to the right are just for mechanical support and are not connected.

The 10 k pull-down resistors from D10 and 11 to GND are visible on the setup to the right.



Downloadable Program listings:

from: https://www.bootprojecten.nl/solar-energy/solar-power-regulated-socket

_240709_Solar_Switched_BoilerSocket.ino
Simpel programma dat alleen het boiler stopcontact aan of uit zet

_240719_Solar_Switched_Boiler_Socket.ino
Als boven met de 3 standen schakelaar “Altijd aan”, ”Zon geregeld”, ”Altijd uit”

_240828_Solar_Switched_Sockets.ino
Als boven met de RC stopcontacten.

The programs are pretty much self explanatory and you can easily adjust the settings to your own situation and preferences.

Heating of water
*$P = m * c * \Delta t / 3600$ (units: k Watt = kg * kJ/kg * degree difference in Celsius or Kelvin)*
c water 4186 J/kg
*To heat 50 l of water 50°: 50 * 50 * 4.186 / 3600 = 2.91 kW is needed*

For feedback, questions or remarks you can mail in Dutch or English to

Jeroen Droogh, bootprojecten@gmail.com

https://www.bootprojecten.nl/solar-energy/solar-power-regulated-socket

https://www.bootprojecten.nl/solar-energy/programming-rc-sockets-433mhz

https://www.bootprojecten.nl/solar-energy/getting-data-from-a-solar-panel-inverter

https://www.bootprojecten.nl/solar-energy/hardware-for-solar-controlled-rc-sockets

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