Battery Charging of the NeoStore

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1 Overview

The PV-generator is connected to the UD80 (stepUpDown-dc/dc converter, MPPT-on input, battery charging functionality at output side). The LiShen LiP battery and the Xtender inverter are placed in parallel.
We try to understand its functionality.

2 Battery Charging Alone

Direct Charging In the simplest configuration the battery would be directly connected to the PV-module, resulting in the working point $U_{PV} = U_{Bat}, I_{PV} = I_{Bat}$ This has various disadvantages.

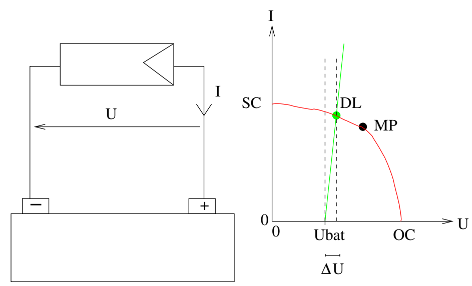

Figure 1: direct battery charging

DC/DC Converter Therefore an improvement is a DC/DC converter with PV-working point U_1, I_1 set as static parameter. At U_1 PV generates I_1 and the output battery voltage is determined by $U_2 = U_{bat} + \Delta U$ with according $I_2 \approx \frac{1}{R_{in,bat}} \Delta U$

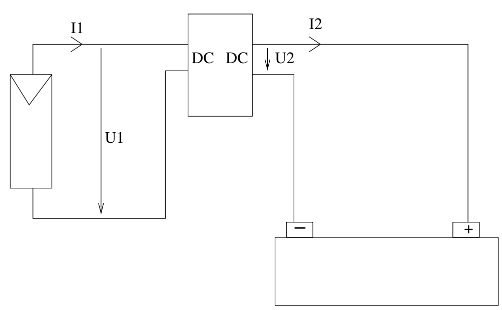

Figure 2: battery charged via DC/DC converter

such that power is conserved. The DC/DC converter normally works with pulse width modulation and is therefore sometimes called PWM-solar charger.

MPPT Charging The best working point for a PV-generator depends on the solar irradiation and temperature and therefore an active tracking to find MPP on the input side is done. For given $U_1 = U_{MP}$ on the input side the resulting voltage difference ΔU at the output side to charge the battery is again already determined due to power conservation restriction.

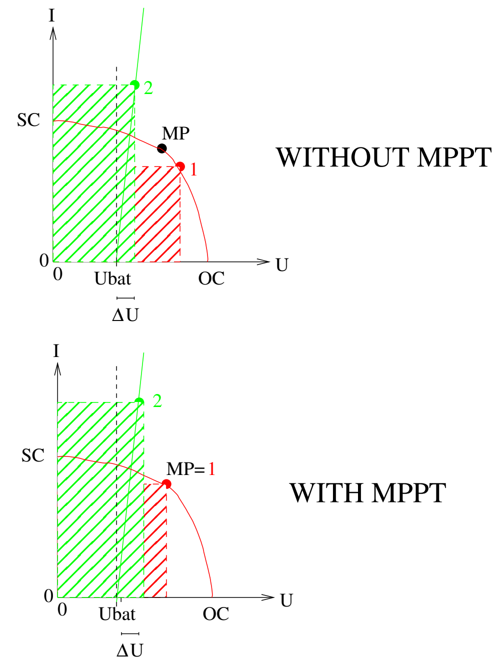

Figure 3: battery charger with MPPT

3 Injection in the Grid

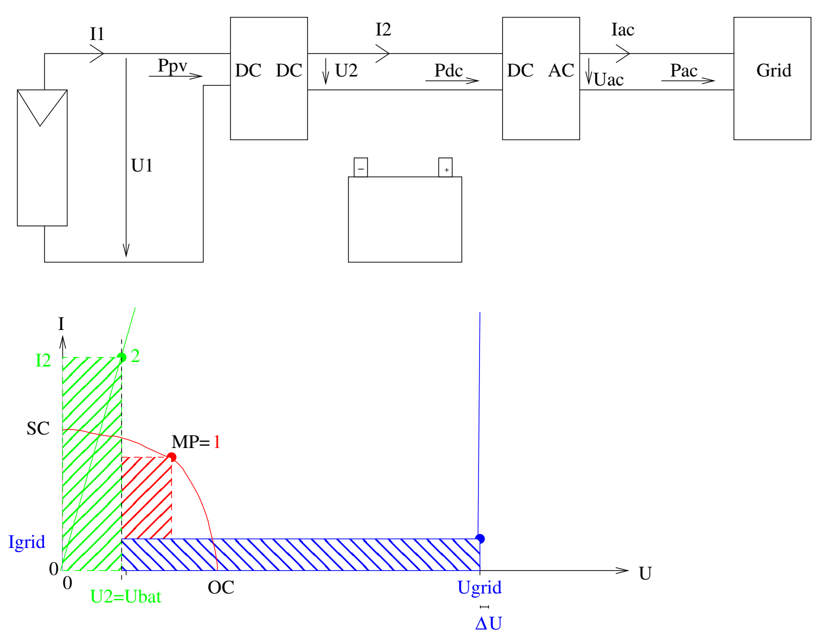

Figure 4: charger only to grid

Only injecting in the grid Now if we imagine the battery disconnected and only inject the PV power to the grid, we are in a similar situation as with battery-only.
The MPP on the input side determines the power P_{PV}, with fixed intermediate voltage level (given $U_2 = U_{Bat}$) that

determines $I_2 = P_{PV}/U_2$ and with given grid voltage U_{ac} that determines I_{ac} (up to AC-Reactive power, Blindleistungskomponente). The voltage increase of the inverter at the AC-side is very small.
That is the system functionality with a battery setting the intermediate voltage, but not involved in energy exchange.

4 Battery and injecting in the grid

The situation becomes more complicated with both battery and inverter connected.

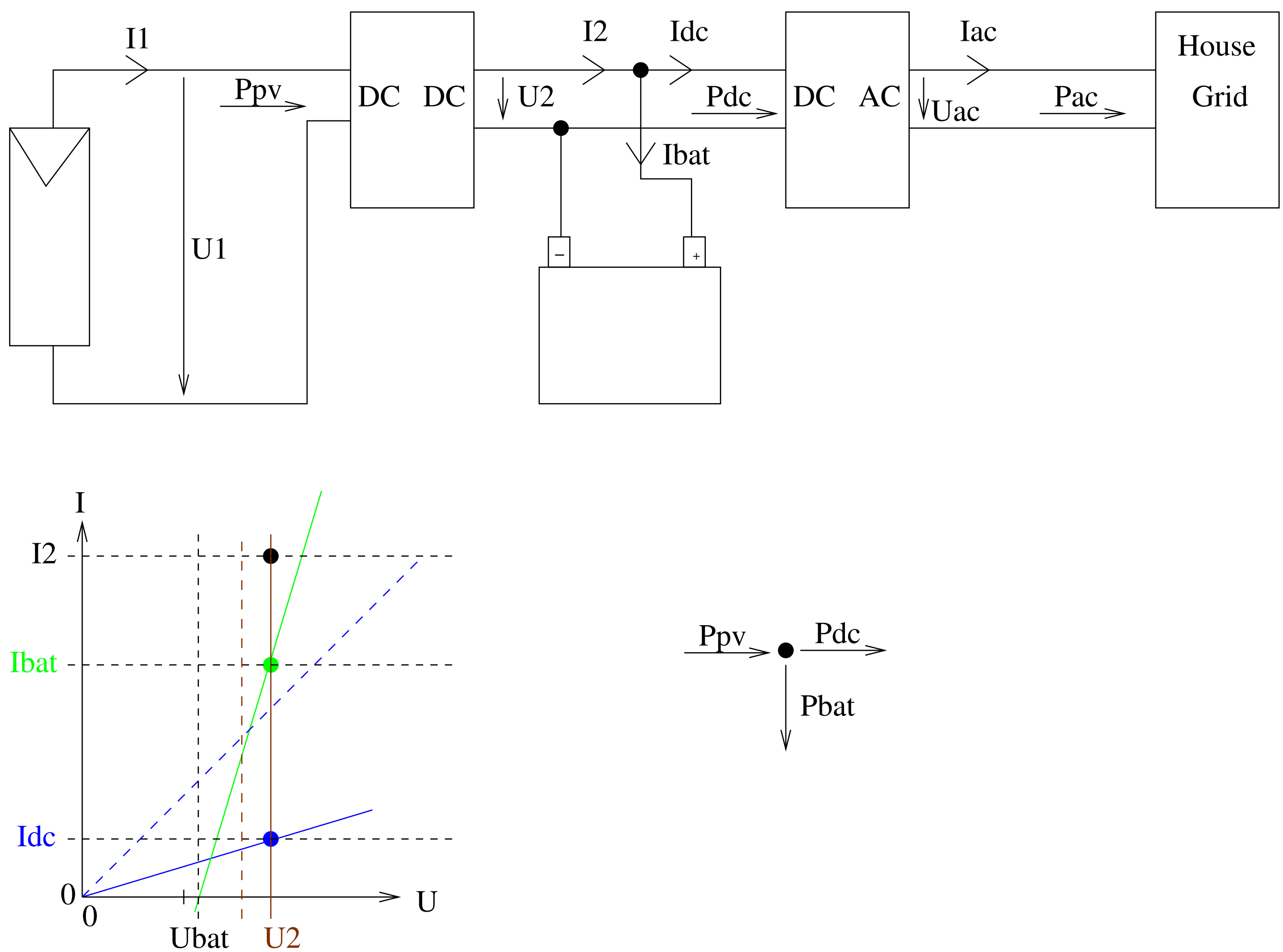

Figure 5: Charger to battery to grid

There are basically two possible strategies:

1. UD80 decides
   (a) UD80 decides on ΔU
   (b) which directly determines I_{Bat}
   (c) inverter gets what is left
2. Inverter decides
   (a) Xtender decides his I_{ac}
   (b) which directly determines I_{dc} by $P_{ac} = I_{dc} * U_{bat}$ (minor difference $U_{bat} \approx U_2$)
   (c) grid injection causes small voltage drop of U_2 to draw from battery
   (d) UD80 causes small voltage increase of U_2 to get rid of his P_{pv}

(e) intermediate voltage U_2 adapts until Xtender gets wanted I_{dc}

Here the inverter can adapt its input resistance $R_{Inv,in}$ to draw as much current I_{DC} as wanted. The battery is charged with the remaining power or may also be discharged.

Power flow At the moment there is always $P_{pv} \geq 0, P_{dc} \geq 0$ are therefore two power flows according to the sign of P_{bat}

1. $P_{bat} > 0$
2. $P_{bat} < 0$

In the future for recovering of battery there could be as well $P_{pv} = 0$ with $P_{bat} = -P_{dc}$.

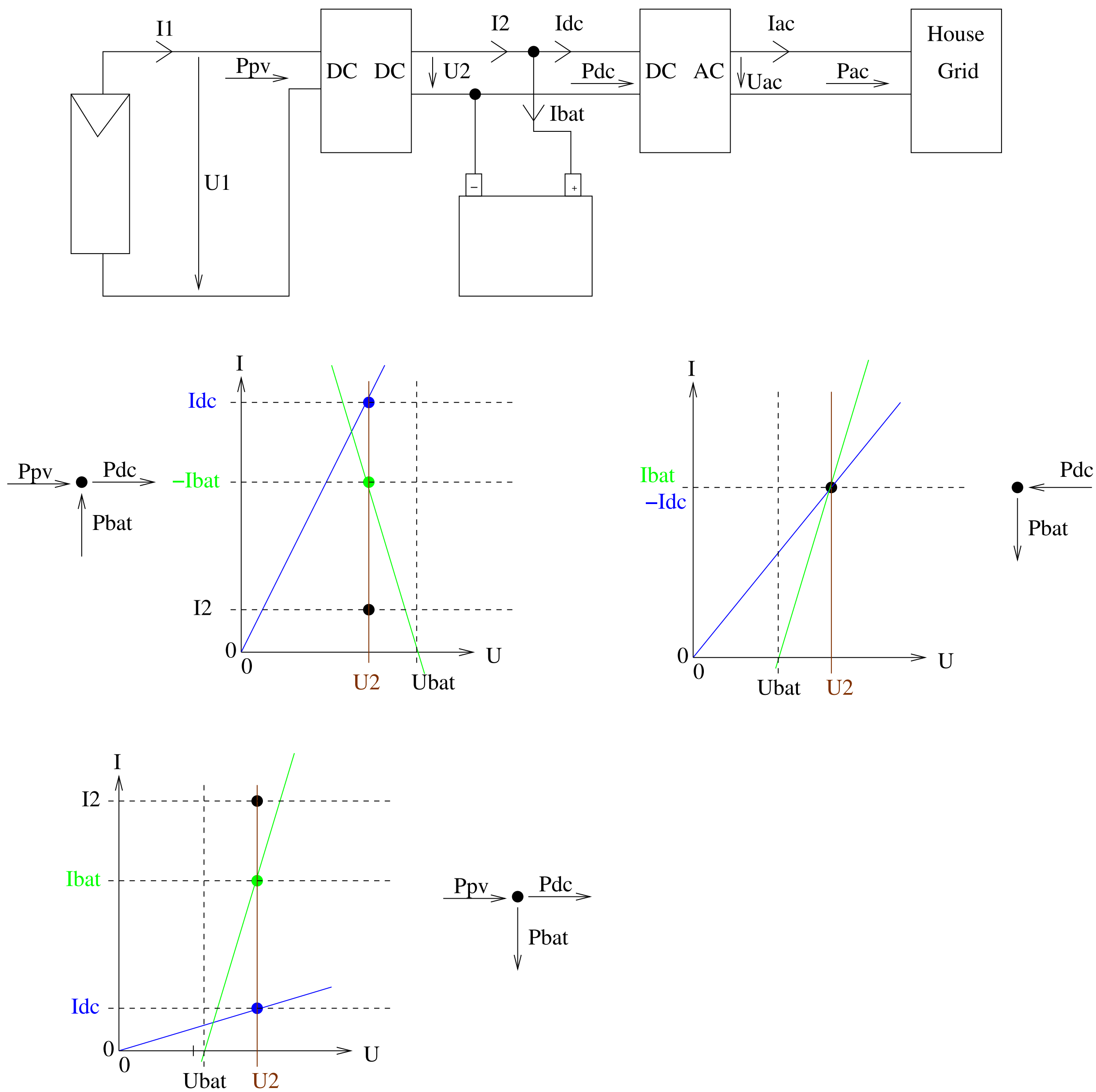

Figure 6: Power flow

5 Remaining Questions are

MPPT on Input-side

1. What is the basic MPPT strategy of UD80? Can one adapt it in SW?
2. Although our dc-simulated source was time-stationary the MPPT algorithm never stopped searching. Within approx. 1sec period it was testing around the red curves indicated in **??**. Shouldn't it reduce the ripple and stay closer at the MPP if stationary dc-input (U, I)-curve?
3. When planning the circuitry of the PV-cells (serial, parallel): Is there prefered mode of operation of UD80, e.g. step-down has higher power-efficiency than step-up!?
4. In long-time charging with stationary dc-source we see some other period of approx. 10h where charging curve changes. Some reasons for that?

BatteryCharger on Output-side

1. What is the basic strategy for battery charging? How technically realized? Xtender initializes after resolving infos from SC36, CVMiniPowerSensor?!
2. Does UD80 have infos about battery voltage, charge-capacity and charging curve?
3. Charging strategy once determined or adapted with aging battery, done in SW?
4. Communication between SC36, BMS, UD80 about proper U_2 output voltage? BMS knows SOC of battery and gives appropriate U_2?