Hybrid Power Solutions - HyPoSol

Ac coupling control strategy

Dosquet Romane & Bastin Bertrand

23/06/2022

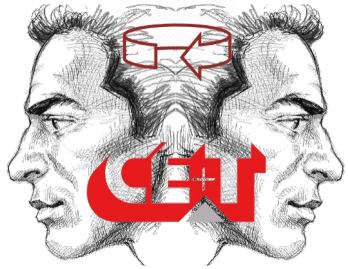
www.cet-power.com

Belgium, Luxembourg, China, India, United States, United Kingdom, France, Germany, United Arab Emirates, Russia, Malaysia, Australia.

Partner Forum 2022

Supporting the grid

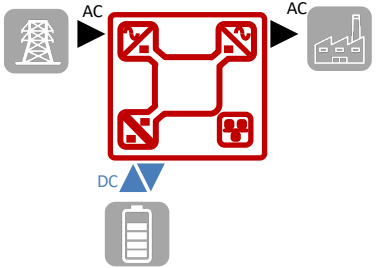
30Y preserving the LOAD



OPPORTUNITIES of the Energy Transition

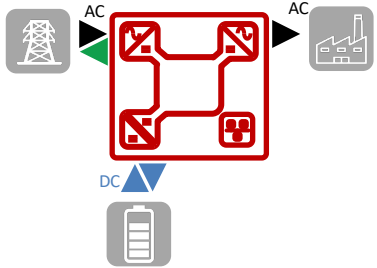
FUTURE in grid stability

Converter



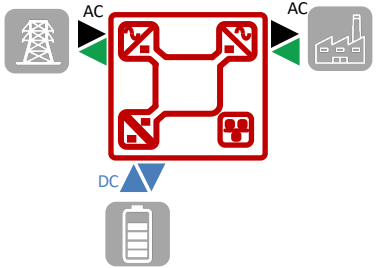
UPS/Backup

C&I Storage



Flexibility

Virtual Power Plant



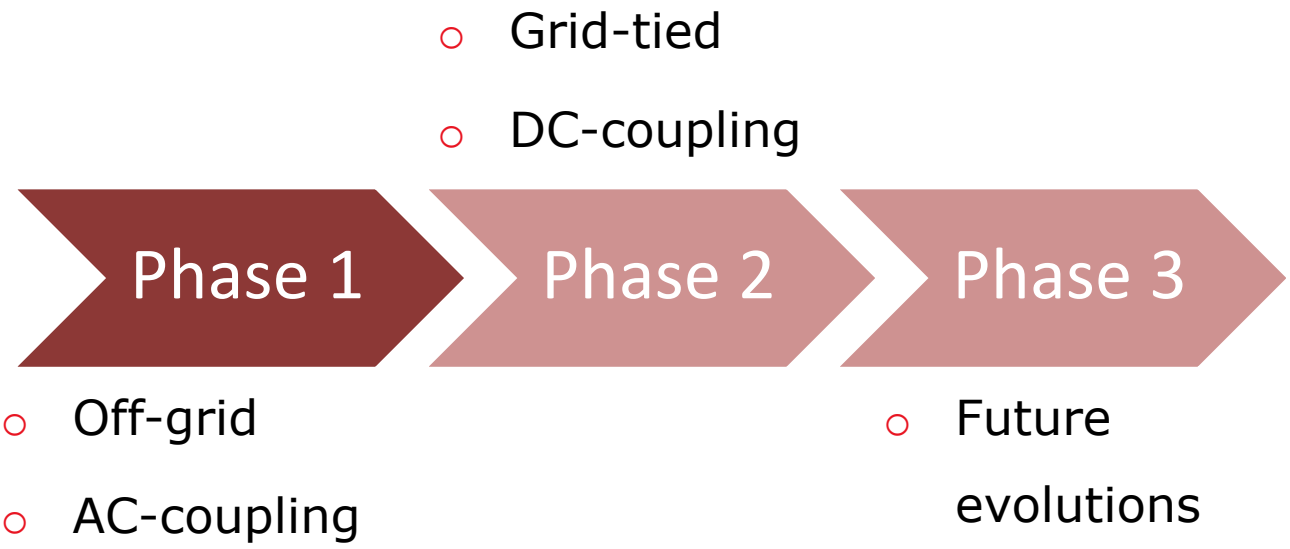
Grid Interaction

Products

Solution Enabler & Turnkey Solutions

PV production is an intermittent renewable source which can be recycled

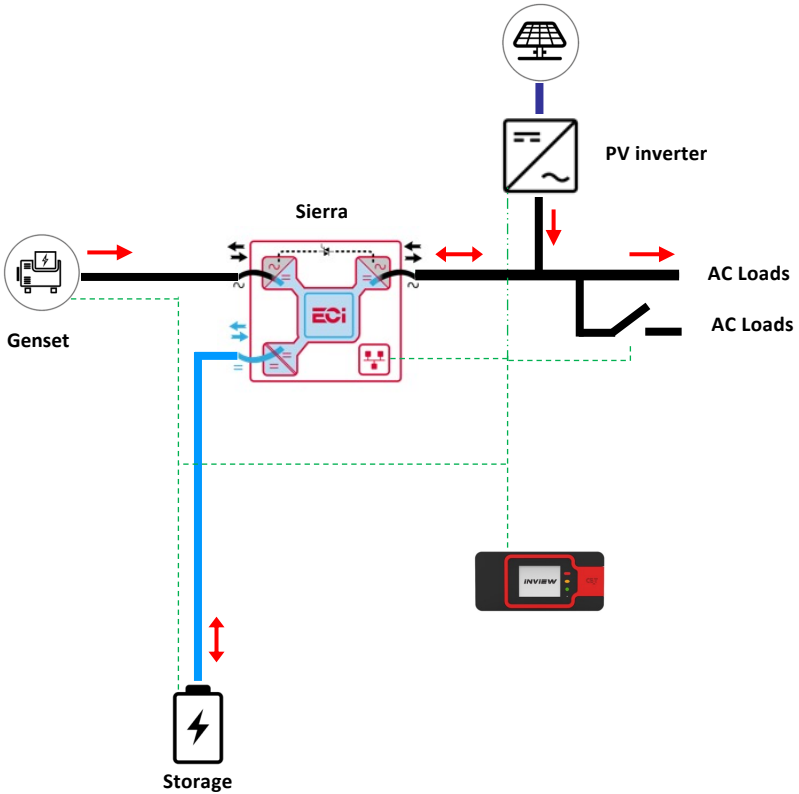
How do we plan to recycle energy from PV with Sierra?



PHASE 1

OFF-GRID & AC-COUPLING

Off-grid & AC-coupling set up:
PV inverter, storage and potentially a genset



PHASE 1

OFF-GRID & AC-COUPLING

AC coupling

= when your PV converters are connected to the AC out of your installation

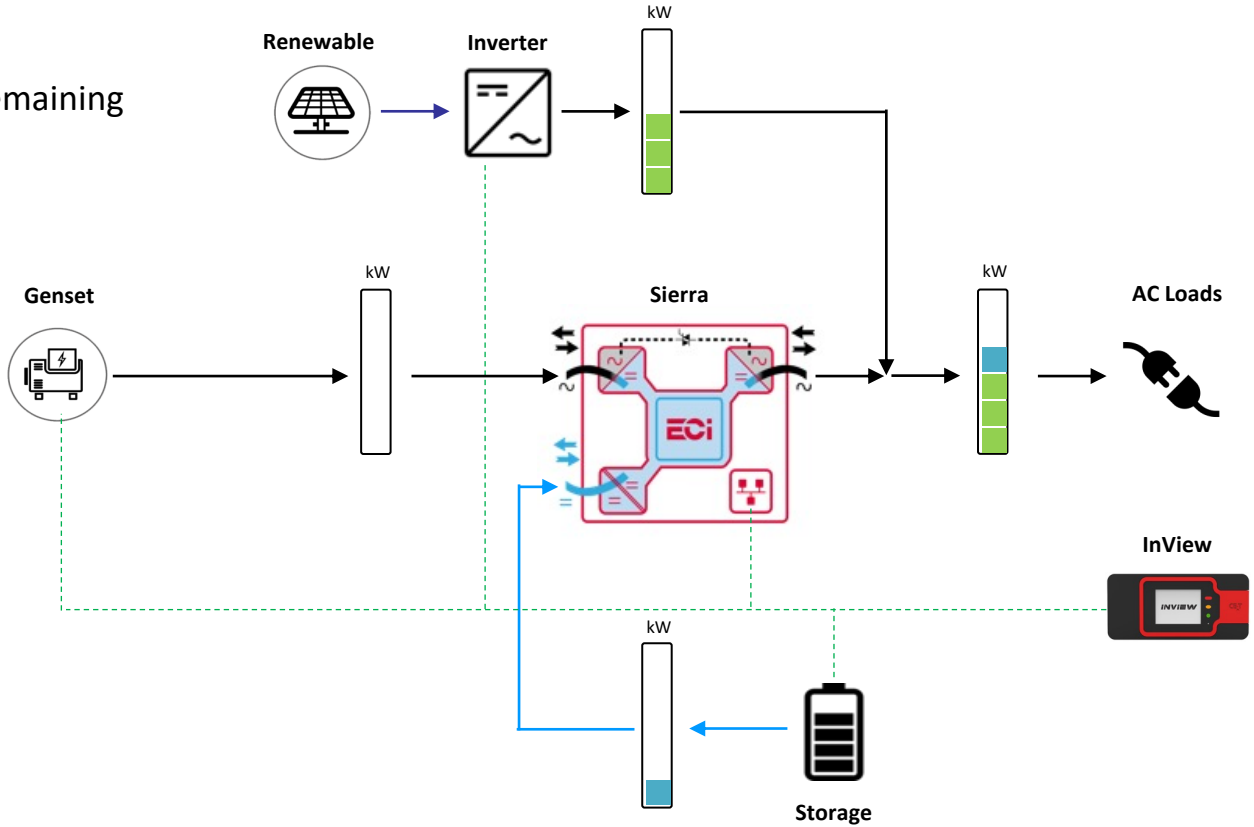
Why using it?

- **Higher efficiency** when used to power AC loads during the day (less conversions)
- Generally lower installation costs for **larger systems**
- Use the existing infrastructure (**brown field**)
- Large choices and possibilities of **integration**

Lack of PV production wrt the loads, the battery discharges

Normal operation:

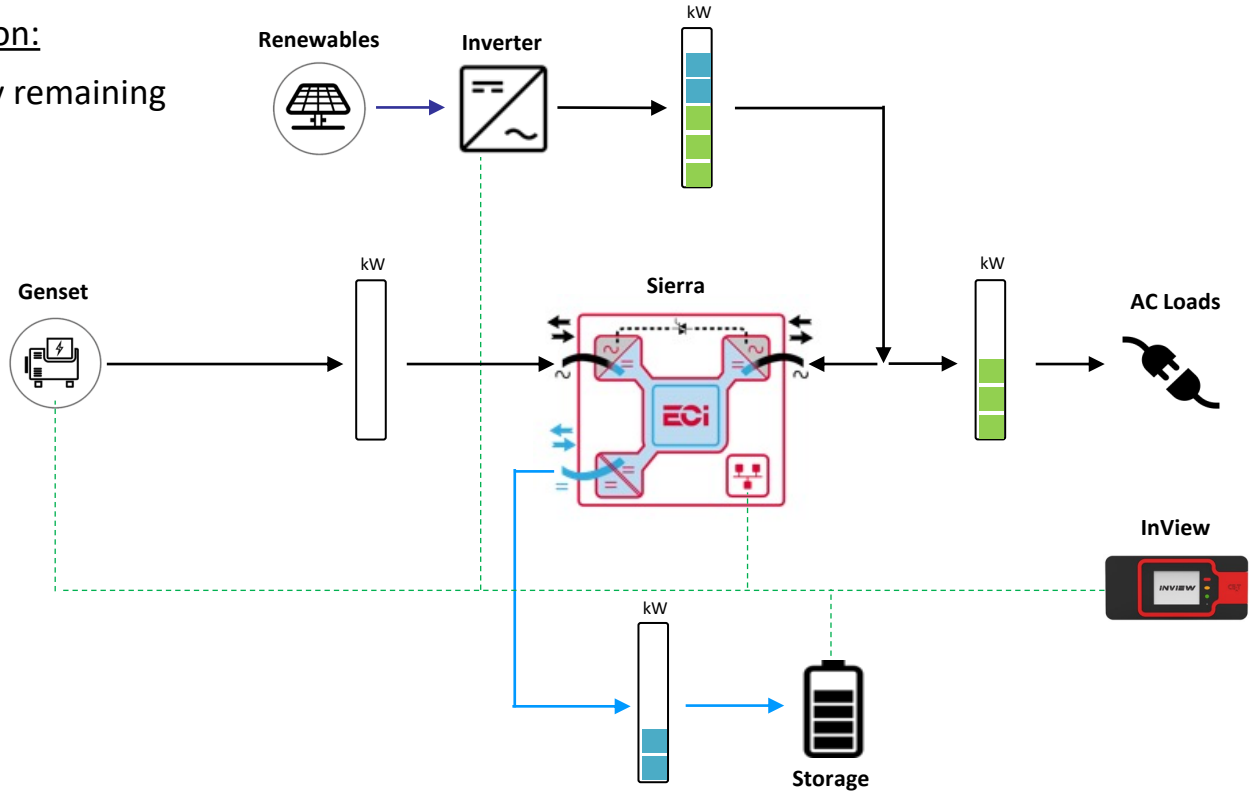
Battery capacity remaining



Excess of PV production wrt the loads, the battery charges

<u>Normal operation:</u>

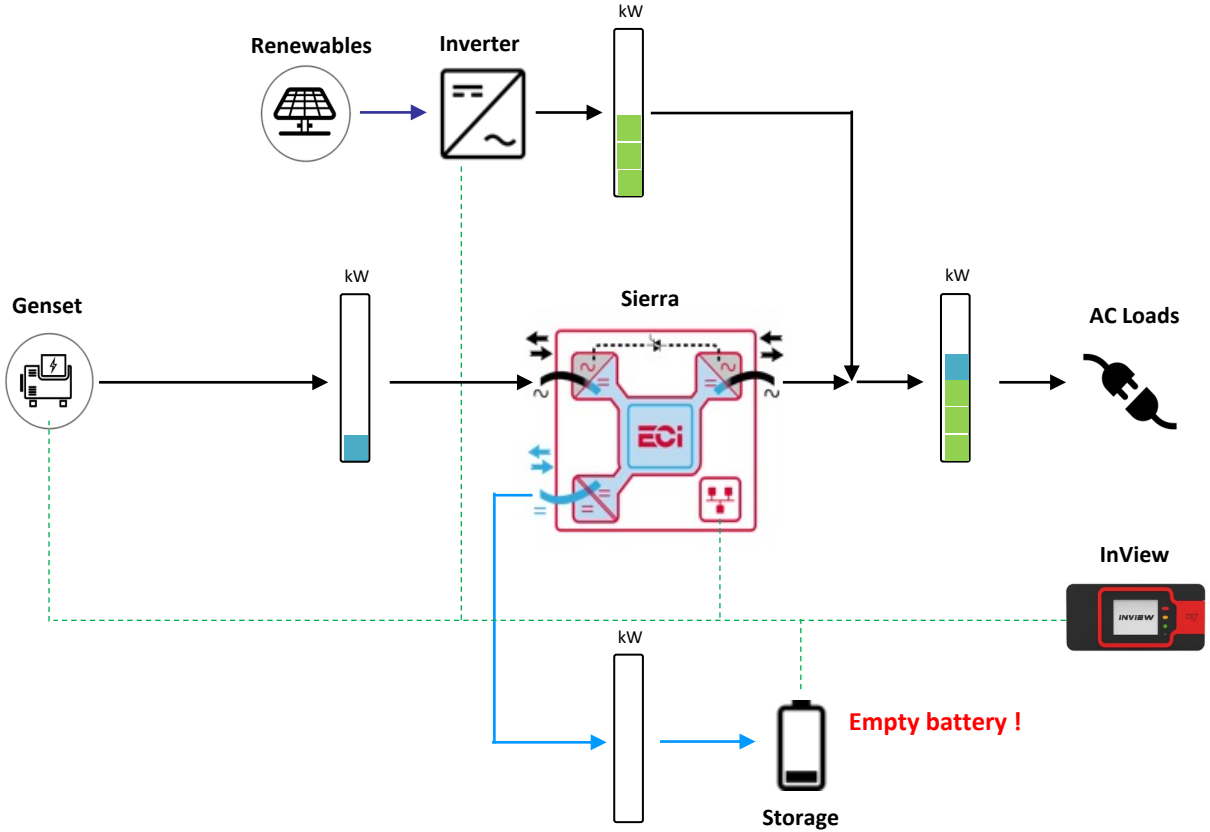
Battery capacity remaining



Lack of PV production wrt to loads with genset connected

Corner case:

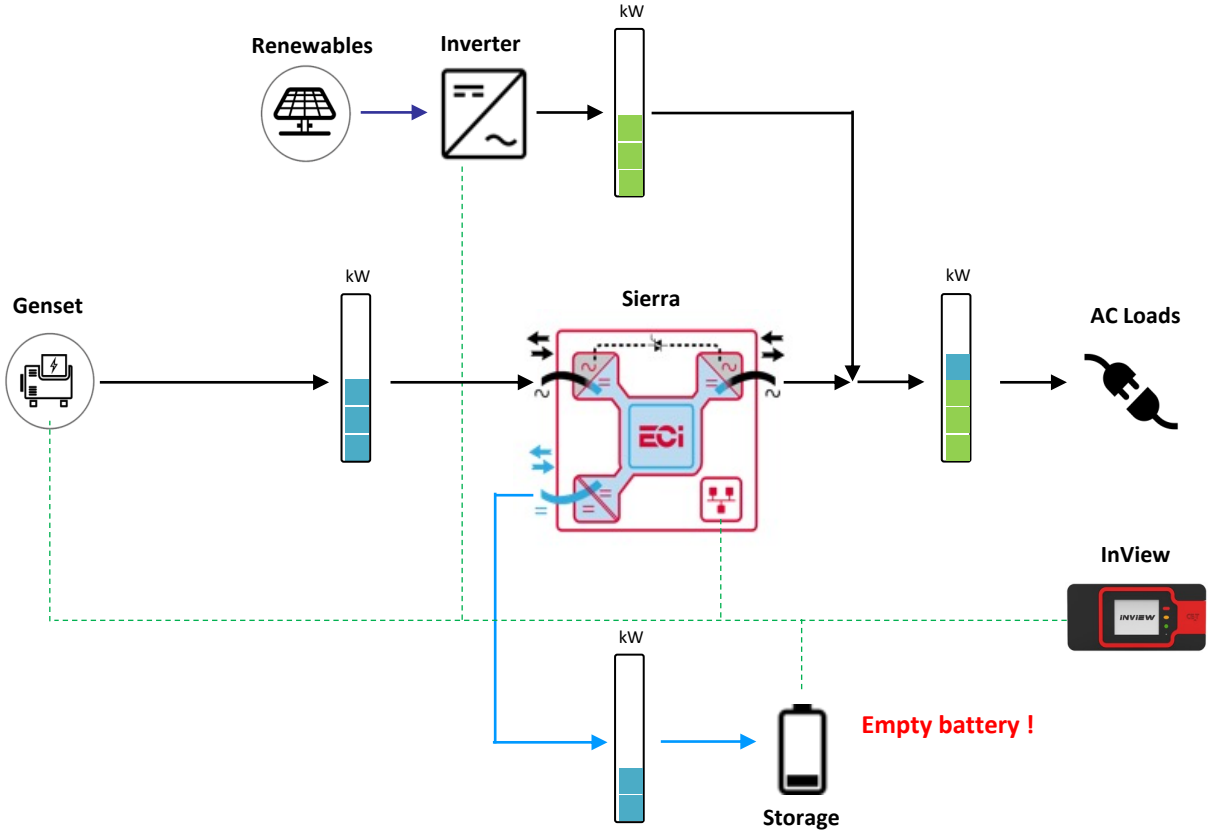
Lack of production
& battery empty
→ Genset



Lack of PV production wrt to loads with genset connected and the battery recharging

<u>Corner case:</u>

Lack of production
& battery empty
→ Genset



Excess of PV production wrt loads and battery full: PV production is curtailed by **frequency control**

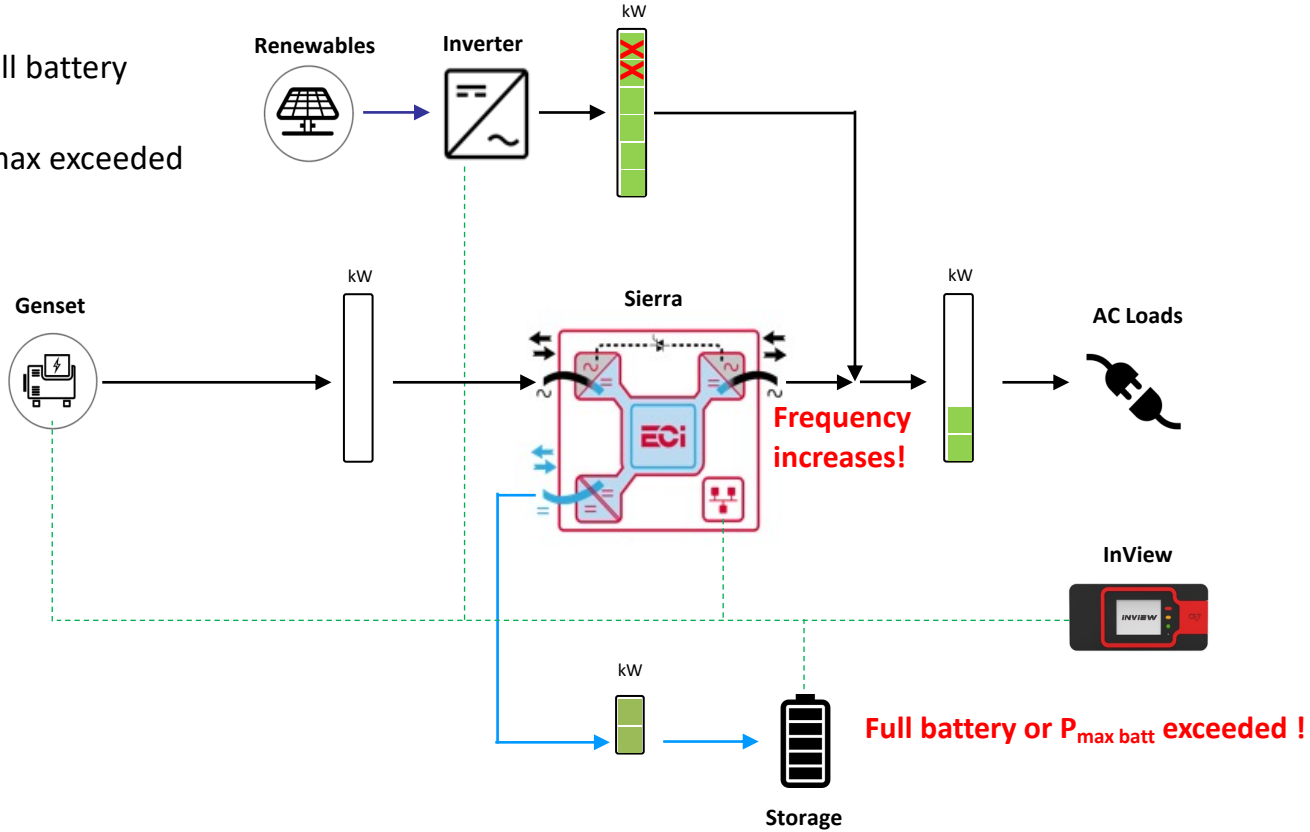
Corner case:

Excess of production & full battery

or

Excess of production & Pmax exceeded

→ Curtailment



Excess of PV production wrt loads and battery full: PV production is curtailed by **communication**

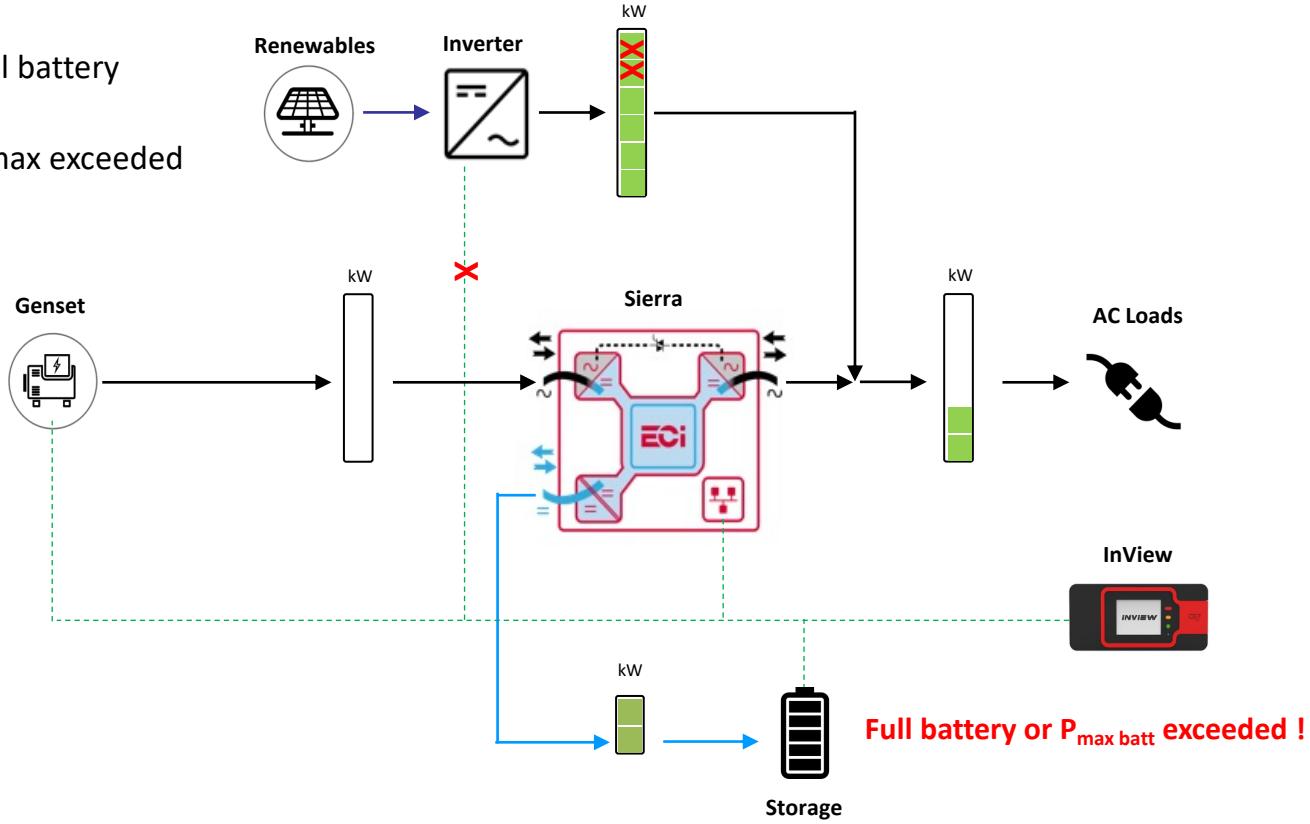
<u>Corner case:</u>

Excess of production & full battery

or

Excess of production & Pmax exceeded

→ Curtailment

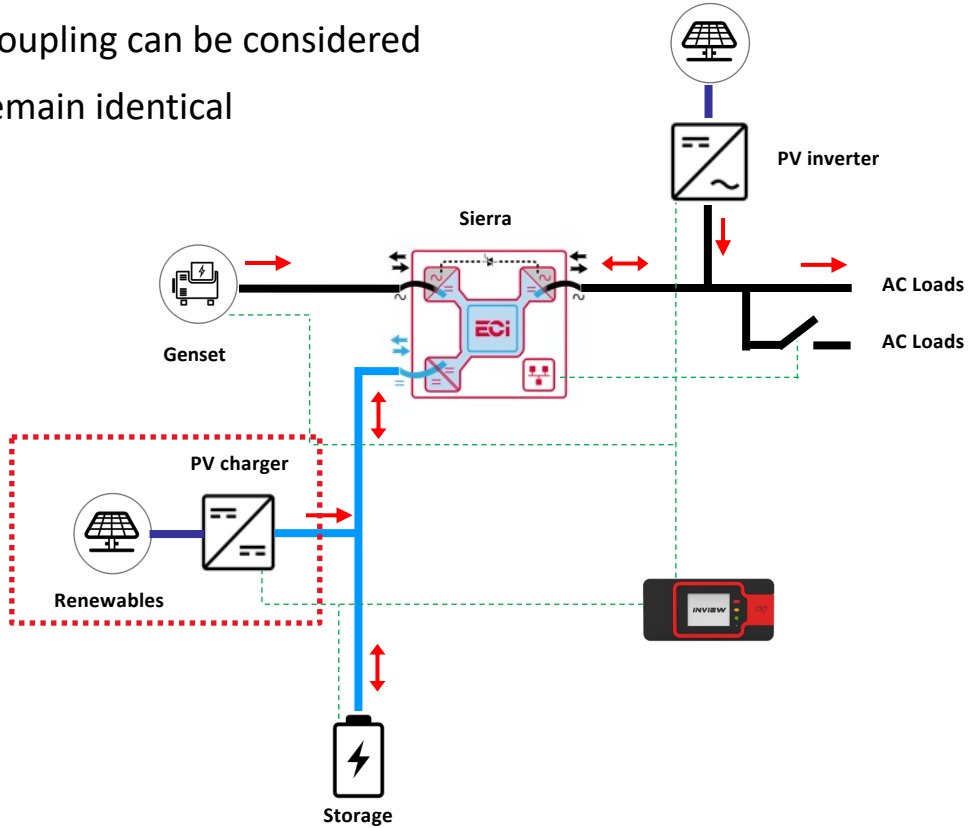


PHASE 2

GRID-TIED & DC-COUPLING

DC-coupling to recharge battery directly from DC side

- Combination of both coupling can be considered
- Operating principles remain identical

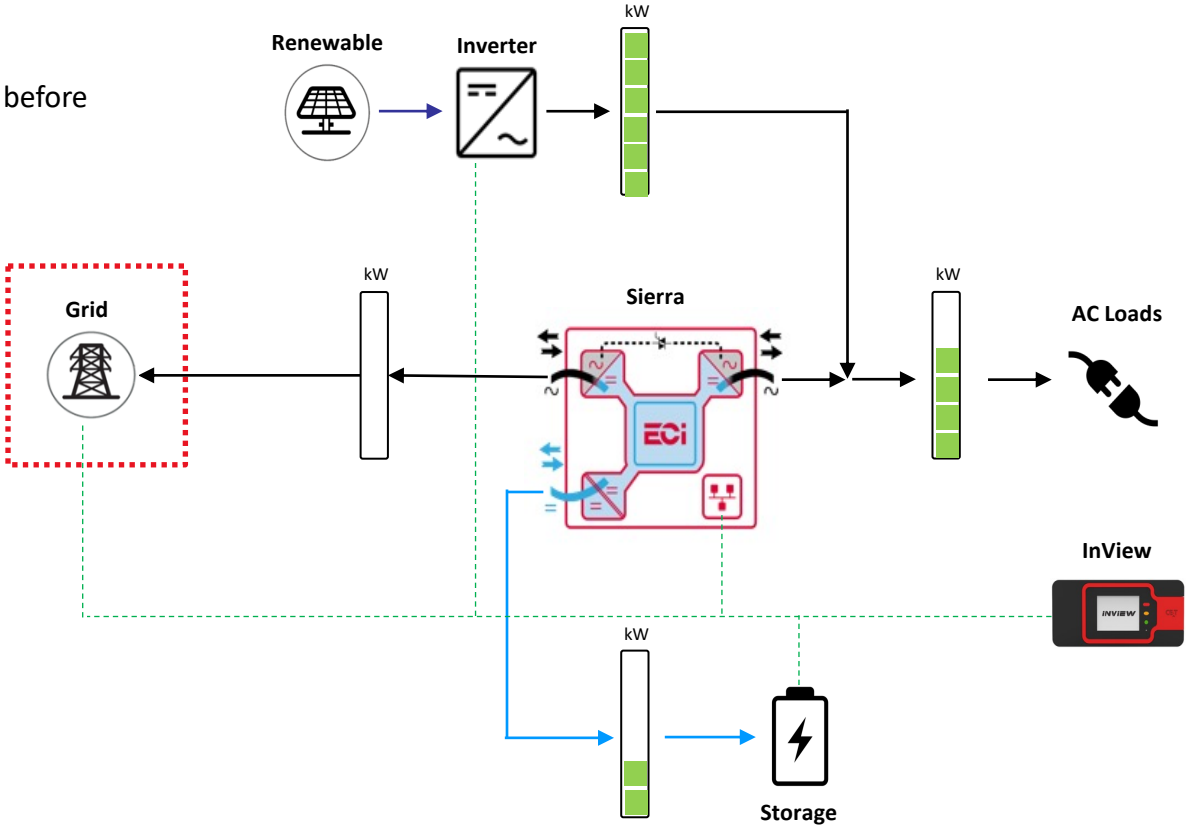


Excess of PV production can be sent to the grid to avoid curtailment

Grid-tied system:

Same functionalities as before

but less curtailment



Grid-tied – Curtailment

Grid injection may be:

- Prohibited
- Allowed
- Allowed with limited power

Curtailment strategy:

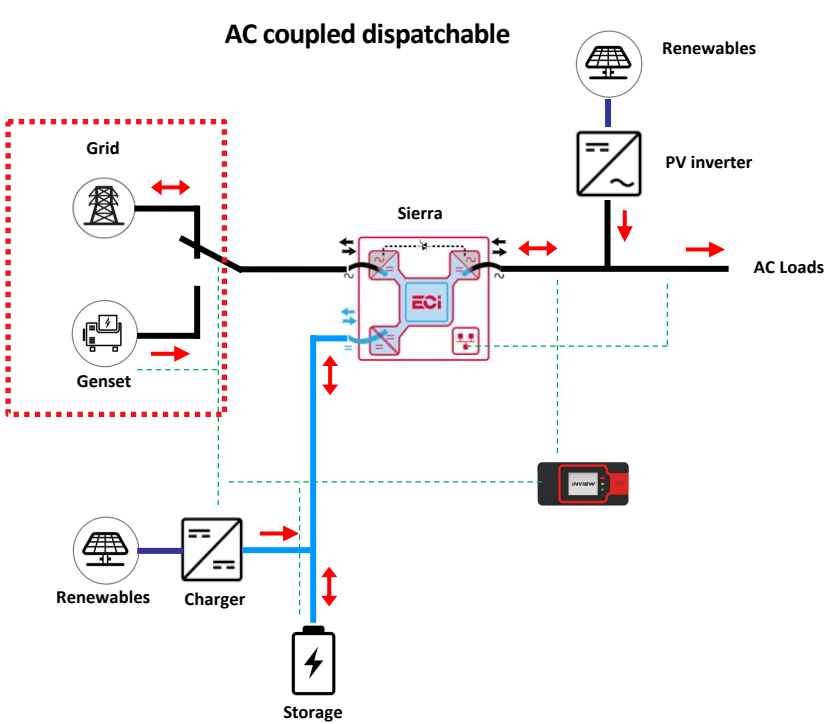
- Not necessary if grid injection is allowed without restriction (excess injection)
- Requires grid disconnection if grid injection is prohibited or if power limitation is exceeded
  - Use frequency shift to manage battery charging, as for off-grid, **once grid disconnected**
  - Means loss of exported power when above limit, w/ possible work-around (later step):
    - Adding “independent” inverters to reinject according to limit (but extra HW)
    - Improved control of PV inverter (communication or source “shedding”) to control reinjection & avoid disconnection
  - **Attention:** Transition required, to re-synch in case of sudden battery loss

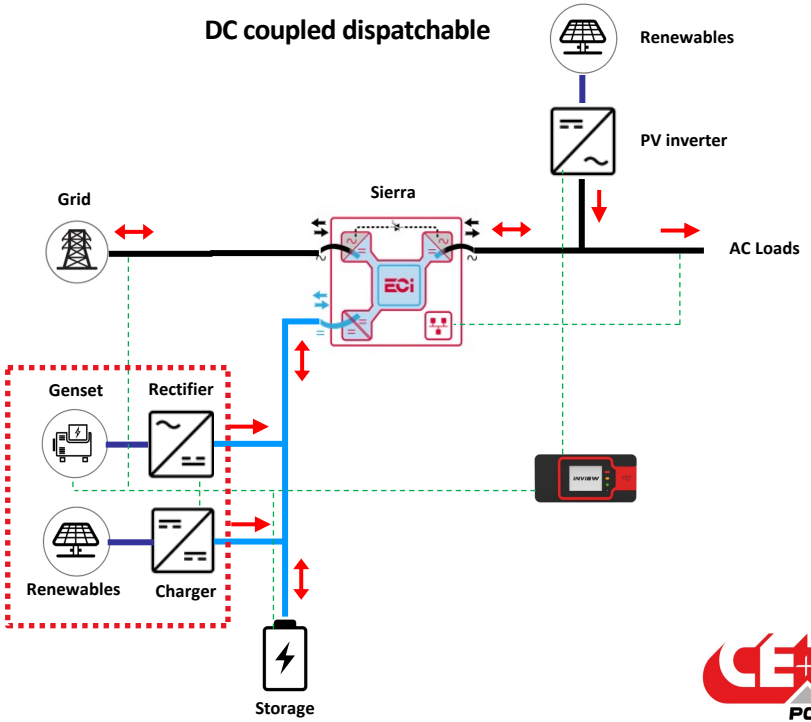
PHASE 3

FURTHER CONFIGURATIONS

Renewable and dispatchable energy sources can be both AC or DC-coupled

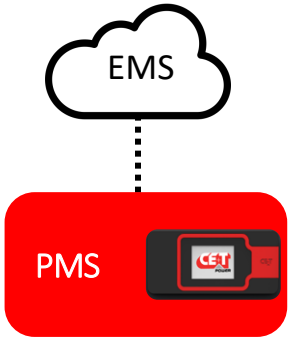
- Basic operating principles remain identical





Additional functionalities

- Grid connection = Increased range of possibilities:
  - Auto consumption maximization
  - Power capping
  - Energy arbitrage (Time of use)
  - Grid injection
  - Grid services
  - Islanding mode
  - …



- Possibility to **combine** different **functions** to **stack revenues/improve efficiency**
- Static (PMS) or dynamic (EMS) rules/control
- Increased role for EMS

DEMO INSIGHT

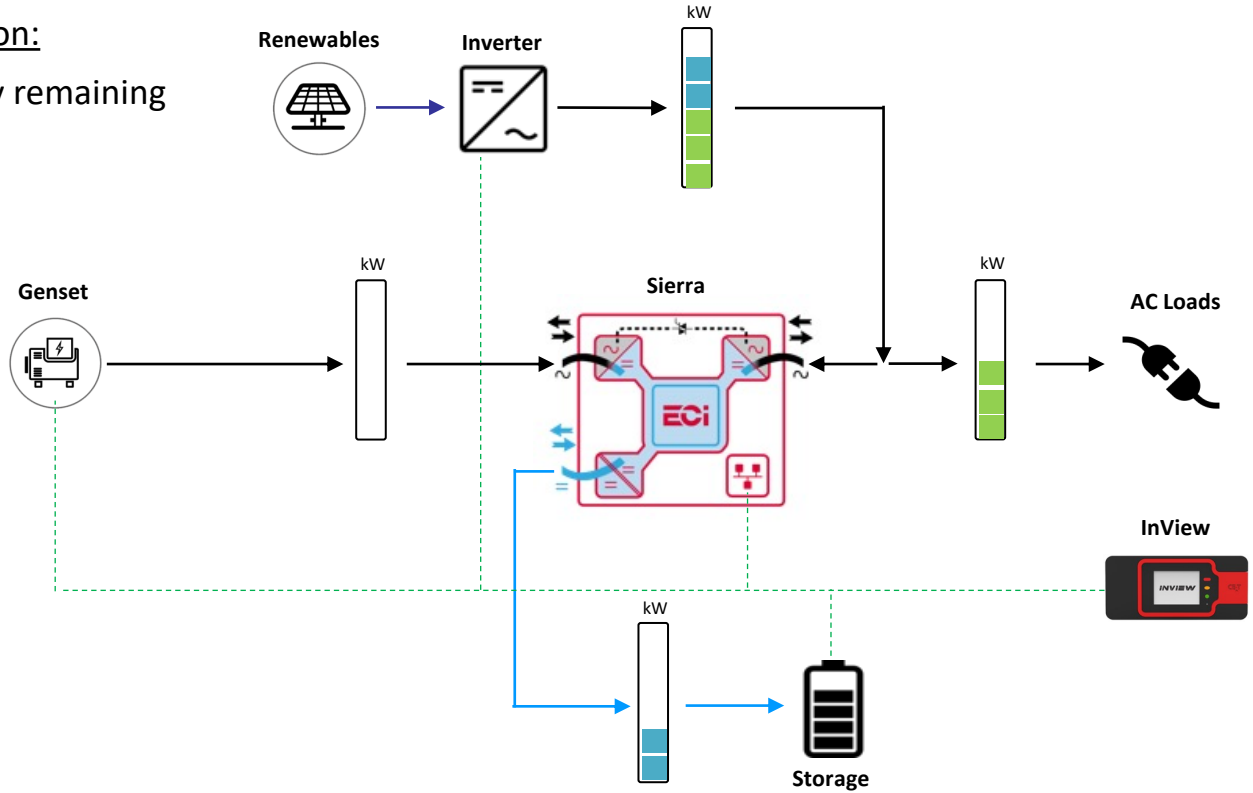
Demo plan

- Simulation of a complete day
- Succession of different steps:
  - Afternoon
  - Evening
  - Night
  - Morning

Step 1: Afternoon – Battery charging due to an excess of PV production

<u>Normal operation:</u>

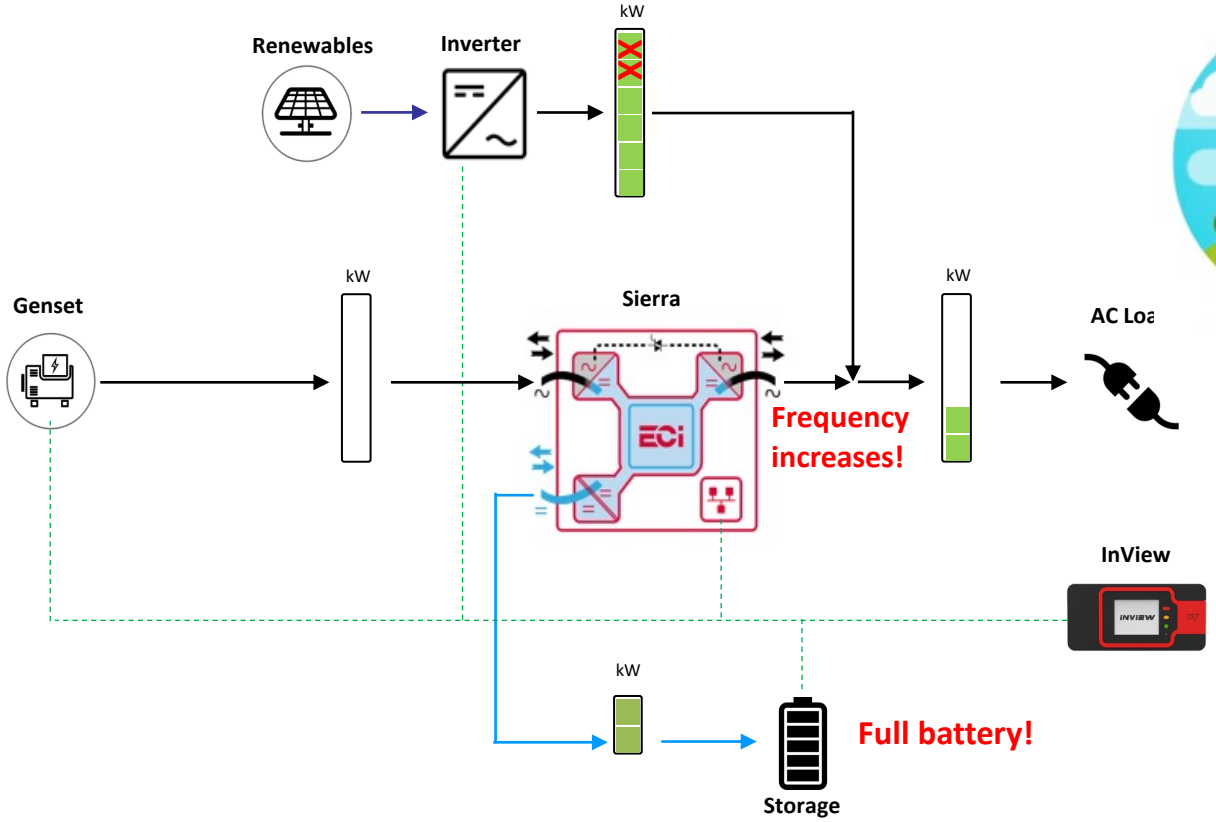
Battery capacity remaining



Step 2: Afternoon – Excess of PV production handled by curtailment

Corner case:

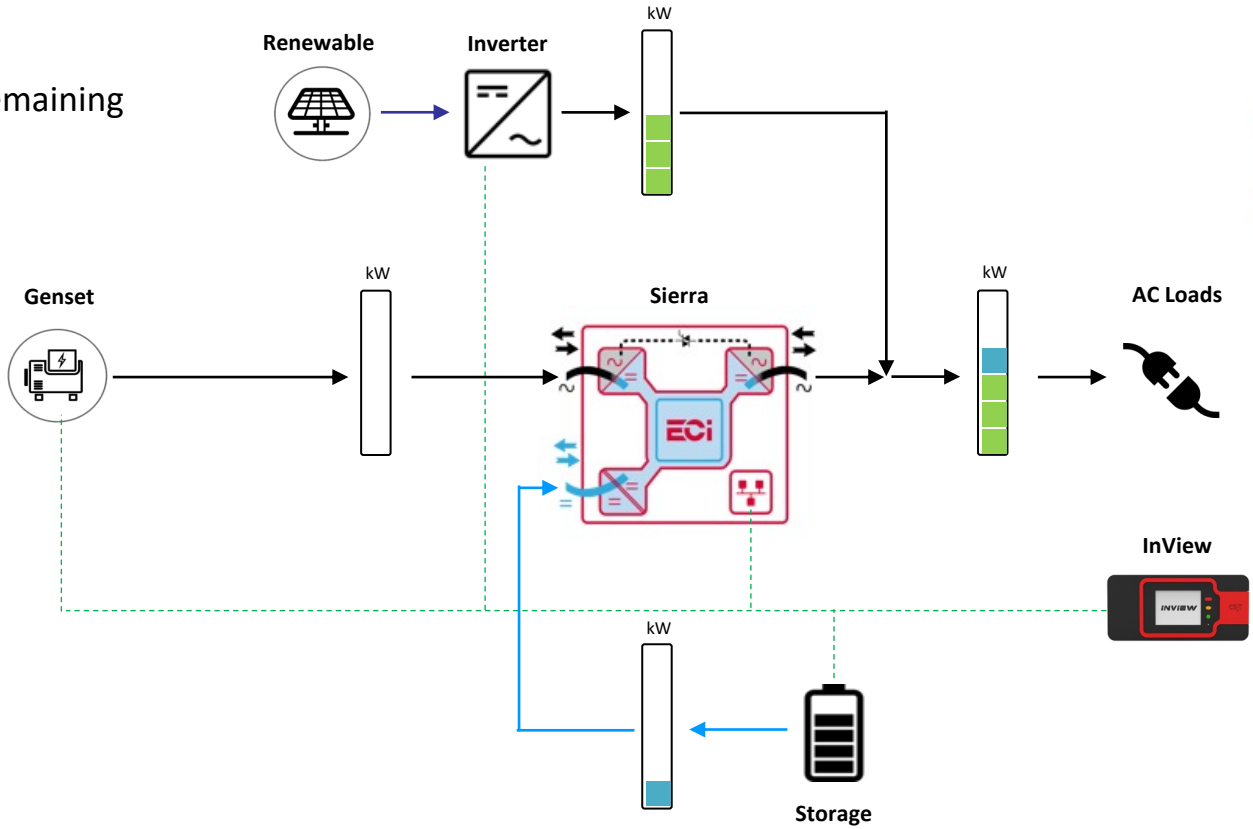
Battery is full



Step 3 - Evening: lack of PV production & storage is discharging

<u>Normal operation:</u>

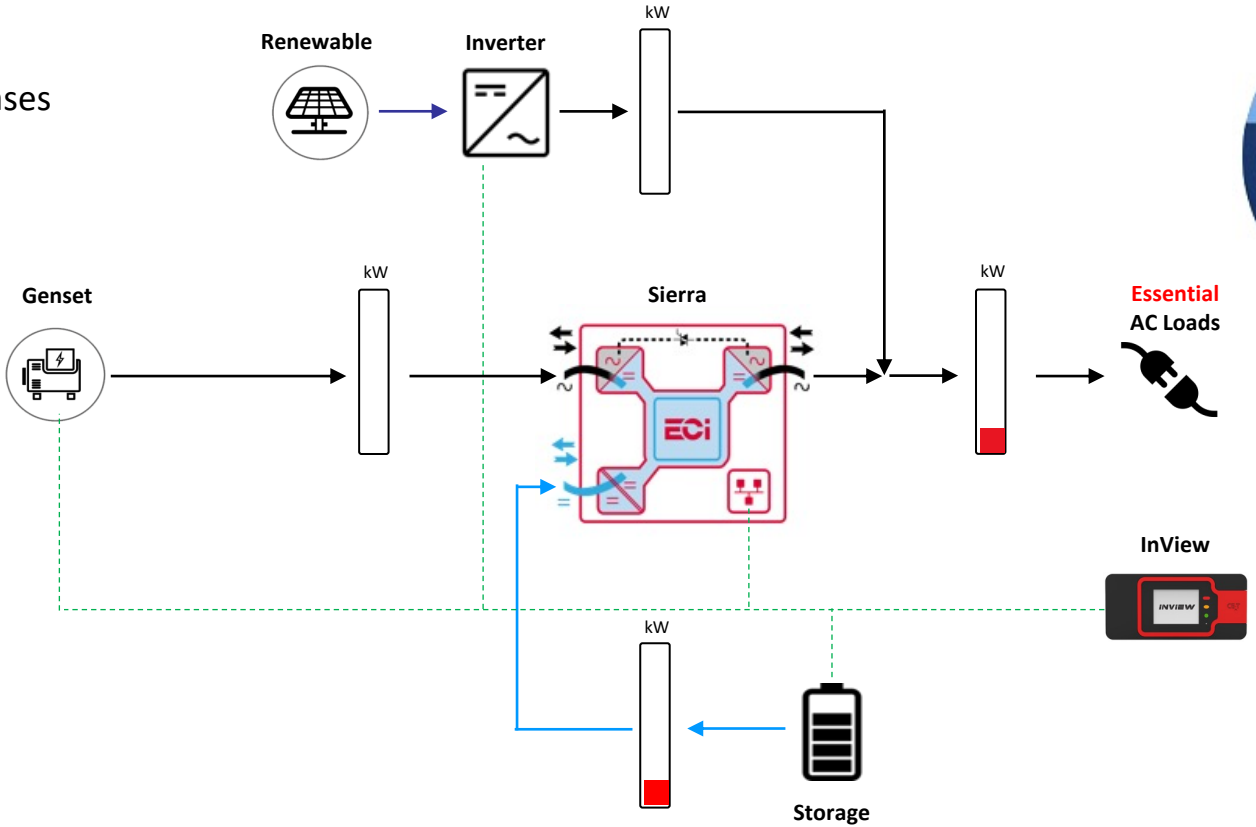
Battery capacity remaining



Step 4 - Night: Load shedding to keep power only for critical loads

<u>Normal operation:</u>

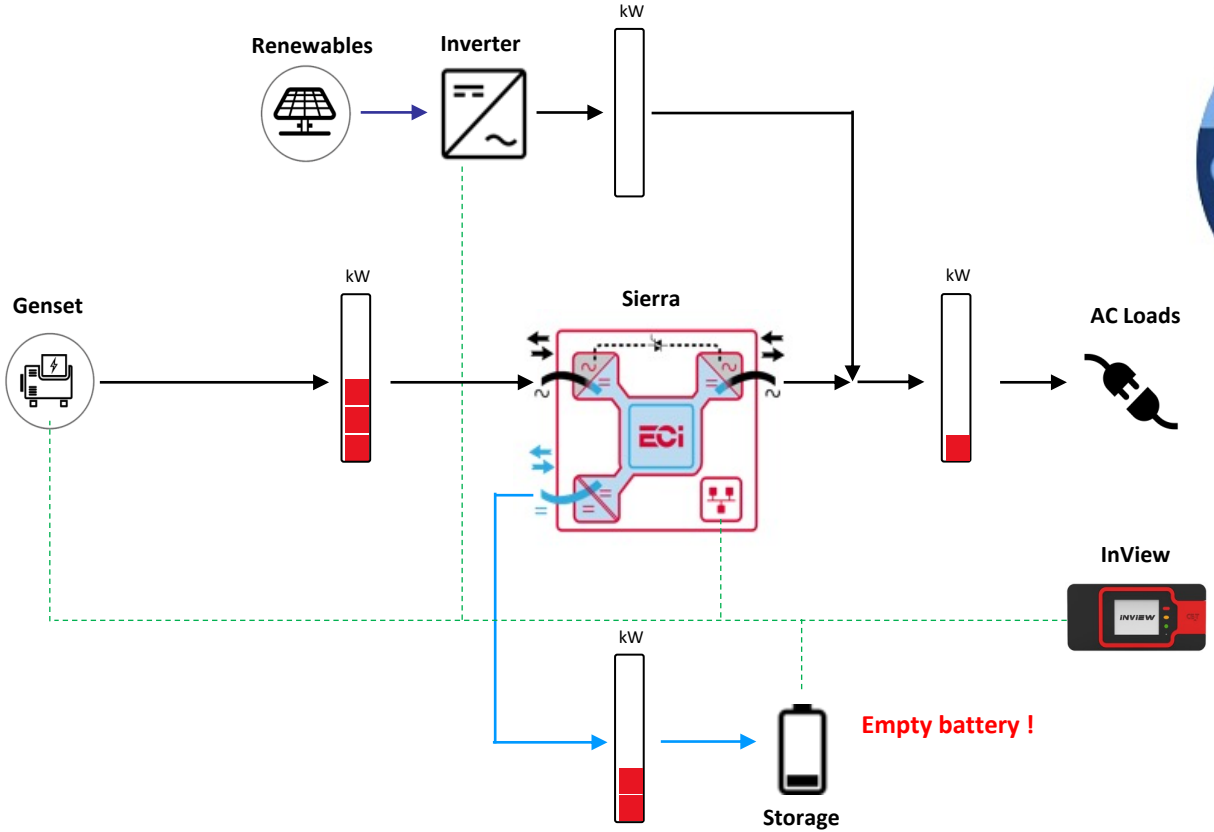
Battery SoC decreases



Step 5 – Night: Genset starts supplying critical loads and battery

Corner case:

Lack of production
& battery empty
→ Genset

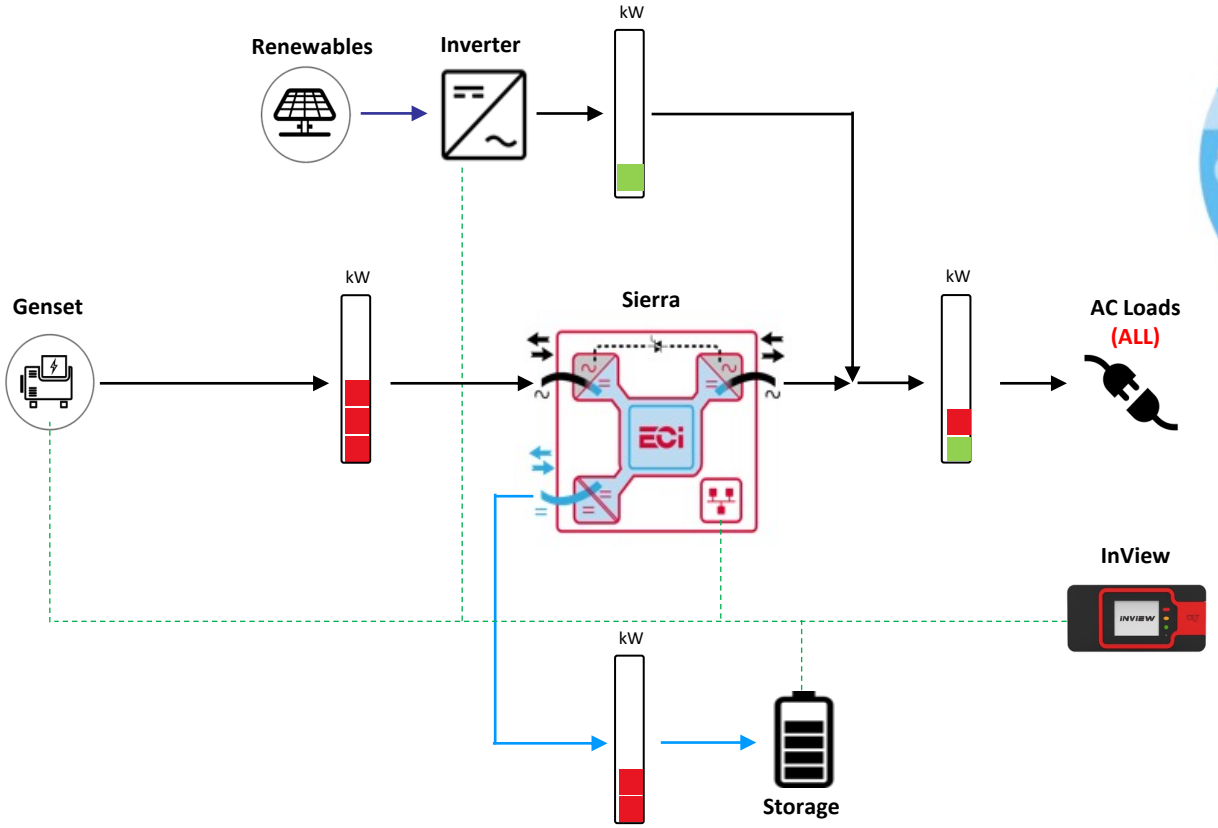


Step 6 – Morning: Non-essential loads are reconnected

Corner case:

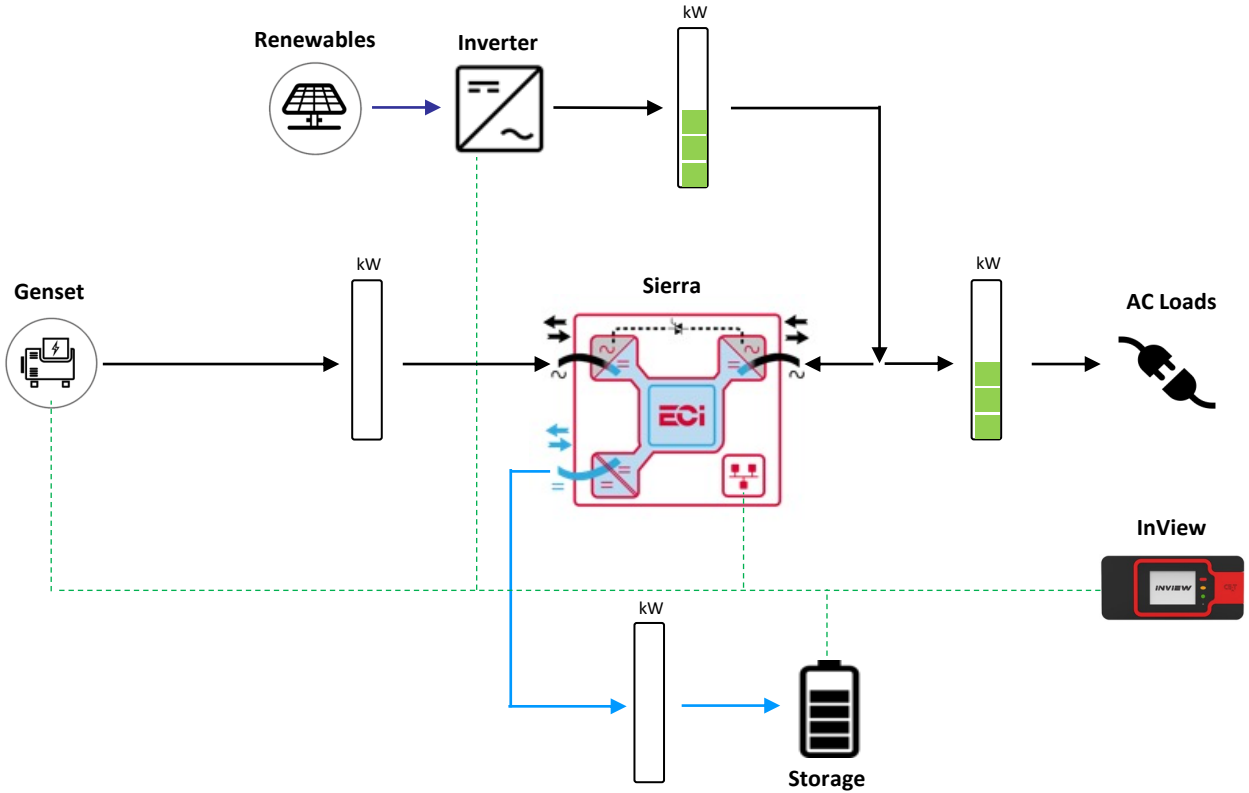
Battery is recharged & sun rise

→ Load reconnection



Step 7 – Morning: Sufficient PV production, the cycle restarts

Sun is shining



Thank you
for your attention

Check our website

www.cet-power.com

Follow us

Partner Forum 2022