

Solar Energy needs Smart inverters

Market insight on flexible connected residential PV inverters (summary)

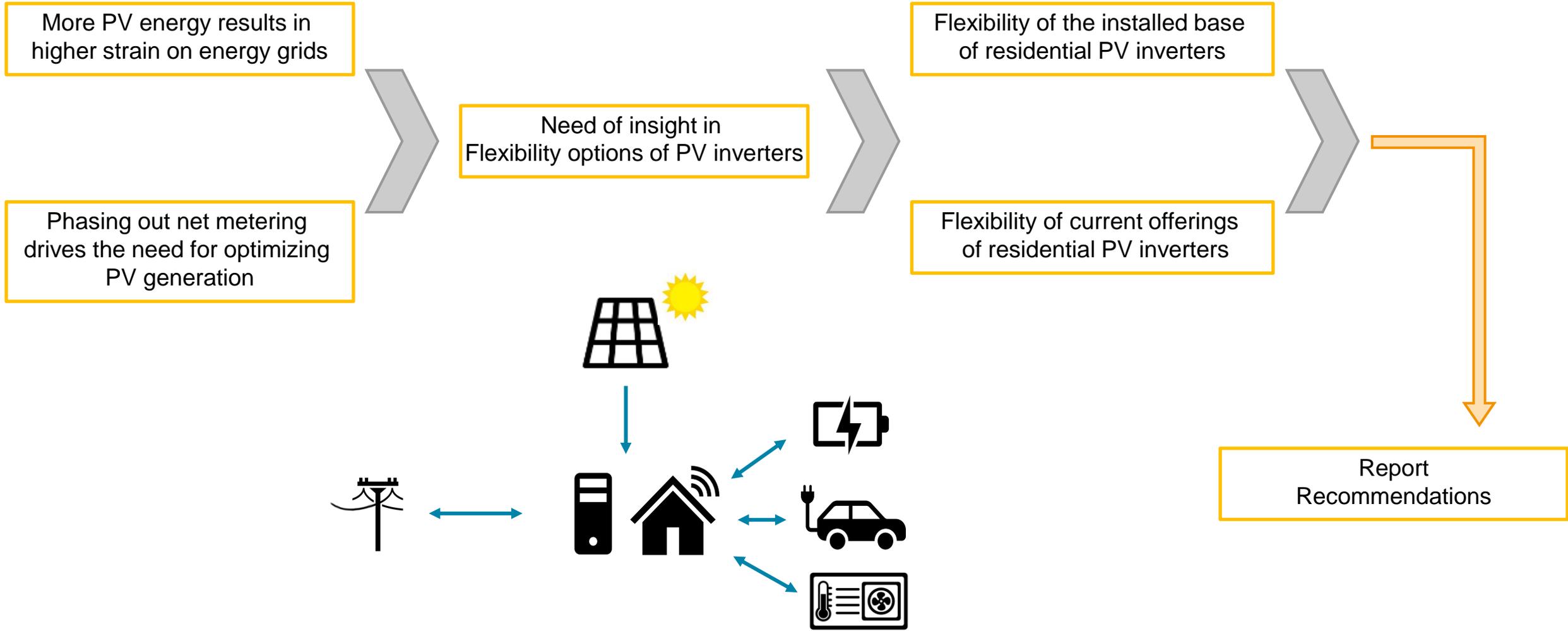
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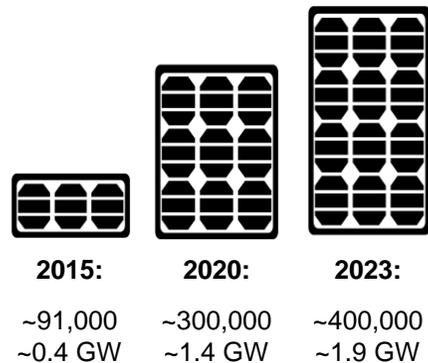
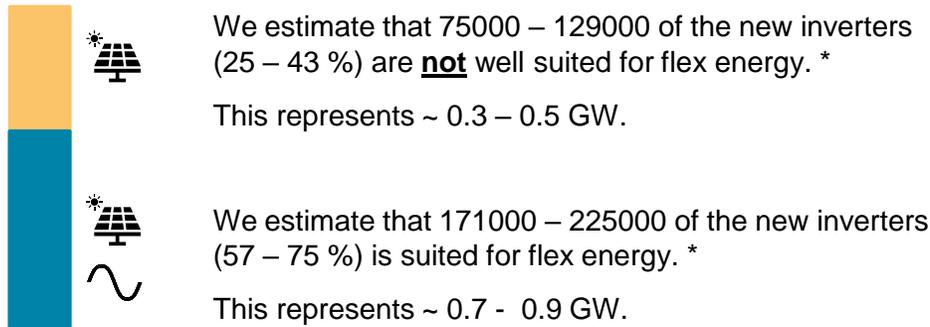
Background



Executive summary 1 / 2 – The trend

→ From the residential PV inverters installed in 2019, over 50% (max 75%) have advanced functionality, allowing them to participate in Flexibility Services.

In 2020, approximately 300000 residential PV inverters will be installed, representing ~ 1.2 GW.



Annual sales:
The residential PV inverter market has grown rapidly, and annual sales will continue to grow.

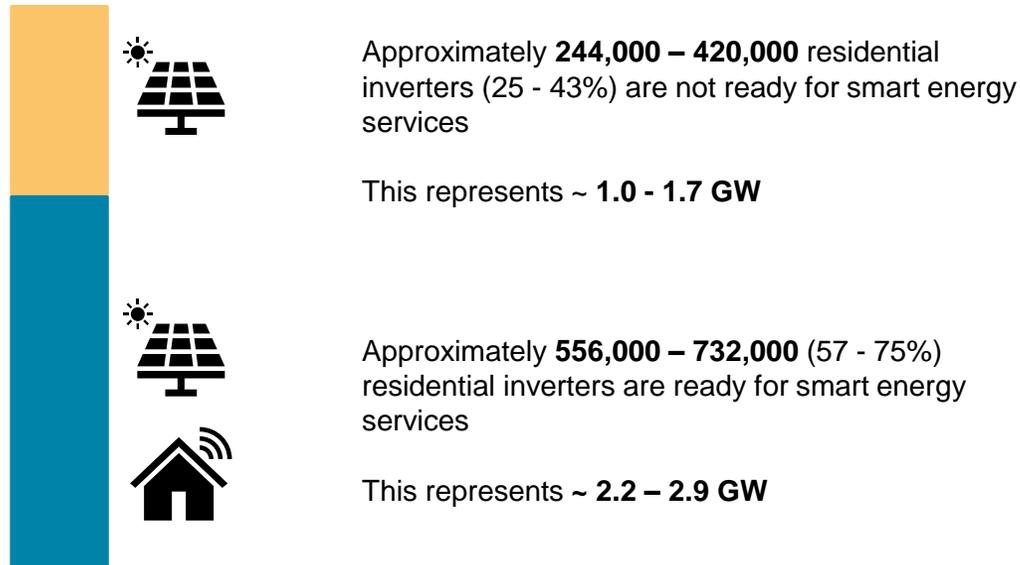
- The installed base of residential PV systems in the Netherlands (NL) is ~0.98 million (2019).
- All new residential inverters available on the market have remote monitoring and diagnostics functionality.
- Products from the market leaders have modulating remote control functionality, enabling them to ‘turn up’ and ‘turn down’ the output of the PV system. These can be considered optimally suited for Energy Flexibility.
 - Since the market leaders hold 57 – 75 % of the market, a large proportion of inverters available on the market today are flex ready.
- In addition to inverters for *new* PV systems, the market for replacement PV inverters is growing.
- Even when the inverter itself is Flex Ready, integrating Inverters into Smart Energy Services is not very scalable currently. Some important hurdles are: no standard for unlocking flexibility, additional extra hardware may be needed, and cloud services from manufacturers may be required.

* We consider inverters ‘ready for Energy Flexibility Services’ when they offer ‘modulating remote control’. 25 – 43 % only offer monitoring or *on / off* functionality. See page 6

Executive summary 2 / 2 – The installed base

→ By the end of 2019, we estimate 57-75% of installed residential PV inverters were ready for some form of Smart Energy Services, representing $\pm 2.2 - 2.9$ GW of PV inverter capacity. *

In 2019, there were approximately **976,000** residential PV inverters in the Netherlands, representing ~ 3.9 GW. The average residential PV inverter size is around 4 kW



- The market is crowded and competitive with at least 12 manufacturers active, with the top 7 brands taking about 95% the market share.
- The flexibility of inverters can play important roles:
 - Mitigating the end of net metering: Manage energy in the home and maximising self-consumption of PV generated electricity.
 - Support grid stability, prevent congestion and operate in VPPs.
- Manufacturers did not express many concerns regarding Flex and Residential PV
- Residential inverters are currently not used for flexibility services in NL.
- **The market** – rather than products – need to develop to enable this to happen.
- Awareness of Energy Flexibility in relation to residential PV is not high:
 - On 'what is Flex', and what is needed for Flex
 - On the benefits of Flex
 - Buyers tend to rely on recommendations of install parties and advisors. This offers good channels to bring forward the need for Flex.

* We consider inverters 'ready for some form of Smart Energy Services' when they offer at least monitoring and/or remote on/off functionality. See page 6

Types of inverters considered in this research

Inverter options today are PV, battery or hybrid

Where solar PV or a battery is installed as a single item, they will be installed with the associated inverter.

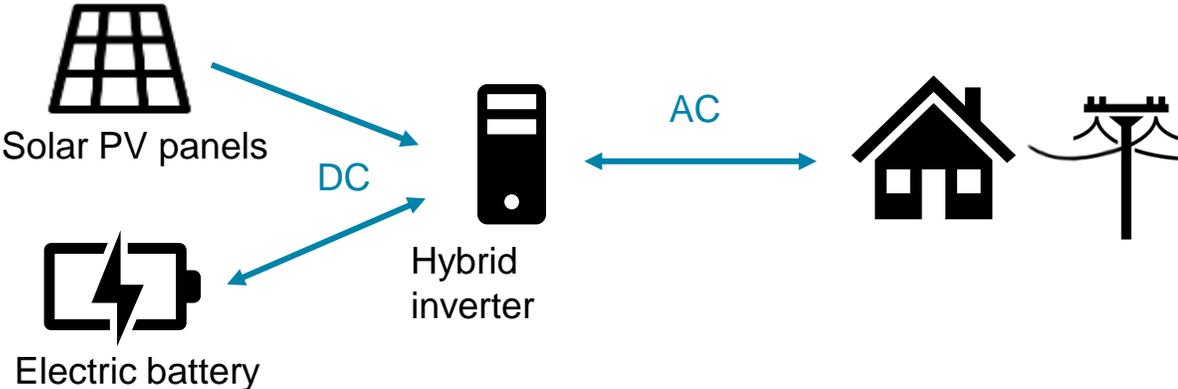
Solar PV inverter



One direction

Where PV and a battery are installed together, they will have a hybrid inverter (or could be installed with an inverter each).

Hybrid inverter

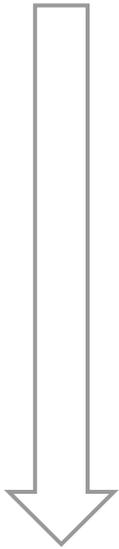


Bi-directional

Inverter flexibility levels

Inverters were assessed against five definitions

Limited/basic
functionality



Advanced
functionality

Inverter functionality	Definition	Approx. % of sales	Prevalence and explanation
1. Dumb / blind	No connectivity or 'smart' elements.	0%	None of the inverters available on the market can be classed as dumb.
2. Monitoring and Energy Insight	Monitor solar system to track performance and fault detection.	16 – 30 % of all inverters	<u>All</u> available residential inverters have this functionality; but only 20% <i>only</i> have this functionality (i.e. do not also have remote control).
3. On/off remote control	The inverter can be switched on and off remotely.	14 – 20 % of all inverters	This functionality exists to enable a PV system to shutdown in an emergency (known as 'rapid shutdown'). This is a requirement under US regulations but not in Europe. It could in theory be used for other reasons (e.g. grid services), but this seems more likely to be developed where inverters have modulating remote control (4 or 5).
4. Modulating remote control (one direction)	The inverter can be turned up or down remotely. One direction means it can only <i>feed into</i> the grid. This is the highest level of flexibility that one-directional inverters can offer.	57 – 75 % of PV inverters	This functionality exists in more advanced inverters, although in the Netherlands this functionality is not currently used. <i>This is described in more detail on the next page.</i>
5. Modulating remote control (bi-directional)	The inverter can be turned up or down remotely. Bi-direction means it can <i>feed in and consume from</i> the grid.	57 – 75 % of hybrid inverters	As above.

Inverter functionality – how can it be used?

The categories are: energy insights, in-home optimisation and flex ready

The manufacturers who are market leaders in the Netherlands are also those with the most advanced inverters.

Energy insights, monitoring and remote diagnostics

All residential PV inverters in the current sales portfolio have remote monitoring to track solar generation, system performance and detect faults. The intelligence and monitoring systems are becoming more advanced.

Most inverters currently available can also track the home's electricity consumption with the assistance of an additional meter.

Inverters will typically come with a mobile app or web portal to view the monitoring system. Increasingly, inverters do not have a display on the unit and instead connect (via Wifi) to a remote device for users to view the monitoring system.



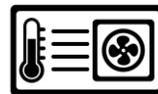
In-home optimisation

Some inverters currently available on the market can connect to energy loads in the home to maximise self-consumption of PV-generated electricity consumed within the home. This can include a battery, hot water tank, EV charger or smart appliances.

However, this functionality often requires an additional controller or meter.

Due to net metering, there has not been a strong driver in the Netherlands to maximise self-consumption in homes. However, this will increase as net metering is phased out.

In-home optimisation can be done intelligently by measuring energy flows and diverting electricity optimally. As connectivity and Home Energy Management (HEM) increases, it is anticipated that functionality will develop further.



Flex ready

Some residential PV inverters in the current offering have modulating remote control: the amount of electricity being fed into the grid (or imported by a hybrid inverter) can be turned up or down. This will be one-way for a PV inverter and potentially bi-directional for a hybrid inverter (although not all hybrid inverters will have this functionality).

This functionality makes an inverter 'flex ready' as it could operate in grid services.

In the Netherlands, this functionality exists in certain inverters, but is not currently used. However, in other countries regulations imply that DSO's or energy suppliers must be able to remotely control inverters. In Germany, an extra 'curtailment device' is added when DSOs want curtailment measures. Similar regulation does not exist in the Netherlands, but it may come in



Future market outlook

Inverters have a key role to play in growing flexibility markets

Where solar PV is installed in homes, inverters will be at the heart of a smart home and a smart grid. Their smart functionality will continue to develop.

In research calls, manufacturers addressed the importance of inverters in Home Energy Management and flexibility and pointed out that they plan to develop their functionality further.

Inverters have the potential to play a role in flexibility now but need the markets to develop.

Intelligently optimising self-generation in the home



Within the home, inverters will become increasingly important in managing and optimising energy, thereby maximizing self-generation. This will include:

- Maximising electricity used in smart appliances
- Optimising EV charging
- Shifting energy consumption
- Storing excess electricity in a hot water store or a battery

One manufacturer shared an ambition for inverters to enable “100% green consumption” in a home by optimising how solar, storage and consumption link.

With a growing PV market in the Netherlands, and the phasing out of net metering, the demand for smart inverters is likely to grow. Furthermore, the growth of smart appliances, EVs, connectivity and HEM will also give inverters a greater role to play within the home.

Enabling the home to operate in grid services



Inverters are likely to have a growing role to play in increasingly smart grids, grid services and flexibility. They can support **grid stability** through:

- Turning up or down electricity fed into the grid
- Managing flexible loads within the home

Virtual power plants (VPPs) can also be developed using a home solar PV and battery system (and potentially EVs). VPPs can help with grid stability and meeting supply shortages.

With increasing annual sales of batteries and increasing flexibility markets, inverters are set to play an increasingly important role. This is recognised by manufacturers, policy makers and other energy system experts. We need consumers choosing *smart* inverters and we need further development of flexibility markets and services.

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This is an extraction from the report “Market insight on flexible connected PV inverters” from Flexiblepower Alliance Network & Delta-EE.

The **full report** is available through the website of Flexiblepower Alliance Network: <https://flexible-energy.eu/>

You may refer to this presentation by quoting “Market insight on flexible connected PV inverters, Flexiblepower Alliance Network & Delta-EE, March 2021”.

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