Grid to great
Powered by Alliander

Digitize | Centralize | Virtualize

Digital transformation of the electricity Grid

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Managing Director

September 6th 2024

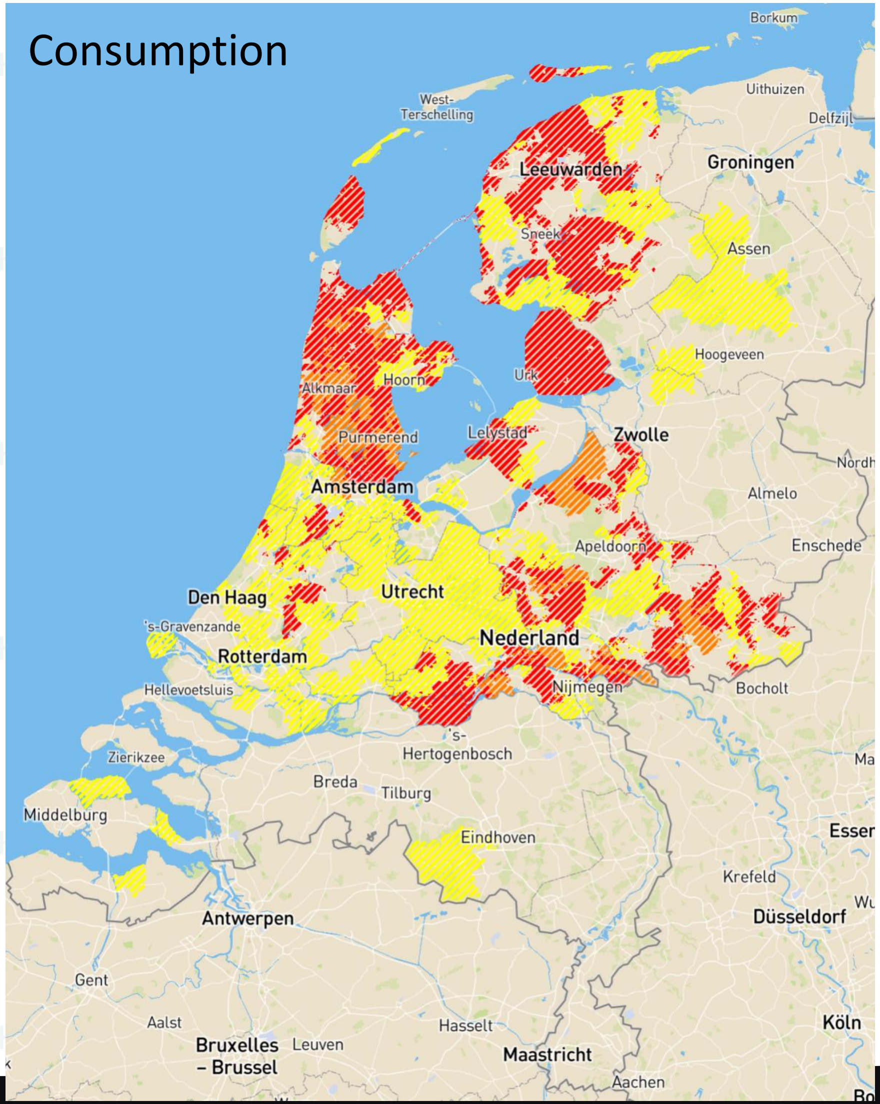
2. Agenda

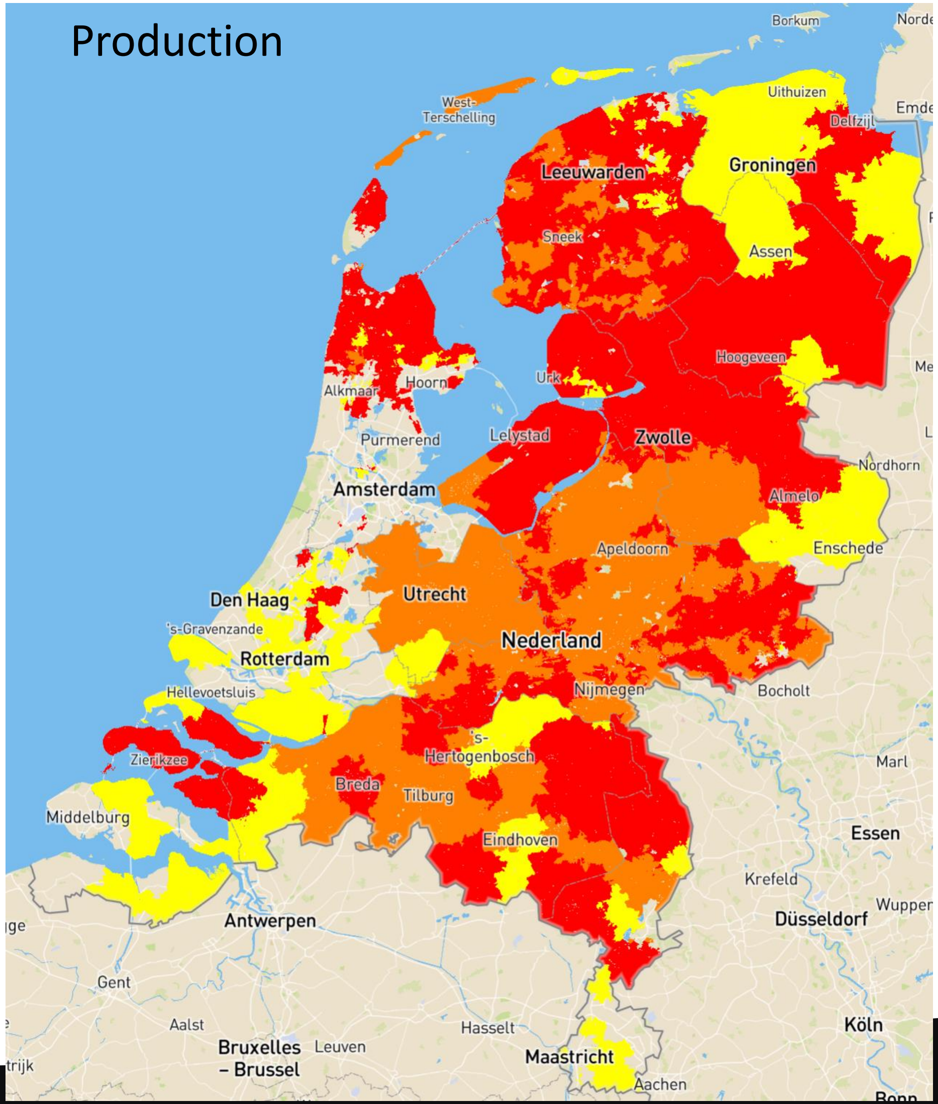
Main topics

- Challenges for DSOs and TSOs
- Expanding grid capacity
- The benefits and challenges of digitalization & virtualization
- Discussion

The Dutch power grid needs a change

Shortage of transport capacity due to the rapid energy transition impacts many





Source: Netbeheer Nederland
Date: **April 2022**

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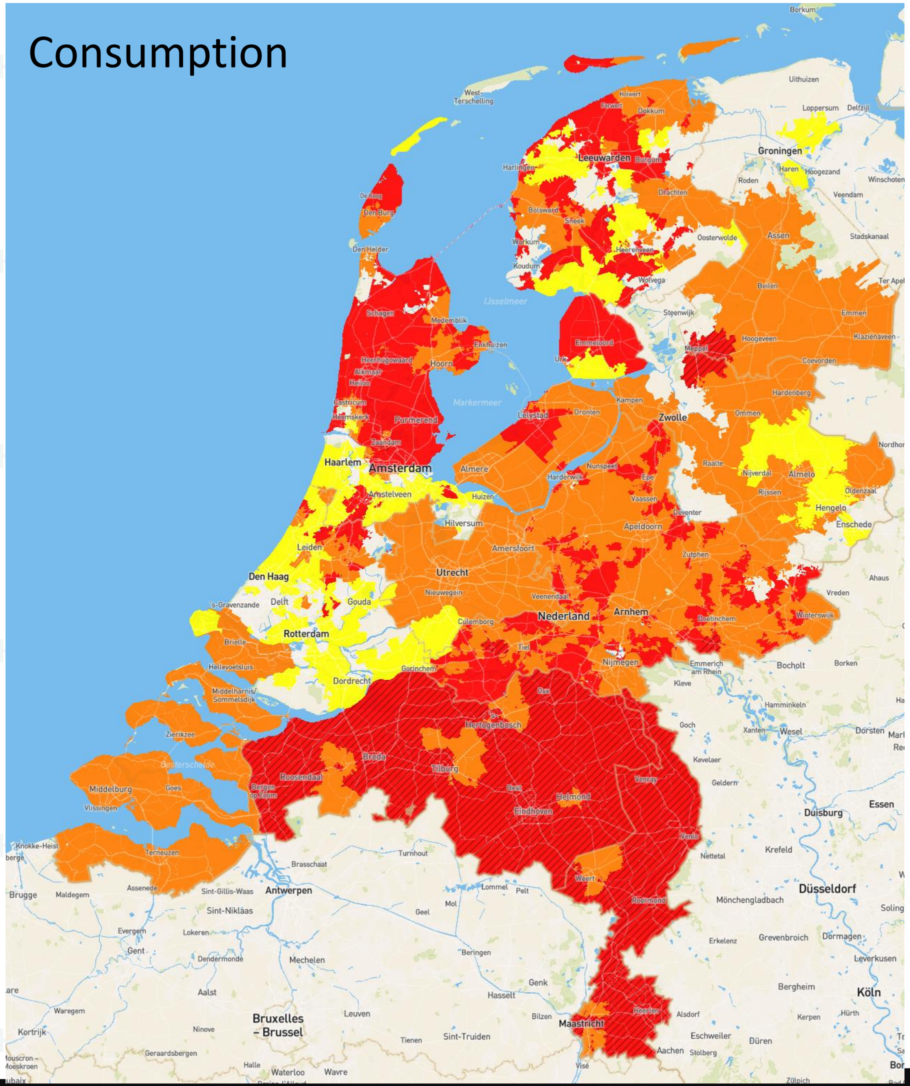

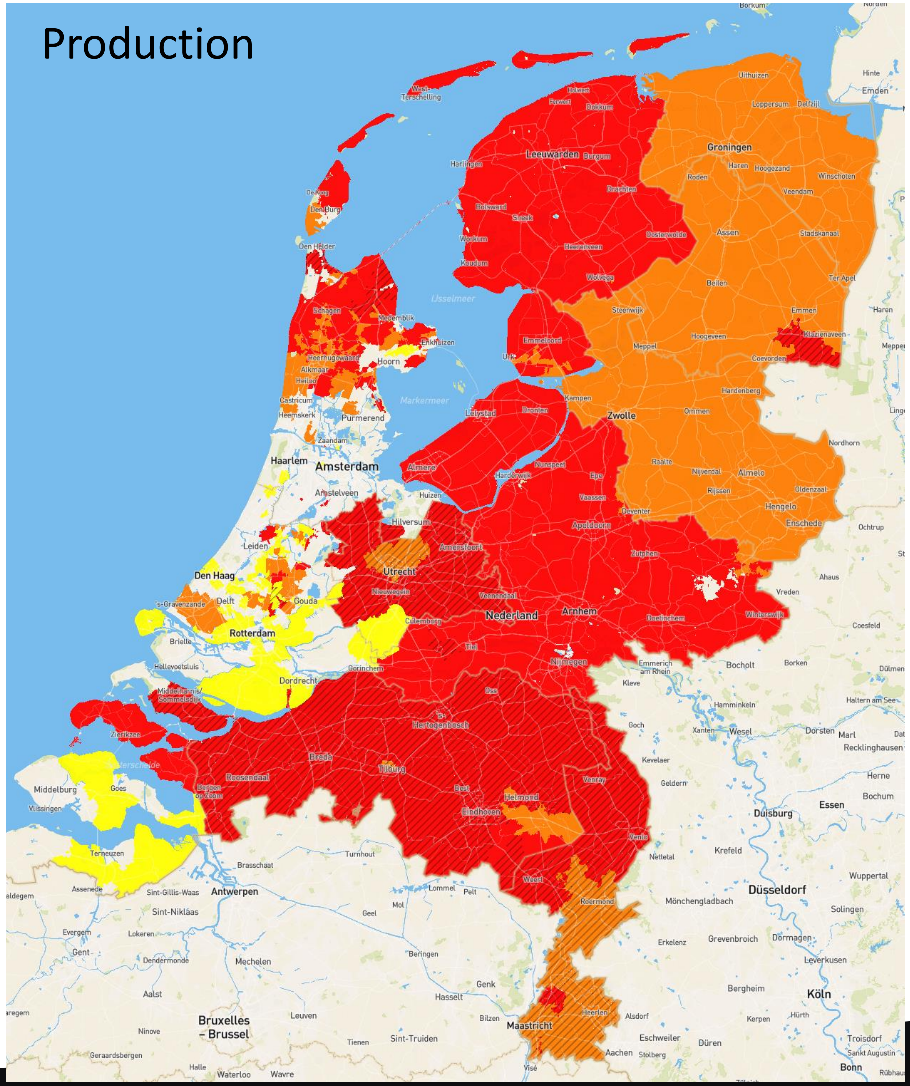

Betekenis van de kleurcodes

- Transparant: Transportcapaciteit beschikbaar
- Geel: Beperkt transportcapaciteit beschikbaar
- Oranje: Voorlopig geen transportcapaciteit beschikbaar in afwachting van uitkomst van het congestiemanagement-onderzoek
- Rood: Geen transportcapaciteit beschikbaar: congestiemanagement kan niet worden toegepast

Met congestiemanagement:

- Transparant gearceerd: Transportcapaciteit beschikbaar o.b.v. toepassing congestiemanagement
- Geel gearceerd: Beperkt transportcapaciteit beschikbaar o.b.v. toepassing congestiemanagement
- Oranje gearceerd: Voorlopig geen transportcapaciteit beschikbaar in afwachting van het verdelen van het vrijgekomen vermogen over de wachtrij o.b.v. congestiemanagement. (het is nog onduidelijk of en hoeveel vermogen er beschikbaar komt voor nieuwe aanvragen die nog niet in de wachtrij staan)
- Rood gearceerd: Geen transportcapaciteit beschikbaar: de grenzen voor de toepassing van congestiemanagement zijn bereikt.

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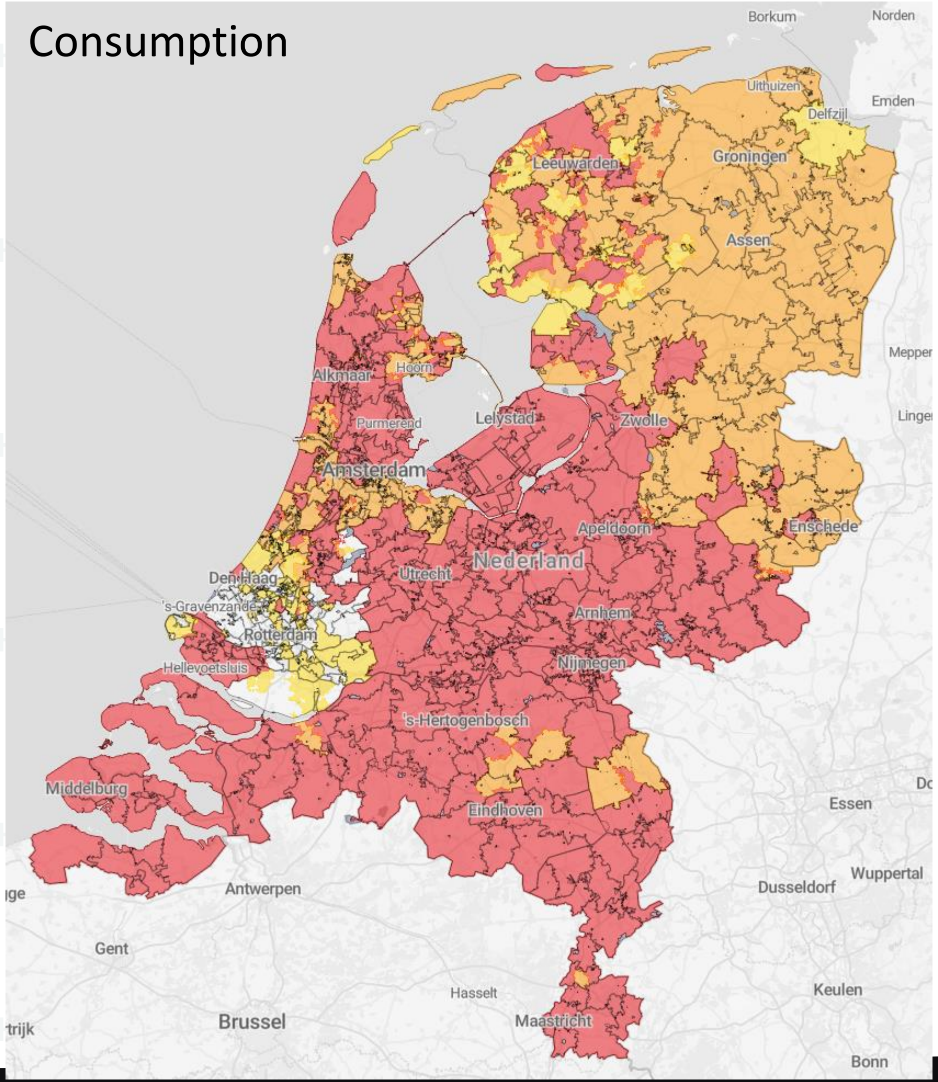

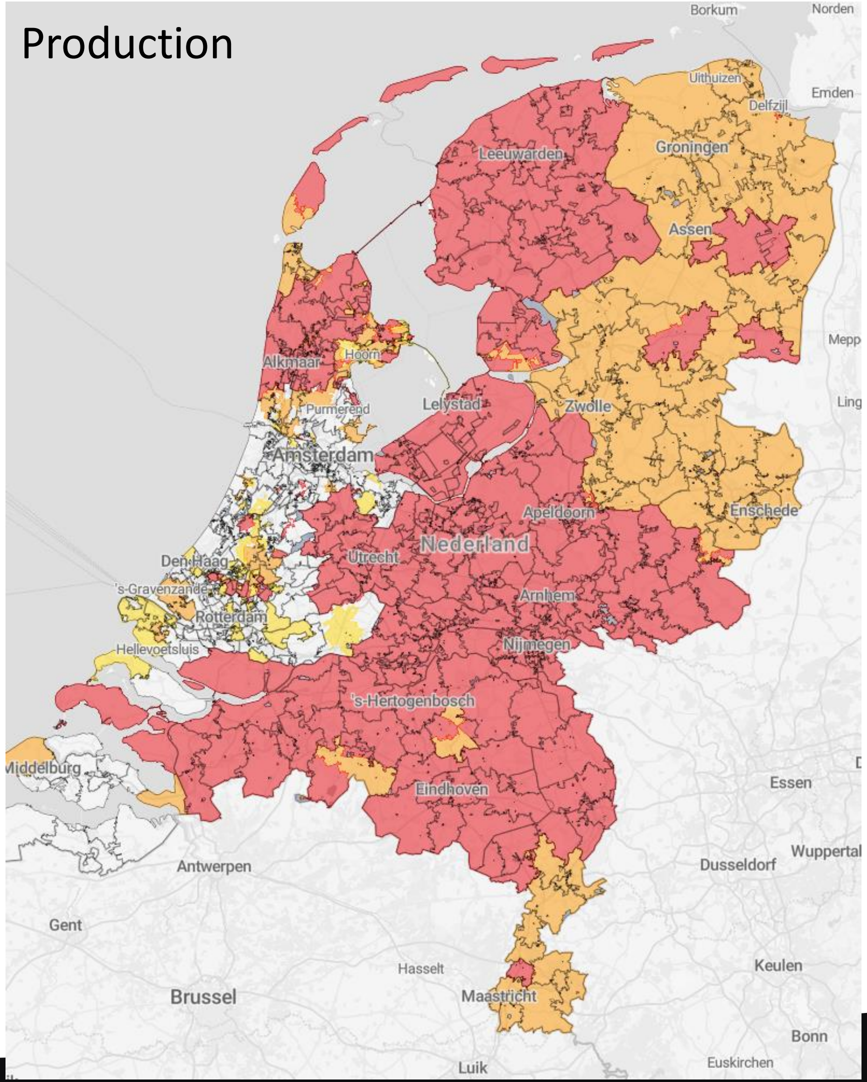

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The strategies & actions of grid operators

1. Expand the grid | 2. increase grid utilization

Expand the grid -> build & build

- Liander electricity grid (2022-2031)
- Install ca. 40.000 km new cables | base ca. 95.000km
- Add or replace ca. 20.000 new secondary substations | base ca. 35.000
- Build or expand 150+ primary substations | base ca. 400

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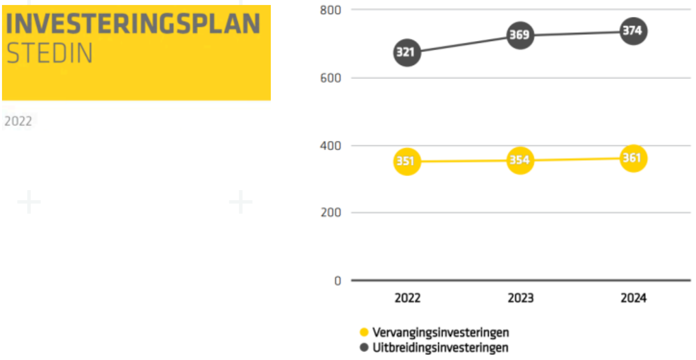
11 april 2022

Netbeheerder Liander kondigt grootste investeringspakket ooit aan

Liander investeert tot en met 2024 €3,5 miljard euro in het elektriciteitsnet in Friesland, Noord-Holland, Flevoland, Gelderland en een deel van Zuid-Holland. Die enorme uitbreiding van het elektriciteitsnet is nodig om tegemoet te komen aan de snel groeiende vraag naar elektriciteit en de grootschalige teruglevering van groene stroom aan het net.

>1.000 million euro / year
2024 H1 : ca. 800 M euro



>700 million euro / year

ENEXIS NETBEHEER

		Verwachte uitgaven* (mln €) 2022	2023	2024
Elektriciteit				
Uitbreidingen				
	Majeur	95	110	90
	Regulier	312	310	320
Vervangingen				
	Majeur	18	20	20
	Regulier	102	120	110
Netgerelateerd		8	10	10
	Totaal Elektriciteit	535	570	550

>500 million euro / year

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Increase grid utilization -> *digitize*

- Need for the right data
- Need a high degree of digitalization
  - Congestion management
  - Dynamic load limits (temperature based)

Key limitation: shortage of skilled people (in both cases)

Substation & substation automation

Controlling the high and medium voltage interconnections in the grid

Transmission substation
50kV substation

Distribution substation
> 400V and < 50.000V

Ca. 400 existing substation

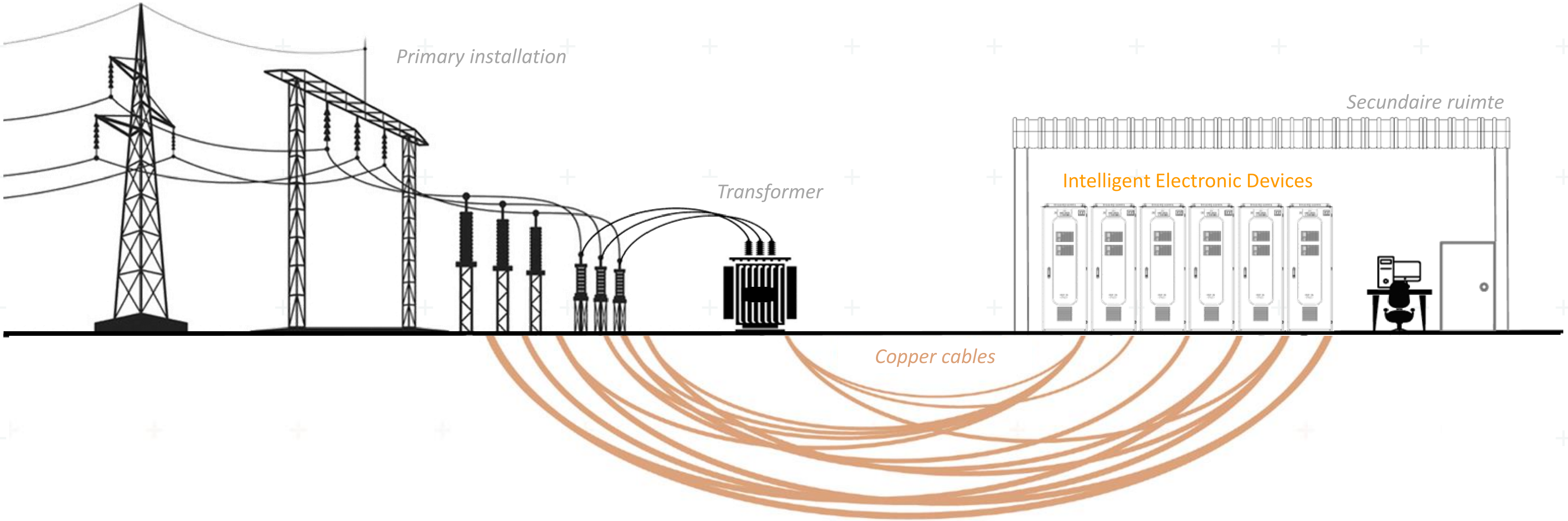
Life cycle 30+ years

Protection, automation and control (PAC) systems from many generations

Digitized, centralized, virtualized substation automation.

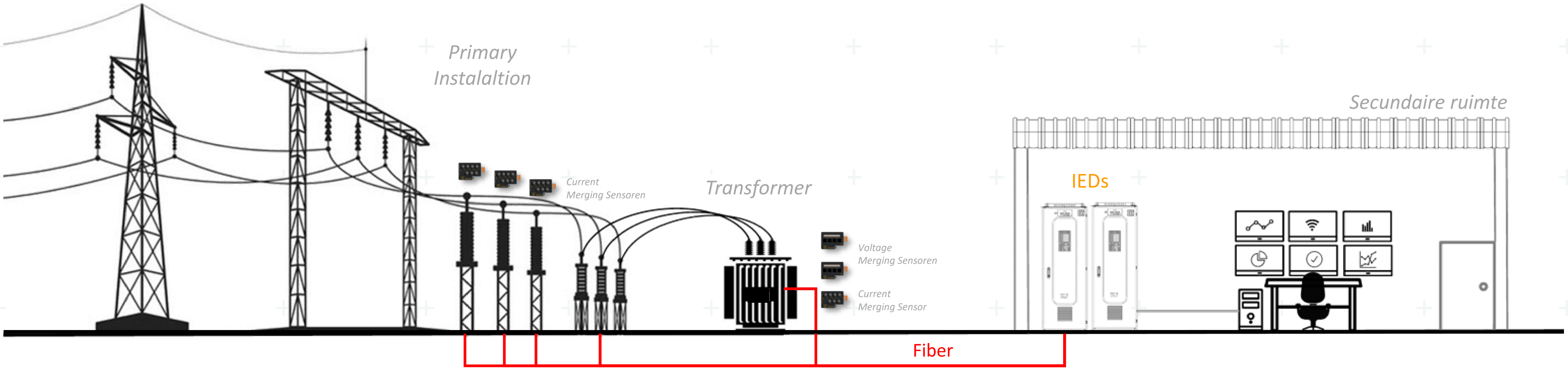
Conventional substations

A lot of copper cables and many devices (IEDs)



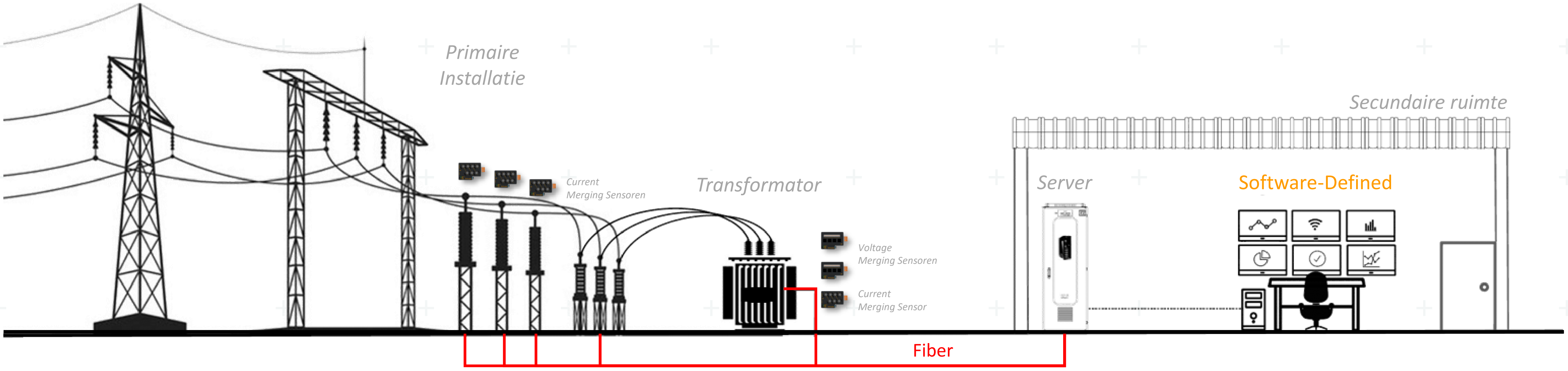
Digitalization at the source with so called merging sensors

Less cables, less devices, less work, less errors.



The Software-Defined substation

Replacing IEDs with software provides extra flexibility and safety



6. Question: what's the Business Case?

Cases based on variety of 150/10kV substations

A. What is the current amount of required engineering resources during various build stages

1. Design & engineering
2. Build
3. Testing & commissioning

4. Operational (not analysed yet)

B. What is this impact of digitalization and virtualization on required resources in these phases?

7. Analysis of required engineering resources during 3 stages

Cases based on variety of 150/10kV substations

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Current distribution of *engineering resources* per phase

New build

Phase	Effort [%]
1. Design & engineering	Ca. 19%
2. Build	Ca. 8%
3. Testing and commissioning	Ca. 73%
4. Operational	n.a.

Renovations

Phase	Effort [%]
1. Design & engineering	Ca. 28%
2. Build	Ca. 12%
3. Testing and commissioning	Ca. 60%
4. Operational	n.a

Note: total sum of engineering efforts depends on type of substation. Totals vary from ca. 4.700 hours – ca. 13.200 hours for cases investigated

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7. Analysis of scarce engineering resources during 3 stages

Cases based on variety of 150/10kV substations

Grid to great

Current distribution of *engineering resources* per phase

Phase	Effort [%]
1. Design & engineering	Ca. 19%
2. Build	Ca. 8%
3. Testing and commissioning	Ca. 73%
4. Operational	n.a.

X

Expected reduction of *engineering resources* for a fully digitized, centralized and software defined substation

Phase	A. Digitize	B. Centralize	C. Virtualize	Total
1. Design & engineering	5%	20%		ca. 25%
2. Build		30%		ca. 30%
3. Testing and commissioning	15%	15%	10%	ca. 40%
4. Operational	-	n.a.	-	n.a.

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New build

Total reduction ca. 36%

Phase	Effort [%]
1. Design & engineering	Ca. 28%
2. Build	Ca. 12%
3. Testing and commissioning	Ca. 60%
4. Operational	n.a

X

Phase	A. Digitize	B. Centralize	C. Virtualize	Total
1. Design & engineering	5 - 15%	20 - 35%		25 - 50%
2. Build	0 – 10%	30 - 45%		30 - 55%
3. Testing and commissioning	15%	15%	10%	ca. 40%
4. Operational	-	n.a.	-	n.a.

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Renovations

Total reduction ca. 40%

Note: total sum of engineering efforts depends on type of substation. Totals vary from ca. 4.700 hours – ca. 13.200 hours for cases investigated

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8. Additional benefits

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Digitalization at the source

- *80% less copper cabling* required between automation and primary side.
- Digitized data available for many purposes including *advanced measurements* and *controls*.

Virtualization of functions

- Great *flexibility* - functionality in software rather dan boxes
- *Quality* improvement - testing can be standardized and automated to a larger extend

Centralization of devices

- Less *space constraints* in the bay
- *Safer* work environment

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9. Challenges & adoption thresholds

How to overcome these challenges?

- New expertise needed
  - Knowledge of / experience with data networks in OT environment (Network redundancy design PRP/HSR , PTP clock)
  - More expertise in software and virtualization technology (orchestrators, real-time behaviour, etc.)
- Guidelines for life cycle management
  - Simple approach for IEDs → 'run to fail'
  - Periodical software maintenance
  - How does this impact testing?
- ……
- ……
- ……