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Active Network Management
Ensure reliable operation with high levels of DER penetration

Tim Joosten Frans Campfens| Qirion Energy Consulting

Smart Grid Flexibility 2019

2 oct 2019

Agenda

- Introduction

- Developing an effective and affordable DER control strategy

- Understanding the different requirements of home area, local area and metropolitan area network management

- Applying autonomous control to rapidly increase hosting capacity of DER

- Case study: From innovation to implementation

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Frans Campfens introduction
Senior Consultant Energy Consulting

alliander Qirion

- Over 34 years of experience in utility business
- Started 2001 with first roll out of smart
  meters in the Netherlands

Knowledge areas:
- Smart meter infrastructures
- Smart grid
- IT/OT integration
- Advanced Analytics / Big Data
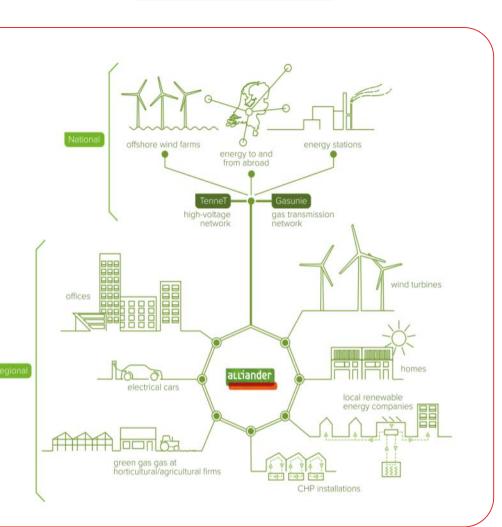
frans.campfens@qirion.nl

About Alliander
Alliander is a large Dutch Distribution System Operator

- ► 37% marketshare
- ► 3,0 million customers (E)
- ► 2,6 million customers (G)
- ► 7000 Employees
- ►100% Publicly owned

Electricity & Gas
Electricity

Grid length (in kilometres)

ELECTRICITY
91,000 km
90,000 km in 2017

GAS
42,000 km
42,000 km in 2017

National
offshore wind farms
energy to and from abroad
energy stations
TenneT — high-voltage network
Gasunie — gas transmission network

Regional
offices
electrical cars
wind turbines
alliander
homes
local renewable energy companies
green gas gas at horticultural/agricultural firms
CHP installations
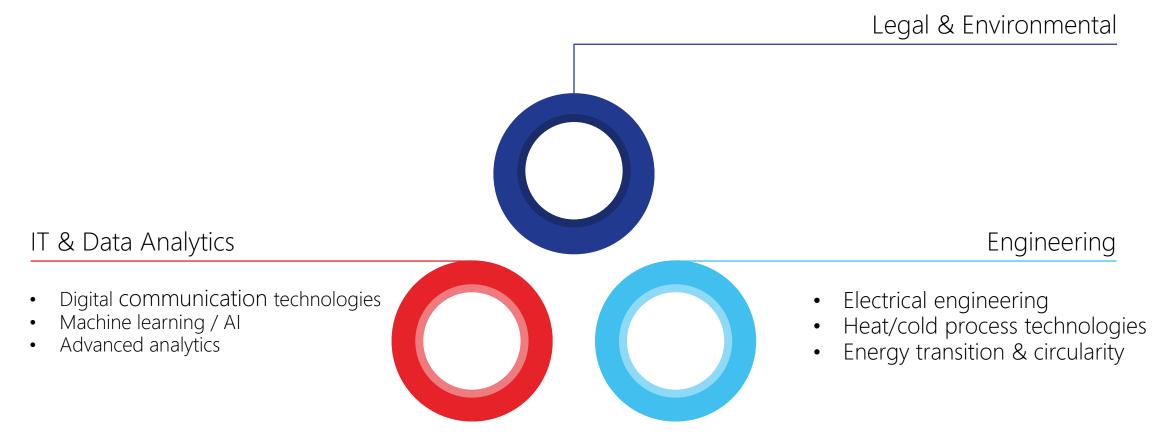
Position of Qirion in the Alliander

About Qirion: a subsidiary of Alliander

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Qirion Energy Consulting is the engineering departement of Alliander
and provides expertise on sustainable and innovative solutions for energy grids.

Legal & Environmental

IT & Data Analytics

- Digital communication technologies
- Machine learning / AI
- Advanced analytics

Engineering

- Electrical engineering
- Heat/cold process technologies
- Energy transition & circularity

Developing an effective and affordable DER control strategy

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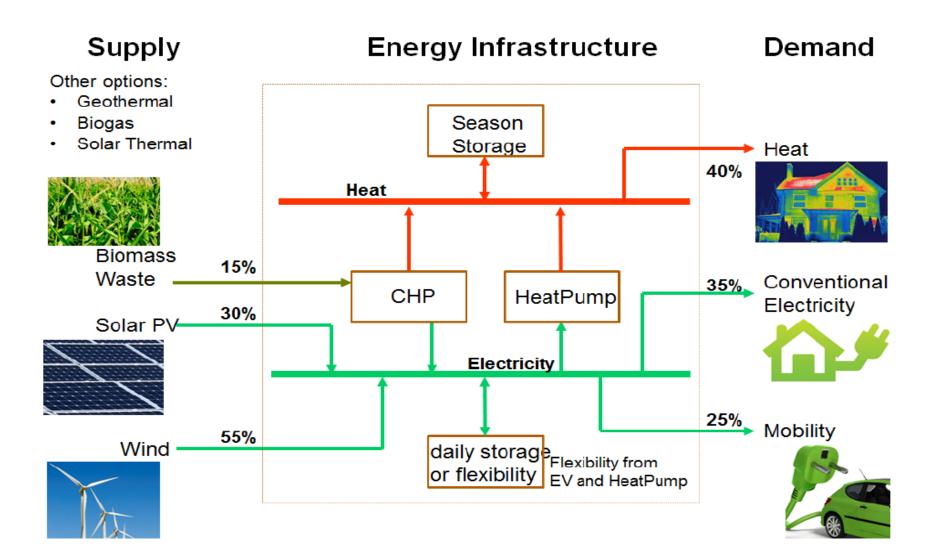SMART GRID FORUMS | Smart Grid Flexibility 2019

Achieving energy system flexibility through effective DER integration & operation

3-Day Conference, Exhibition & Networking Forum
1 - 3 October - London, UK

Energy Mix in the Netherlands 2050 (source TNO)

Dramatic increase in solar energy

Figuur: Opgesteld (piek)vermogen zonne-energie [MW]. Bron: Intranet – Alliander in cijfers

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Voltage*	Capacity*	Powerfactor*
High	Overload	< 0.5
Low		> 0.9

* only as an example but also
- Power quality
- Short Circuit Current
- Inertia
- Frequency stability
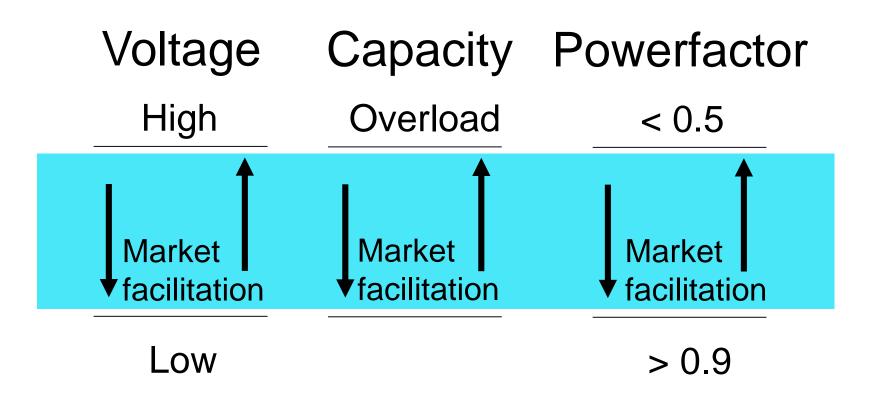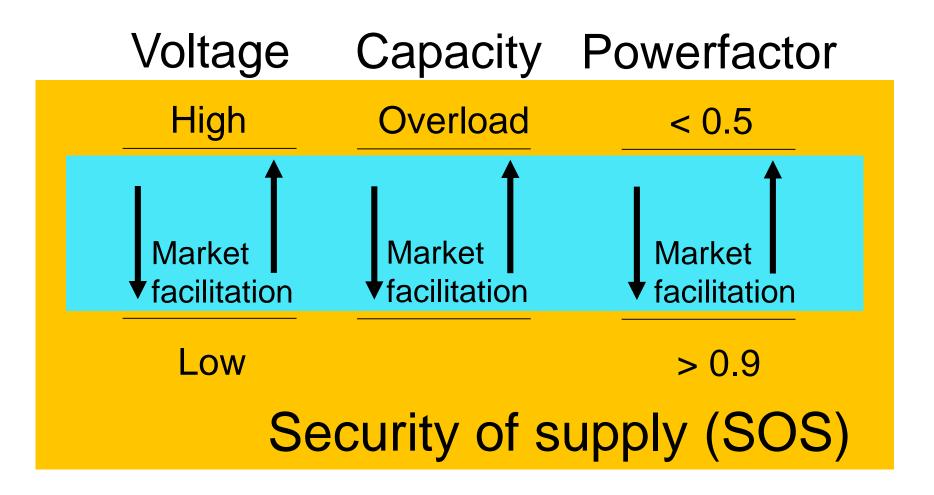
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Voltage	Capacity	Powerfactor
High	Overload	< 0.5
Market facilitation	Market facilitation	Market facilitation
Low		> 0.9

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Voltage	Capacity	Powerfactor
High	Overload	< 0.5

Market facilitation   Market facilitation   Market facilitation

| Low | | > 0.9 |

Security of supply (SOS)

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Control of generation
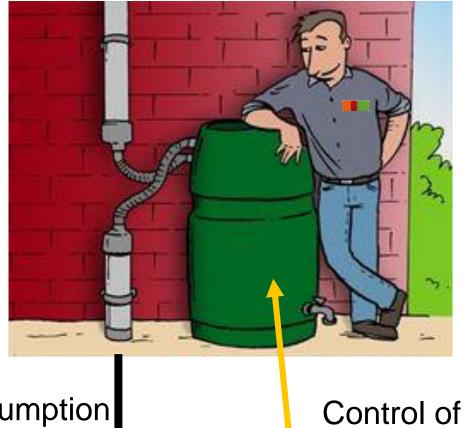
Who is in control?

Control of consumption

Control of storage

13

Source: garra

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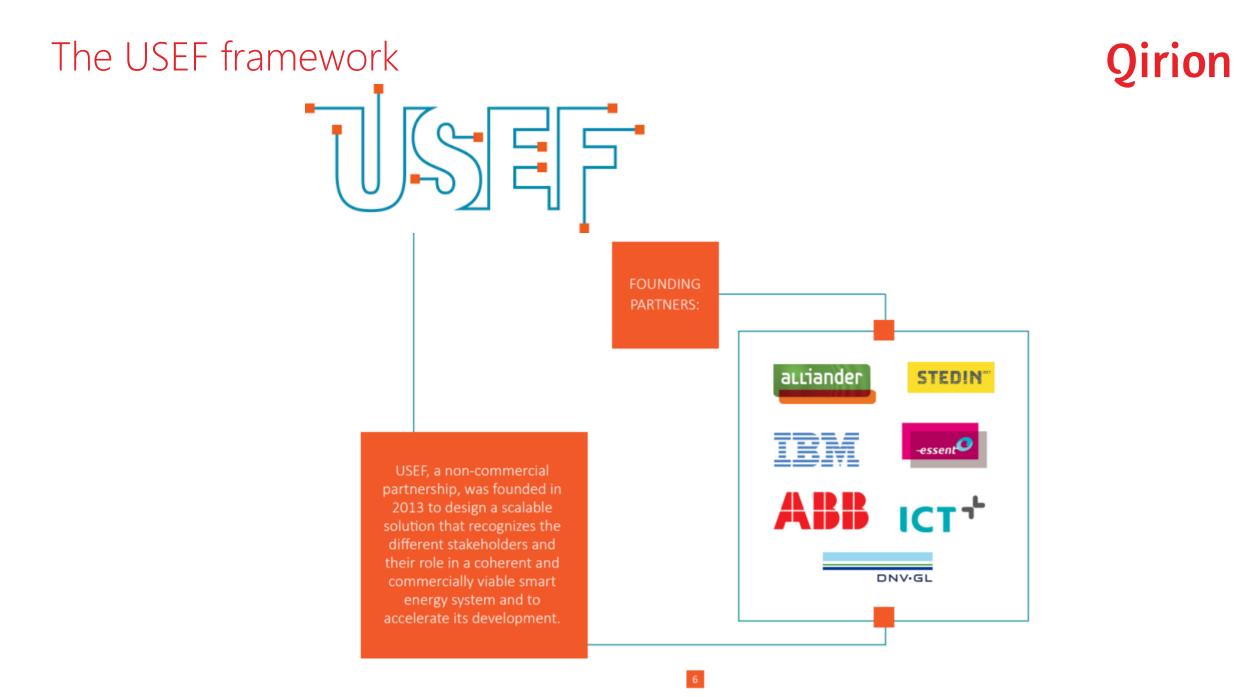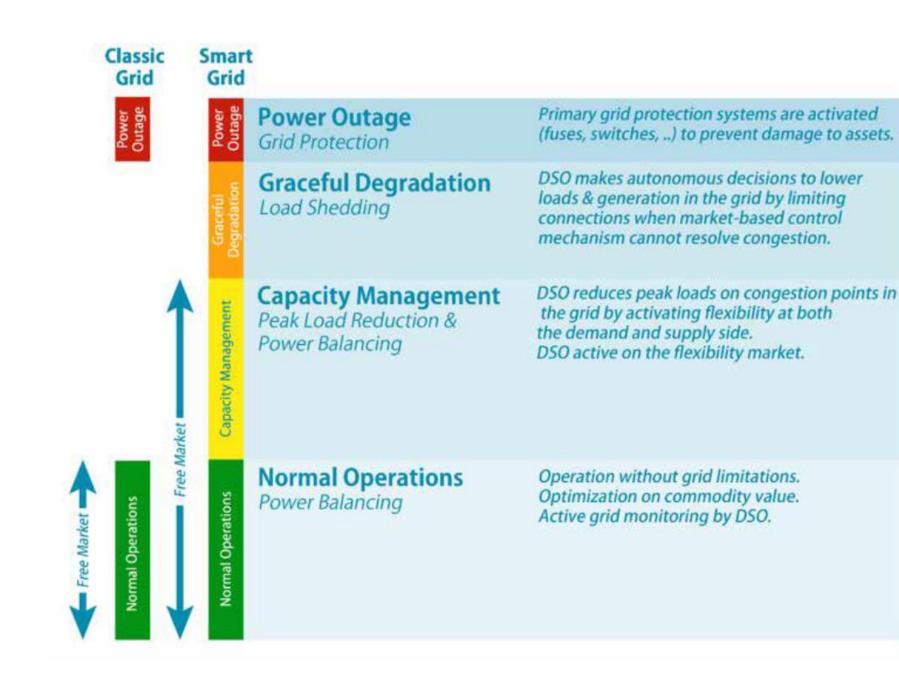
DSO should be in control !!

Four angles:

- Market (USEF)
- Topology
- Telecontrol
- Security

Source: gamma

The USEF framework

FOUNDING PARTNERS:

USEF, a non-commercial partnership, was founded in 2013 to design a scalable solution that recognizes the different stakeholders and their role in a coherent and commercially viable smart energy system and to accelerate its development.

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Classic Grid	Smart Grid		
Power Outage	Power Outage	**Power Outage** *Grid Protection*	Primary grid protection systems are activated (fuses, switches, ..) to prevent damage to assets.
	Graceful Degradation	**Graceful Degradation** *Load Shedding*	DSO makes autonomous decisions to lower loads & generation in the grid by limiting connections when market-based control mechanism cannot resolve congestion.
	Capacity Management	**Capacity Management** *Peak Load Reduction &* *Power Balancing*	DSO reduces peak loads on congestion points in the grid by activating flexibility at both the demand and supply side. DSO active on the flexibility market.
Normal Operations	Normal Operations	**Normal Operations** *Power Balancing*	Operation without grid limitations. Optimization on commodity value. Active grid monitoring by DSO.

Free Market

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Intelligence

Knowlegde

Interconnect

Data

Instrumentation

Electricity

MSR

LS

MSR

Telecontrol response timing

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Response time

Hour

Minutes

Seconds

Milliseconds

connections

10^5 10^4 10^3 10^2 10 1

Introduction: network topology
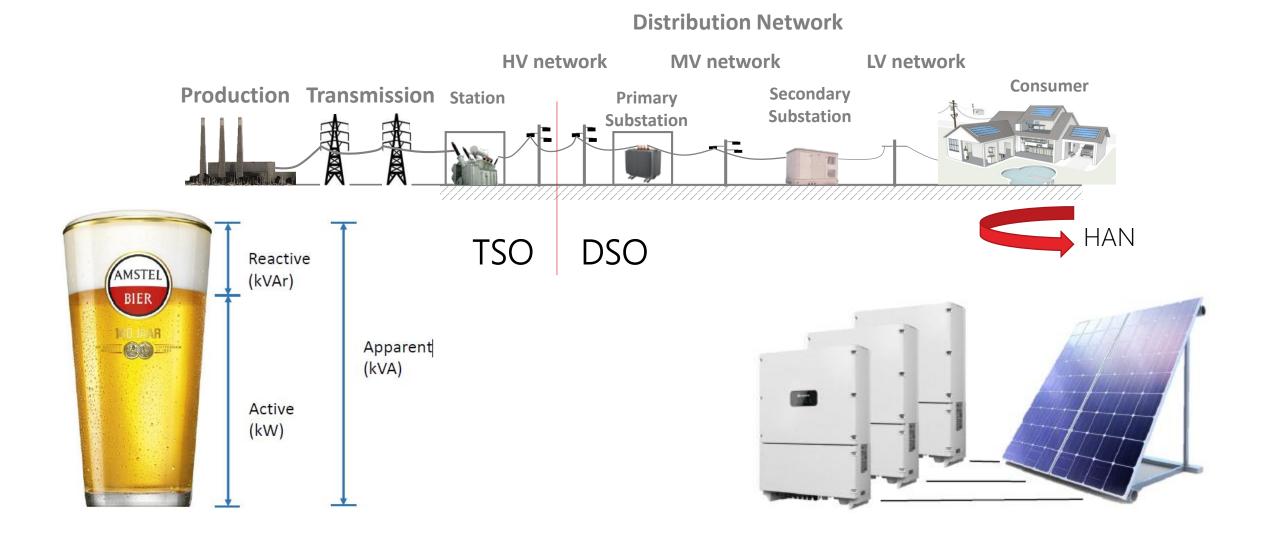
Topology: HAN, LAN MAN WAN control loop

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Distribution Network

HV network   MV network   LV network

Production   Transmission   Station   Primary Substation   Secondary Substation   Consumer

TSO | DSO

HAN
LAN
MAN
WAN

Intelligence — Knowlegde

Interconnect — Data

Instrumentation — Electricity

MSR
LS   MSR

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Autonomous Grid Support → Tim

Distribution Network

HV network **MV network** **LV network**

Production **Transmission** **Station** **Primary Substation** **Secondary Substation** **Consumer**

TSO | DSO

HAN

Reactive (kVAr)

Apparent (kVA)

Active (kW)

AMSTEL BIER

Tim Joosten introduction
Project Manager Grid Innovations

Master's degree in Management of Technology from Delft University of Technology.

Personal ambition is to apply new technologies from across different industries and use them to accelerate the renewable energy transition.

- Responsible for research into autonomous voltage control for modern power electronics;

- Testing new capacity tariff structures for Dutch households in a case study;

- Currently running a pilot involving 10+ DERs using P- and Q-droop control mechanisms actively balacing grid voltage;

Achieving energy system flexibility through effective DER integration & operation

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Case study: Autonomous Control
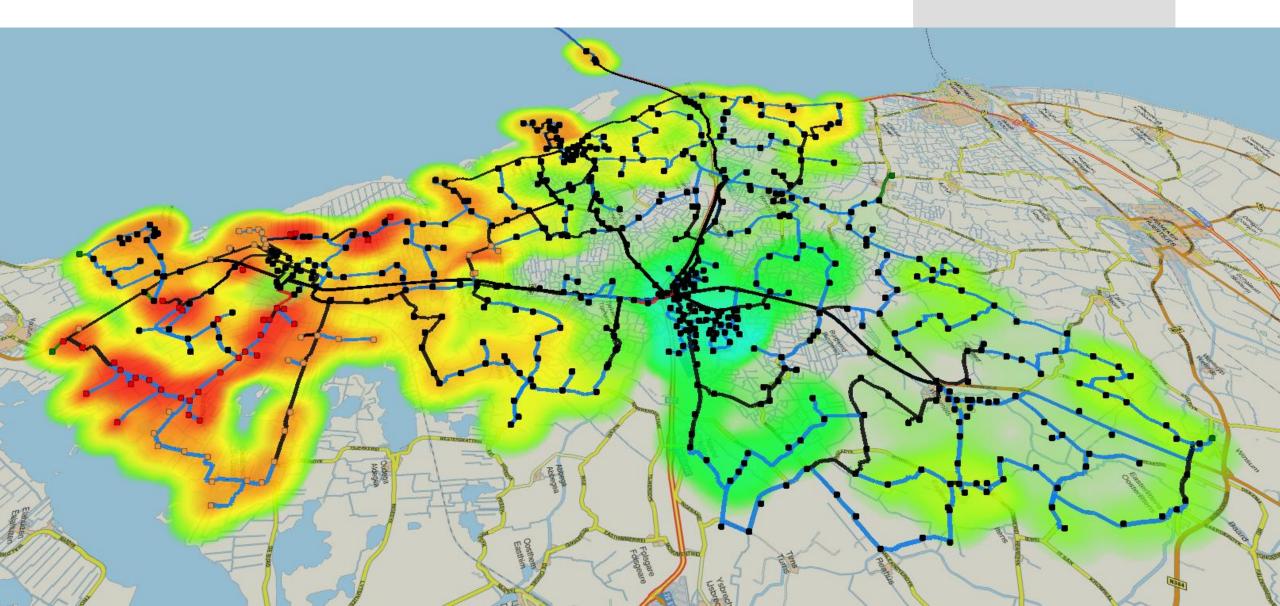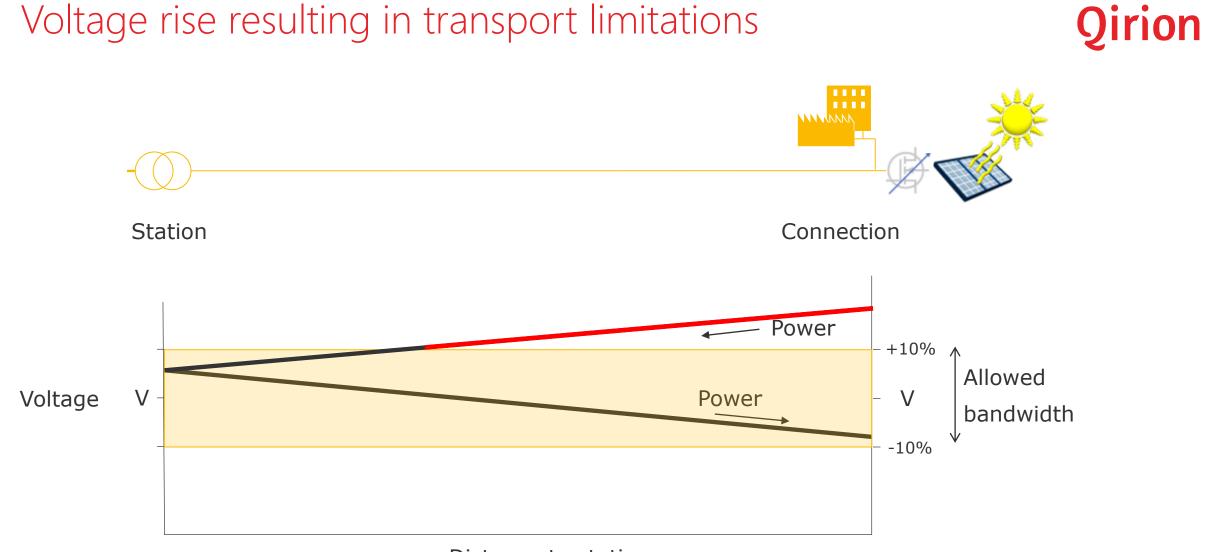
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Voltage rise resulting in transport limitations

Station

Connection

Power

Power

Voltage

V

V

+10%

-10%

Allowed
bandwidth

Distance to station
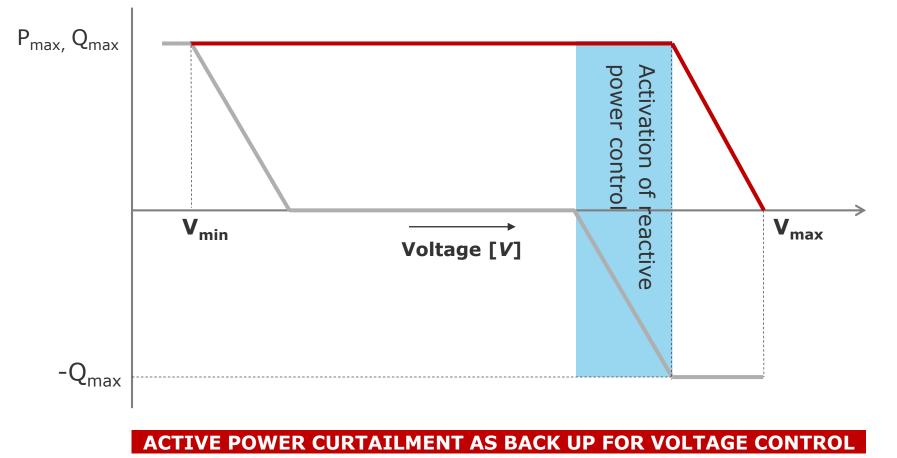
Local control mechanism in the DER's power electronics
Active- and reactive power control effectively reduce voltage variation

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ACTIVE POWER CURTAILMENT AS BACK UP FOR VOLTAGE CONTROL
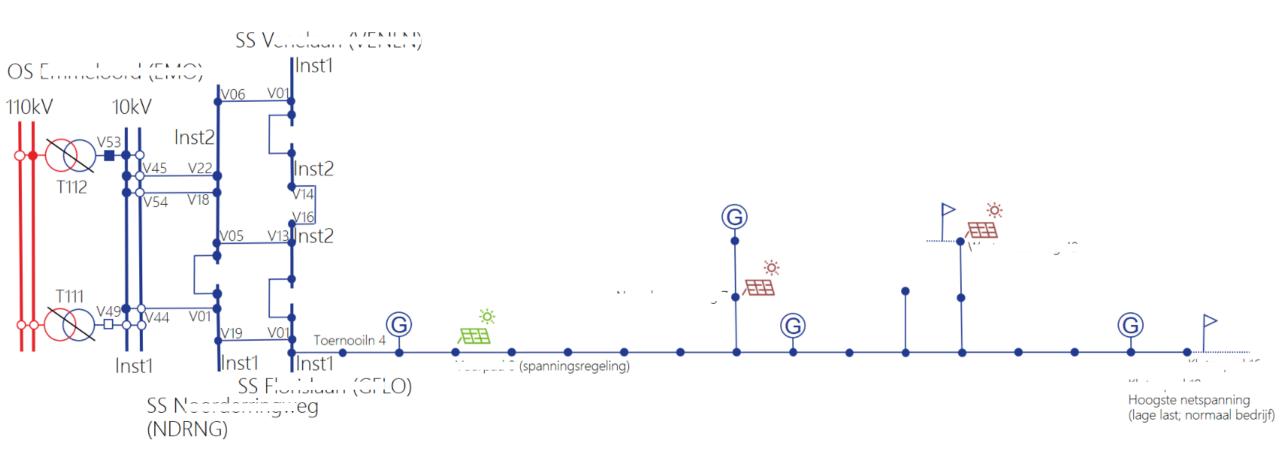
Understanding transport limitations
Ideally, the solution is located at the problem-area

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Voltage control in practice
Using software settings on hardware components already in place

Communicating
grid voltage

Control signals
(re)active power

PQ monitor

Solar Park 'cluster' controller

Inverters

PV-panels
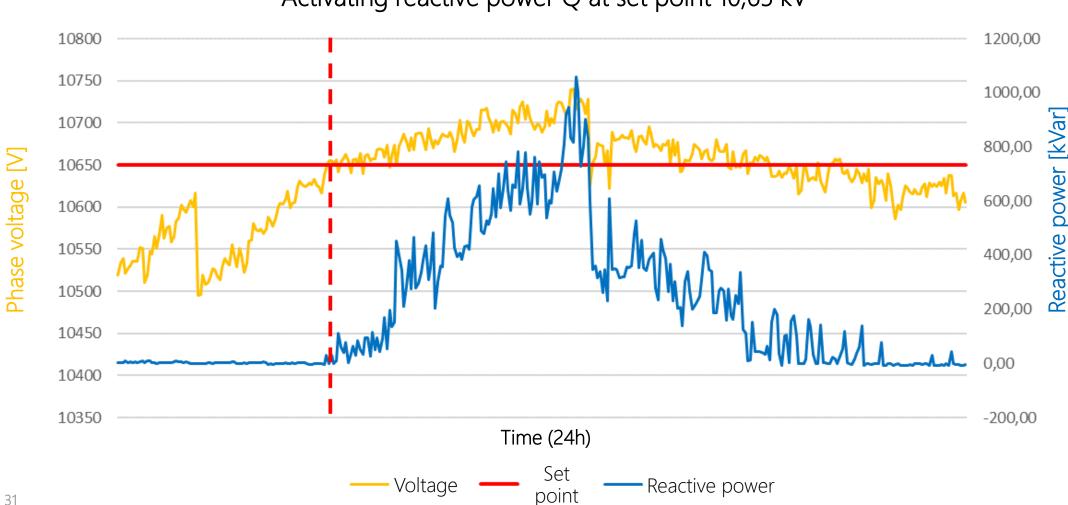
Field study using
MV and LV measurements

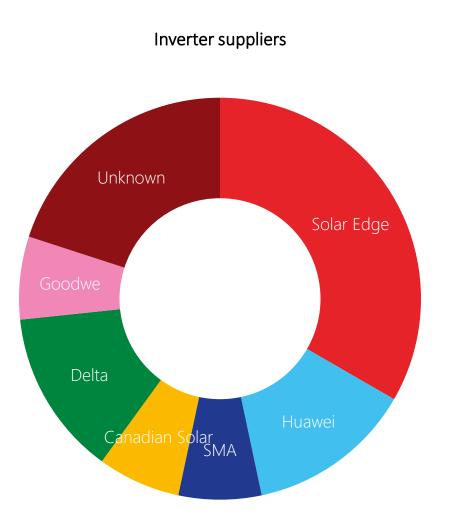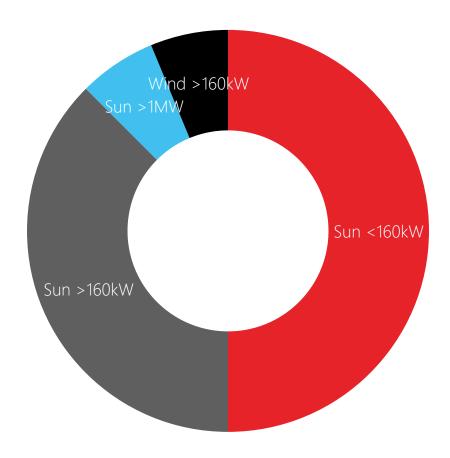# Voltage control in the field
Measurements of a sunny day
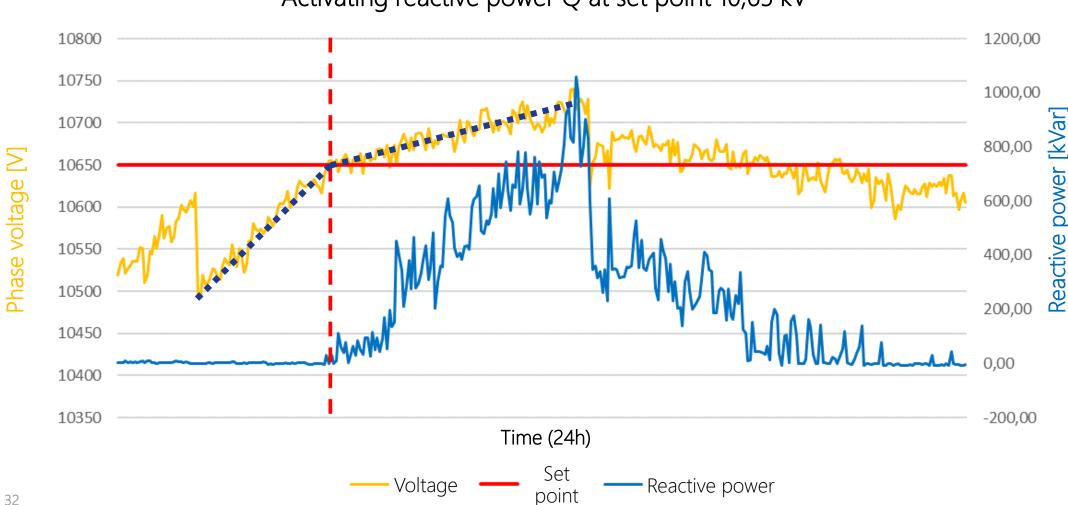
Activating reactive power Q at set point 10,65 kV

Learning from unique locations
Effectiveness of Q(u) and P(u) droop control at 15 locations

Inverter suppliers

- Solar Edge
- Huawei
- SMA
- Canadian Solar
- Delta
- Goodwe
- Unknown

Type of Connection

- Sun <160kW
- Sun >160kW
- Sun >1MW
- Wind >160kW

From a case study to large scale roll-out

How to scale to a network wide solution?

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Deployment strategy Set points
What is the impact of the set points to the applicability of the solution?

Effectiveness of coordinated Q and P droop control locally
How effective is droop control in balancing voltage in several local network-setups>

How do customers respond to this solution?
How is the customers acceptance to changing settings in their inverters?

Governance of the roll-out
Who will coordinate the roll-out and who will be responsible?

Contracting and compensation
How do the contracts with the DER look like? Will they be compensated and in what way?

Processes and changes in the way-of-working
How will this new solution affect our current way of working and what processes should be changed?
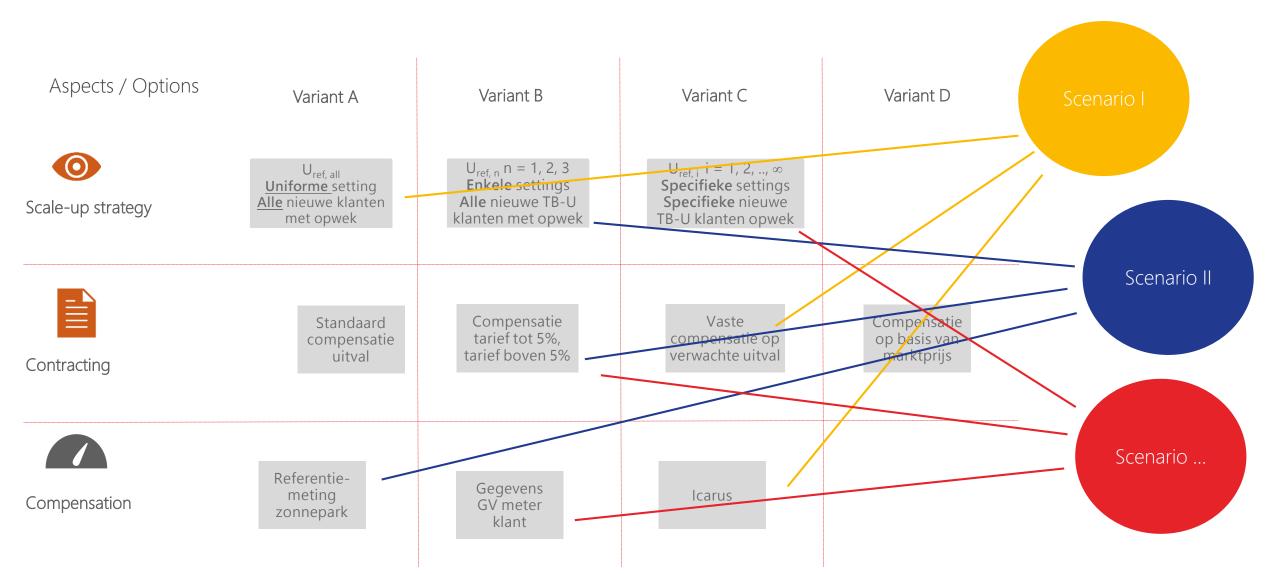
National strategy to develop unified requirements
Generating a nation wide view on the implementation of PQ controls

Compensation strategy
How to handle customers who can not generate 24/7?

Key take aways

- Cybersecurity of DER is underestimated industry-wide

- Dutch DSO's can not keep up with the 'Stimulation of Sustainable Energy Production'

- Grid edge control as preferred solution to increase hosting capacity

- Hosting capacity doubles when applying PQ controls

- Large scale implementation of PQ would greatly increase grid utilization, Society benefits.

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End of our presentation
Thank You

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