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LEMUR project

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TALENT

Cost effective technological developments for accelerating energy transition

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Cumbre del Clima. Tiempo de Actuar Oviedo, 10th December 2019

Agenda

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A short description about Talent project.

02 TALENT Intro

Why Talent is important to the energy transition?

03 TALENT Concept & Objetives

What we plan to do to help in the energy transition.

04 TALENT Implementation

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05 TALENT Impact

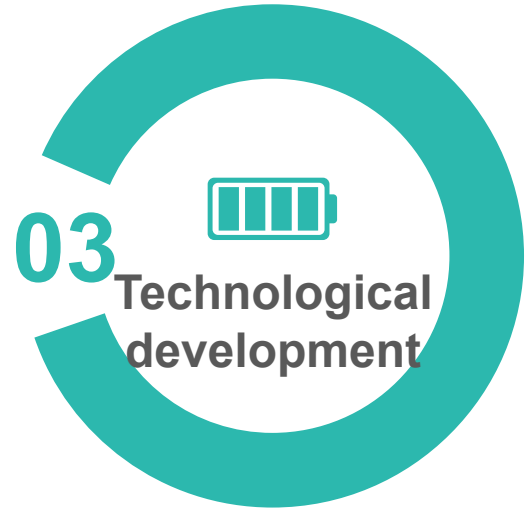
The expected impact on the energy transition.

Not always a name means what it seems.....

Cost effective technological developments for accelerating energy transition

Research on advanced tools and technological development.

A number of tools and future technologies need to be developed, matured and tested to cover gaps and/or to prepare the energy system of 2030 and beyond.

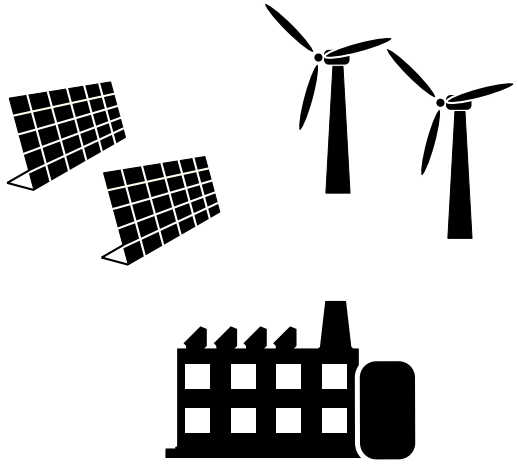


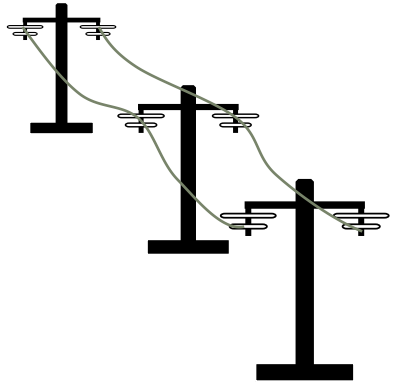
Power electronics for **batteries** and software to manage combined or hybridised decentralised energy systems, also combining several energy vectors: a key focus is on significant **cost reduction** of these key components **for homes, districts and larger systems** which have the potential to accelerate significantly the energy transition of the electricity network.

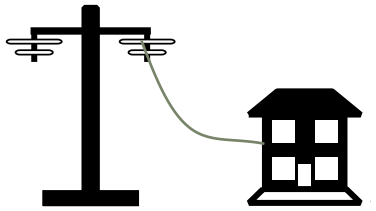
Intro TALENT

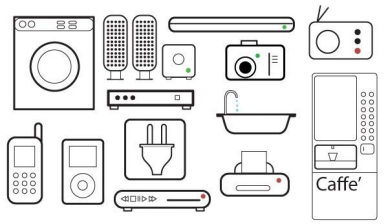
Changes to come in the electrical sector...

How we produce and consume the electricity









GENERATION → TRANSPORT → DISTRIBUTION → END CONSUMER

efficiency [33%,55%]

Losses 15%

Net energy 30%

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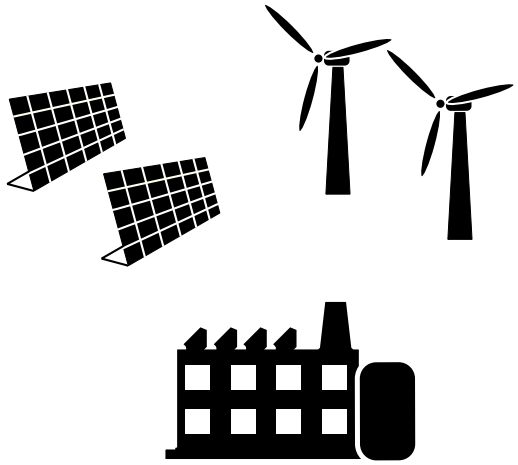
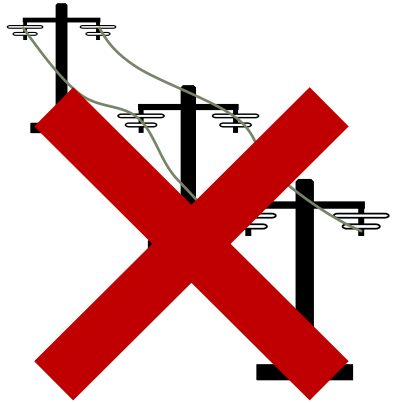
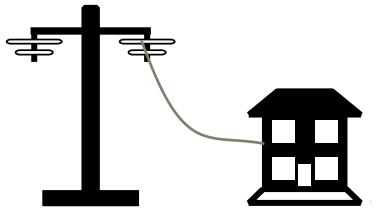
Intro TALENT

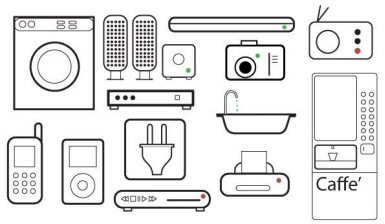
Changes to come in the electrical sector...

How we produce and consume the electricity. Generation gets closer to the final consumer.









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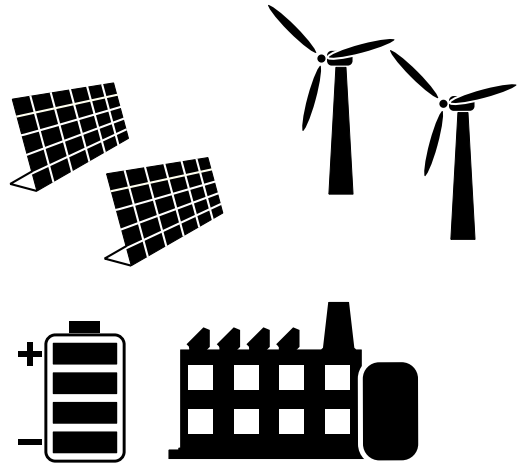
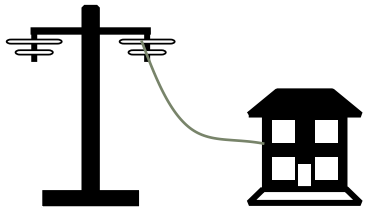
Intro TALENT

Changes to come in the electrical sector...

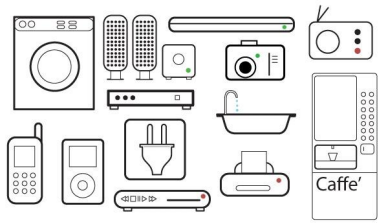
How we produce and consume the electricity. Generation gets closer to the final consumer. Needs for energy storage.



GENERATION



DISTRIBUTION



END CONSUMER

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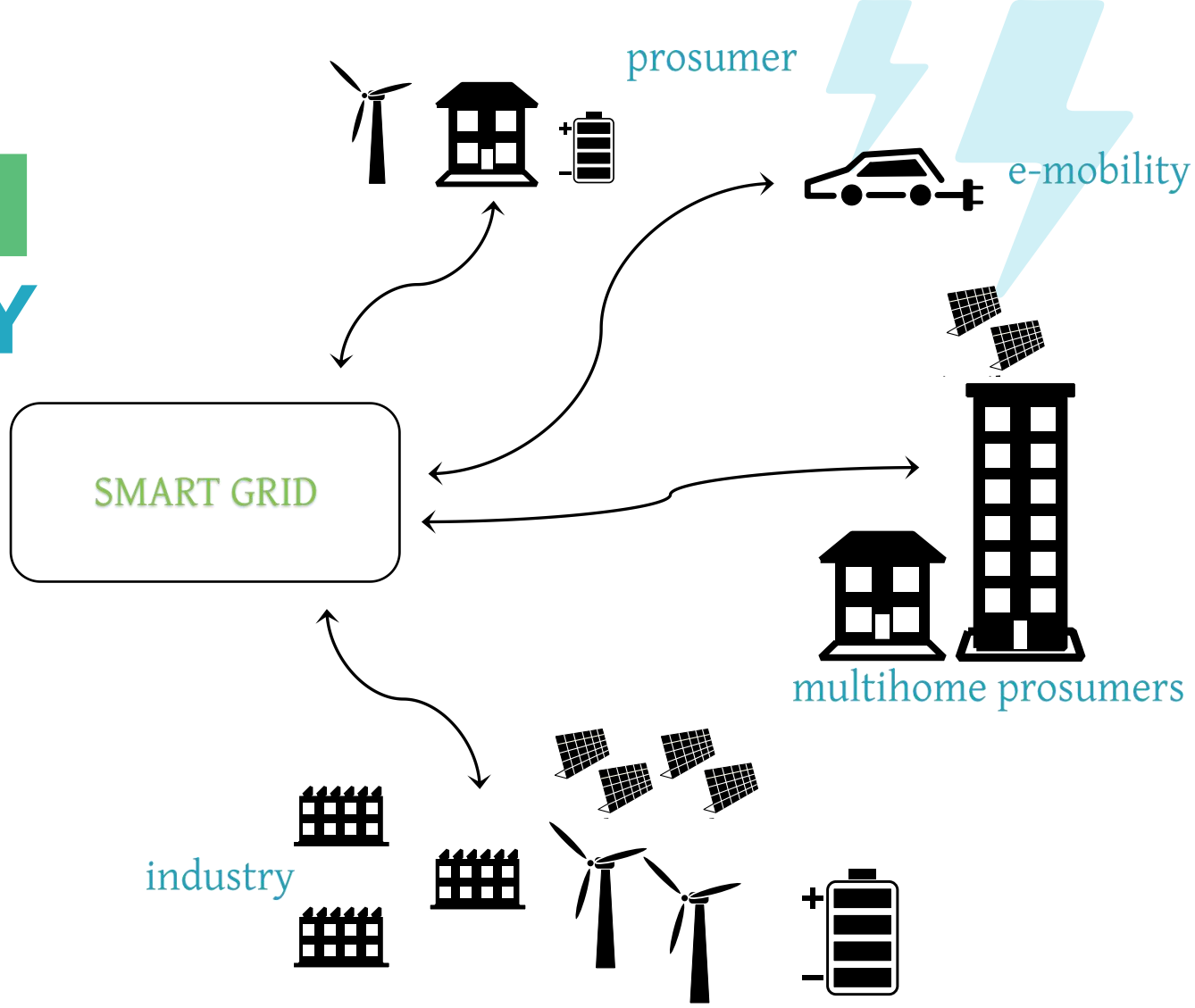
CLEAN ENERGY

TALENT
Integration into the SmartGrid concept

TALENT aims to promote a wide and cost-effective integration of batteries in the grid that will lead to an increase of the flexibility in the energy system.

Our approach is based in:



Scalable and modular power electronics topologies

Reuse designs for different applications allows for a cost reduction.

Power electronics devices

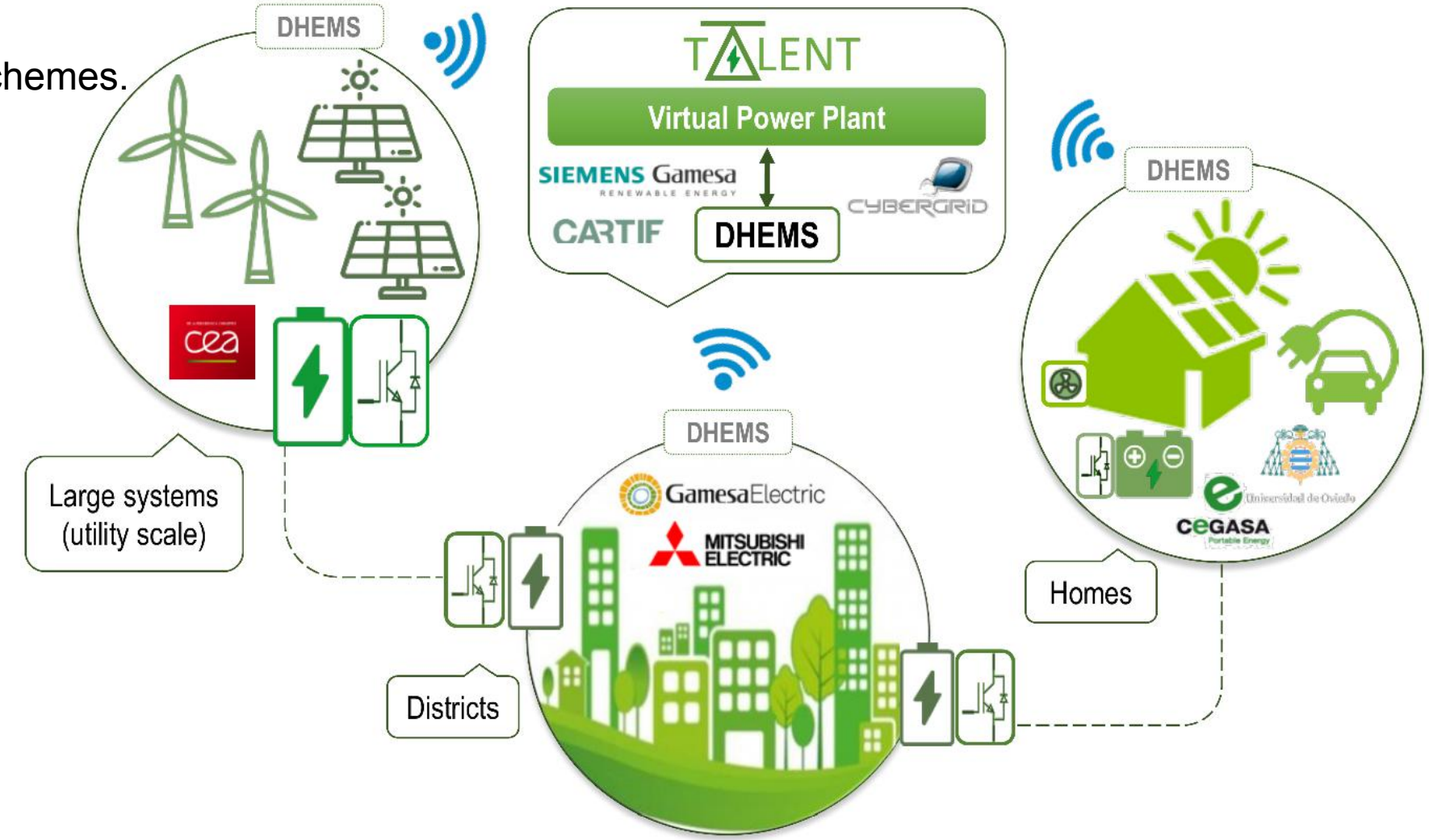
New wide band-gap power electronic devices for different voltage levels that allow for a simplification and efficiency boost in the power converter structure.

Interoperable software

Interoperable software as a service for energy resources management.

Intro TALENT

- Novel power electronics schemes.
- Plug and play software.
- Cost reduction.
- Regulatory aspects



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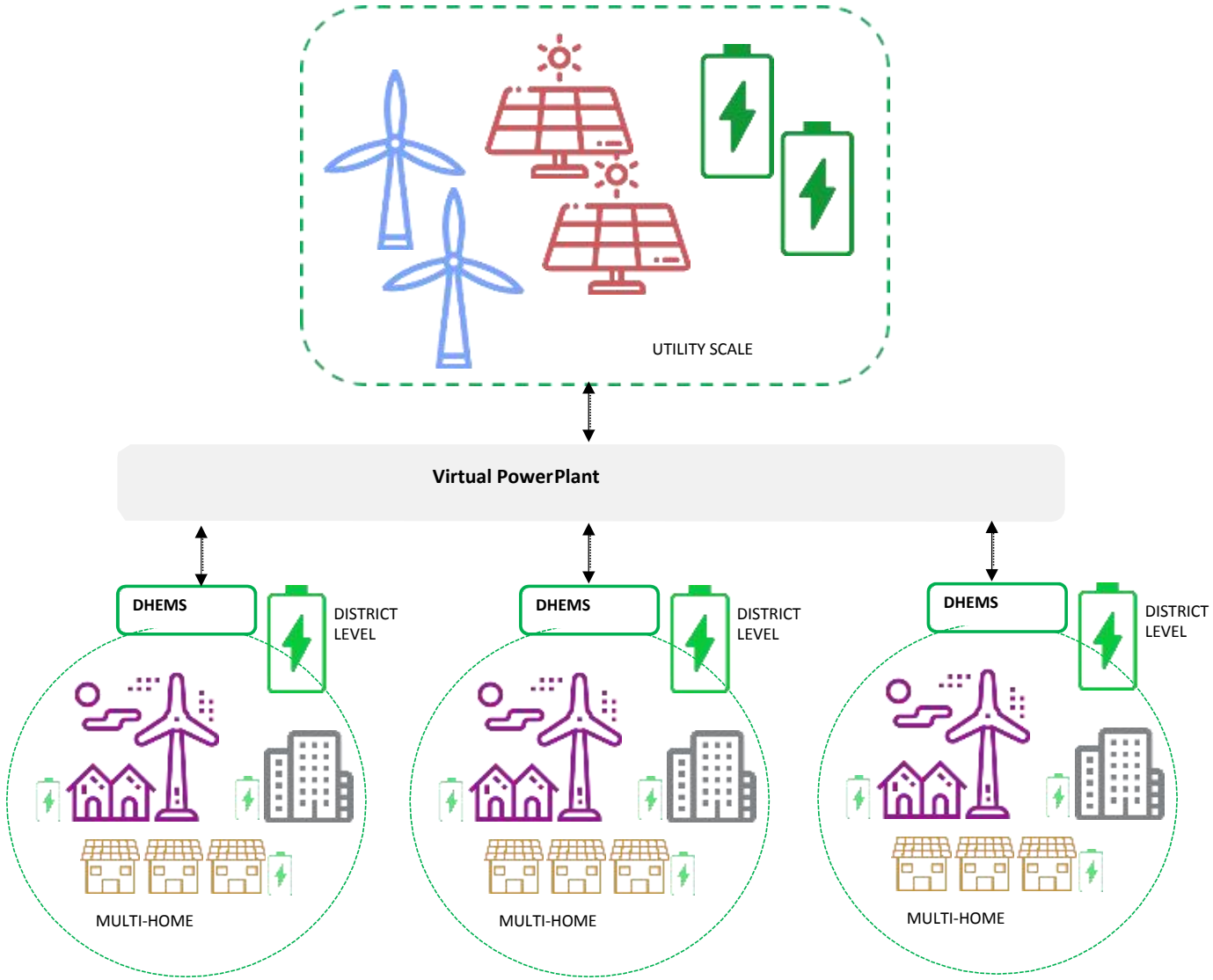
TALENT Concept

- TALENT works for a future grid where many energy producers of different power ranges collaborate for a sustainable energy system in which electric batteries allow for a high penetration of renewable sources.



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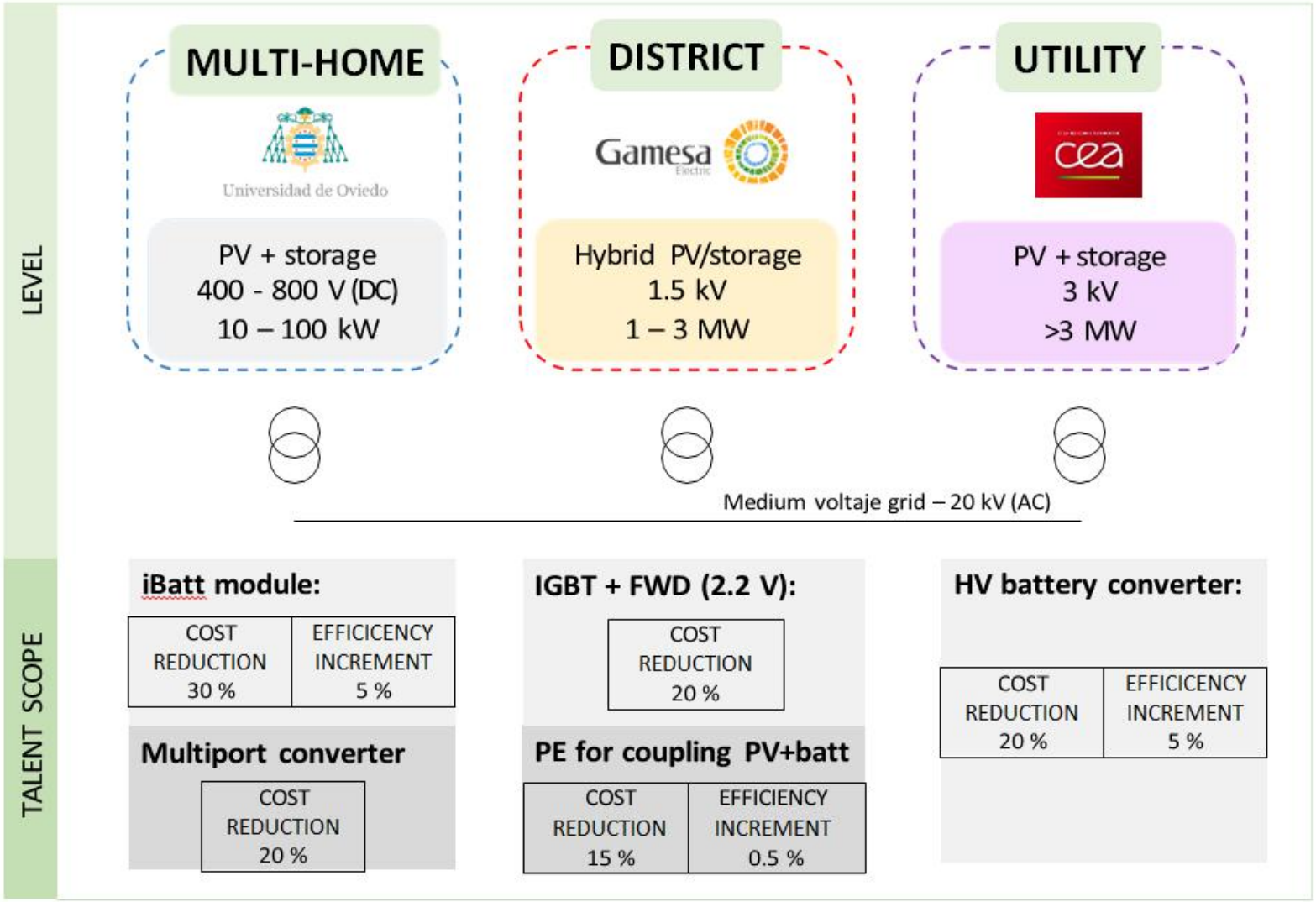
TALENT Concept

TALENT focus is in the **cost reduction of hardware and software components** at three different levels: building, district and large scale.

Selected components for cost reduction:

- Power electronics for batteries
- Management software of hybridised decentralised energy systems.



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TALENT Objetives

To reduce costs in power electronics for batteries

400-800 V level
New power electronics architecture for the combination of PV and storage. 20% cost reduction. 5% efficiency increment.

1,500 V level
New semiconductor devices (IGBT+FWD) at 2.2 kV. 20% cost reduction. Three-port converter system for hybrid PV system with DC coupled batteries at 1.5 kV. 15% cost reduction. 0.5% efficiency increment.

3,000 V level
New 3 kV converter for batteries replacing 6.5kV IGBT with 4kV SiC MOSFET. 20% cost reduction. 5% efficiency increment.

Modular battery
To develop new modular battery featuring a multiport converter (iBatt). Several modules that can be combined to set-up batteries for 800V, 1,500V and 3,000V applications. 30% cost reduction.

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TALENT Objetives

Software for decentralised and hybridised energy systems

To develop a distributed energy management system able to interact with VPPs, DSOs, market and users. To reduce cost it will be offered as interoperable software as a service.

Interoperable software as a service
To develop the interoperability framework for VPP, DHEMS, DSO, market and users under the SaaS paradigm.

Edge computing
To develop edge computing architecture able to solve the optimisation and control problems common to the DHEMS with no LCOE increment or control degradation.

Battery digital twin
To develop a stationary battery model to predict its performance and properties along its life-cycle. Error target is 5%.

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Changes in the regulations boost TALENT proposal
Royal Decree 244/2019, 5th April 2019.

- **New regulations for self-consumption**. Two main alternatives:
  - Self-consumption **without** surpluses.
  - Self-consumption **with** surpluses:
    - **No compensation:** The surplus energy can be sold as any other generation plant.
    - **Compensation:** Those consumers with installations **< 100 kW** can receive a compensation in their electrical tariff.
- **Collective self-consumption** is enabled:
  - Common generation and energy storage installations are allowed.
  - Production and energy storage elements can be installed either in the same internal distribution grid (building) or at the low-voltage (< 1 kV) grid within a distance **< 500 m** from the consumers.

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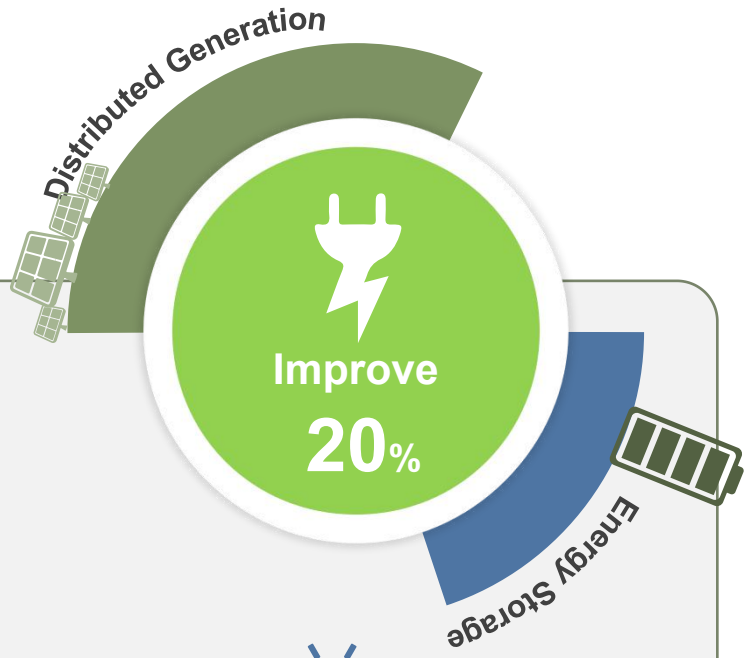
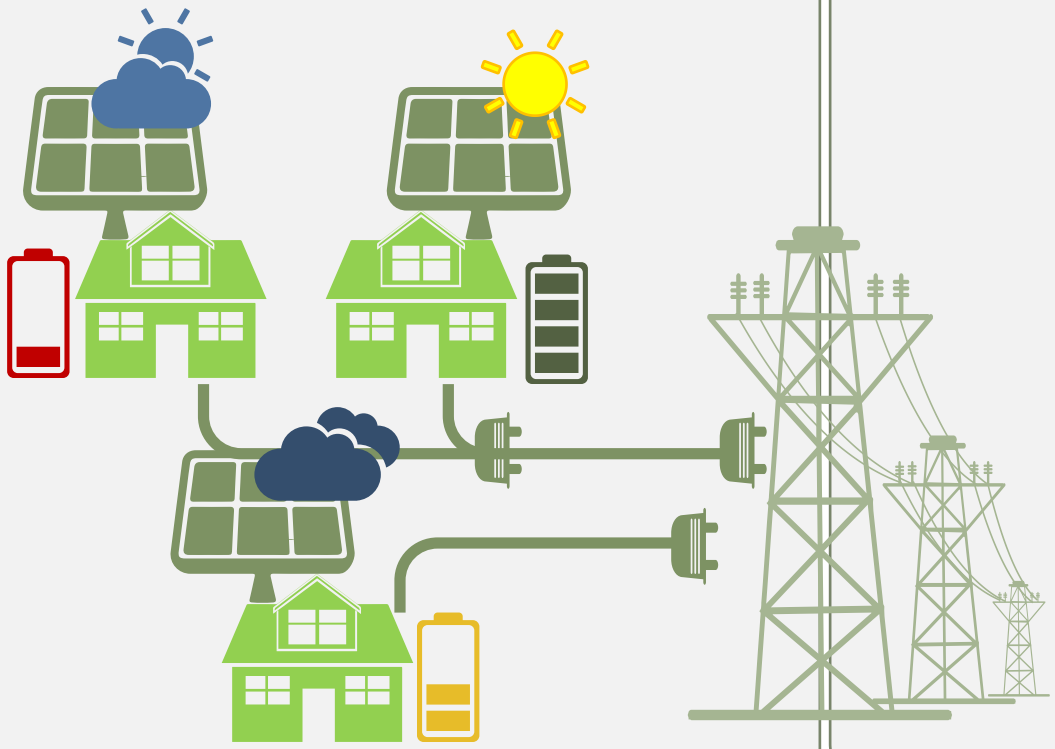
TALENT
Multihome scenario: detached homes



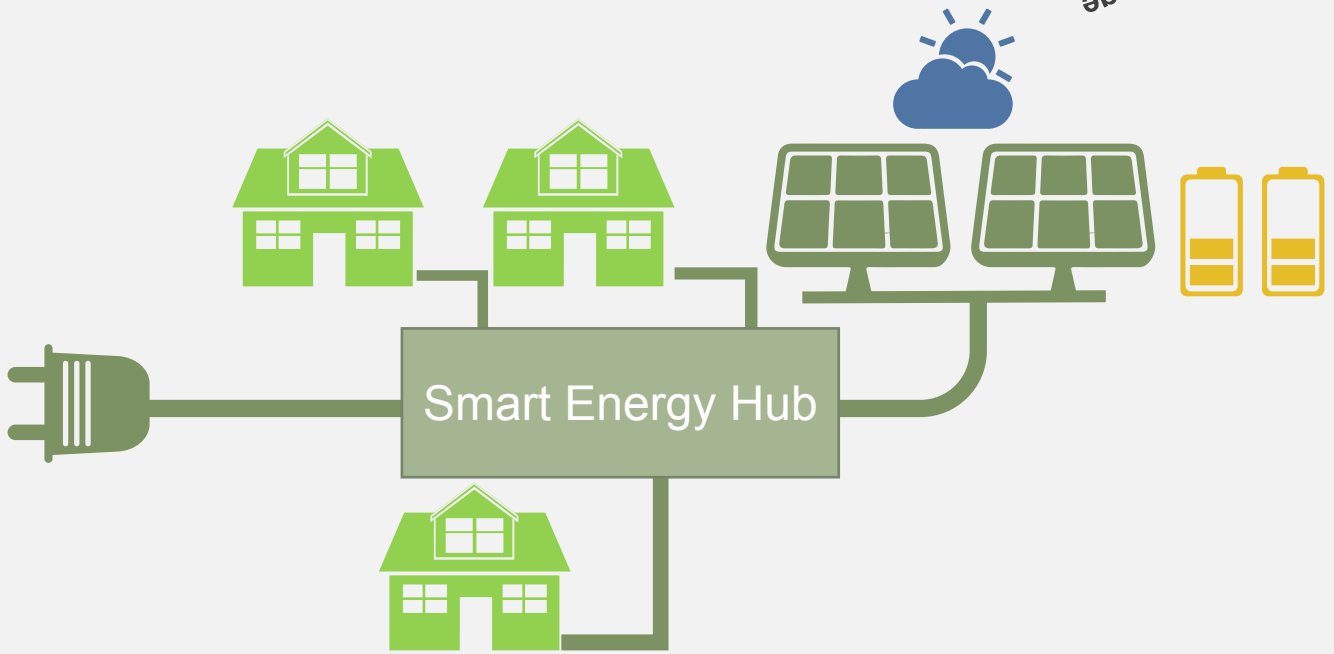
From individual distributed systems...

Costs assumed by each prosumer
System oversizing



...To agregated ones

Costs shared among the prosumers
Size optimization



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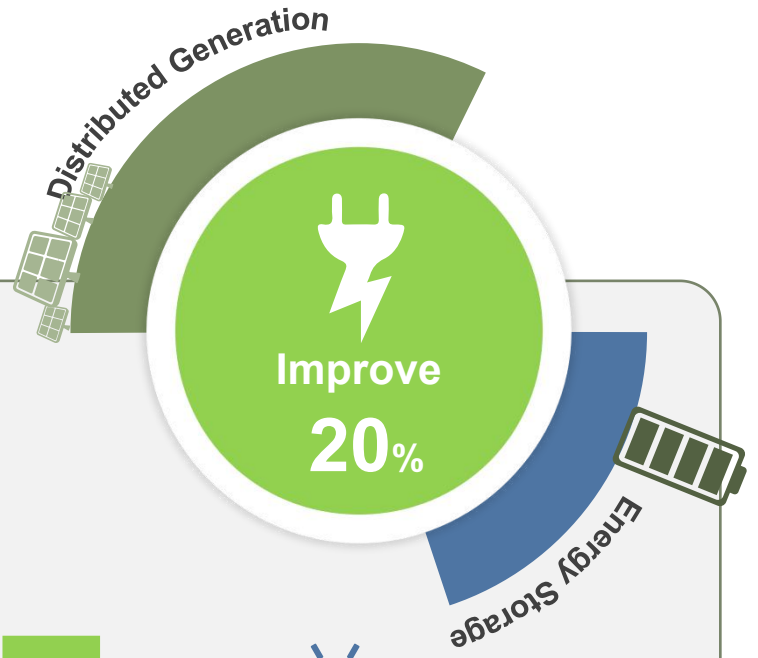
TALENT
Multihome scenario: buildings



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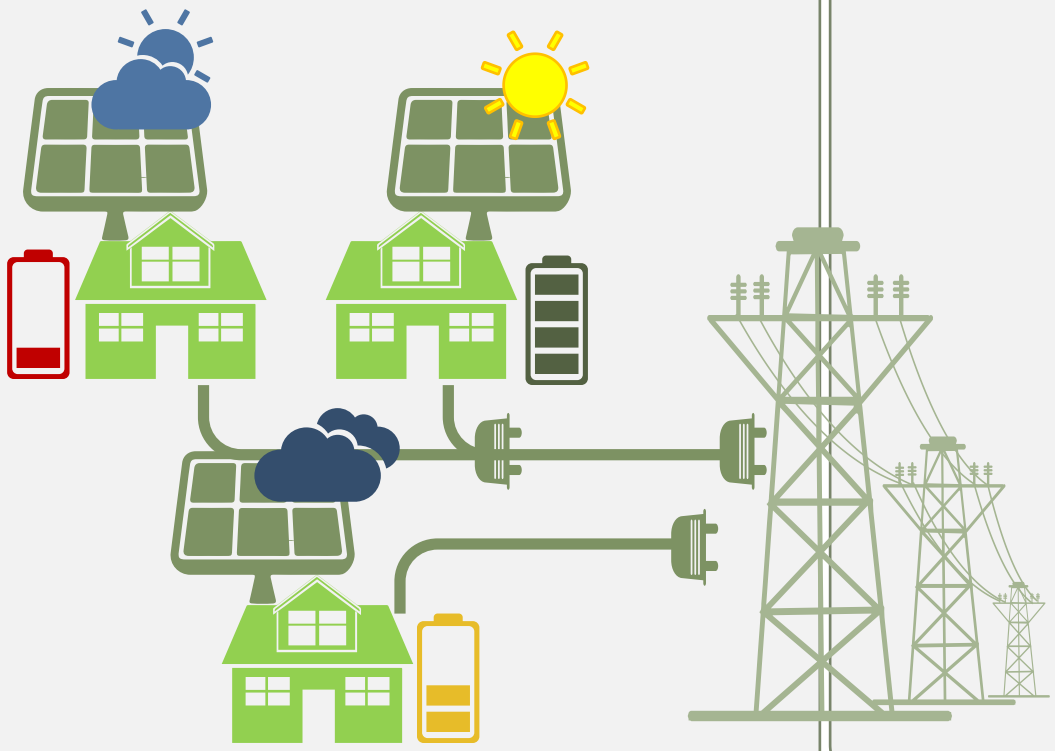

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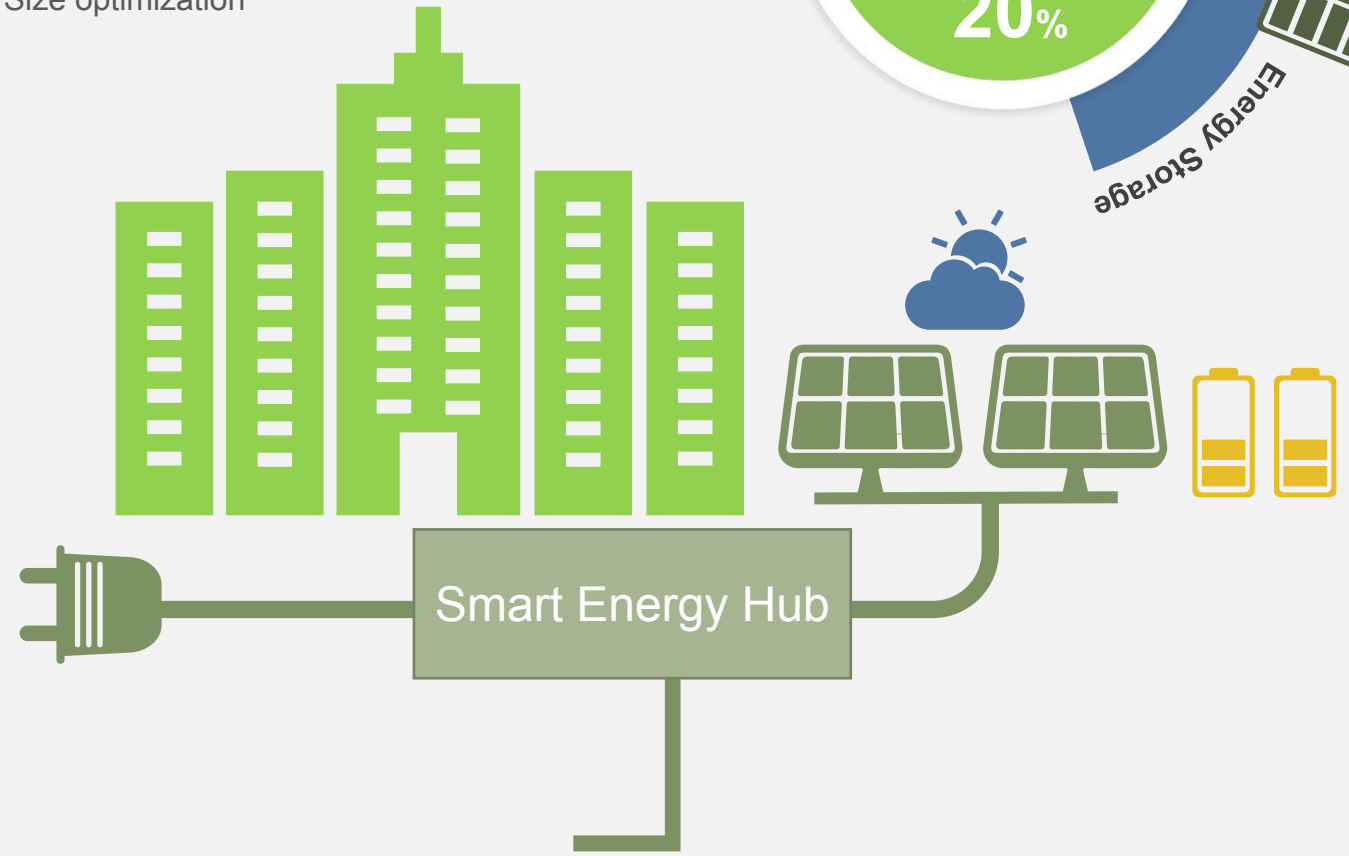

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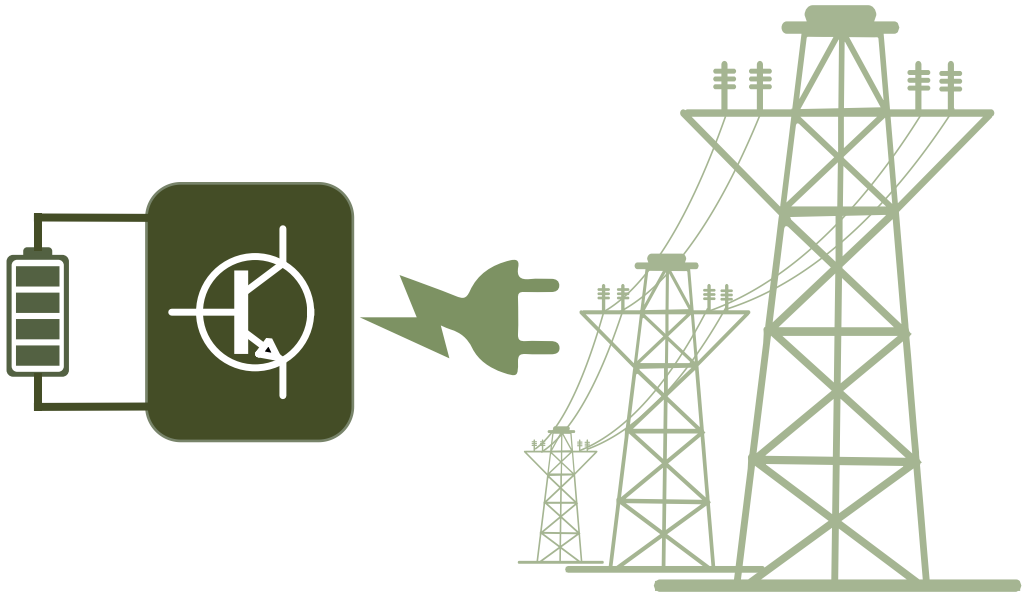
TALENT Implementation
How we do it?

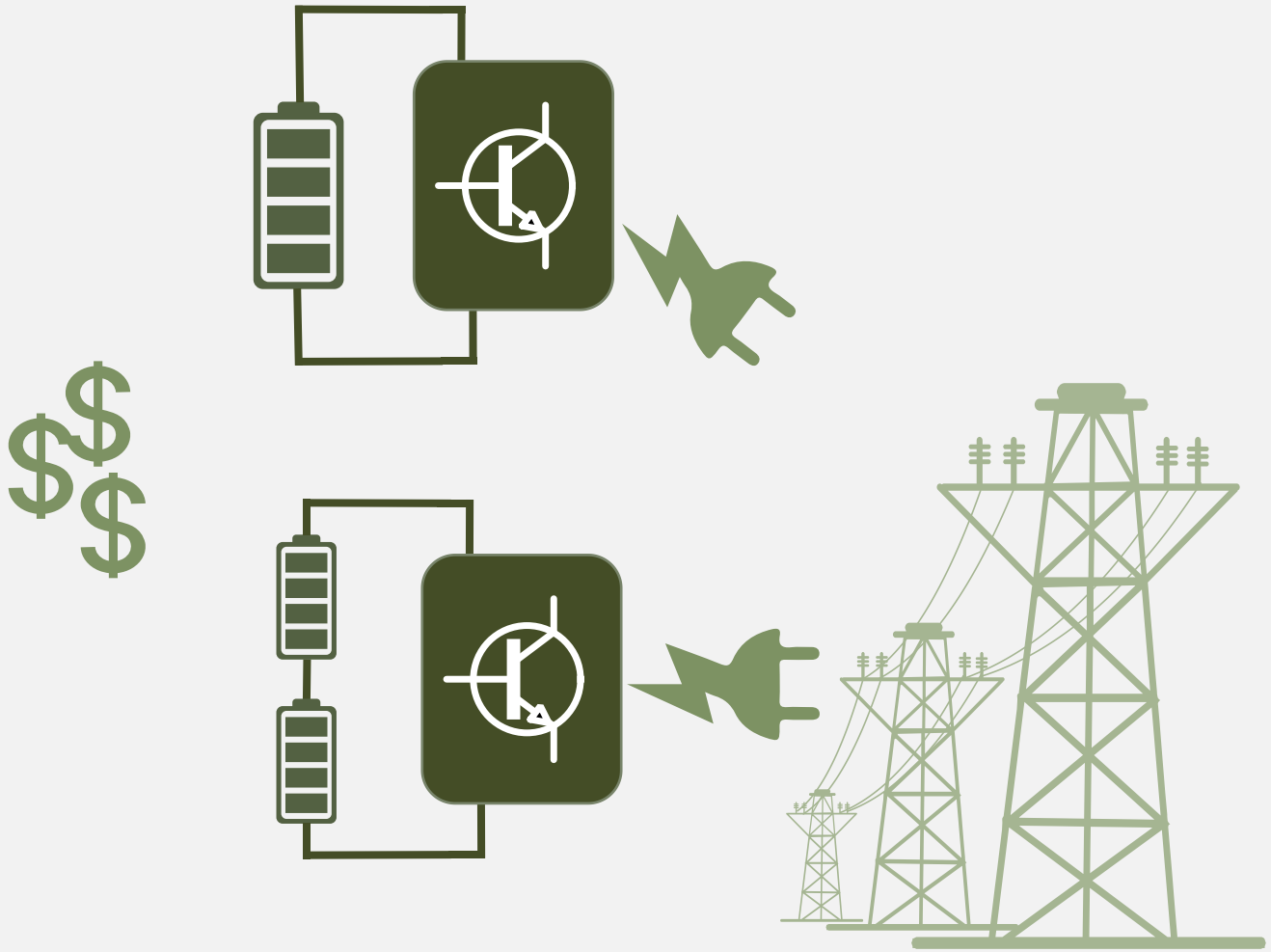
Current market situation

Today energy storage systems for end users are oversized in energy terms due to low voltage



> 15 kW

The battery voltage has to be boosted up to certain levels that allow the grid integration.
Only one module is enough for the energy needs



> 15 kW

A dedicated larger module or two series-connected modules are needed so the power electronics can do the integration.
The storage capacity (in Wh) is doubled so does the system costs.

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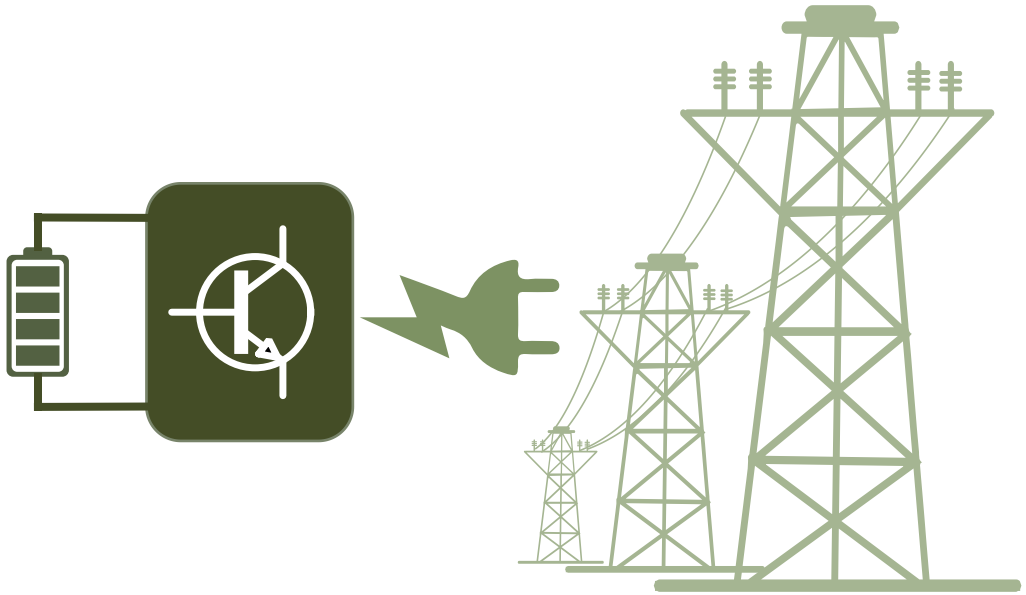

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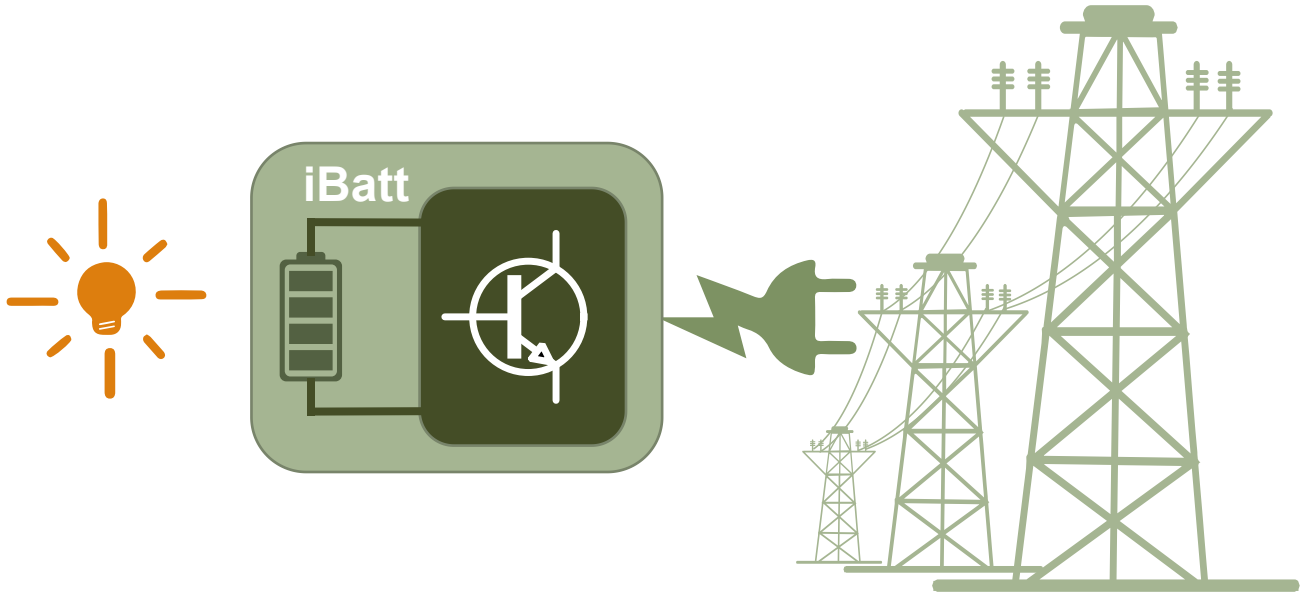

> 15 kW

New high-gain power electronics modules that are able to directly connect the energy storage to ghe grid.
Optimized system capacitance

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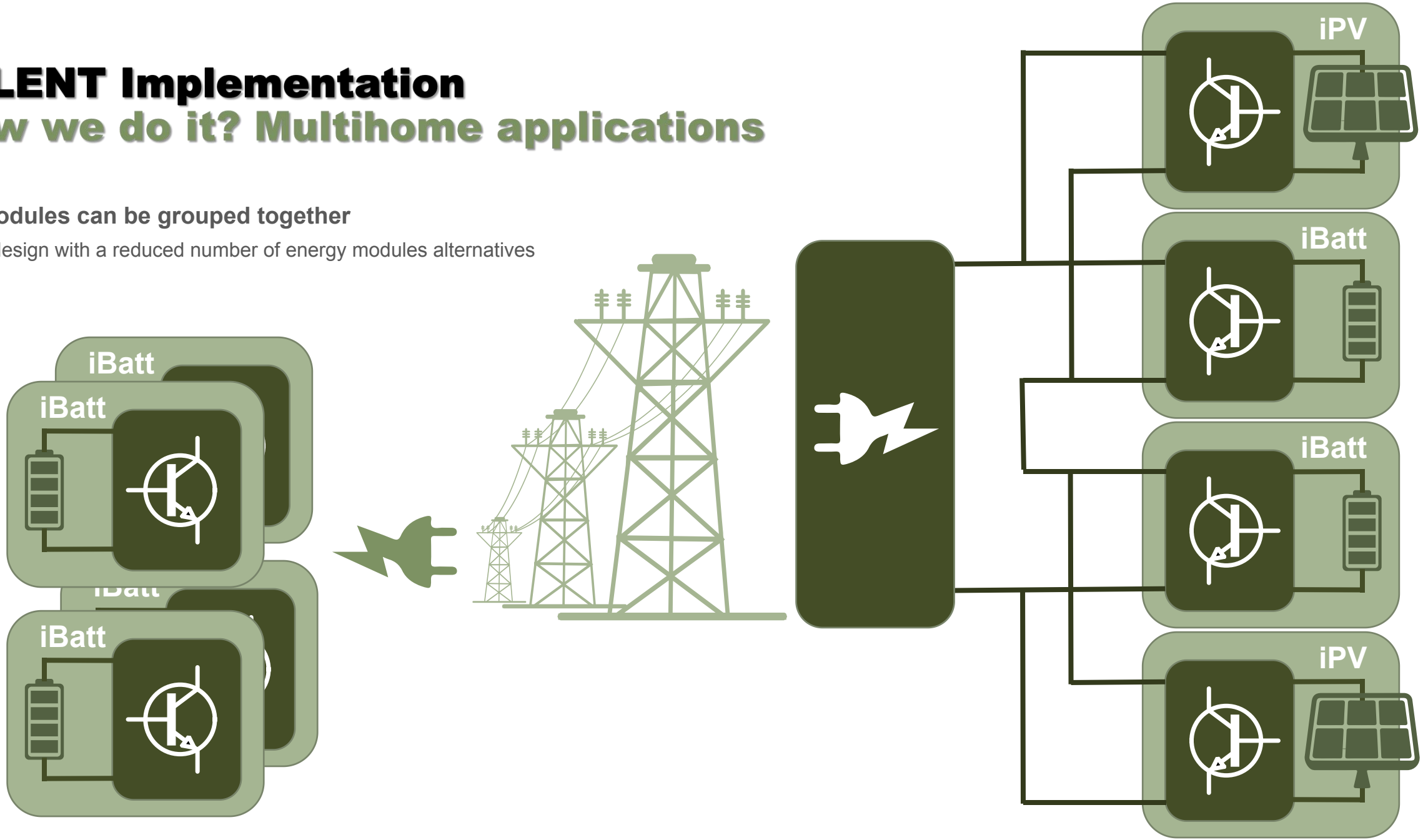
TALENT Implementation
How we do it? Multihome applications

iBatt modules can be grouped together

Optimal design with a reduced number of energy modules alternatives



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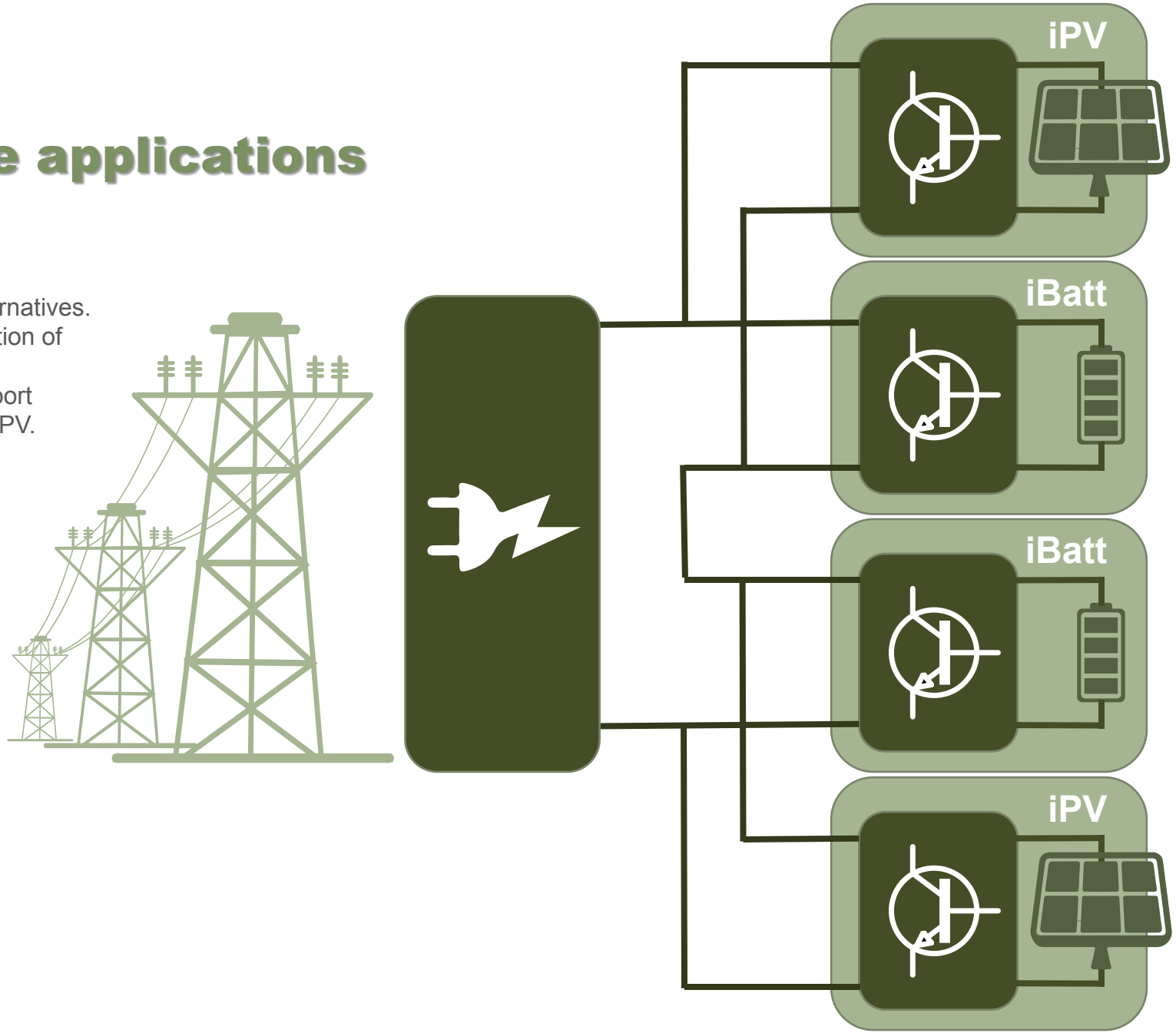
TALENT Implementation
How we do it? Multihome applications

iBatt modules can be grouped together

Optimal design with a reduced number of energy modules alternatives.
Use different combinations of the iBatt modules for the integration of distributed resources.
The proposed intelligent modules will be here used for a multiport converter that allows for the integration of energy storage and PV.



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TALENT Implementation

How we do it? District-level storage systems for 1.5 kV battery systems

Power electronics converters for 1.5 kV batteries and PV panels based on new semiconductor devices

The switches are typically realized using Silicon Insulated Gate Bipolar Transistors (IGBTs) with anti-parallel Forward Diodes (FWDs).
A new generation of semiconductor devices (IGBT and FWD) with a break- down voltage of 2-2.2 kV will be developed and applied in TALENT.
Hybrid PV-storage solutions using multi-port converters for grid integration of PV farms.

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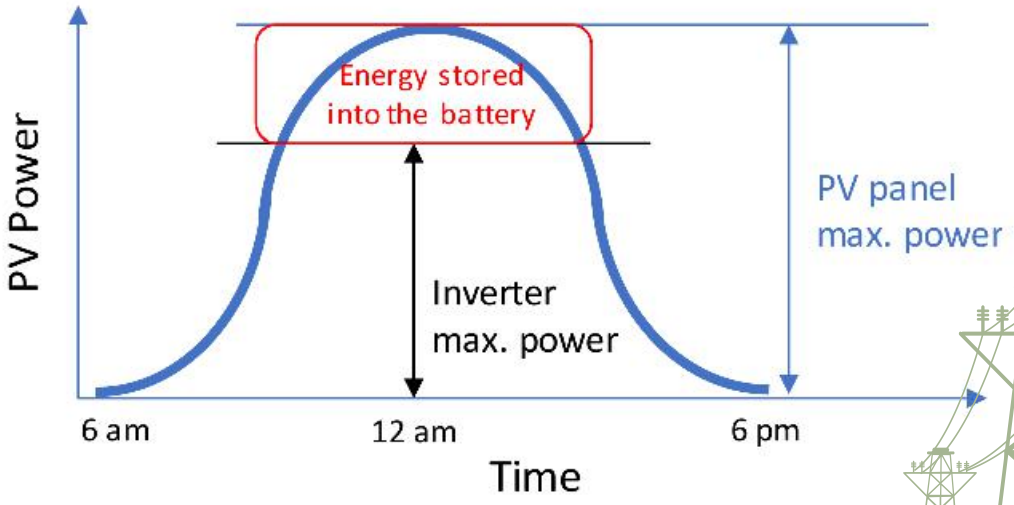

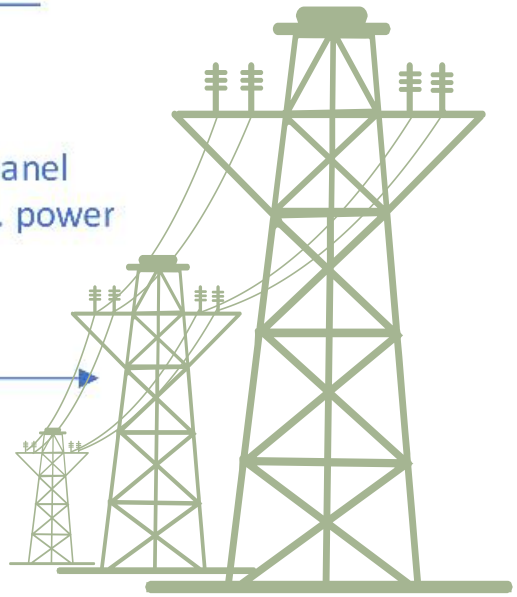

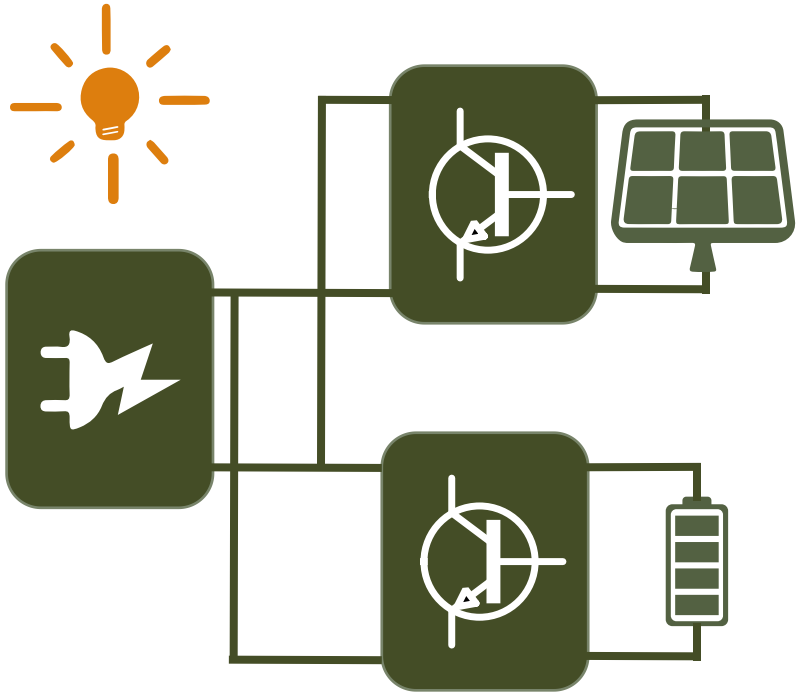

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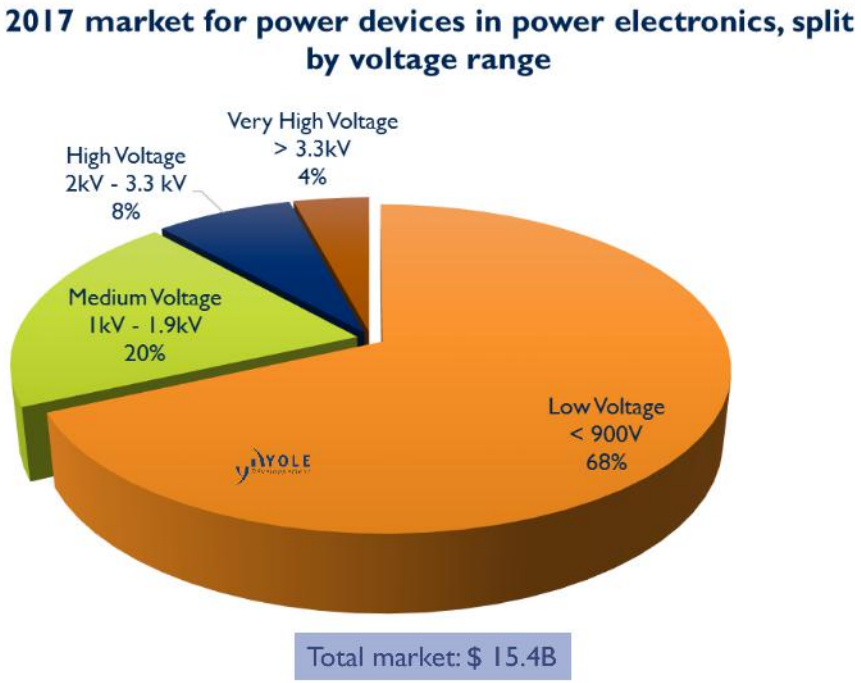
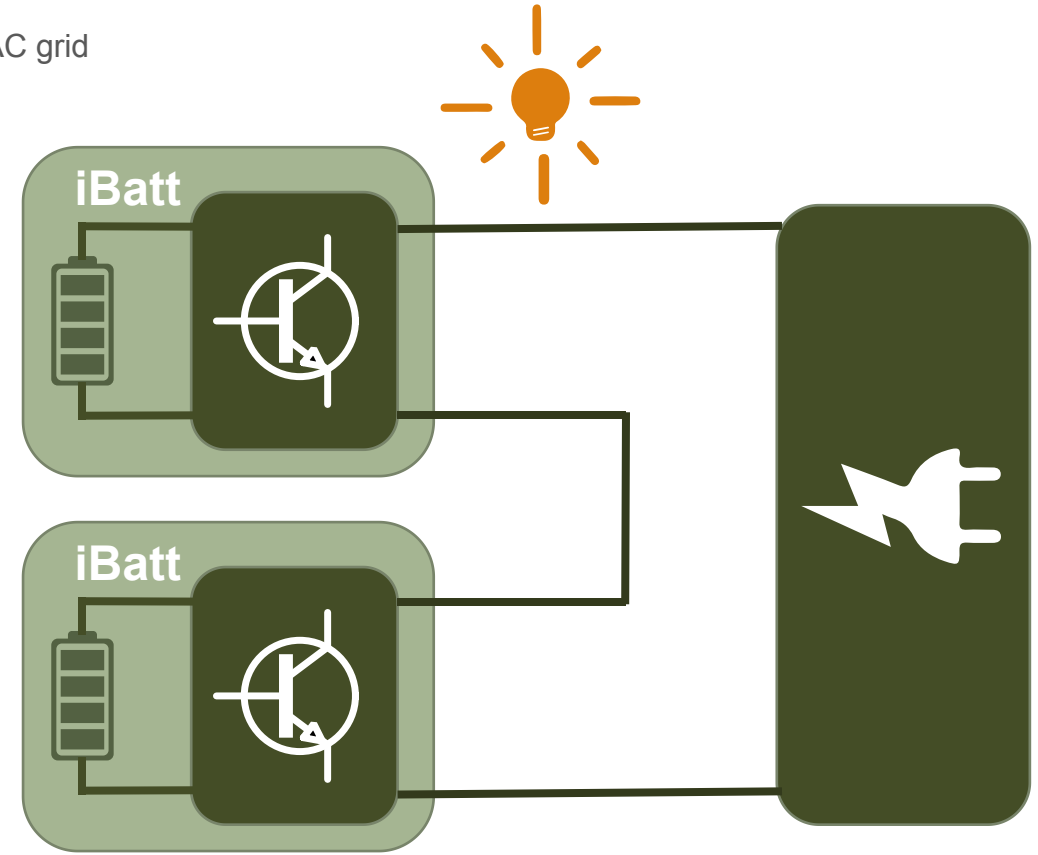
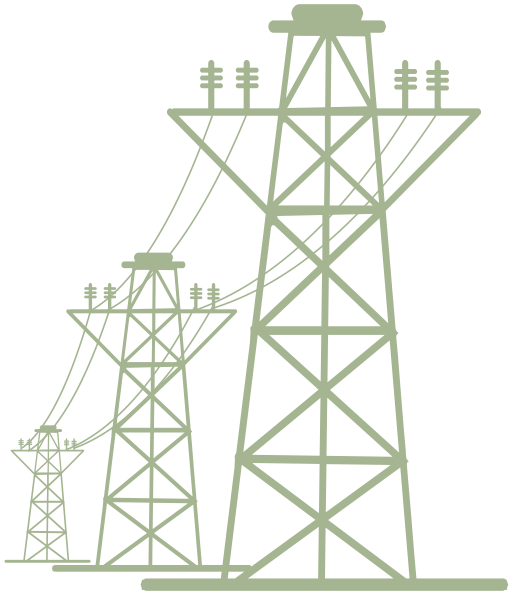
TALENT Implementation
How we do it? Utility-scale storage system

iBatt modules can be grouped together

High-voltage battery (3 kV) for interfacing to a high-voltage AC grid
Use of 4.5 kV SiC instead of 6.5 Si devices.







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TALENT Implementation

How we do it? Distributed Hybridised Energy Management Systems and Virtual Power Plants

Distributed Hybridised Energy Management Systems (DHEMS)

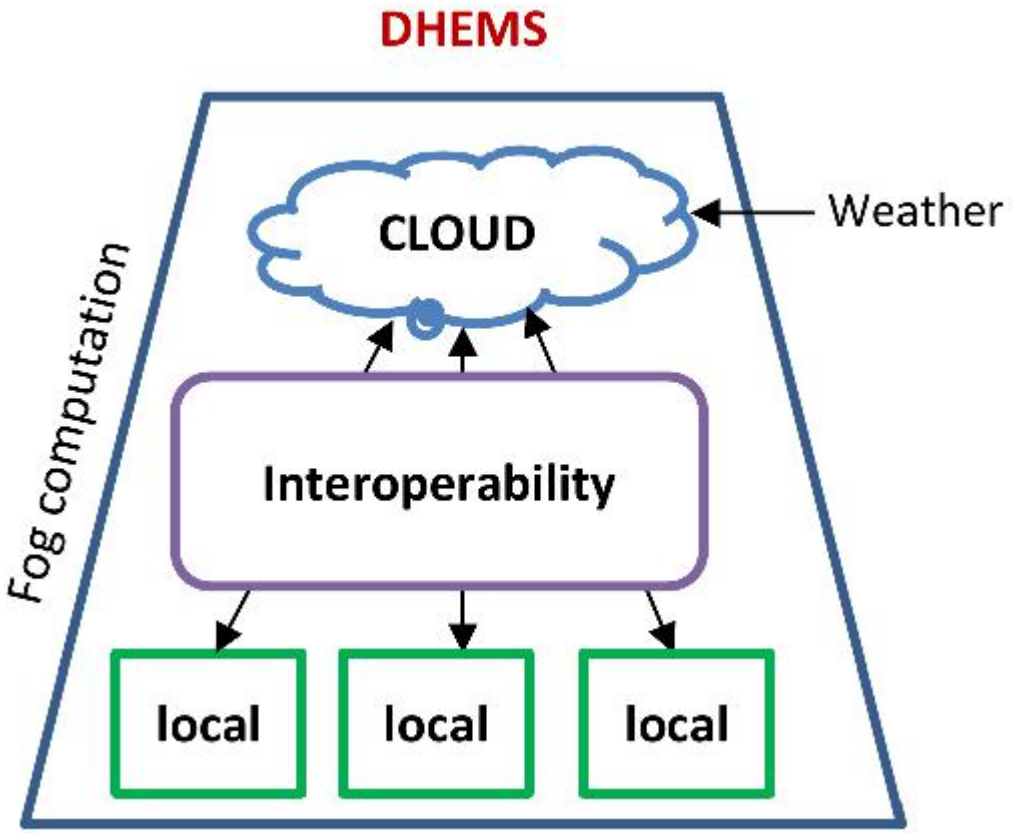
Software tool in charge of managing a set of heterogeneous generation sources, controllable loads and batteries according to different criteria of stability, efficiency, cost, maintenance, environmental and power flows requirements.

Virtual Power Plant (VPP)

Software tool for aggregation of flexibility resources (loads, distributed generators and storage) into a clean energy asset which acts like a conventional power plant.

DHEMS vs VPP

The main difference between DHEMS and VPP is that DHEMS is close to the physical layer (local controls of generation, storage and loads that guarantee the stability of the grid), while VPP is close to the electricity markets (aggregating flexibilities, forming products, bids, and activations).



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TALENT consortium

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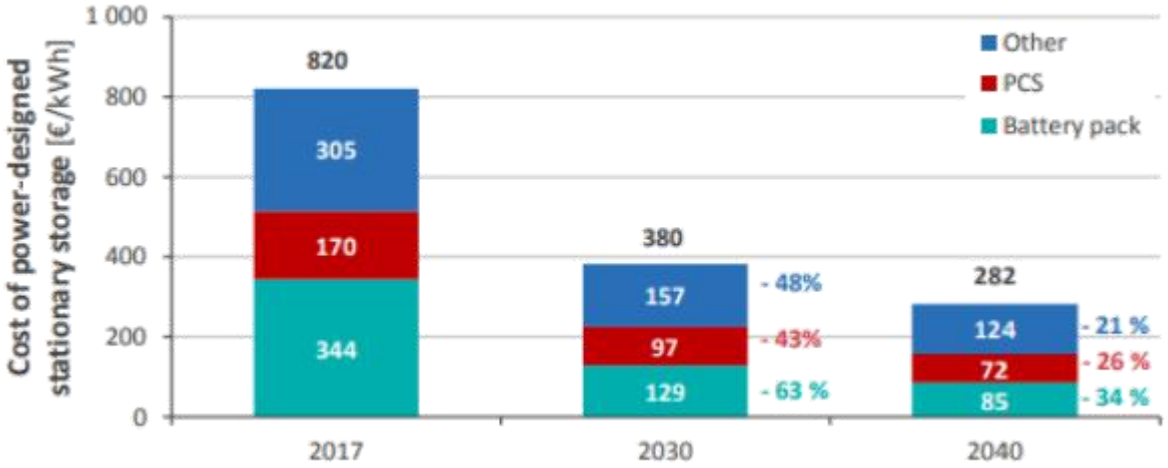
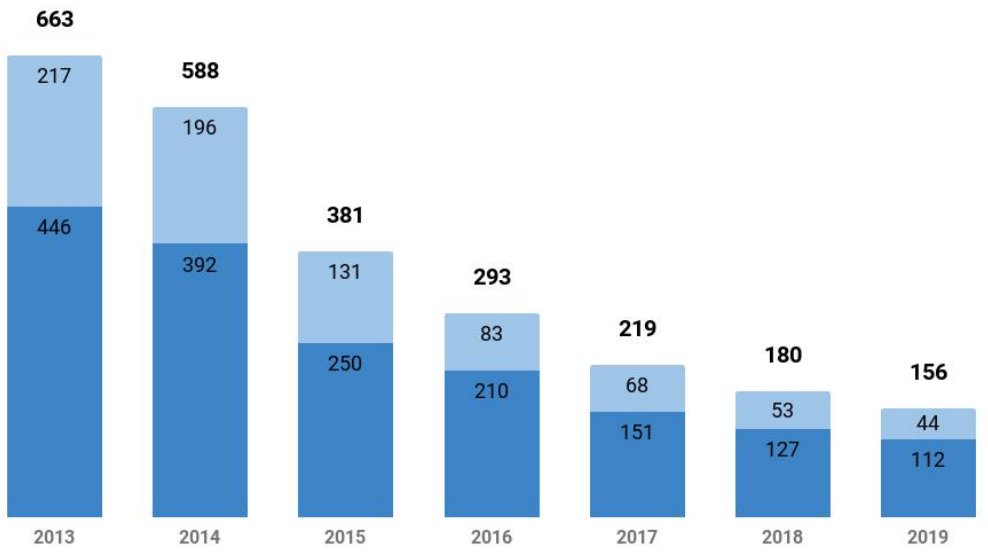
TALENT Impact.
Market Trend for Batteries

- Energy storage, and in particular batteries, is frequently addressed as the technology that may unlock the transition to a decarbonised and clean energy system.
- For decades, energy storage has had important restrictions due to an enormous limitation over the cost and volume of the available technologies. However, a new generation of very competitive energy storage systems allows for a cost reduction.
- According to some forecasts, from 2025 onwards **Europe could capture a batteries market of up to 250 billion € a year**, served by at least 10 to 20 Gigafactories (battery cells mass production facilities) to cover EU demand.
- The "Declaration of Intent of SET Plan Key Action 7" sets **a target of 75 €/kWh for a battery pack for automotive applications and 150 €/kWh for stationary storage applications at a system level by 2030**.
- The **battery pack is the key cost component that represents 42 to 50% of the total cost** and on such component is related the major reduction (around 75% by 2040). The Power Conditioning System (PCS) and other component will have a similar rate (around 60% by 2040).



2019 BNEF Battery Price Survey (with Cell and Pack split)

Data derived from BNEF, prices in 2019 USD, 2019 cell/pack split estimated. Prices are industry weighted averages, not cost leaders



Graphic © Maximilian Holland / CleanTechnica

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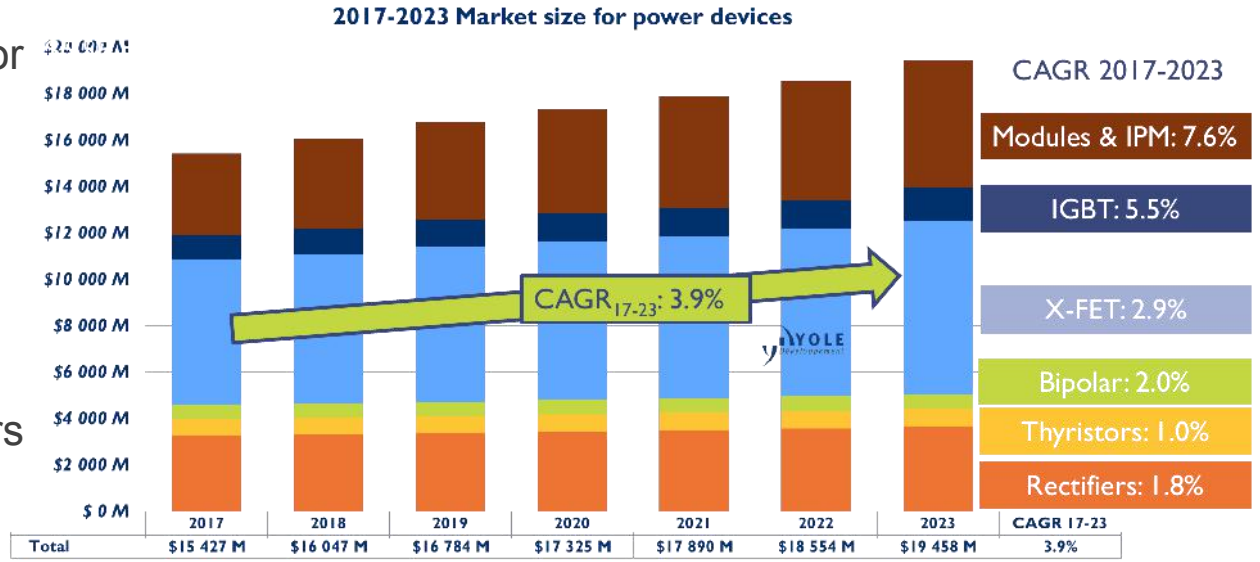
TALENT Impact.
Market Trend for Power Electronics

- Power electronics for Distributed Energy Resources are highly developed in different configurations that depend on the type of micro-grid: DC integrated, AC integrated or Hybrid.
- **The power electronics market was valued at 32.28 billion € in 2017 and is expected to reach 44.59 billion € by 2023, at a CAGR of 5.5% during the forecast period**.
- Growing demand for battery-powered portable devices and upgrade of power infrastructure are the major drivers for the power electronics market growth, while complex design and integration process for advanced technological devices might restrain such growth.



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TALENT Impact.

Market Trend for micro-grid control technologies

- More than 1437 microgrid projects, that represent nearly 13,400 MW of capacity, are proposed, planned, under construction, or are operating worldwide.
- **Microgrid control systems market was valued at 18.2 billion € in 2017 and is expected to reach a market value of 36.5 billion € by 2023, registering a CAGR of 12.25% during this forecast period**.
- This market growth will be supported by solving typical issues in microgrids' applications:
  - RES generation could exceed demand and be curtailed, when the micro-grid is operated in islanded mode
  - Energy Storage Systems battery life expectancy is in many cases not effectively considered
  - Conventional droop control strategies do not consider the actual state of charge, but the nominal power of the ESS inverters.
  - Demand response is neglected in most commercial micro-grid applications, however its potential for balancing the system and avoid RES curtailment is indisputable.
  - Centralized and de-centralized control techniques. As a complement to control technologies, the digital representation of physical systems has become a cutting-edge practice done by several control manufacturers and gains ground in the area of renewable energy systems. The term "Digital Twin" is used to describe the map of physical assets to digital platform.

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Conclusions

- New disruptive ideas are needed for reducing the acquisition and operation costs of distributed energy generation and energy storage.
- Changes in the regulations framework triggers new opportunities.
- Added value to already existing technologies is the key idea for new developments.
- Huge economical impact due to a change in the paradigm of how do we generate and consume electricity is about to happen.
- Favouring research and development lines on these particular field is a must.
- Out region, already generates the needed TALENT for new business opportunities but we need to get the consumers of this TALENT closer to the generation.

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Thank You!

Questions?

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