KAN ELBILERNE HOLDE ENERGISYSTEMET I BALANCE?

Elbilnetværket 2023
Breakoutsession: Energisystemet

Hanne Binder, Seniorenergianalytiker, Energinet

VI ARBEJDER FOR DIG

Vi er ejet af Klima-, Energi- og Forsynings-ministeriet.

Vi skal varetage Danmarks samlede interesser.

Vi er ca. 1800 medarbejdere fordelt på 7 lokationer - med hovedsæde i Fredericia.

ENERGINET

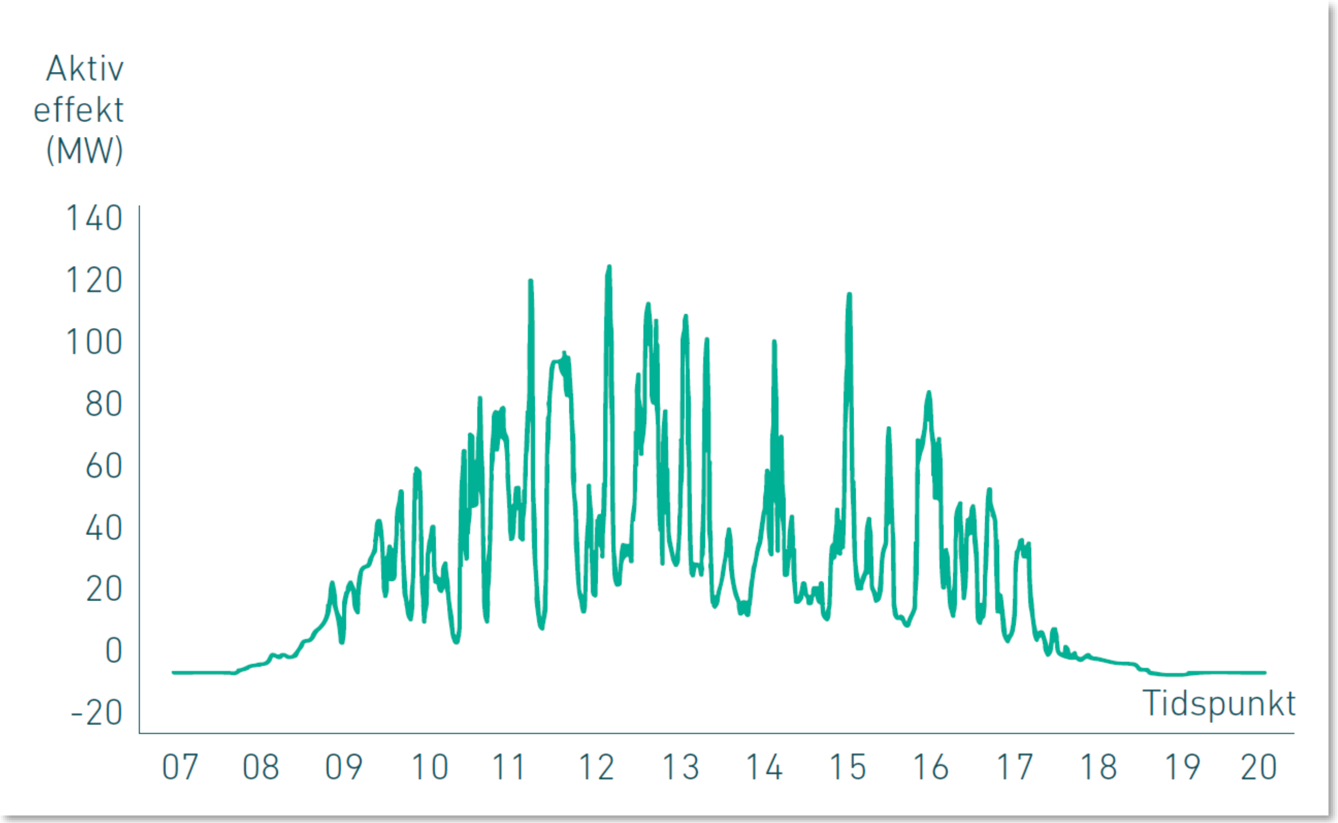
I HJERTET MELLEM PRODUKTION OG FORBRUG

ENERGINET

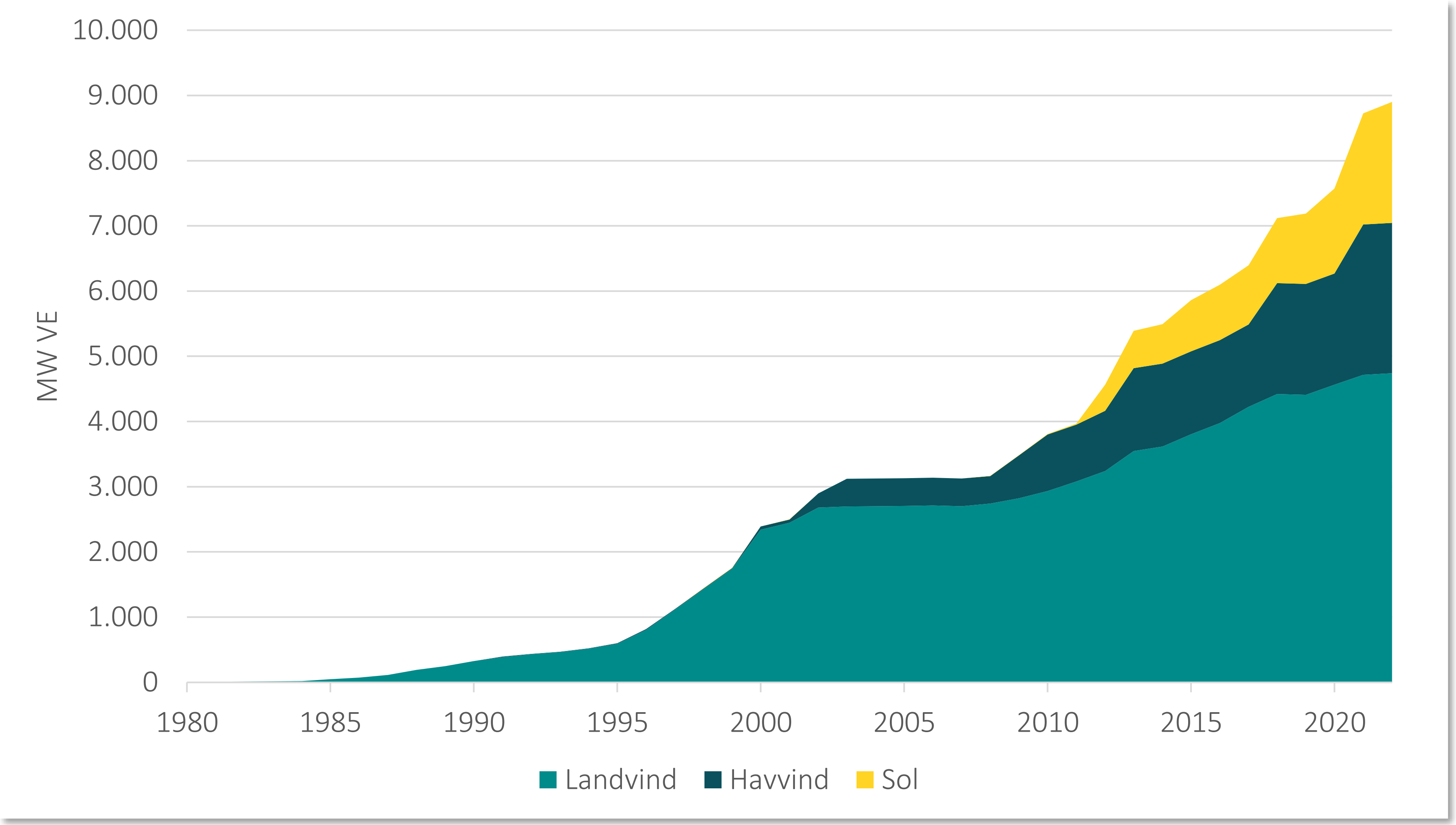
GRØN FORSYNINGSSIKKERHED

De tusindvis af nye grønne produktionsanlæg, fx solcelleanlæg, kan ikke stabilisere elnettet på samme måde, som de traditionelle kraftværker gør i dag.

Hvordan mobiliserer vi billigst produktions- og forbrugsteknologier til at løse balanceudfordringen?



MERE END 40 ÅR MED VINDKRAFT I DANMARK



ENERGINET

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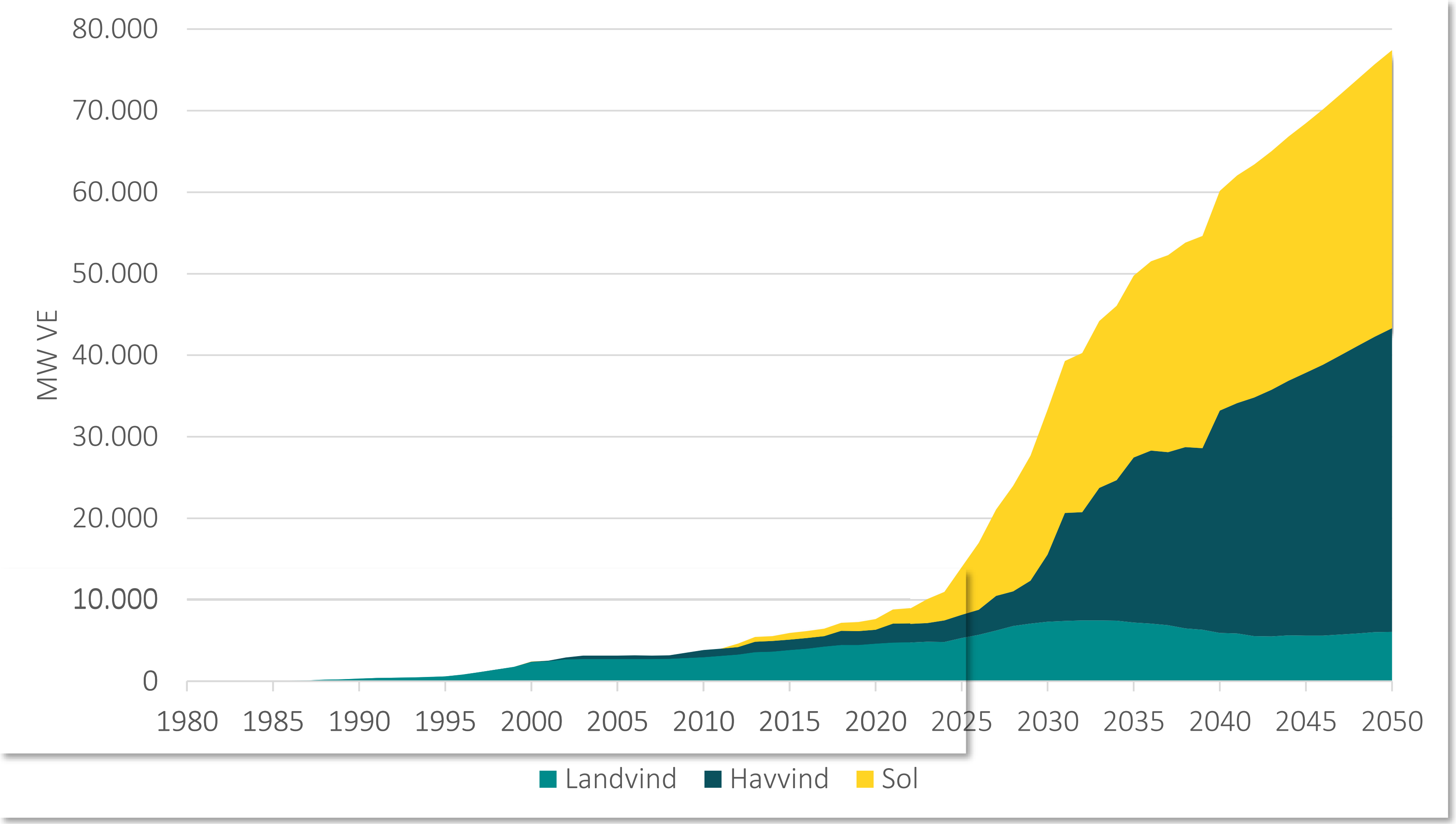
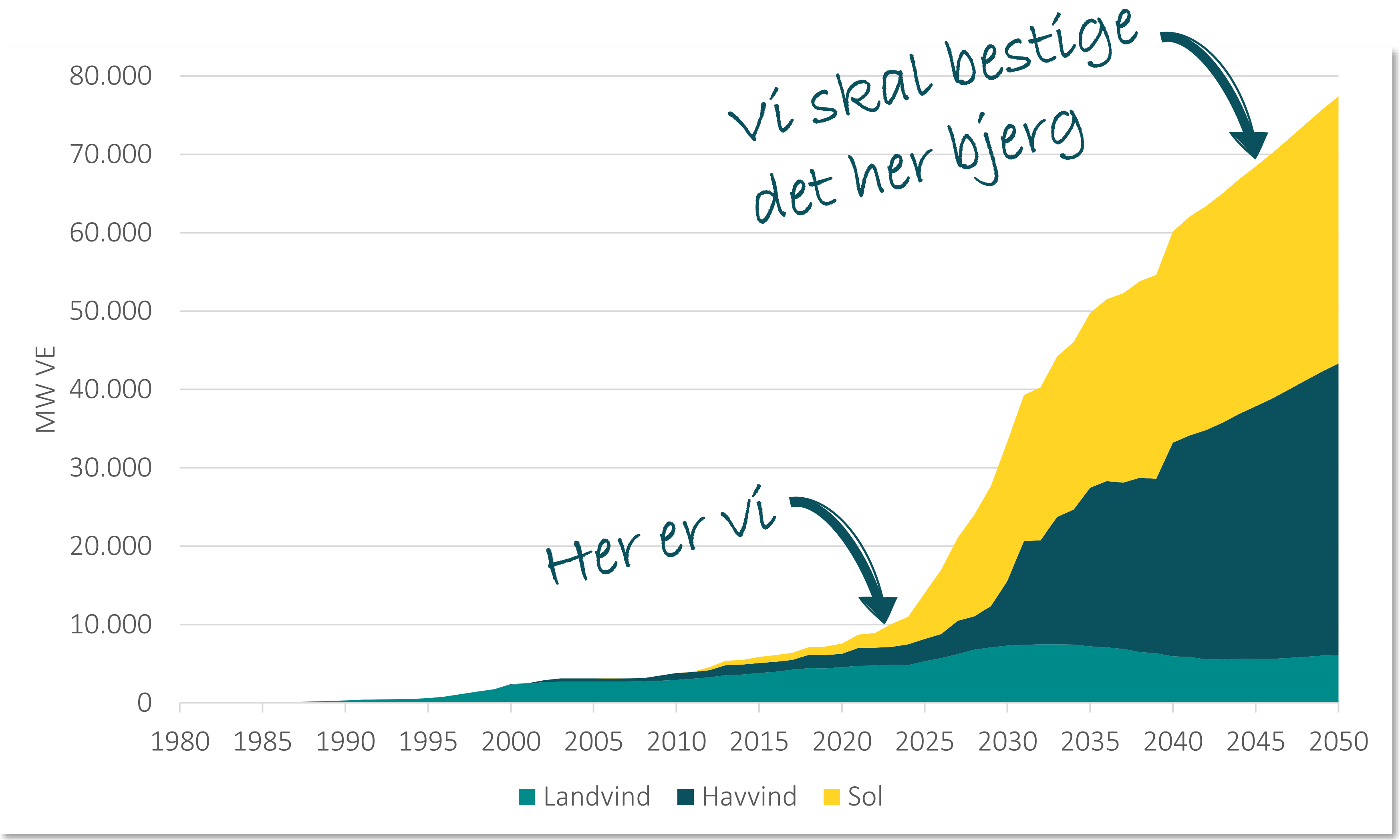


NYE MÅL - HØJERE TEMPO
MERE END 40 ÅR MED VINDKRAFT I DANMARK



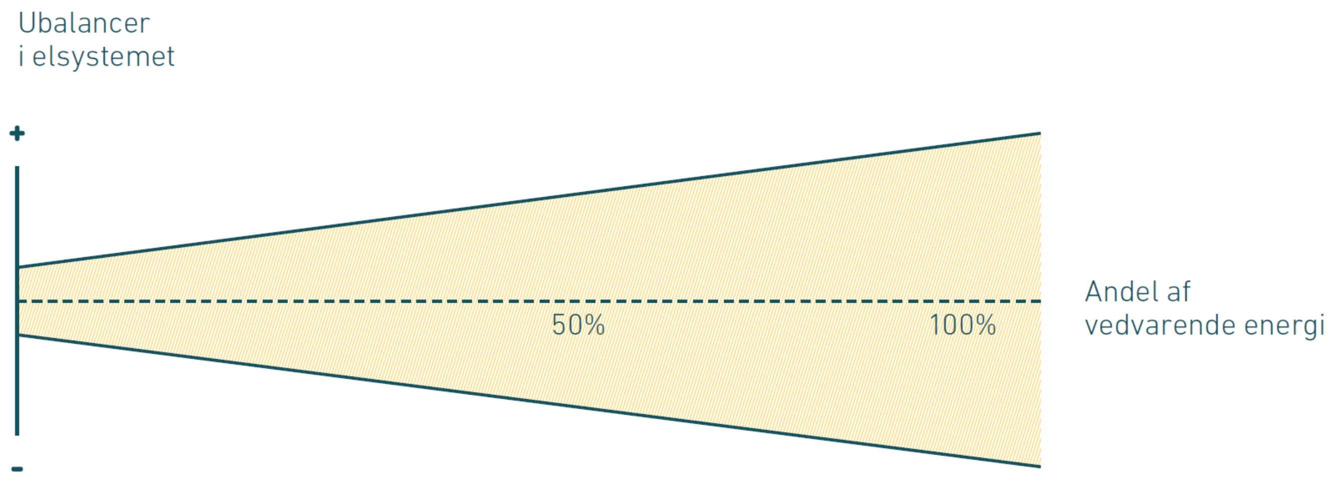
ENERGIMARKEDER TIL FREMTIDEN

NY GRØN BALANCEKUNST

Et stærkt stigende behov for systemydelser kræver nye markedspladser.

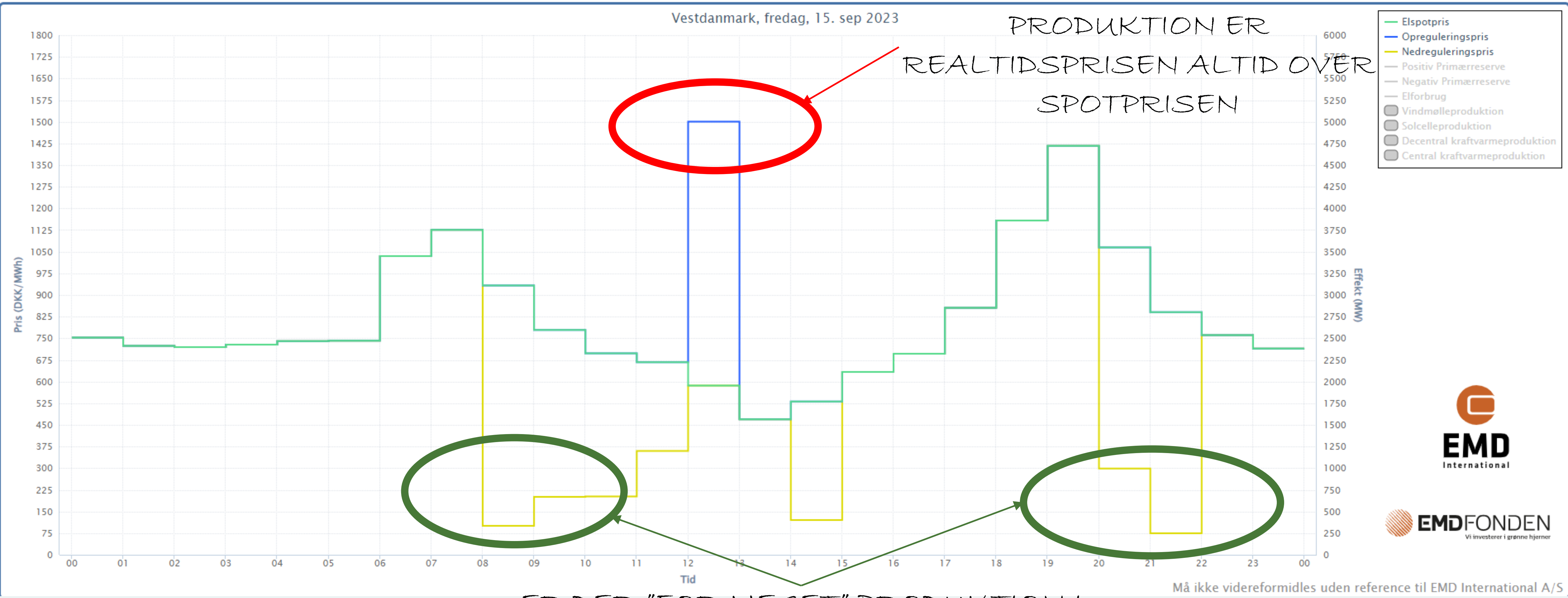
Der er brug for fleksibilitet fra forbrugere og producenter, som ikke i dag kender til behovet og muligheden.

Der er et stort uudnyttet potentiale for sektorkobling.

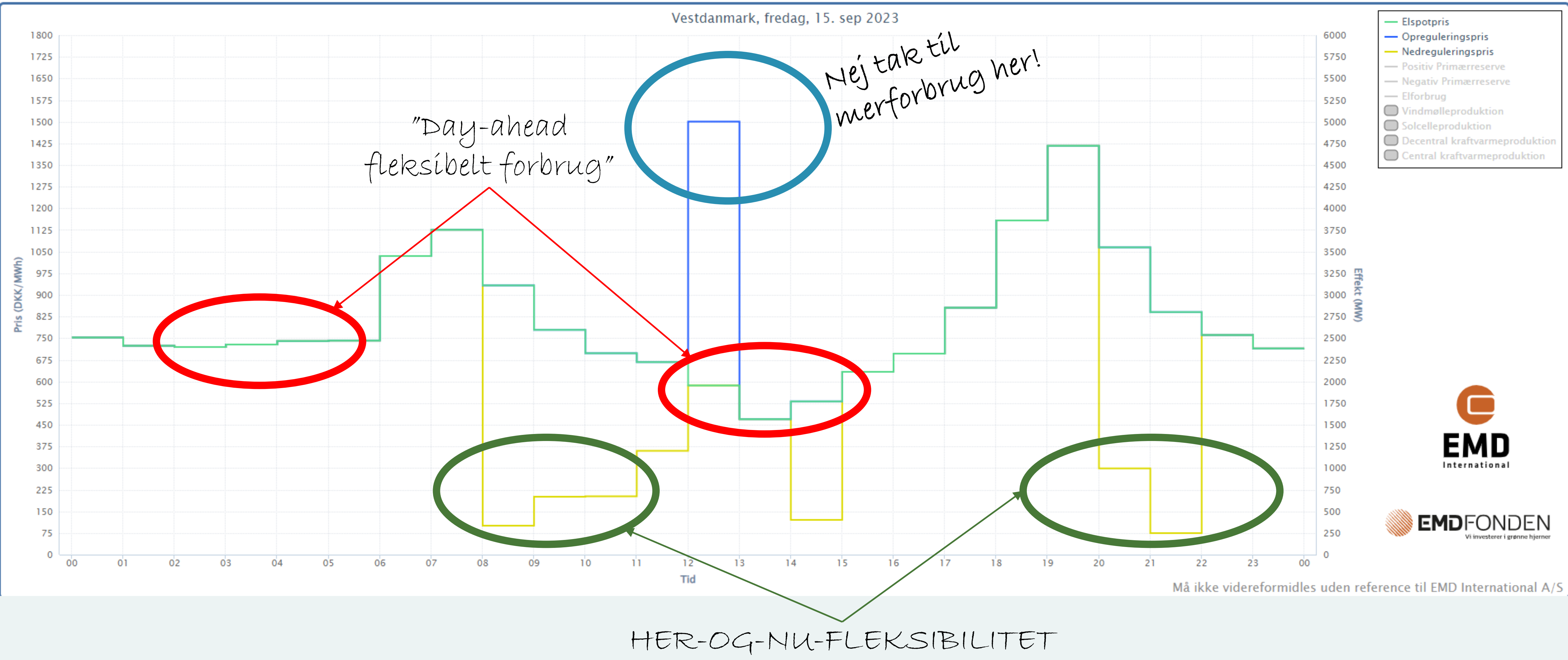


HVOR PRÆCIS ER DEN LOKALE VEJRUDSIGT FOR I MORGEN?

ER DER "FOR LIDT" PRODUKTION ER REALTIDSPRISEN ALTID OVER SPOTPRISEN



ER DER "FOR MEGET" PRODUKTION I SYSTEMET, SÅ ER REALTIDSPRISEN ALTID UNDER SPOTPRISEN



Vestdanmark, fredag, 15. sep 2023
Elspotpris
Opreguleringspris
Nedreguleringspris
Positiv Primærreserve
Negativ Primærreserve
Elforbrug
Vindmølleproduktion
Solcelleproduktion
Decentral kraftvarmeproduktion
Central kraftvarmeproduktion
Pris (DKK/MWh)
Effekt (MW)
Tid
"Day-ahead fleksibelt forbrug"
Nej tak til merforbrug her!
HER-OG-NU-FLEKSIBILITET
EMD International
EMDFONDEN
Vi investerer i grønne hjerner
Må ikke videreformidles uden reference til EMD International A/S

UBALANCE-PRISEN AFSPEJLER DET AKTUELLE UBALANCE-BEHOV – NU OG HER!

Det er markedsprisen på levering af mere eller mindre strøm akkurat nu.

ER DER IKKE "RIGELIG" FLEKSIBILITET FRA DE STORE ELEKTROLYSE-ANLÆG? JO, MEN…

- Et bremset elektrolyseanlæg går glip af brintproduktion
- Hvilken værdi går en elbilsejer glip af, ved at udskyde/fremskynde opladningen?
- For hver eneste kWh ufleksibelt forbrug skal der finansieres produktions-kapacitet

HVOR MEGET FLEKSIBILITET BLIVER DER BRUG FOR?

Dyk ned i detaljerne i Energinets *Outlook for ancillary services 2023-2040*:

[outlook-for-ancillary-services-2023-2040.pdf (energinet.dk)]

FIGURE 29 DEVELOPMENT IN FORECASTED NEED FOR mFRR UP-REGULATION IN DK1

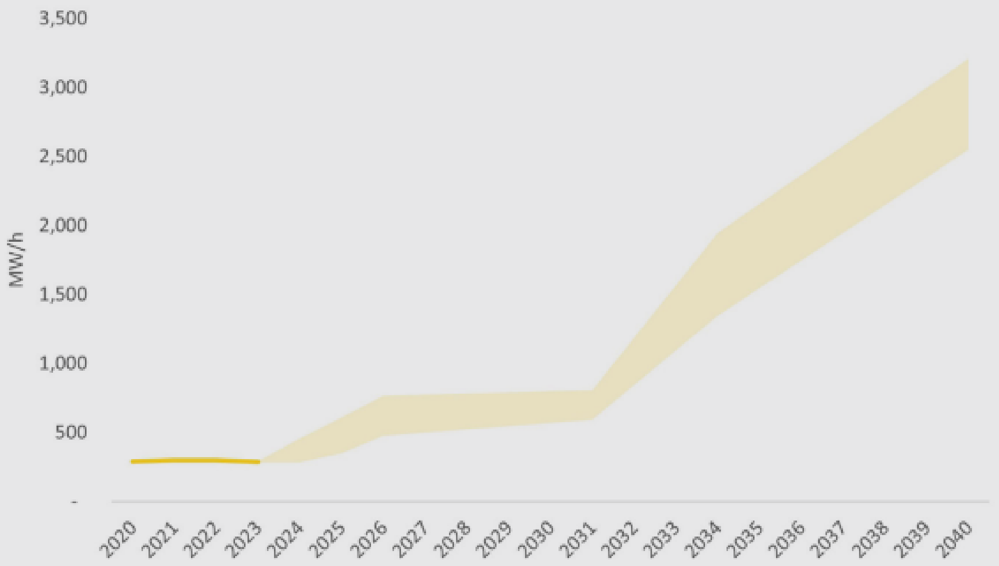
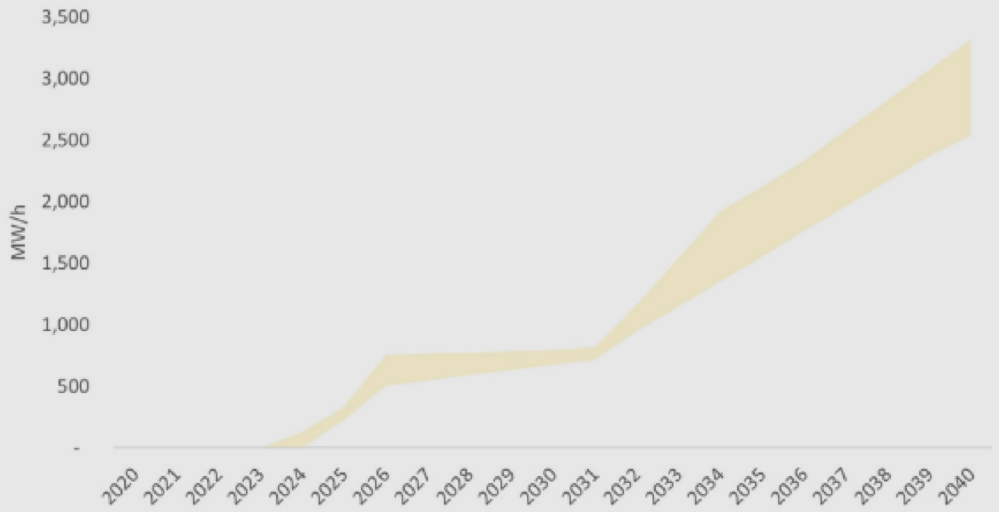
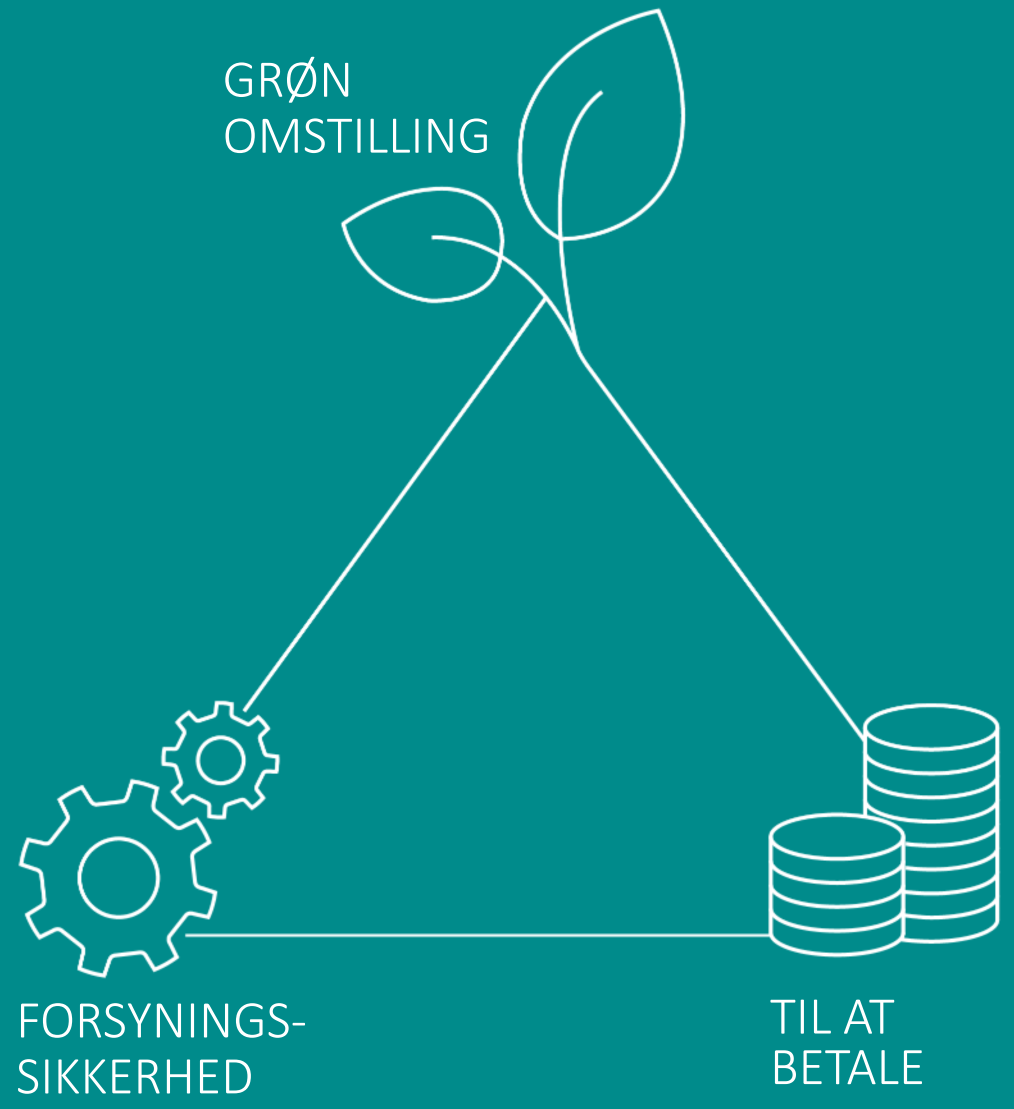


FIGURE 30 DEVELOPMENT IN FORECASTED NEED FOR mFRR DOWN-REGULATION IN DK1



EN BALANCEGANG

Elbiler kan være med til at holde forsyningssikkerheden høj og prisen lavere end ellers, hvis de integreres i elsystemet og ikke blot bliver et passivt forbrug



HANNE BINDER

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Hvor langt er vi med smartladning og V2G?

Maja Sig Vestergaard, MAVG@ramboll.dk, 5161 1137

RAMBOLL

Bright ideas.
Sustainable change.

Pres på elnettet kræver løsninger!

- Et stigende behov for el + vedvarende energikilder skaber behov for effektive løsninger til intelligent brug
- Udfordring på globalt plan -> forskning i løsninger

- Smartladning og V2X (V2G) bliver vigtige teknologier i forhold til at udnytte den begrænsede el og netkapacitet– nu og fremtiden

- Copenhagen Electric får udarbejdet en ny rapport om, hvor langt er vi med smartladning og V2G her i efteråret 2023? Inklusiv cases, hvor teknologierne er udnyttet.

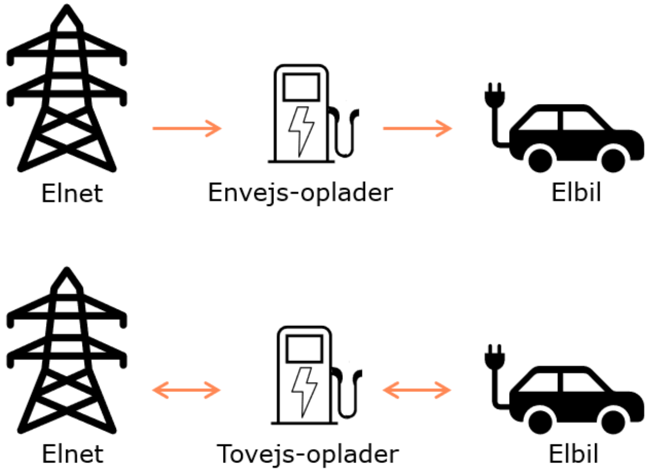
- **Målgruppe:** virksomheder der kunne være interesserede i at komme hurtigere i gang med omstillingen og skabe økonomisk og miljømæssig merværdi. Samtidig kan virksomhederne også styrke deres bæredygtighedsprofil eller ESG-profil.

Photo by Mathew Henry on Unsplash

Hvad er smartladning og V2G?

Envejsopladning versus tovejsopladning

Envejsopladning er ikke ensbetydende med kommunikation med elnettet



Hvad er smartladning og V2G?

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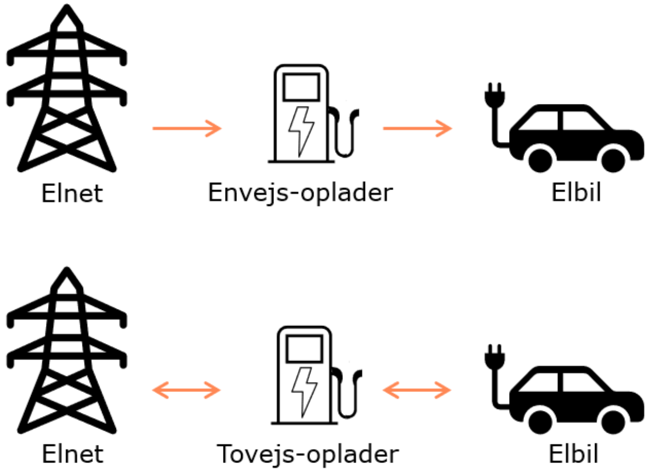
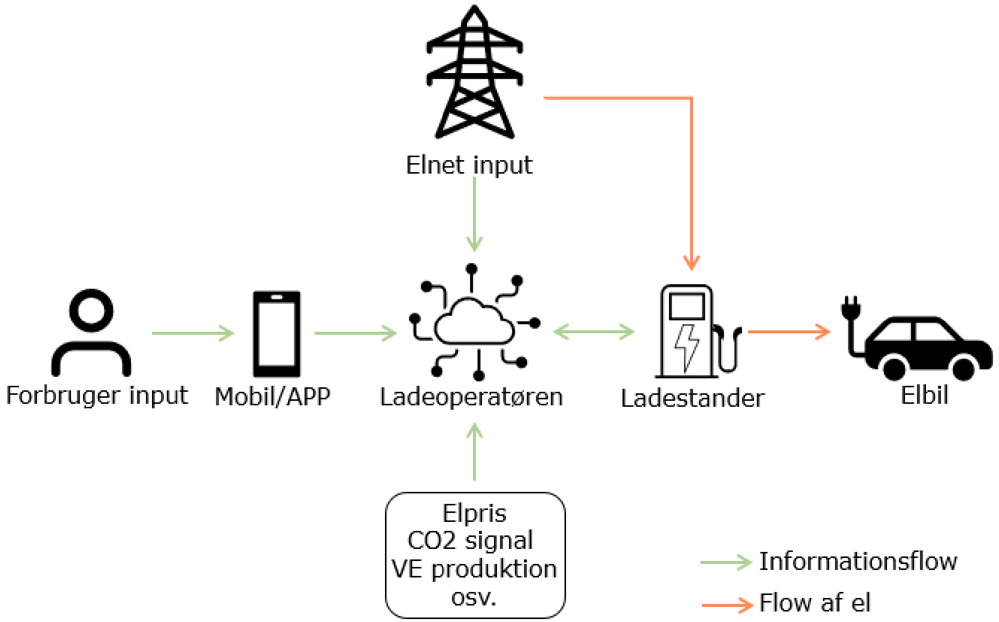


Smartladning er en form for envejsopladning, men funktionaliteten bruges til at optimere og styre opladningsprocessen ud fra de valgte parametre.

Afhængigt af formålet med smartladning kan dette gavne både elbilejeren og elnettet.

Brugeren får typisk mulighed for at styre opladningen via en app, hvor de kan indtaste deres personlige præferencer og behov, f.eks. i forhold til, hvornår elbilen skal være fuldt opladet



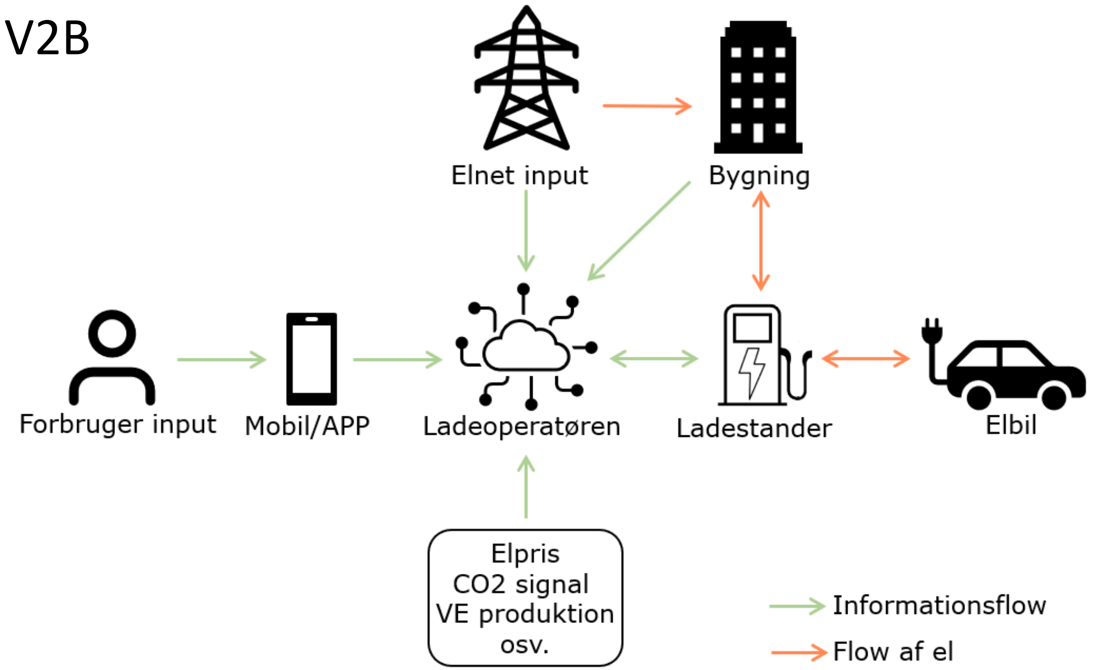
Hvad er smartladning og V2G?

V2X, Vehicle-to-Everything er et bredt begreb, der omfatter den teknologi, der gør det muligt for elbiler at kommunikere med andre enheder

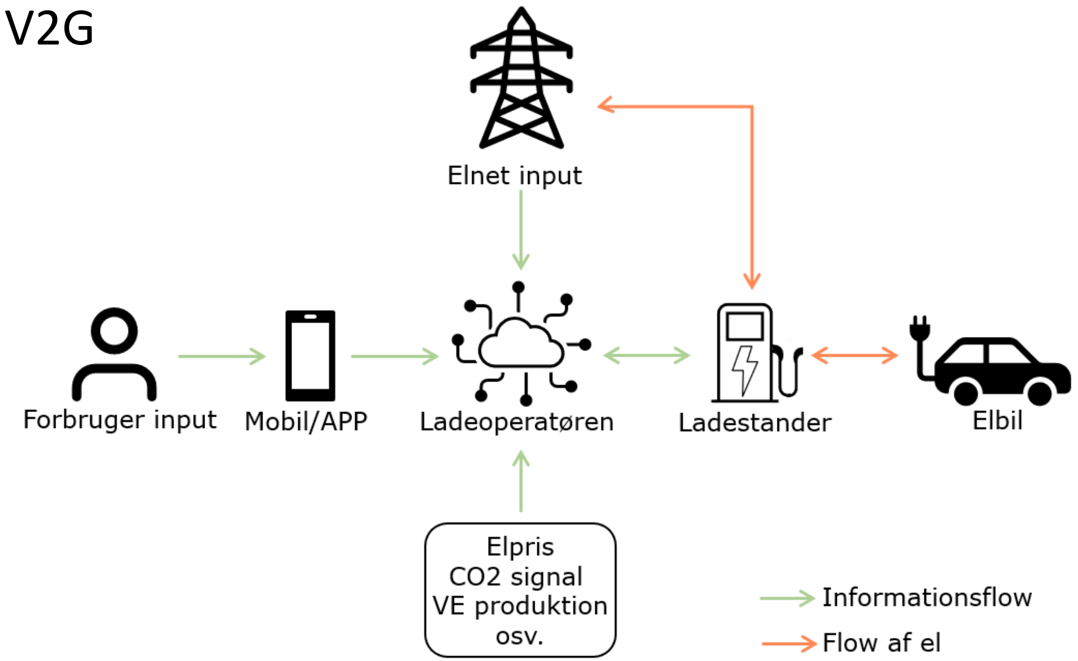
- V2B – vehicle-2-building
- V2G – vehicle-2-grid

I forbindelse med elnettet dækker V2X den teknologi, at en elbil kan levere strøm til forskellige elforbrugere. V'et står for elbilen, mens tallet 2 angiver, at strømmen kan gå begge veje - fra elnettet til elbilen og fra elbilen til X. For at opnå dette sker der kommunikation mellem elbilen og en ekstern enhed eller system (f.eks. elnet, boliger, bygninger, belastninger), som repræsenterer X'et i V2X.

V2B



V2G



Elbiler kan blive en del af løsningen fremfor problemet

Uforudsigelige vedvarende energikilder

+

Flere elbiler der er forudsigelige i deres forbrug

=

Elnettet belastes af stadig større udsving i udbud og efterspørgsel

- Behov for lastfordelingsforanstaltninger - i udgangspunktet dyre ekstrainvesteringer
- Elbilbatterier kan dog med deres betydelige energilagringskapacitet øge elsystemets fleksibilitet.

Elbiler kan indgå som aktiver i elsystemet:

- I spidsbelastningsperioder, hvor det generelle energiforbrug overstiger produktionsniveauet, kan elbiler f.eks. fungere som supplerende energikilder ved at tilføre el til nettet.
- Elbilerne kan bidrage til et mere stabilt elnet ved frekvensregulering ved at
    1) levere strøm tilbage til nettet, når forbruget overstiger produktionen
    2) trække strøm fra nettet og lagre det til senere, når forbruget er mindre end produktionen
- Behovet for investeringer i elnettets udbygning kan begrænses.
    - På trods af, at netselskaberne ofte antager den mere konservative løsning med netopgraderingen, kan udnyttelsen af batterierne i elektriske køretøjer give fleksibilitet og være en potentiel løsning på netproblemerne.

Fordele og ulemper ved smartladning og V2G

For slutbrugeren

Fordele

- Besparelser på TCO
- Bekvemmelighed
- Miljøfordele
- Forsyningssikkerhed

Ulemper

- Initialinvestering
- Indlæringskurve
- Afhængig af infrastruktur
- Databeskyttelse

For virksomheden

Fordele

- Balancering af elnettet
- Optimeret energiforbrug
- Fleksibilitetsydelser
- Miljømæssig bæredygtighed
- Markedspositionering
- Understøttelse af elbiler

Ulemper

- Initialinvestering
- Kompleksibilitet
- Databeskyttelse og sikkerhed

Specifikt for V2X

For slutbrugeren – Fordele:

- Energideling
- Backup strøm
- Elnetsupport

For slutbrugeren – Ulemper:

- Ny teknologi
- Batterinedbrydning

For virksomheden – Fordele:

- Backup strøm

For virksomheden – Ulemper:

- Dyr teknologi
- Regler og standard

Fordele/ulemper for elbilens batteri

Elbilens performance i forhold til rækkevidde og ydeevne er relateret til batteriet, bl.a.:

- Batteristørrelse (kWh)
- State-of-Charge (SoC)
- Nedbrydning (hvor meget af batteriets oprindelige ydeevne er tilbage)

- Batterilevetiden afhænger af forskellige parametre, såsom
  - Batterianvendelse
    - Benyttes bilen ofte, holder den parkeret i længere periode, eller benyttes den til V2G?
  - Tidens tand
  - Temperaturer
  - SoC
    - Rækkeviddeangst -> En SoC på 100% fører til en hurtigere batterinedbrydning

- Smartladning kan have en positiv effekt på batteriets levetid, bl.a. fordi ladeeffekten ofte reduceres
- V2G betyder mere slid og dermed i teorien en hurtigere nedbrydning, men forskning tyder på, at dette ikke er tilfældet

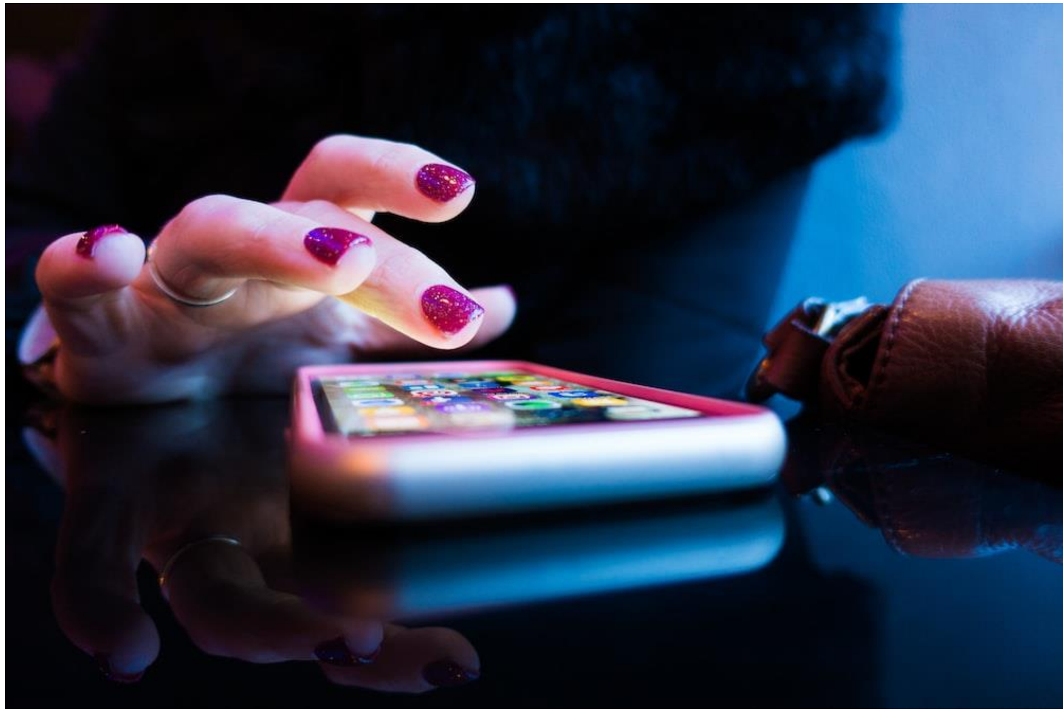
Photo by JUICY on Unsplash

Markedets smartladning og V2X-readiness

Smartladning

- Velintegreret og benyttet funktionalitet på markedet af både ladestandere og elbiler.
- Mange ladestandere har allerede indbygget smarte funktioner, som brugeren kan benytte sig af
- Andre funktioner kan effektueres ved hjælp af tredjepartsvirksomheder, såsom ladeoperatører/EMSP’er

= For virksomheder, der råder over flere elbiler og ladestandere, vil der være behov for tredjepartsvirksomheder til yderligere at styre og kontrollere opladning af elbilerne



Markedets smartladning og V2X-readiness

V2G
V2X-teknologien er det nødvendigt, at både bilen og opladeren kan sende el begge veje, altså oplade og aflade. Kun få biler på markedet er kompatible med tovejsopladning.

CHAdeMO-stikket (DC ladning) muliggør tovejsopladning, men er på vej ud af det europæiske marked grundet EU-standarder. Hvis man ønsker at udnytte V2G-teknologien i dag og købe et færdigt produkt, er CHAdeMO-kompatible biler og opladere svaret.

Bilproducenter og ladestanderproducenter arbejder på at gøre teknologien på CCS både med AC- og DC opladning. Det er dog uvist, hvornår produkterne er færdigudviklede.

Bilproducent	Bilmodel	Readiness	Ladeindtag AC/DC
Nissan	Leaf, MY22	V2H, V2G	Type 2 / CHAdeMO
VW	ID.5 Pro	V2H, V2G*	Type 2 / CCS
Tesla	Model X	V2H, V2G*	Type 2 / CCS
Skoda	Enyaq 80	V2H, V2G*	Type 2 / CCS
Mercedes-Benz	EQA	Ingen	Type 2 / CCS
Audi	Q4 e-tron	V2H, V2G*	Type 2 / CCS
BMW	Ix	V2H*	Type 2 / CCS
Kia	Niro	V2L	Type 2 / CCS
Polestar	2	V2L	Type 2 / CCS
Hyundai	IONIQ 5	V2L	Type 2 / CCS
Volvo	EX90	V2L, V2H, V2G*	Type 2 / CCS
Cupra	FØDT	V2G, V2H	Type 2 / CCS
Ford Mustang	Mach-e	Ingen	Type 2 / CCS
Peugeot	E-208	Ingen	Type 2 / CCS
Renault	Megane E-Tech	Ingen	Type 2 / CCS

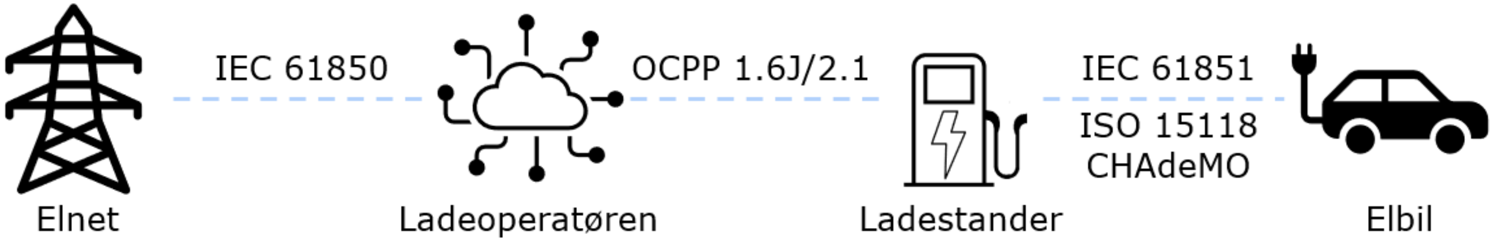
Ladeproducent	Lademodel	Forberedelse	Ladestik	Status
Wallbox	Quesar	V2G, V2H	CHAdeMO	Lanceret
Wallbox[8]	Quesar 2 Annoncer	V2G, V2H	CHAdeMO	Ukendt lancering
Rectifier Technologies[8]	Highbury tovejs DC-oplader	V2G, V2H	CHAdeMO og CCS	Ukendt lancering
Ford[8]	Ladestation Pro	V2H	CCS	Lanceret
SolarEdge Teknologier[8]	tovejs elbiloplader	V2G, V2H	CCS	Lanceres 2024
Enphase Energi[8]	tovejs elbiloplader	V2G, V2H	CHAdeMO og CCS	Lanceres 2024
Autel Energi[8]	MaxiCharger V2X	V2X	CCS og CHAdeMO	Ukendt lancering
Delta Elektronik[8]	V2H tovejs oplader	V2H	CHAdeMO	Ukendt lancering
Fermata Energi[8]	Energi FE-15	V2G, V2H	CHAdeMO	Lanceres Q1 2023
Indra	Ukendt	V2H	CHAdeMO	Ukendt lancering*
Indra	Ukendt	V2G	CHAdeMO	Ukendt lancering*
Enel	Ukendt	V2G	CHAdeMO	Ukendt lancering*
E-ON	Ukendt	V2G	Type 2	Ukendt lancering*

Lovgivning og standarder

Kommende EU-lovgivning:
Energy Performance of Buildings Directive -> ladestanderbekendtgørelse

Nye krav:
- ladestandere skal være i stand til at yde intelligent opladning (smartladning)
    - især ved parkering ved bygninger, hvor der parkeres igennem længere sammenhængende tid såsom beboelsesejendomme og arbejdspladser
- ladestandere skal være i stand til at yde tovejsopladning, hvor det er relevant (V2X)

Standarder giver udfordringer
OCPP 2.0.1 – er ved at blive implementeret
ISO 15118 – giver udfordringer



Køreplan for etablering af smartladning/V2X ladeinfrastruktur

1. Behov og mål

Bestem virksomhedens mål for opladning af elbiler.

2. Lokalitetsudpegning

Identificer placeringer for ladestandere. Overvej tilgængelighed, nærhed til bygningsindgange mv.

3. Overvejelser ift. gældende og kommende lovgivning

Overvej EU og DK regler og standarder, f.eks. antallet af opladere, der skal installeres og forberedelse til fremtiden.

4. Elektrisk system

Undersøg det elektriske system, der er til stede, og hvordan/om det kan bruges til at installere opladere. Overvej muligheden for skalérbarhed i fremtiden.

5. Opladningsudstyr

Undersøg de ladestandere, der opfylder virksomhedens behov ift. opladningseffekt, tilslutningsmuligheder, software, skalérbarhed.

6. Smartladning og V2X

Overvej de specifikke muligheder for smartladning og V2X i virksomheden mht. f.eks. vedvarende energi, elnetforbindelsesgrænser.

7. Yderligere krav til virksomheden

Bestem krav til f.eks. betalingsmetode, brugeroplevelse, virksomhedens bæredygtighedsmål.

8. Løsningsvalg, installation, test, drift

Bestem den løsning, der bedst imødekommer de opsatte krav. Igangsæt installation, test og overvåg driften.

Bygningsejerens brug af smartladning

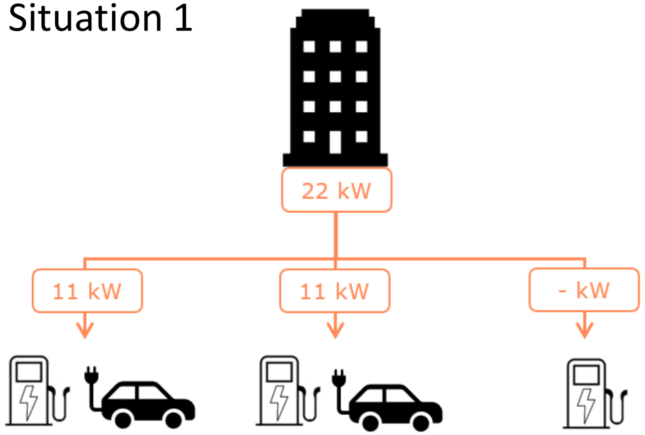
Deling af strøm (Power sharing)

Lastbalancering

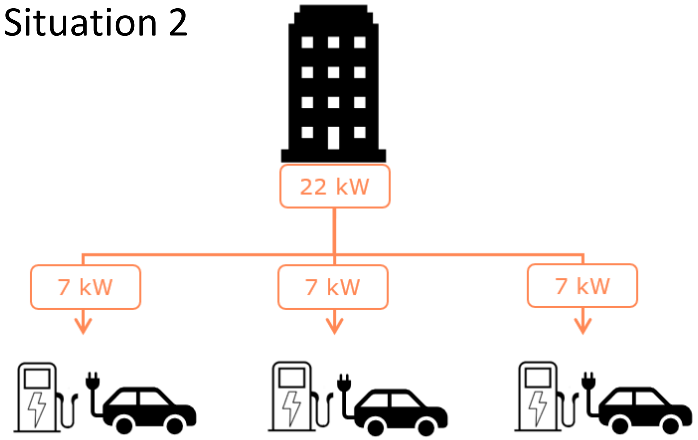
Udskydelse af opladning til:

- når elprisen er lav
- når CO2-værdierne er lave
- når produktionen af vedvarende energi i nettet er høj
- når det er elnet-venligt

Situation 1

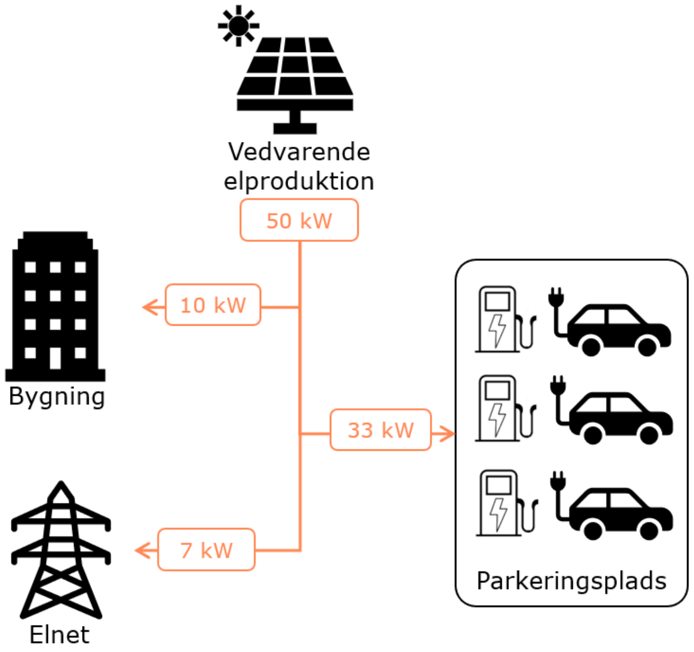


Situation 2



I kombination med vedvarende energikilder

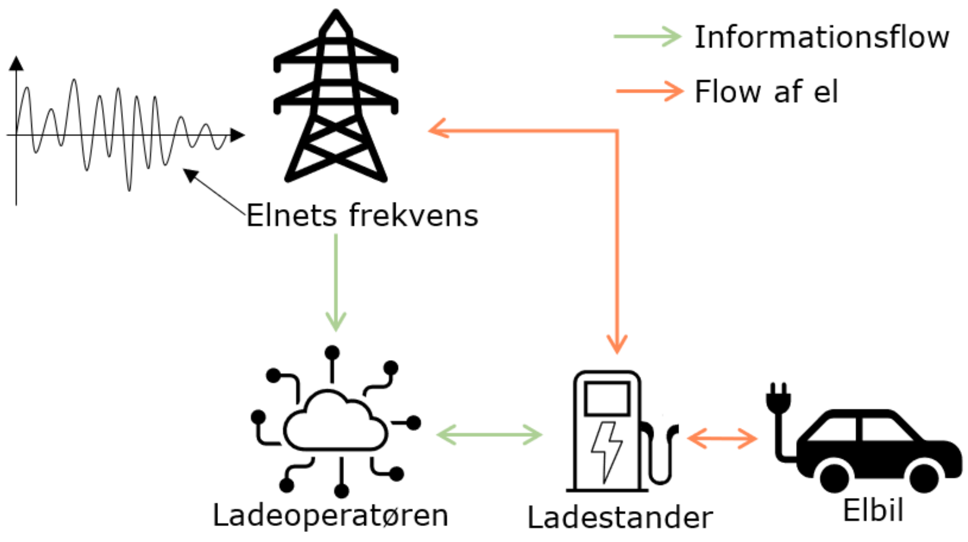
Batterilagringssystem

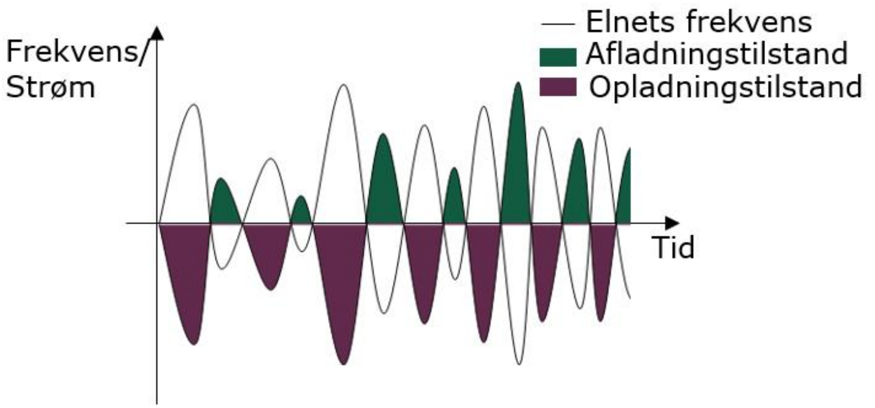


Bygningsejerens brug af V2X

Den samme funktionalitet som smartladerne plus:

+ Backup strøm ved strømafbrydelser
+ Integration med vedvarende energikilder
+ Understøttelse af elnettet





Tre cases

PostNord/Monta

- Elbiler i Brøndby
- Lastbalancering
- Prioritering af ladepunkter
- Fase rotering
- Dynamisk kø

ViggoEnergy/Spirii

- 14 lynladere (300 kW)
- Demand-respons flexibility services
- Spirii er autoriseret af EnergiNet til at yde frekvensreguleringsservices

Utrecht/We Drive Solar

- Tovejsopladning med ladestandere udviklet af We Drive Solar
- Renault Zoé og Hyundai Ioniq 5s
- Til tider så attraktivt at yde frekvensregulering at det bedst kan svare sig at benytte bilerne til dette.

Tak for opmærksomheden!

Maja Sig Vestergaard
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Bright ideas.
Sustainable change.

Electric vehicles –
a double-edged sword for the energy system?

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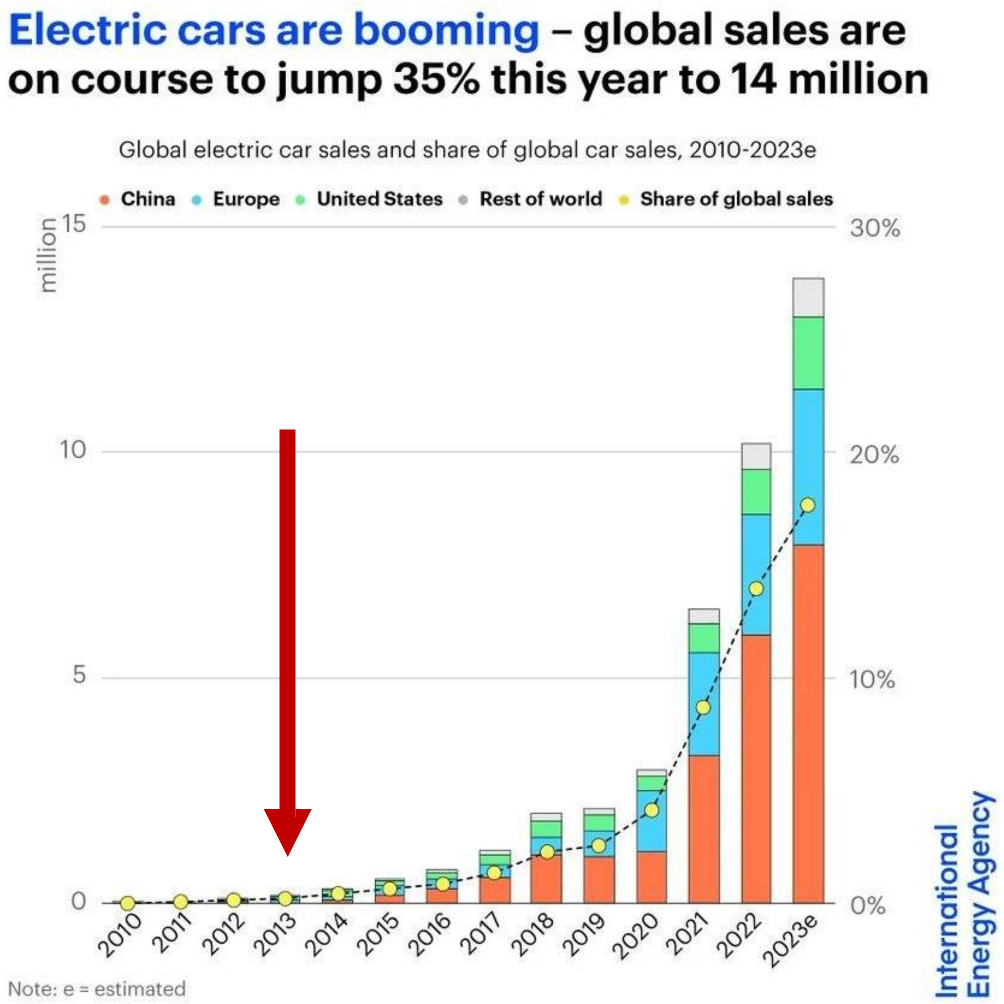
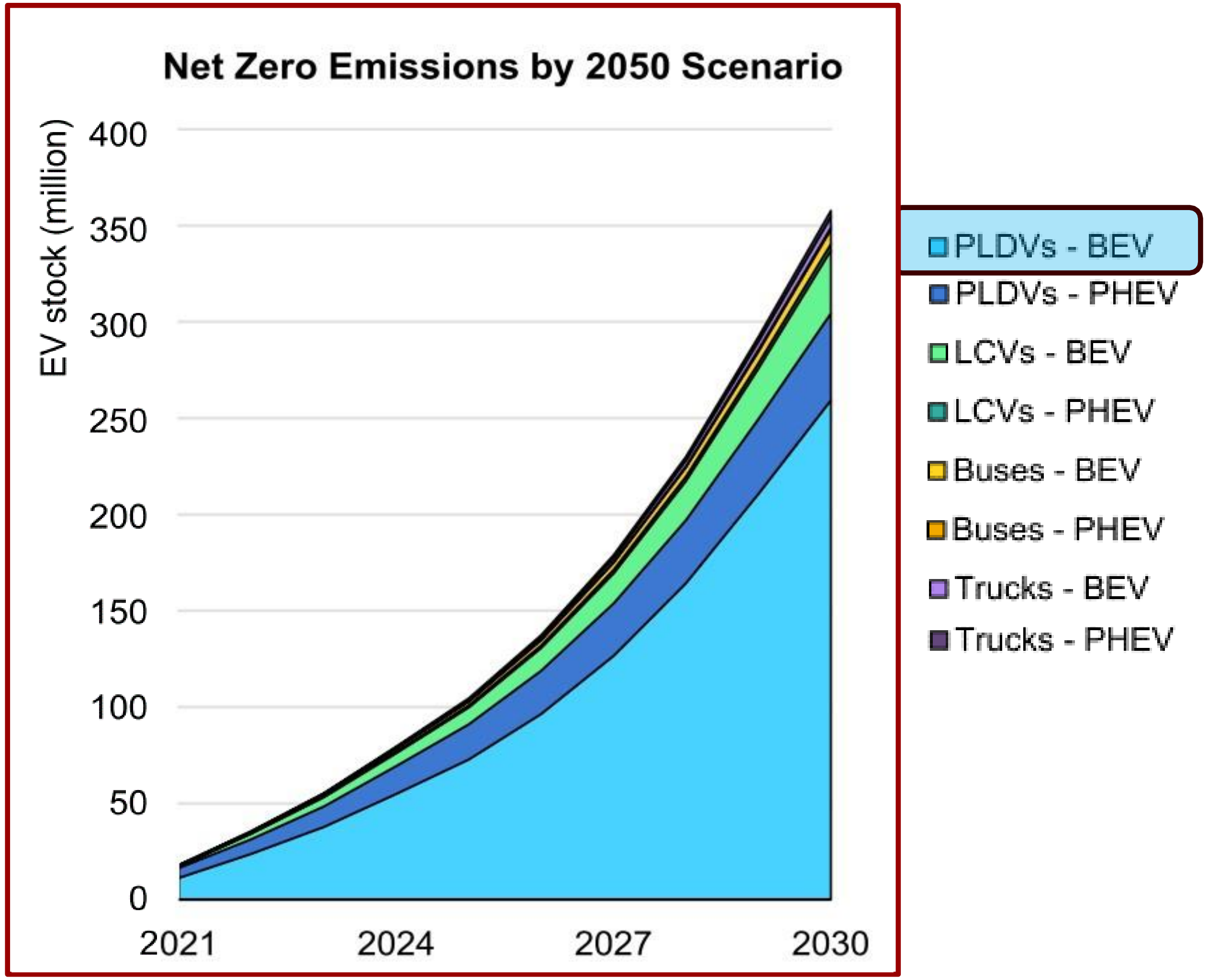
Risø Campus, DTU – Department of Wind and Energy Systems

Outline

- EV deployment status and energy needs
- Charging prices and opportunities in the Danish system
- Natural vs induced charging
- Home charging with a photovoltaic system
- A prospect into V2G (vehicle-to-grid)
- Future trends

Electric vehicles deployment – where are we?





Source: "Global EV Outlook 2022 – Analysis - IEA." https://www.iea.org/reports/global-ev-outlook-2022

ICE vs EV – energy needs and CO_2 emission - extended

100 km @ 16 km/l & 9.5 kWh/l

❼ 59 kWh ❼ 77 kWh (WtW)

CO_2 @ 0.25 kg/kWh = 19 kg

100 km @ 5 km/kWh

❼ 20 kWh ❼ 26 kWh (B)

CO_2 = 3 kg (*)

(*) Battery manufacturing footprint
(100 kg C02/kWh corresponding to a 0.03 kg/km for a 60-kWh battery over a lifetime of 200000 km)

Coal power plant

26 kWh ❼ 64 kWh ❼ 71 kWh

CO_2 @ 0.35 kg/kWh = 25 kg

Combined cycle gas plant

26 kWh ❼ 48 kWh ❼ 53 kWh

CO_2 @ 0.20 kg/kWh = 11 kg

EU energy mix (gas, coal, renewable, nuclear)

26 kWh ❼ 42 kWh ❼ 47 kWh

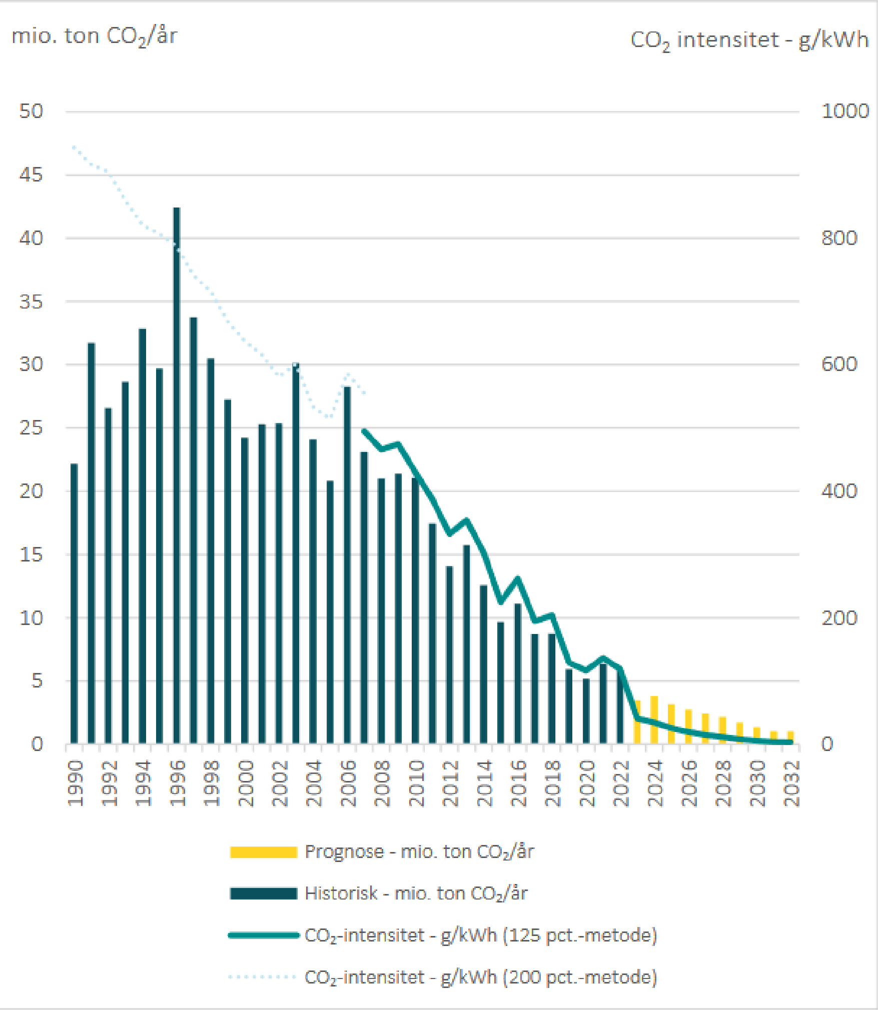
CO_2 @ 0.23 kg/kWh_el = 6.9 kg

Photovoltaic and/or wind-based plant

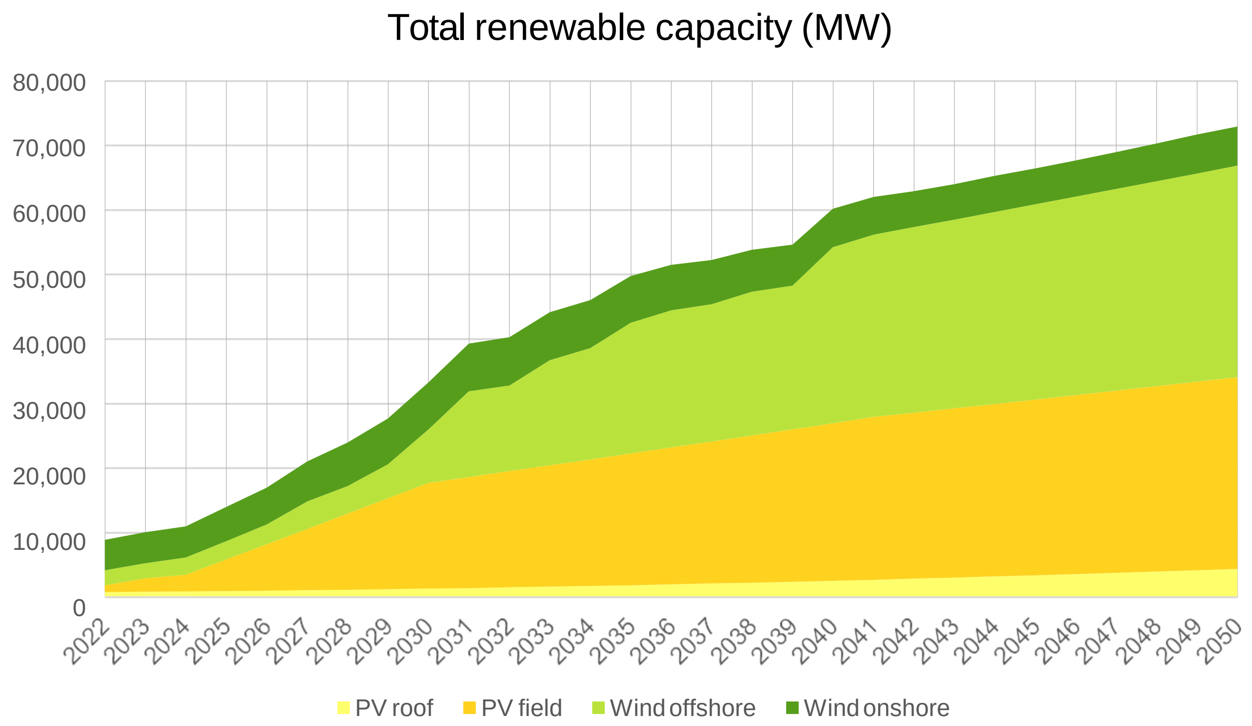
26 kWh ❼ 29 kWh ❼ 32 kWh

CO_2 @ 0.02 kg/kWh = 0.6 kg

Danish electricity system decarbonization over time



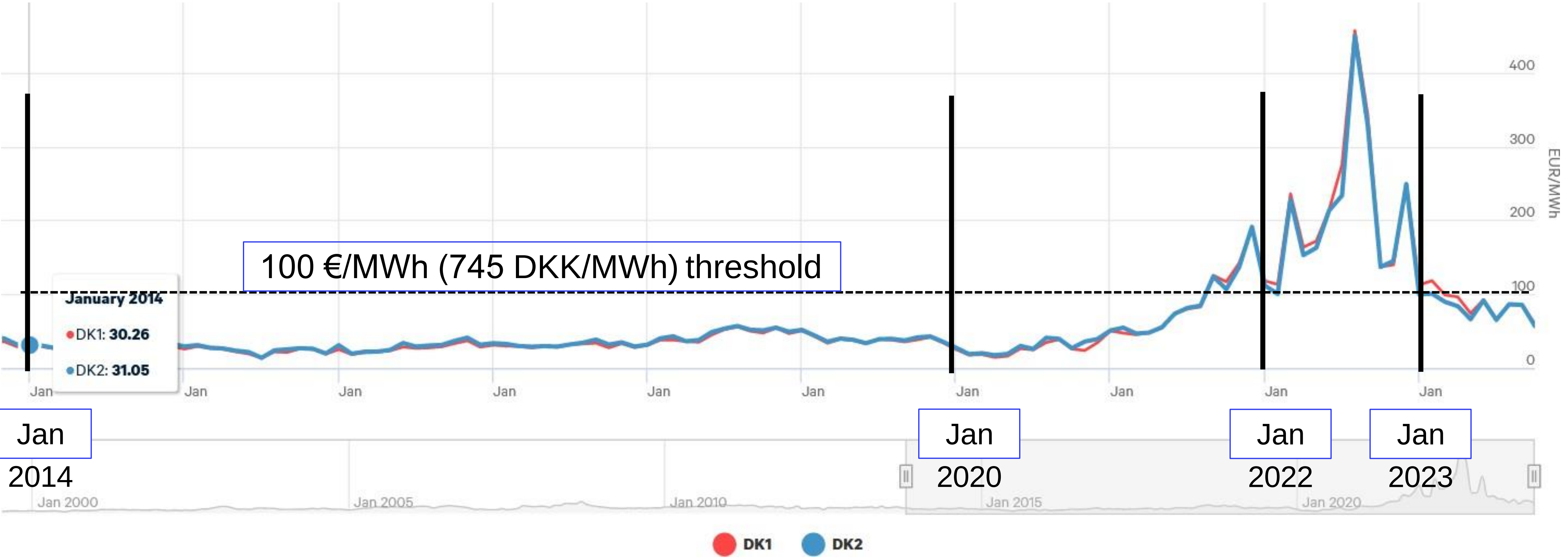
- In 2022, 59% of the annual electricity demand in DK was covered by domestic renewable production.
- Renewable capacity is forecast to quadruple in the next 10 years, and further double until 2050.



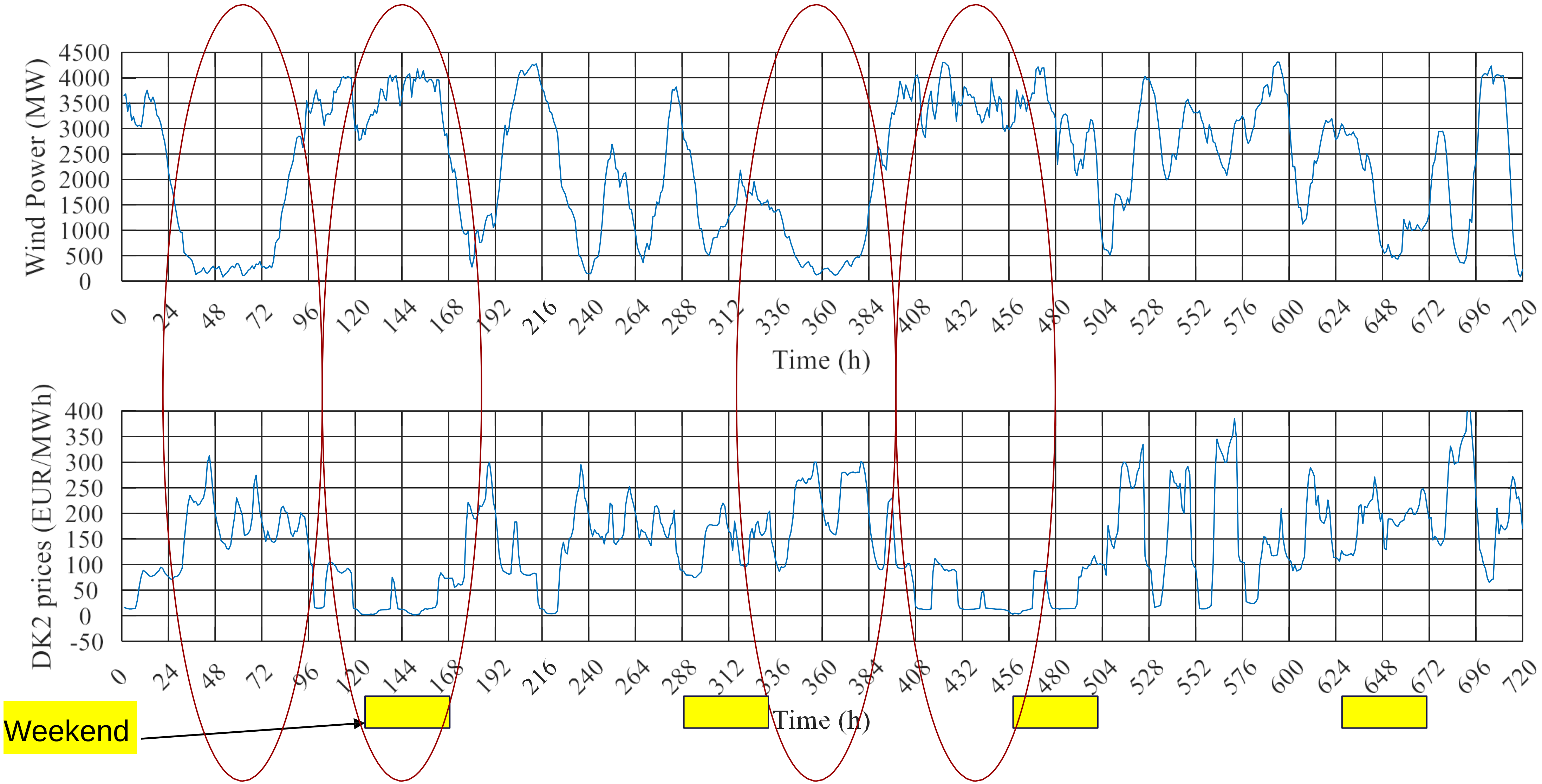
Energistyrelsens annual "Analyseforudsætninger

https://ens.dk/service/fremskrivninger-analyser-modeller/analyseforudsaetninger-til-energinet

Monthly average spot prices DK1 and DK2 in EUR/MWh



Wind power vs electricity prices in DK (November 2021)



DSO fee for residential customers (type C) – assuming spot price equal to 0

- **From October to March**
- (@ spot price = 0)

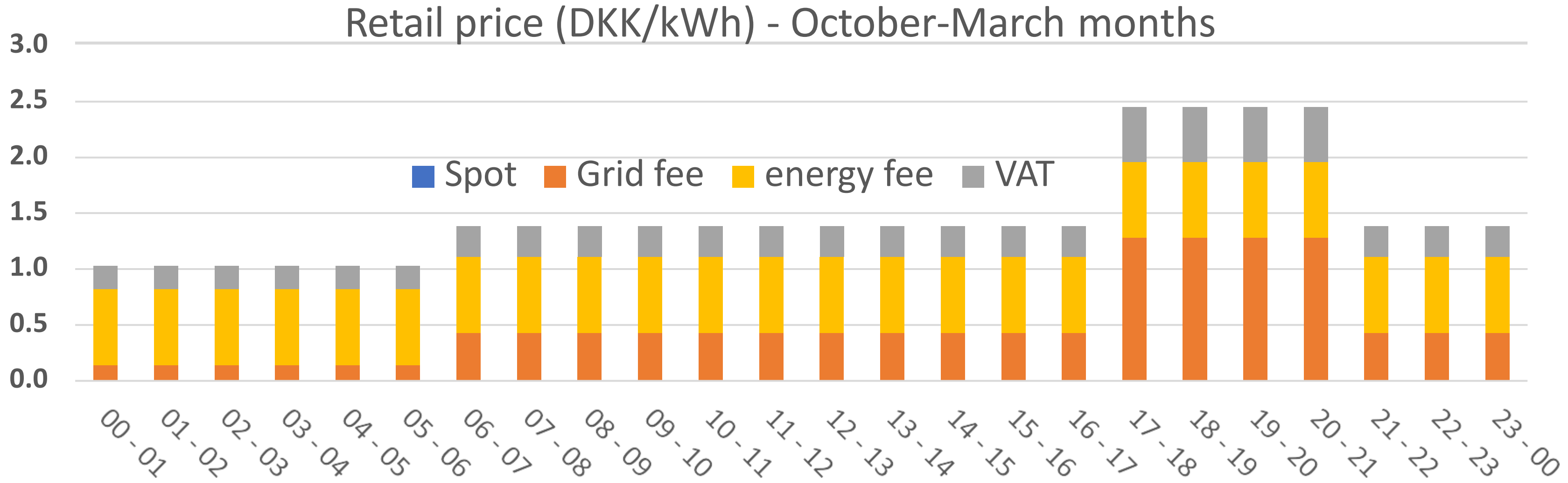
min cost: 1.03 DKK/kWh;

min cost: 13.8 c€/kWh;

max cost: 2.45 DKK/kWh;

max cost: 32.9 c€/kWh;

https://cerius.dk/priser-og-ariffer/tariffer-og-netabonnement/



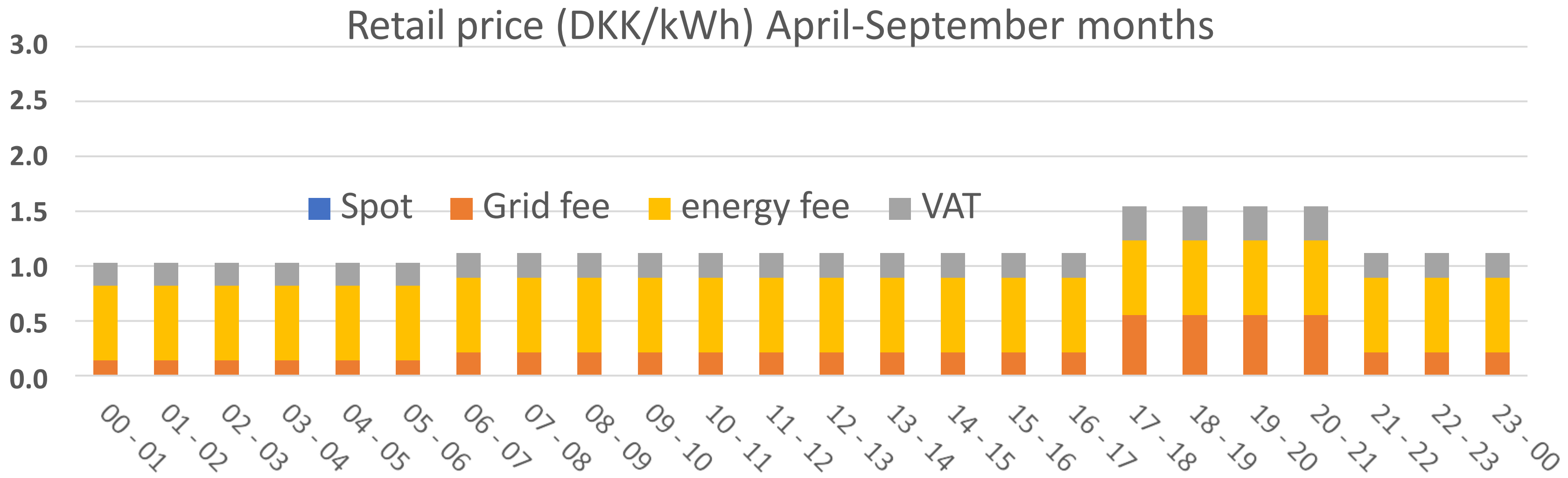
- **From April to September**
- (@ spot price = 0)

min cost: 1.03 DKK/kWh;

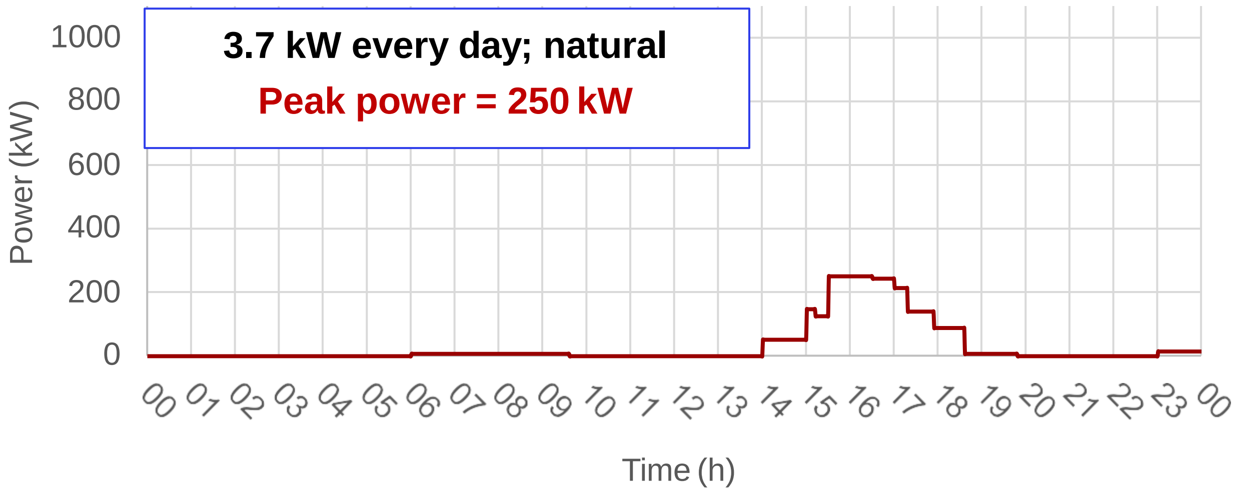
min cost: 13.8 c€/kWh;

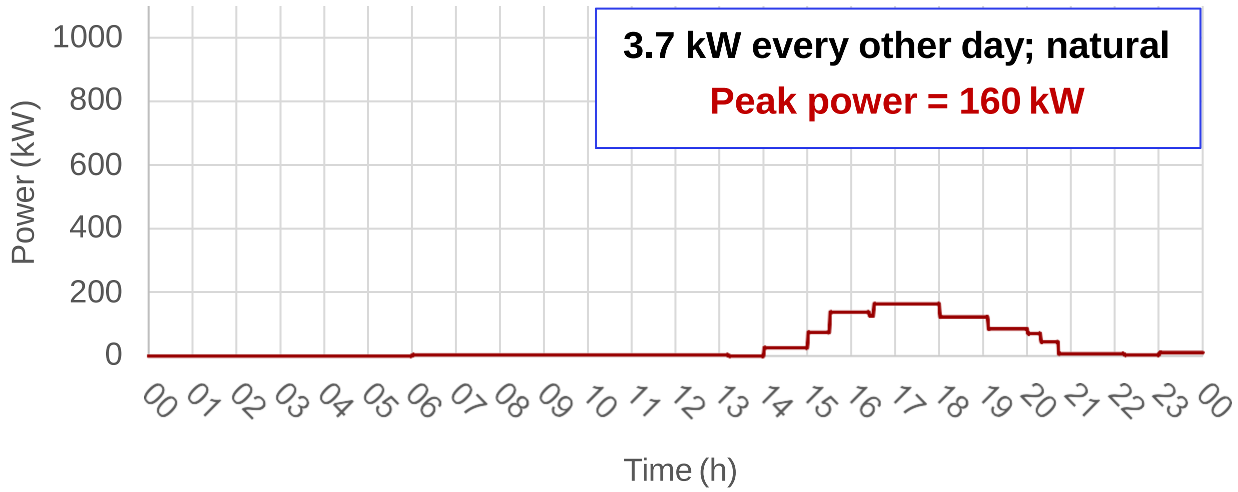
max cost: 1.54 DKK/kWh

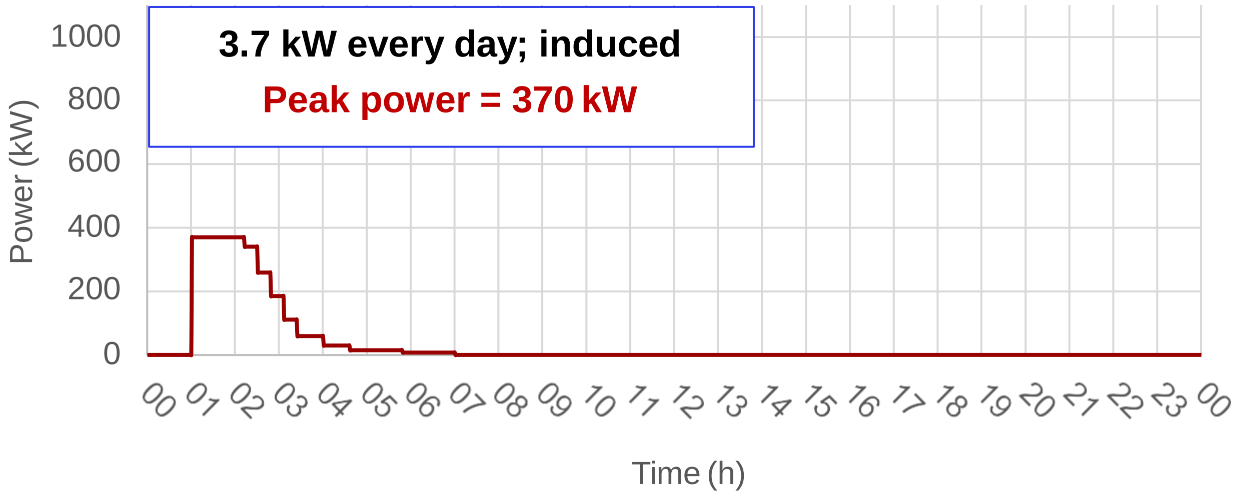
max cost: 20.7 c€/kWh

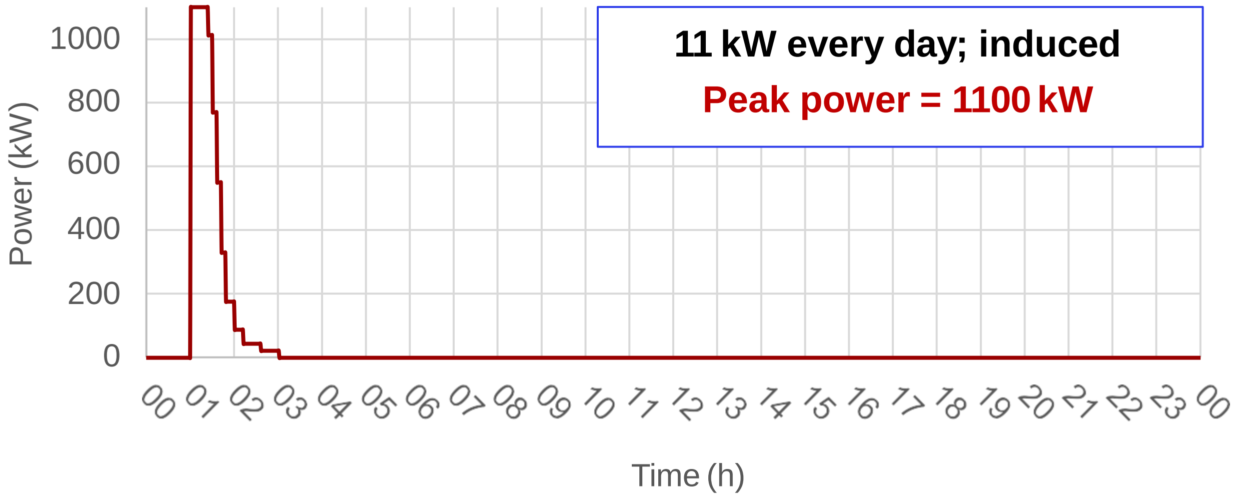


Smart charging: natural vs price/tariff induced – assume 100 EVs in an area…









Tarifmodel 3.0

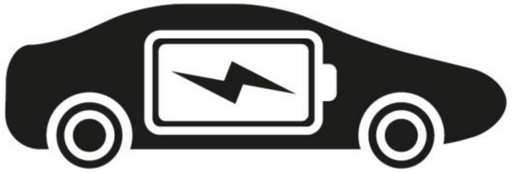
- **Tarifmodel 3.0 was introduced 1st of January 2023.**
- The aim of the model, is to reflect the load of the power grid so high consumption (evening peaks) equals higher tariffs and low consumption (nighttime) equals lower tariffs.
- Some highlight of the model are:
  - ➢ General difference between summer & winter
  - ➢ Three different levels
  - ➢ Different “profiles” on different voltage levels
- **TM3.0 is generic model and does not consider local geographical differences or sudden changes**

Lastperioder

Vinter | alle dage	Lav last	Høj last	Spids last	Høj last
Sommer | alle dage	Lav last	Høj last	Spids last	Høj last
	00.00-06.00	06.00-17.00	17.00-21.00	21.00-24.00

Courtesy of Radius

Unfolding energy and power needs for 100% EVs



Danish EV drives 15000 km/y ❼ 3 MWh/y

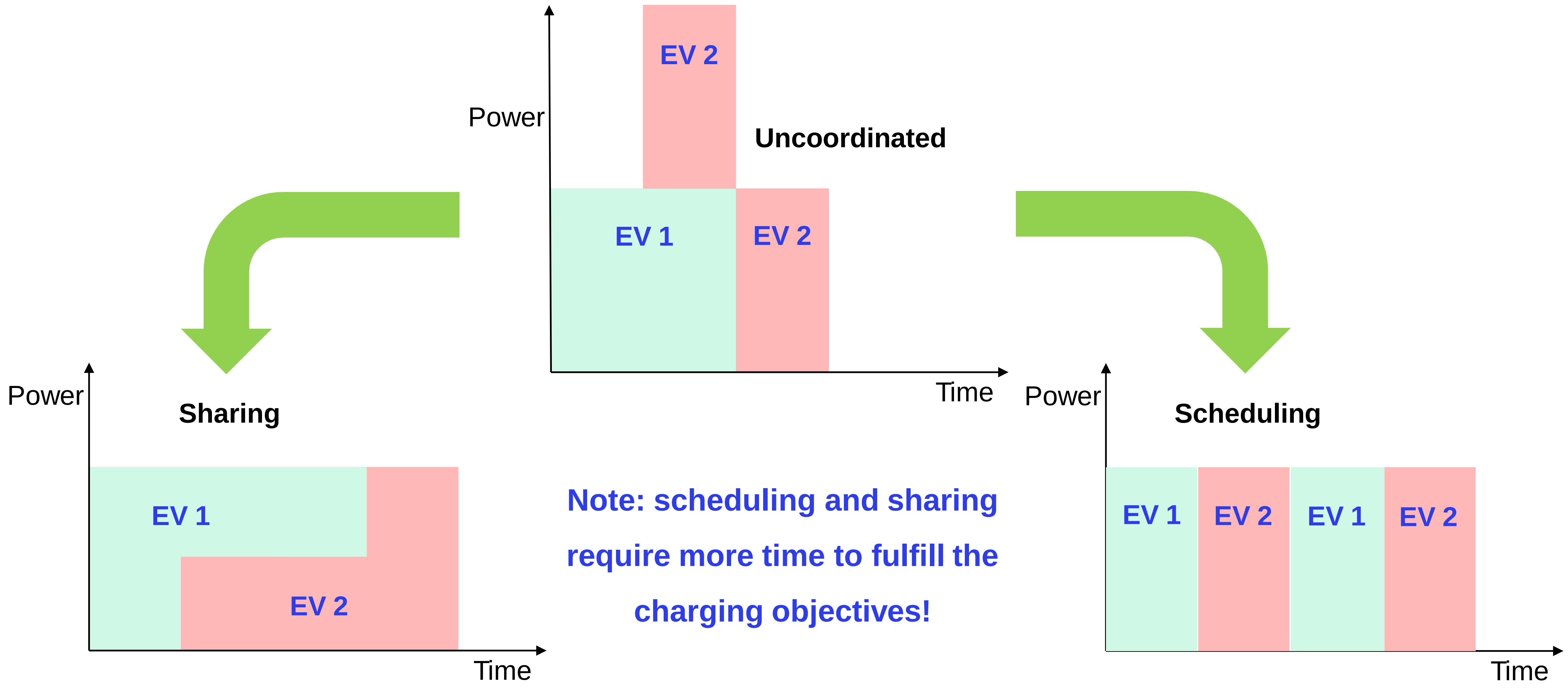
3 million EVs ❼ 9 TWh/y

Danish electrical consumption: 36 TWh/y

Peak power consumption: 6 GW

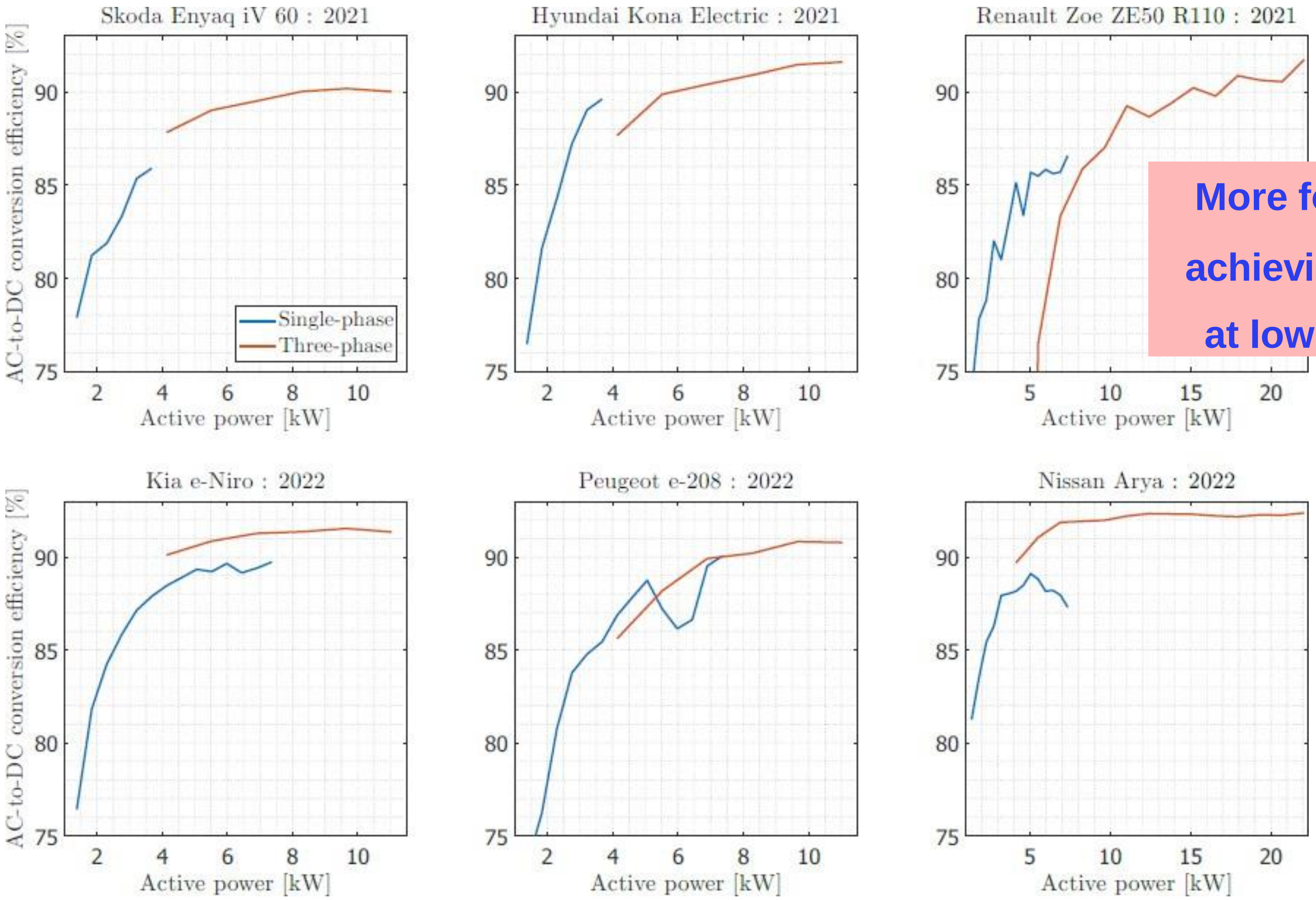
Charging concurrency	Additional power	Increase in peak consumption
Evenly distributed charging	1.0 GW	**17%**
3.7 kW @ 30% coincidence factor	3.3 GW	**55%**
3.7 kW @ 100% coincidence factor	11.1 GW	**185%**
11 kW @ 100% coincidence factor	33.0 GW	**550%**

Uncoordinated vs smart (modulated) charging (sharing and scheduling)



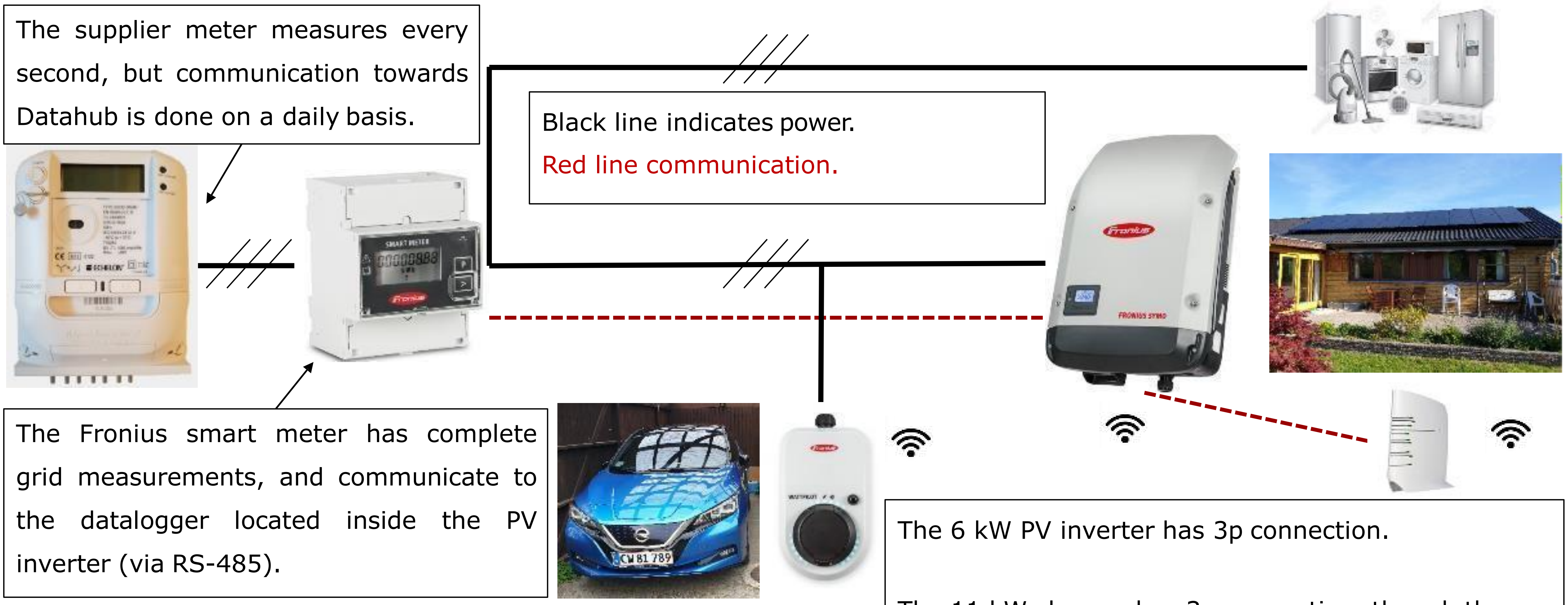
Note: scheduling and sharing require more time to fulfill the charging objectives!

Efficiency of electric vehicle under different loading conditions



More focus is needed at achieving high efficiency at low charging power!

EV charging with a PV at home



The supplier meter measures every second, but communication towards Datahub is done on a daily basis.

Black line indicates power.

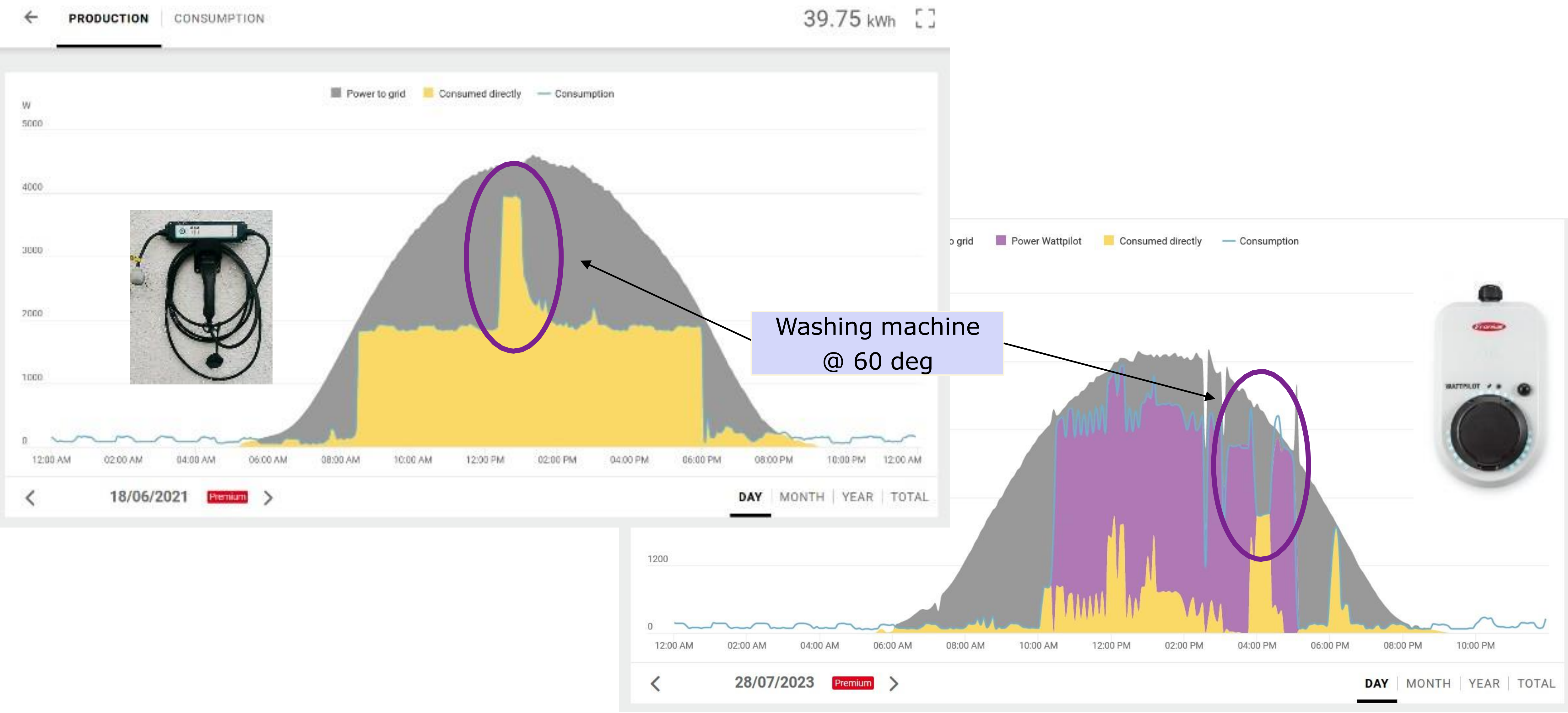
Red line communication.

The Fronius smart meter has complete grid measurements, and communicate to the datalogger located inside the PV inverter (via RS-485).

The 6 kW PV inverter has 3p connection.

The 11 kW charger has 3p connection, though the LEAF will only charge up to 3.7 kW (6-16 A 1p)

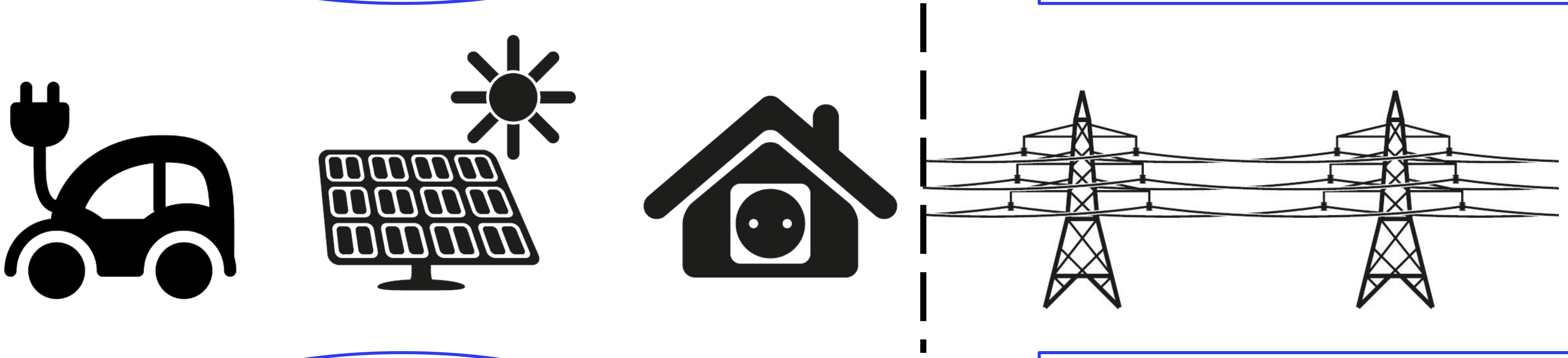
Time-based constant power vs PV-based variable power EV charging



V2G & V2H ❼ use cases

Vehicle-to-Grid (V2G)
(bidirectional flow with power fed into the grid)

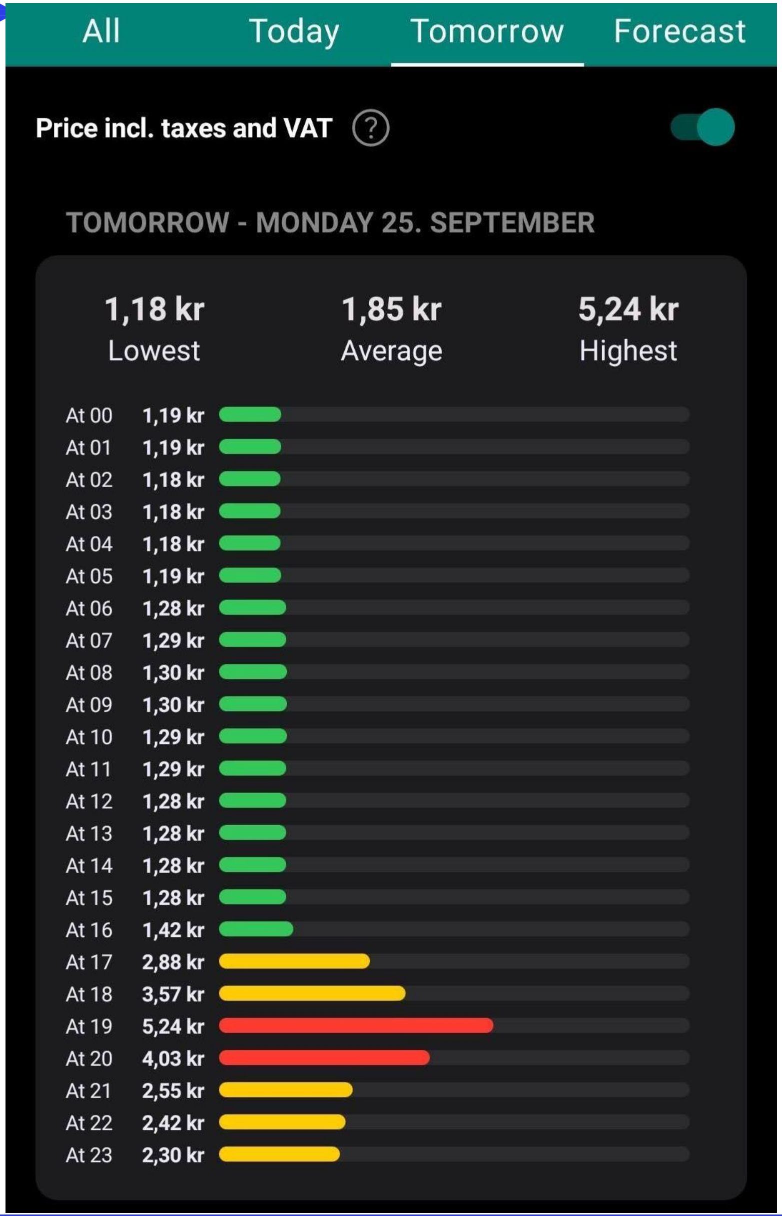
- **Frequency services (f)**
- Price arbitrage (€)
- Price arbitrage with renewables (€ + RES)



Vehicle-to-Home (V2H)
(bidirectional flow with **no** power fed into the grid)

- **Time-of-use (t ❼ €)**
- Time-of-use with renewables (t + RES)
- Grid deferral or limited capacity (Pmax)

Retail and spot prices in DK2 – 25/09/2023



Spot price min: -0.01 €/kWh

Spot price max: 0.38 €/kWh

Retail price min: 0.16 €/kWh

Retail price max: 0.70 €/kWh

V2H use case

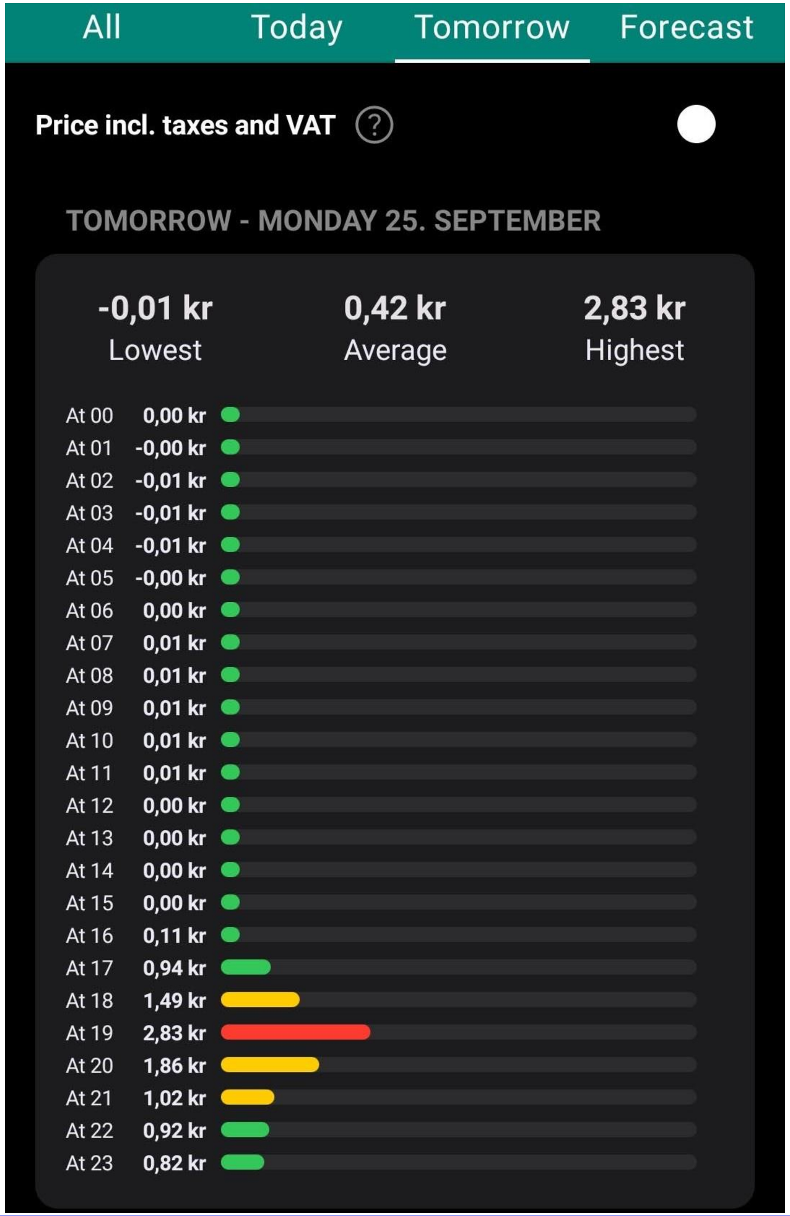
Delta retail max – retail min

0.54 €/kWh (4.06 DKK/kWh)

V2G use case

Delta spot max – retail min

0.22 €/kWh (1.65 DKK/kWh)



Future directions 1/2

V2G is it finally the right time?

Battery degradation

Low-power low-cost public charging for everybody

Cyber-security!

Future directions 2/2

Electrification of commercial and heavy-duty vehicles

Guidelines – Charging Infrastructure for Truck Depots

Coordinated operation of large fleets for grid services

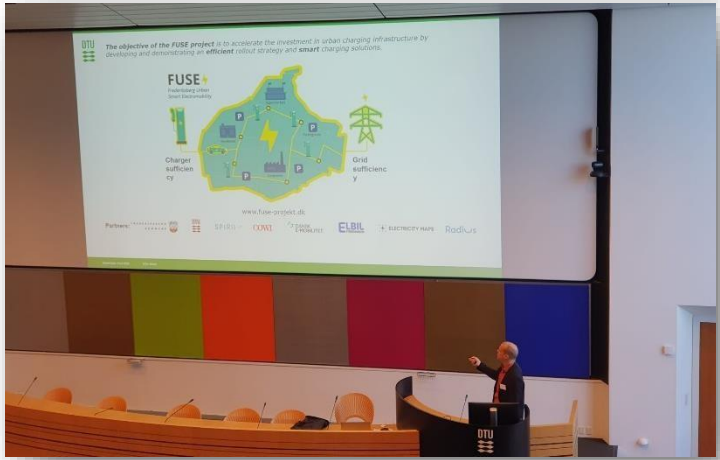
Autonomous and user-friendly chargers

Seminar on Grid Integration of EVs

(ACDC+FUSE+EV4EU+FLOW Projects)

- A 2-day seminar event in Risø with speakers from academia, research and industry.
- Demonstrations from ACDC and FUSE projects and future directions in FLOW and EV4EU projects.
- 20 companies involved
- 100 participants.

- **Main Topics:** Smart charging, architectural perspective, Aggregation and flexibility with live demonstration of autonomous chargers.
- **Event slides:** https://drive.google.com/drive/folders/1r99lowpJPJf-2Kd0mOTJzlxAviS30Nrr



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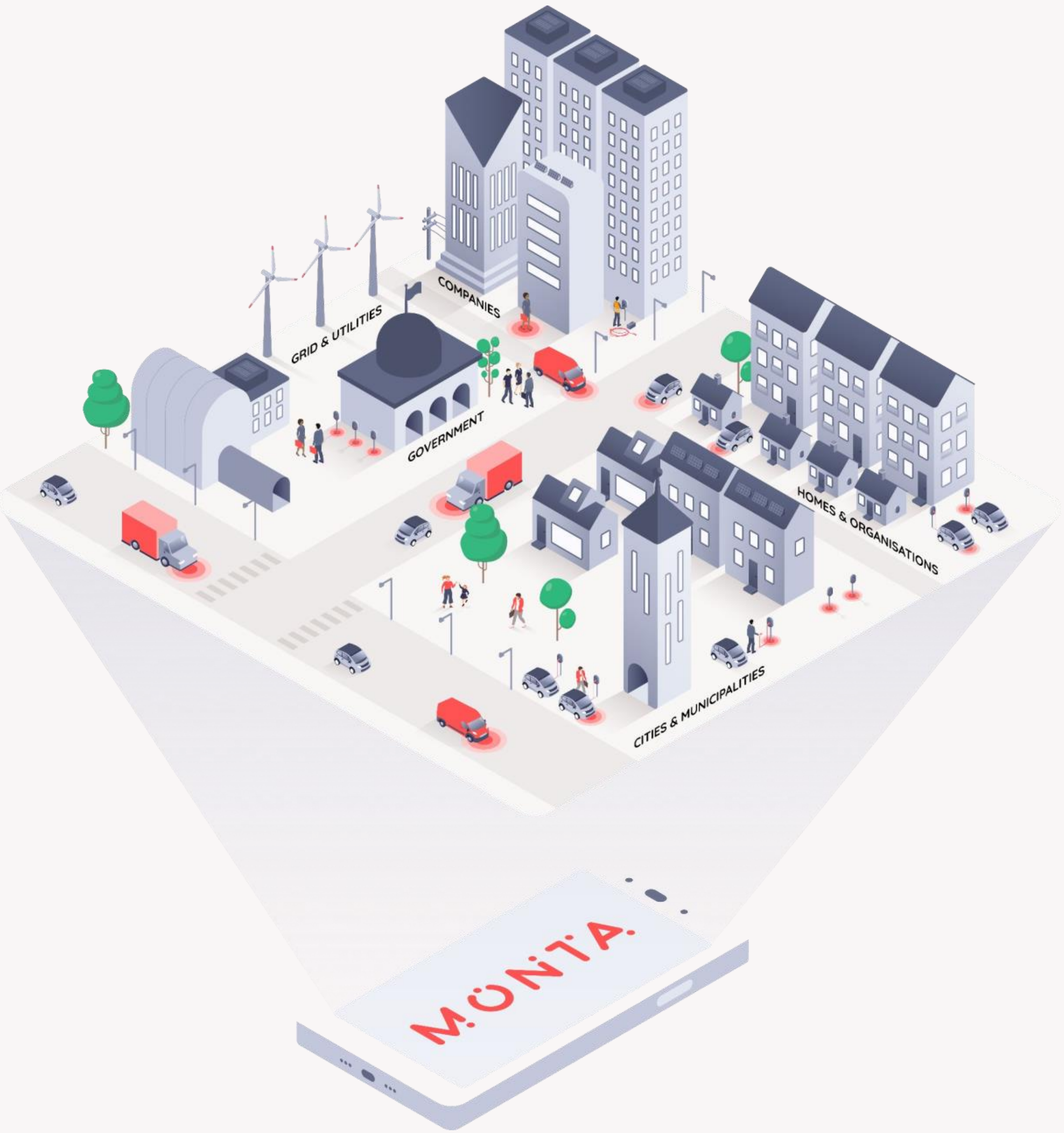
MONTA

EV better

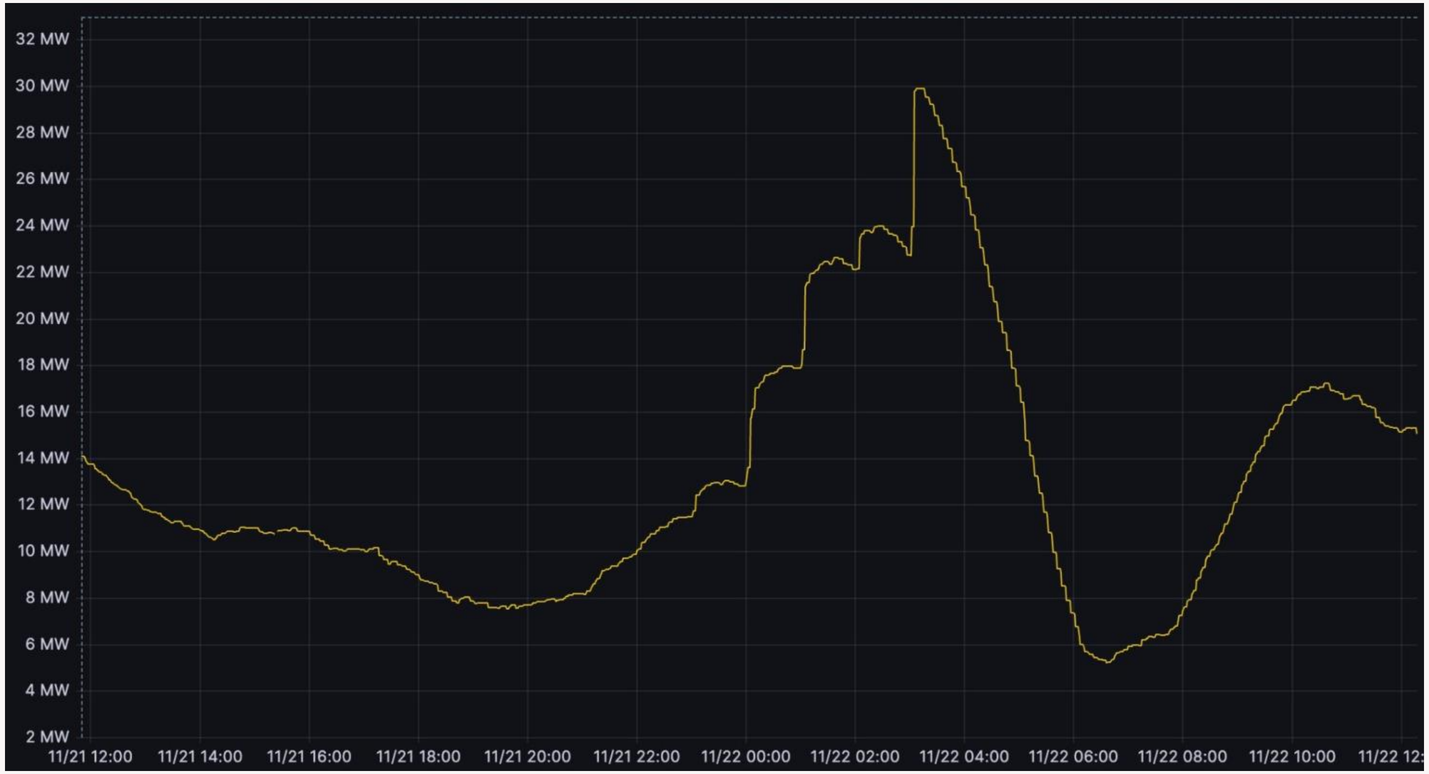
Monta.

We created Monta to build a seamless charging experience across the ecosystem.

- Software technology that allows CPOs launch, manage and scale EV needs & operations.
- Agnostic and future proof solutions. Monta integrates and collaborates with all major charge point brands.
- We believe that accelerating and democratising the adoption of EV technology is key to fostering the sustainable future we so desperately need



Monta’s impact on the Energy System.



Targeted as a Critical infrastructure for the grid by Energinet in the summer of 2022

Why is Monta focused on Grid Services?

- Monta **has the responsibility** to build a scalable charging ecosystem that is capable of assisting the grid's performance and stability.

- As a tech-driven company, Monta is constantly building innovative **software based solutions** to promote sustainability.

- We believe that accelerating and democratising the adoption of EV technology is key to building a better future. **We want to turn charge points into revenue streams for end users.**

The Grid is facing challenges.

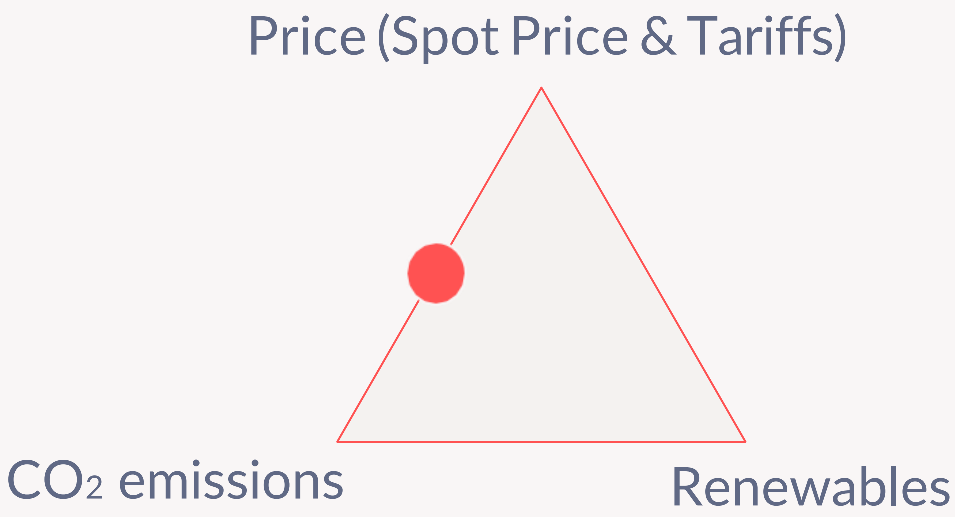
Consumption: The Grid was built last century and thus not scaled for today's electricity needs or EV penetration. Local grids are already suffering from congestion issues.

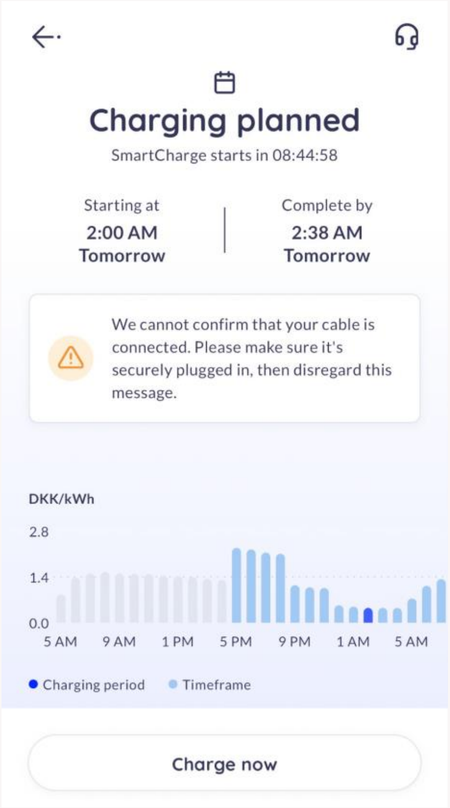
Generation: The increase in renewable energy has made the production of electricity more volatile.

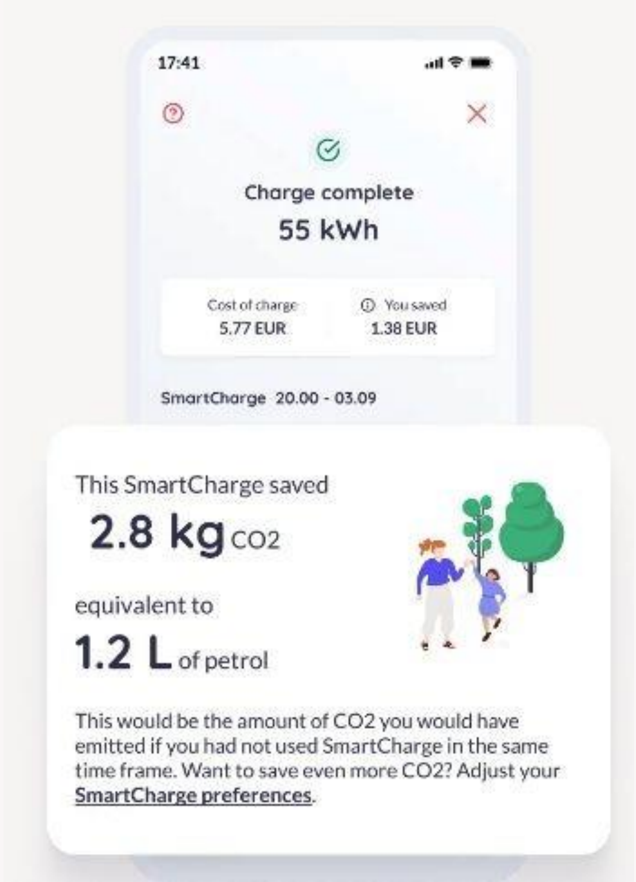
If either suffer from an unexpected change, the grid suffers from an imbalance in the frequency that can cause a blackout within seconds.

Smart Charging

Monta's Smart Charging algorithm helps end users schedule the charge **outside peak-hours**, when congestion problems are most probable to happen.







PowerBank: Grid services powered by EVs

Via **Aggregation** we're able to control all charge sessions simultaneously on the Monta platform.

Whenever a **risk of an imbalance** is detected bulk a command is sent to the ongoing charges.

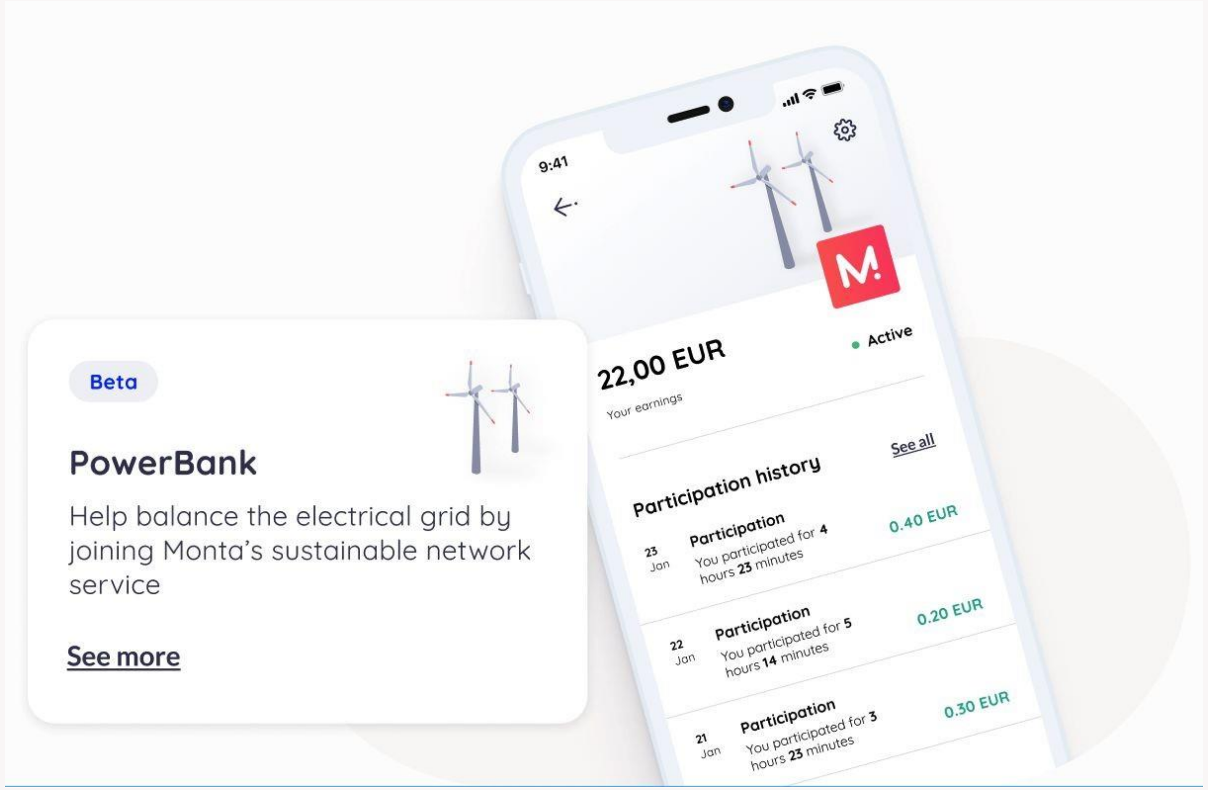
This control paired with Montas technology enables us to pause and restart ongoing charge sessions, reducing the consumption, turning the EVs into a valuable asset to the Grid.

PowerBank: Grid services powered by EVs

This technology allows Monta to participate in flexibility markets with the consumption of the CPs.

Monta's CPs are pre-qualified for FCR-D in Denmark, which allows us to generate revenue from PowerBank.

Monta's goal is to forward this revenue to end users, to turn CPs into small revenue streams and accelerate EV adoption.



What is our strategy for the future?

- PowerBank and SmartCharging are just the first step into having a more balanced grid and predictable grid.

- Connection to Smart Meters connected in a local grid. → Gives Monta and user a better understanding of electricity assets

- Include these assets in a platform that interact with the charging ecosystem (solar panels, batteries, heat pumps, smart houses, grid's congestion and stability levels etc.).

The Energy System of the future?

- Our Smart Charging algorithm and insights on end users charging patterns gives us a **good understanding on charging needs.**

- We want to change the electricity consumption **from unpredictable to predictable** and planned, by closely collaborating with grid operators and participating in **Energy markets** for more than just flexibility purposes.

- **V2X and V2G** —> Will unlock a new world for the charging experience but has also a lot of potential for grid operators (balancing purposes, scheduling a charge or discharge, etc.)

Thank you!

alir@monta.com