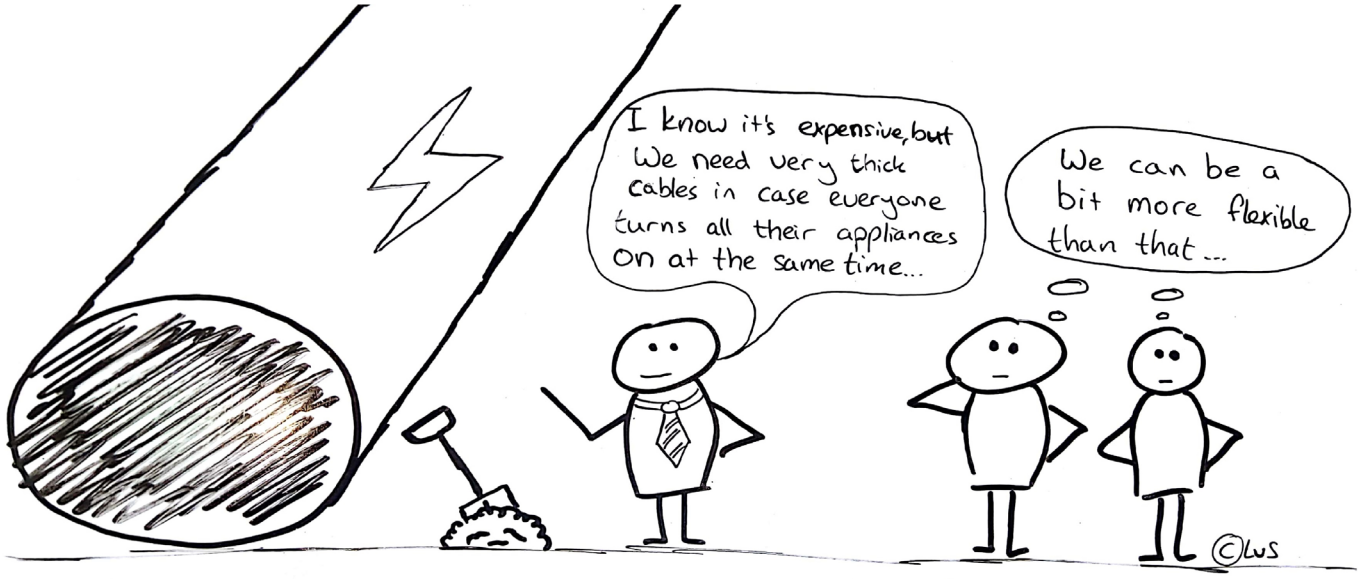
Crash course | Energy flexibility

WHAT?

This Crash Course explains what flexibility is, why it is increasingly important and how energy communities can benefit from providing flexibility.



Energy Flexibility

Flexibility means being able to adapt. Energy flexibility entails an adaption in the timing of energy supply and/or demand.

Two types of flexibility can be distinguished:

- **Supply-side flexibility:**
  Changing the moment at which energy is generated and supplied
  –> With RES this is difficult because we cannot influence the weather (we can only decrease supply by disconnecting RES, which leads to a loss of RE).

- **Demand-side flexibility:**
  Changing the timing of electricity use, and therewith the timing of the energy demand.
  –> Use of appliances can be shifted to other moments in time.

Providing demand-side flexibility means: ‘Changing the moment at which electricity is used’. This can be achieved in several ways: controllable appliances can be used at a different moment compared to their usual use, and/or an energy can be stored in storage systems.

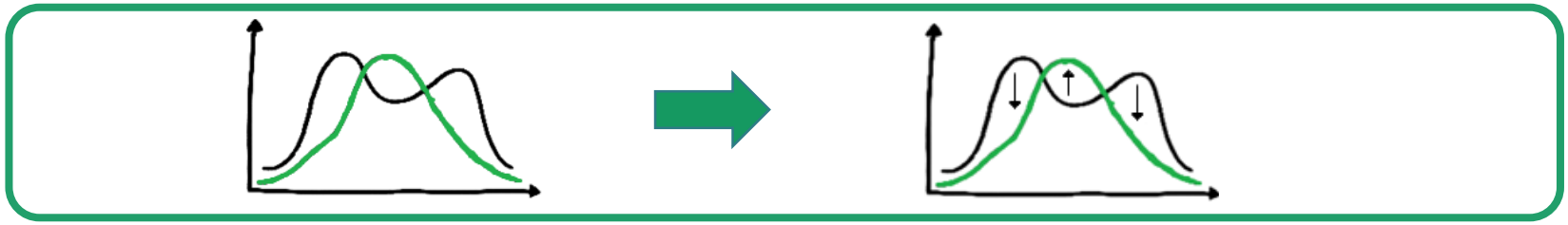
The following slides focus on demand-side flexibility, as this fits best to the possibilities of energy communities.

Why does the electricity system need flexibility?

In order to ensure a safe and reliable electricity system, supply and demand of electricity must be equal at each moment in time. However:

- RES that generate electricity depend on the availability of sun and the wind, which are not always present.
- Households use electricity when they need it, regardless of the availability of sun or wind.

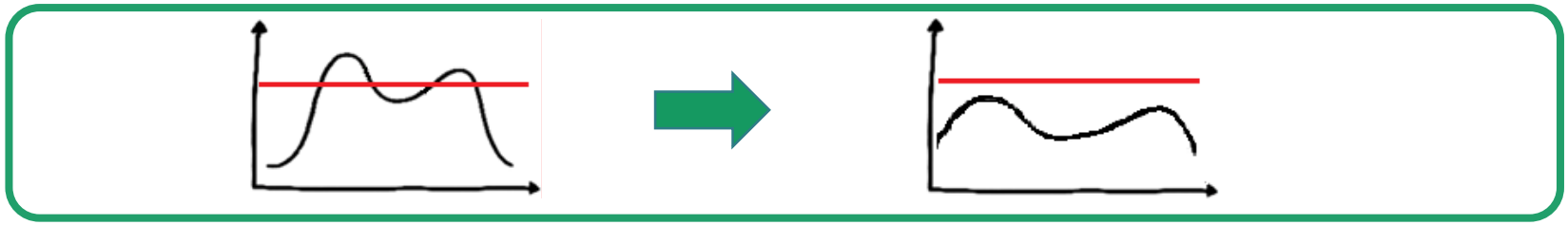
The figures below exemplify how demand-side flexibility can be used to balance demand and supply. It presents an example of **solar generation** (green line) and an **average household consumption pattern** (black line) over the timespan of a day.



By using fewer appliances at moments when no RE is available, and using more appliances when RE is available, the **household consumption pattern** becomes more similar to the **solar generation pattern**, which contributes to a better 'matching' of supply and demand.

Flexibility in order to prevent the need for grid reinforcement

Next to the need for balancing, demand and supply must also stay within the limits of the maximum capacity of electricity that can flow through the cables of the distribution and transmission network (**red line** in the figure below). In case capacity is insufficient to meet demand or supply, networks need to be reinforced, which is costly.



Demand side flexibility can provide a solution: by shifting energy demand (or supply) in time, away from the peak moments, the amount of electricity transferred can stay within the capacity limits. This way network reinforcements can be prevented.

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Why is flexibility interesting for energy communities?

- There can be a financial reward for providing flexibility and contributing to solving balancing and capacity issues.
- This way more flexibility can contribute to the integration of an increasing number of RES to the electricity network.
- Flexibility offers an opportunity to maximise use of self-generated, renewable electricity, by balancing demand and supply within the community. Thereby minimising the amount of electricity to be bought from third party suppliers.

Flexibility provided by controllable appliances

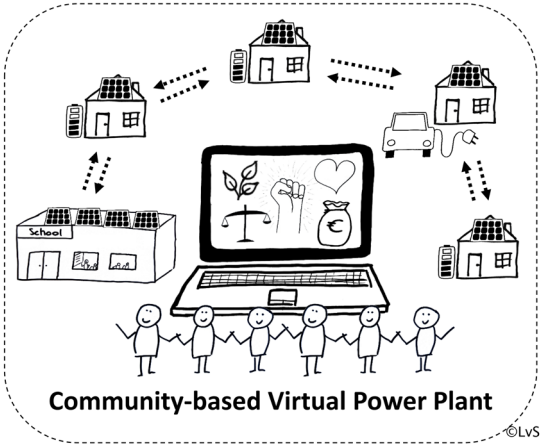
Examples of appliances that are suitable to use for flexibility are: heat pumps, electric vehicles, electric boilers and other electrical appliances such as washing machines and dishwashers.

Households can offer demand-side flexibility in two different ways:

- ☐ Behaviour and routines are changed to reduce or shift energy consumption in time.
  e.g. the dishwasher is used at different moments in time.

- ☐ Appliances are controlled autonomously by an ICT based energy management system to reduce demand.
  e.g. energy is stored in batteries at moments when generation is higher than demand.

In a cVPP flexibility is provided **collectively** by connecting all households to one energy management system (EMS), which controls not only generation, controllable appliances and storage systems installed in households, but potentially also collective resources.
(e.g. wind turbine, solar farm, neighbourhood battery).



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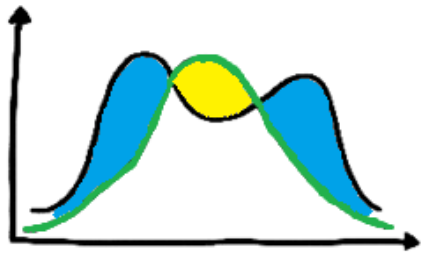
How can energy communities provide flexibility by means of energy storage systems?

A storage system, such as e.g. a battery, can provide flexibility in a special way.
Storage can influence electricity demand (just like other appliances), but also can influence the supply of electricity.

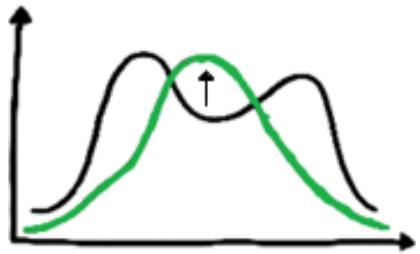
A storage device can act in two modes:

- Charging mode:
  acts as a 'normal' appliance by demanding energy

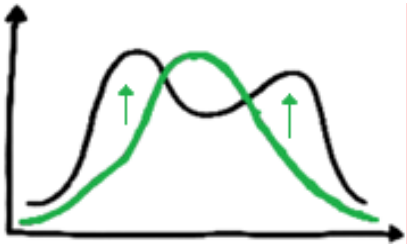
- Discharging mode:
  acts as an energy source by supplying energy



During **yellow moments** (more supply than demand),
the storage device can be set to **CHARGING mode**.
This results in an increase of demand.



During **blue moments** (more demand than supply),
the storage device can be set to **DISCHARGING mode**.
This results in an increase of supply.



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Explicit and implicit Demand Response: providing flexibility to the energy market

It is still uncertain how exactly the future market for flexibility will look like for individual households and energy communities.

Often a distinction is made between two demand response categories, each with its own financial incentives for demand-side flexibility:

- **Explicit Demand Response:**
  The community has a contract with an aggregator or directly with an actor interested in flexibility (e.g. a DSO or TSO). When this actor needs flexibility and notifies the community, the latter is required to deliver the amount of flexibility for a specific amount of time, which is agreed upon in the contract. Non-compliance may result in a penalty.

- **Implicit Demand Response:**
  Energy prices are dynamic and reflect the (dis)balance between demand and supply and/or the available capacity of the network. This creates a financial incentive for households and communities to shift energy demand to moments in time when prices are low.

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What does this mean for energy communities?

Participating in flexibility activities can provide opportunities for individual households and energy communities to work towards their environmental, social and economic goals. Examples of such activities are (see also **tool | Value - Goal - Activity**):

- ☐ Use flexibility provided by storage and household appliances to change household energy demand and/or supply in response to dynamic prices (e.g. lowering energy demand when prices are high)
- ☐ Use flexibility provided by storage and household appliances to balance demand and supply at the community level
- ☐ Use flexibility provided by storage and household appliances to minimise the peak power usage (and peak of energy fed back to the distribution network) within households to lower the capacity tariff of households (tariff depending on size of connection with the network)
- ☐ Actively collecting, aggregating and selling flexibility from RE, controllable appliances and storage (bundling this with flex from other communities, as an aggregator) (at distribution or transmission level)
- ☐ Actively collecting flexibility from RE, controllable appliances and storage and sell this through a third-party aggregator (at distribution or transmission level)

Further information regarding flexibility, related to citizen energy communities can be found in the whitepaper of USEF on Energy & Flexibility Services for Citizens Energy Communities.