Unlocking grid flexibility:
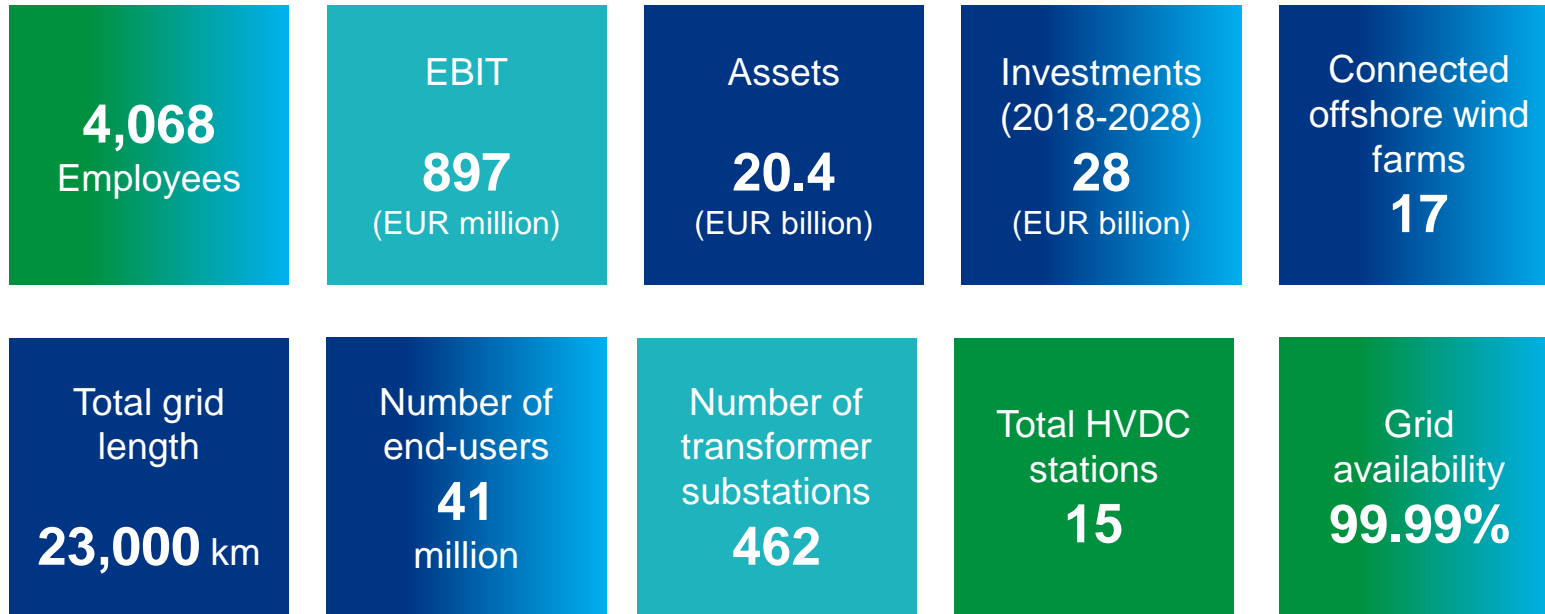
November-7-2018

Jan Vorrink

TenneT at a glance 2017

Europe's first cross-border grid operator
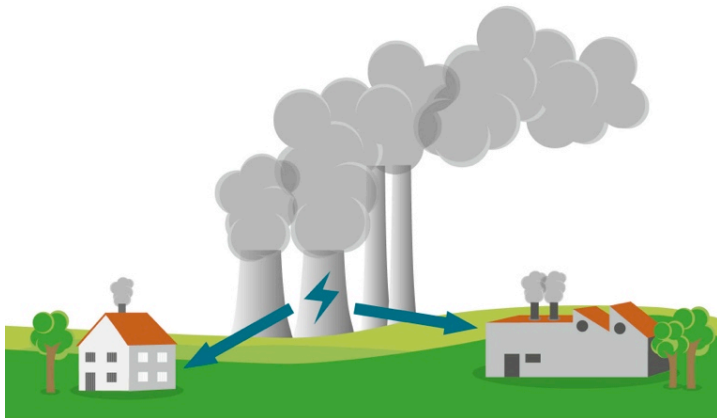
4,068 Employees	EBIT **897** (EUR million)	Assets **20.4** (EUR billion)	Investments (2018-2028) **28** (EUR billion)	Connected offshore wind farms **17**
Total grid length **23,000** km	Number of end-users **41** million	Number of transformer substations **462**	Total HVDC stations **15**	Grid availability **99.99%**

Unlocking grid flexibility:

Renewables challenge the Grid

Renewables fundamentally change how power grids work

| The old Electrical Power System | The new Electrical Power System |

Big fossil or nuclear power plants close to the industrial centers feed electricity into the transmission grid. The connected distribution grid supplies consumers.

Renewable energy, produced locally, sometimes far away from industrial centers and storage facilities provide electricity at all grid levels depending on the weather.

Distributed Flexibility

With an increasing amount of volatile renewable energy in the system, an **optimal dispatch of flexibility options is needed** to guarantee security of supply and affordability.

Demand-side management (DSM)
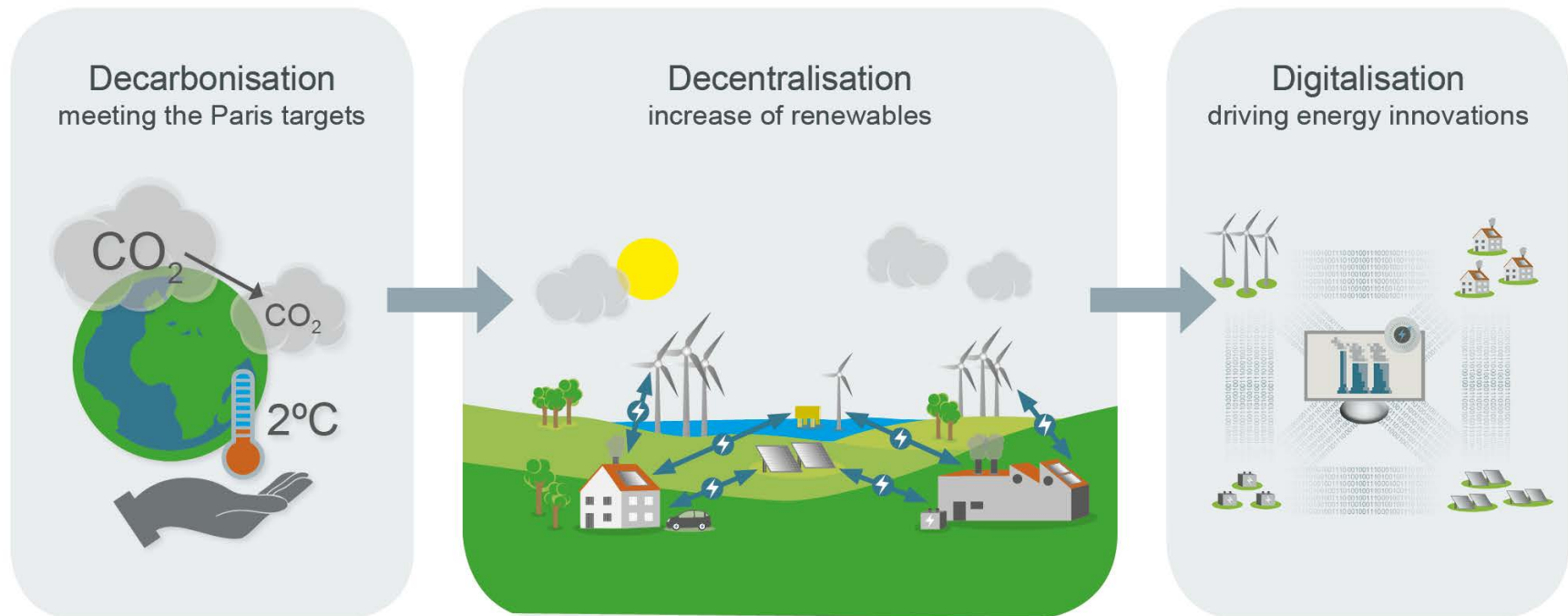
Storage

Flexible supply

Energy efficiency / savings
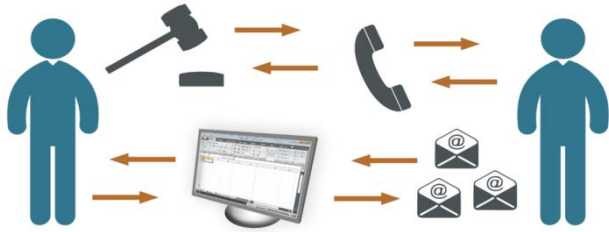
Innovation drives the Energy System of the Future

Decarbonisation and the resulting decentralization of power supply raise demand for digital innovations.

Decarbonisation
meeting the Paris targets

Decentralisation
increase of renewables

Digitalisation
driving energy innovations

An economic layer the web never had

Transactions without blockchain

Distributed system of records shared across a public or business network	**Shared Ledger**

All parties agree to verified transaction on the same network	**Consensus**

Transactions with blockchain

Crypto-graphy	Secure, authenticated & verifiable transactions

Smart Contract	Business terms embedded in ledger & automatically executed with transactions

Note: **Bitcoin** operates on the basis of Blockchain technology, but a **Blockchain can be used for many more applications** than just Bitcoin.

There is a lot of potential

Blockchain is here to stay: foundational technology
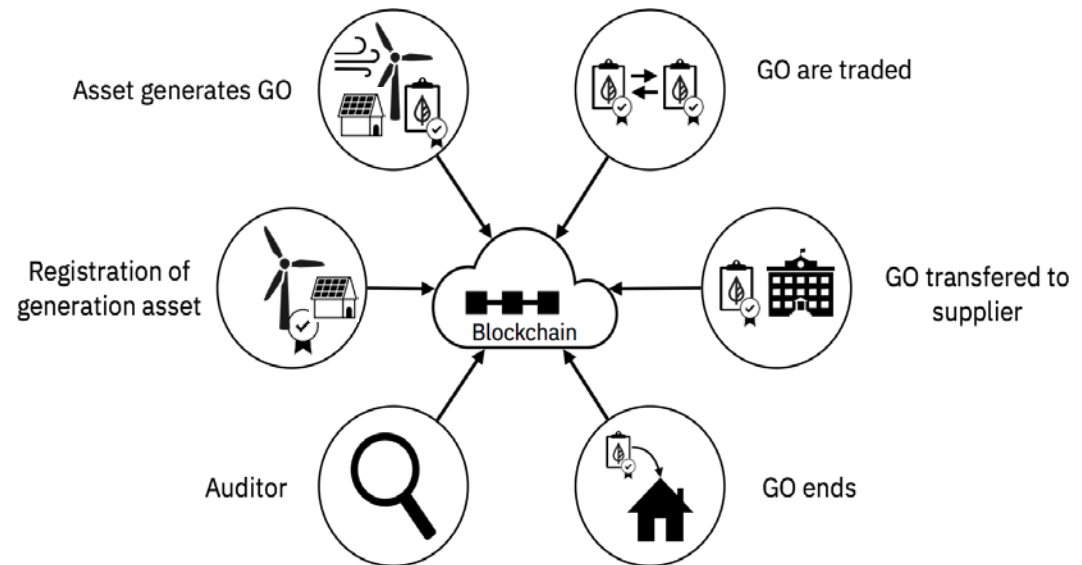
Learn fast, fail often (business use cases)

Why blockchain?

The leading blockchain platform is not invented yet

Only store relevant data on-chain

Certify decentral sustainable energy production

→ *Blockchain captures the end-to-end process in one ledger. All parties work on the same data.*

- Asset generates GO
- GO are traded
- Registration of generation asset
- Blockchain
- GO transfered to supplier
- Auditor
- GO ends

certiq

There is a lot of potential

Blockchain is here to stay: foundational technology

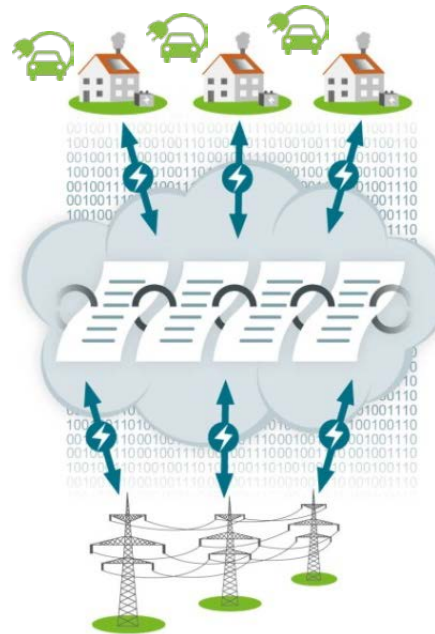**Learn fast, fail often (business use cases)**

Why blockchain?

The leading blockchain platform is not invented yet

Only store relevant data on-chain

Unlocking decentral flexibility

→ *Gaining practical experience with blockchain technology and interfacing with existing TenneT systems and processes.*

Aquarii

redispatch with home batteries

RepubliQ

aFRR with electric vehicles

Blockchain video

Aggregator Vandebron

Stop and postpone charging process: regulating <u>up</u>

Pilot description

- Voluntary aFRR bids (1 MW)
- Realtime data communication:
  - TenneT setpoint & verification
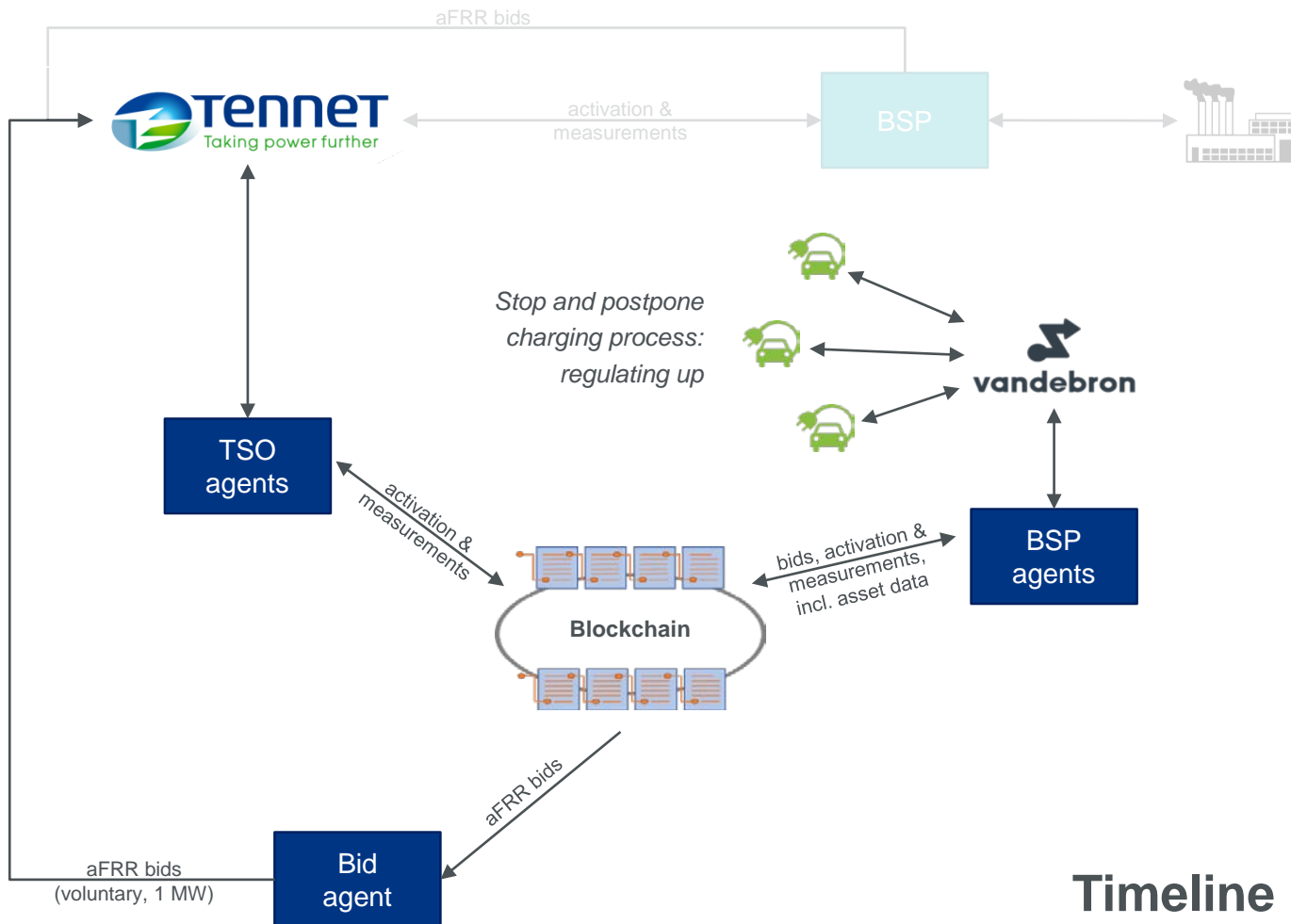 - Aggregated power signals
  - *Data on asset level*

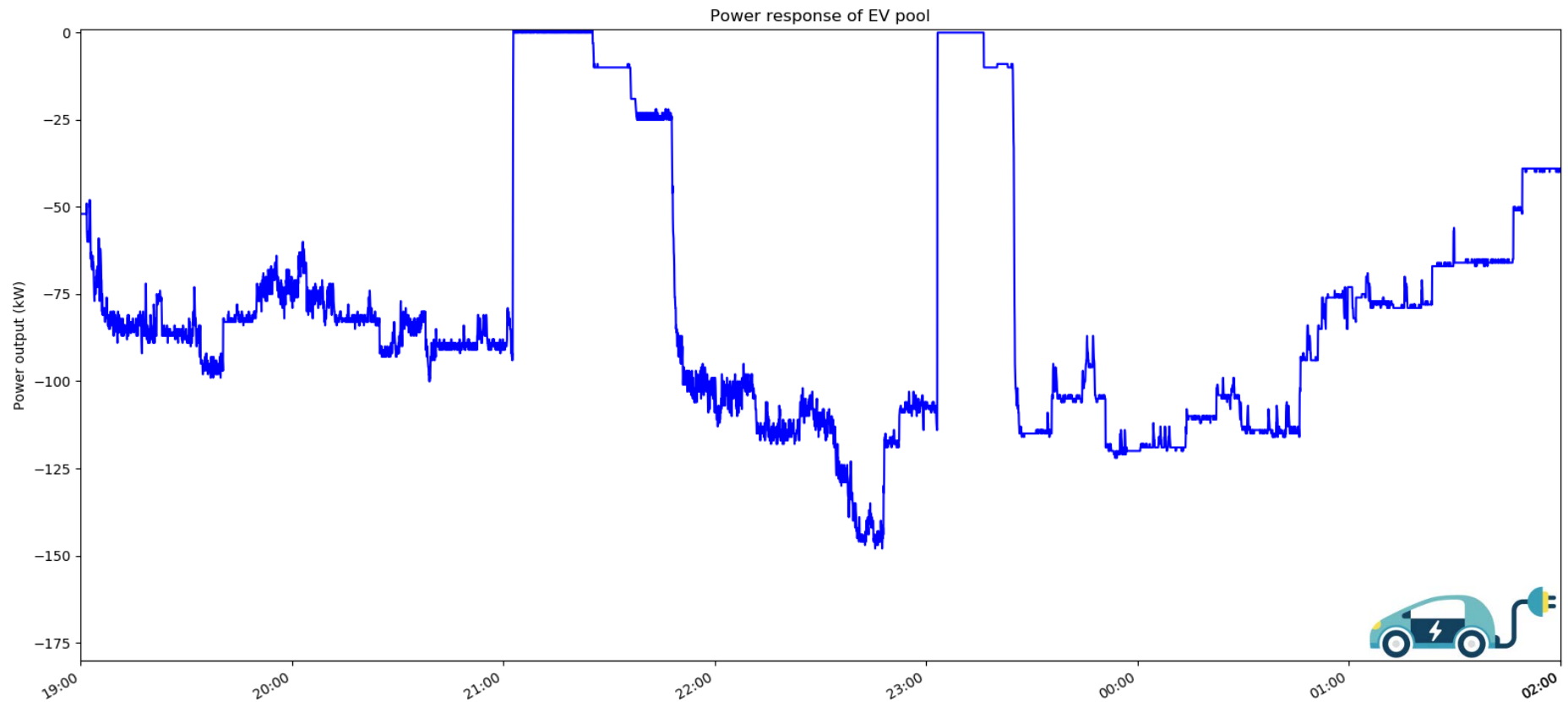vandebron

automatic Frequency Restoration

aFRR bids

activation & measurements

BSP

RepubliQ implementation

Timeline

- ✓ 2017: first BC implementation
- ➢ 2018: evaluation phase
- ➢ 2019: to be determined

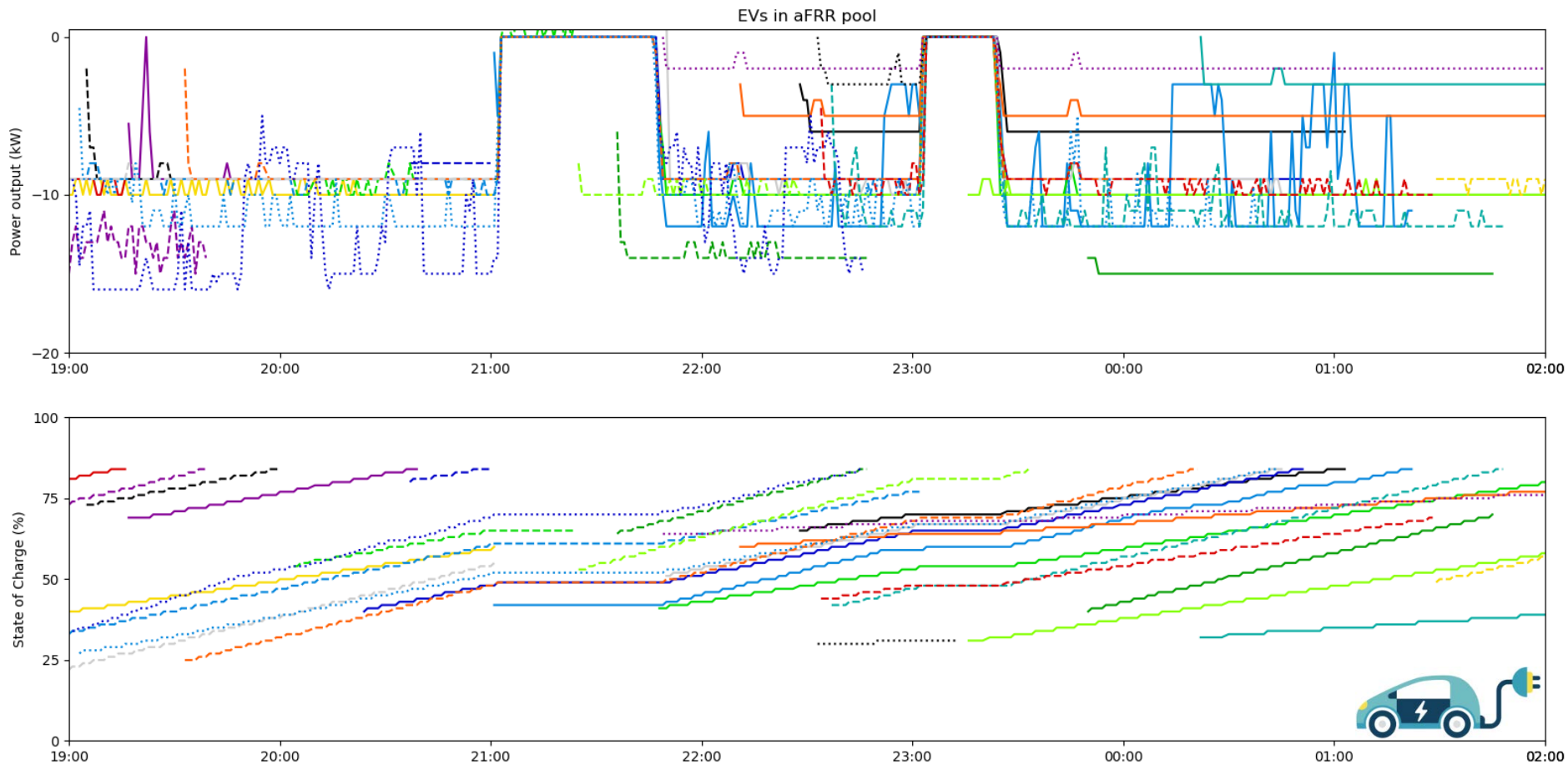**Unlocking grid flexibility:**

Evaluating activated bids

Power response of EV pool

Evaluating activated bids
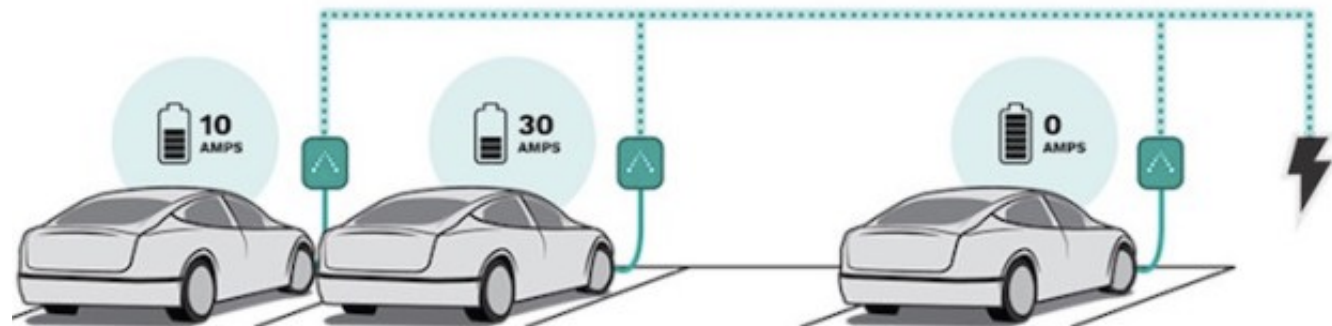

EVs in aFRR pool

Unlocking grid flexibility:

Outlook

Continuation of pilots!

- Evaluation / operation with Vandebron: more cars, more bids
- Startup of aFRR pilots in Q3 2018
- Further development of blockchain pilot following European tender procedure

Thank you for your attention!

Questions?

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TenneT is a leading European electricity transmission system operator (TSO) with its main activities in the Netherlands and Germany. With approximately 22,000 kilometres of high-voltage connections we ensure a secure supply of electricity to 41 million end-users.

Taking power further