Target grid: pdf bij de Kamerbrief samen met II3050 / ETES / Inwonerraad

- er is nog geen duidelijk beeld van de toekomstige elektriciteitsinfrastructuur die wij nodig hebben om de klimaat doelstellingen te ondersteunen. twr
- target grid: blauwdruk "in wording" van het elektriciteitsnet in het klimaatneutrale energiesysteem van 2045.
- opwekking van duurzame elektriciteit x5, x10 NL+DL = 70 GW offshore
- beeld gebruiken om te kunnen backcasten.
- eind 2023 ⇒ "breed gedragen en geaccepteerd target grid".

2023 ontwerp target grid.. | 2025 uitvoeren nu portfolio op volle capaciteit | 2030 target grid gerealiseerd (?)

- Niet gelijk overgaan tot bouwen maar alle voorbereidingen treffen. | 2045 ⇒ gebouwd
- offshore windenergie efficiënt ontsluiten ⇒ 72 GW in 2050
  ↳ II3050 → Nationaal leiderschap met 52/20
  ↳ waterstof

• wat was ook alweer nationaal leiderschap? NL streeft naar een energetisch efficiënt systeem binnen de NL mogelijkheden en stuurt nationaal sterk op de invulling van de energiemix. elektrificatie industrie.

- grensoverschrijdend ontwerp van het energiesysteem dat uitgaat van de doelstellingen voor woz uit de verklaring van Esbjerg. (18/05/2022 DK, België, Duitsland, NL) ⇒ 150 GW in 2050 (65 GW 2030)
  ↳ North sea as the green power plant of Europe.
  NL+DL → 140 GW.

• uitgangspunten: • hoge elektrificatie eindgebruik.
  • gecentraliseerde opwekking offshore
  • zoveel mogelijk directe elektrificatie.
  • Duurzaam opwek DL → 1030 TWh
    NL → 453 TWh.
  • DL → tekort 75 TWh / NL overschot 198 TWh.

(AP) vragen waarom NAT zonder synthetische brandstoffen?

• Bouwstenen * AC/DC * meshed DC
- voor transport van grote hoeveelheden over lange afstanden met hoog capaciteit + weinig verliezen ⇒ DC verbindingen. is er al tussen NL/UK NW/DK. Duitsland → wordt aangelegd Noord/Zuid.
- meshen ⇒ onderling verbinden van DC kabels in hubs (beter bestand tegen storingen).

• AC net NL: 2 belangrijke corridors ontstaan
  • westen (Zeeland, Maasvlakte) ⟶ zuidoosten (Maastricht).
  overvloed offshore wind → chemelot + export België/DL.
  Nu al projecten ⇒ 380 kV Borssele - Tilburg + versterking.
  • van Eemshaven → Maasvlakte. Als er geen wind is invoer elektriciteit via interconnectoren. (?)

• AC net duitsland
  • Noord (wind) → zuid (industrie).
  • in mindere mate zuid (trend) → Noord.

DC net

- Radiale en hubverbindingen => ontlast de AC stroomnet.
- duitsland in het ontwerp NEP 2023 -> vijf nieuwe onshore DC verbindingen.
- eerste DC hubs zullen in Duitsland liggen.
- in NL -> eerste projecten -> verbinden offshore met aanlanding. verkenning aanlanding WOZ -> 38 GW aan te landen. 16 GW lokaal gebruik. 16 GW via A.C transport (of omzetting).
- DC hub in maasbracht (na de 38 GW) -> chemelot, ruhrgebied, België.
- DC hub zeeland (België/Noord Frankrijk)
- offshore interconnecties tussen landen (vraag ? UK)

cijfers bld. 23 -> Email?

wat is er nodig

- politiek draagvlak + tijdige besluitvorming
- bepalen vraag centra.
- " beperkingen opleggen op het koperen plaatmodel voor de industrie?
- vergunningproces voor energiecorridors opstarten. Aangepaste procedures (leg uit! !)
- DC net Niet redundant aan leggen (?)
- offshore biedzones + kosten verdeel vraagstuk.
- Veiligstellen leveringsketen marktpartijen.

perspectief

- industrie: vraaggebieden, flexibiliteit, elektrificatie, DC overlay
- toezichthouder: Niet elk kwh zelfde prioriteit, impact uitval weegt op tegen kosten extra infra, toekomstbestendig bouwen, kostenallocatie
- overheid: toewijzen corridors + startprocedure, noordzeestrategie, leveringsketen veiligstellen.

Adequacy outlook

goal:
- explore what supply & demand resources are needed in a net zero carbon energy system.
- sensitivity in different scenario's.
- economic viability of capacity resources -> Leg uit
- high level implications

definitie: resource adequacy: ability of power system to ensure aggregate demand for electricity can be met at all times @ a price consumers are willing to pay.

Resource adequacy (demand/supply) -> transport adequacy
-> system adequacy.

Reliable. sustainable. affordable.

⚠ economic damage associated with involuntary load shedding -> difficult to asses -> new type of consumption pattern/types of consumers.

- studies done before -> 1-10 years term. net zero electricity ≠ energy assume level of reliability.

Scope NL / DE. Rest meegenomen in model maar niet in detail gemod.
lyseerd

(JAAR) – No specific target year. "a point in the future once the transit to net zero has taken place". Pace of transition is set by policy makers (dus zou 2040 of 50 kunnen zijn).
– transport adequacy → not adressed. Transmission within countries ⇒ "copper plate".

methodologie – storylines
– energy system model / electricity market simulaº → analysis
(demand) (hourly)

2 high level storylines: National electrificaº / International hydrogen economy

efficiency, elektrificatie, preference for local RES. Domestic productº H_2 (veel electrolyse)

↳ international market H_2 (goedkoper). less electrificaº.

⇒ mix tussen II3050 (eerste editie :·) Netzentwicklungsplan 2023, 10 yr network dvlpmnt plan (rest of europe).

considered technologies: solar, wind, various types of zero carbon thermal capacity, storage

parameters: nominal efficiency, short term marginal cost, firm capacity (available during scarcity situations), overnight capital cost, fixed operation + maintenance costs, construction time.

"construction time onshore wind → 2 jaar. Nuclear 6 jaar".

price of hydrogen onzeker ⇒ 21 €/GJ LHV NEL
12 € /GJ LHV IHE (sahara/Australië).

- No distinction in the study between grey / green / blue hydrogen.
- No distinction H_2 or ammonia
- original net zero scenario's do **not** include burning fossil fuels with CCS

⚠
- no nuclear in Germany. In NL → only in NEL scenario. 0,5 €/GJ LHV
- biomass → small role. No BECCS.

AANNAMES

P2G → Fully price responsive load.
P2H → " " " demand.

(30).

technical potential DSR fully exploited ⇒ most cost effective capacity resource
load shifting ?? (30)

Assumption for how much EV flexibility is available @ any given moment
⇒ 20% hourly demand for EV can be shed. 700 € / MWh.
HP → 20% → 500 € / MWh.

- batteries ⇒ 2 types 4 hrs / 8 hrs. more? hydrogen.

Two main assumptions Ⓐ value of lost load → economic damage associated with involuntary load shedding as TSO needs to disconnect
Since 2020 harmonized methodology
NL ⇒ 6887 €/MWh] verschil verklaren.
DE ⇒ 12 240 € /MWh]

- market price cap: maximum clearing price applied in periods of insufficient supply → currently 4000 €/MWh for day-ahead.

- apply 15,000 €/MWh for all countries (because unclear where # comes from) to avoid bias.
  → VOLL estimates based on customer behaviour today → new pattern of consumption / price reaction.

  price cap also @ 15,000 € b/c 33.

Take-aways: crossborder transmission plays a major role and certain borders contribute more to adequacy than others.
→ 25% of the capacity needed in scarcity situations if all rely heavily on solar/wind → NW, France, UK better to support NL/DE
→ other wind patterns + different generation mixes.

Conclusies: 4 – 16 GW hydrogen cap. needed → NL
8 – 56 GW → DE.

which technology can play a role in ensuring adequacy?
→ firm capacity = installed capacity x derating factor.
- Hydrogen CCGT/OCGT – 90%.
- derating factor of RES approaches zero. solar PV → 1%. wind 3–6%
- DSR HP/EV → 40 → 80%
- P2G, P2H → 100% (assumed fully price-flexible + no tech. constraints).

⚠ ↳ low capacity factor 20% CCGTs, 3% OCGTs.

LOLE → hoeveel uur zonder stroom: met max hydrogen capacity
52 GW → 6 uur/jr. 26 → 70 uur. 0 → 380.

firm capacity indispensable but incremental adequacy contribution reduces as more capacity is added.

- DSR → activated 120 uur per jaar.
  maar uncertainties → how many EV/HP deployed, how are they operated, how many consumers willing to pay to consume or to reduce demand. → cost effectiveness of investm?

- Battery → maybe not fully charged before period of scarcity.
  derating factor 8 hrs battery (70%). 4 hrs → 30%.

Dan gekeken naar welke klimaatjaren hadden geleid tot meer LOLE → 1996 → 8 days in December with low offshore wind, low solar generaᵗ, cold & dark. Kalte Dunkelflaute.
↳ all wind dependent countries → struggling. battery storages quickly depleted. All thermal capacity used.

- hydrogen → in NEL → all demand from industry + electricity productᵒ can be met with domestic productᵒ in NL.
  (fuels?) Germany enough for electricity → not for industry.
  (Net Nipoerter).

Imports depend on climate year. Sometimes with a factor 2. (5)

economic viability

- viability of hydrogen plants driven by scarcity revenues, average market prices + annual operating hours.
  ↳ if scarcity revenues are high enough → little hours is ok
- viability of RES ⇒ baseload price, capture rate, investm^t costs (not scarcity revenues).
- DSR from industries with high activa° cost unlikely.
- wholesale market enough revenues if:
  - accept that period of scarcity are ok.
  - market price cap = VOLL.
  - market price can reach high levels without intervent°
  - sufficient flex demand.
  - inv. risks are kept as low as possible
  - inv. cost continue to decrease.
  - power syst op basis van high share solar → more expensive than one with high share of wind.
  - price of imported hydrogen ⇒ major impact on domestic electricity price.

⇒ blz. 62 → uitleggen?

⚠ all electricity sold / bought on day ahead - intraday market. No long time PPA. Revenues from ancillary services, optionality, subsidies + CRM not accounted for.

Vraag uitleg over conclusie P2X blz 68?

evaluation hurdle rate:
- hydrogen CCGT, OCGT
  4h - 8h battery
  DSR < 8.000 € / MWh
  offshore wind
  } likely market viable.

BANKEN!

- onshore wind] strongly market viable.
- solar PV: marginally market viable (worse in germany) (in NEL solar)
- nuclear ⇒ unviable without support (investm^t costs WACC of 5% needed).
- 180 € / MWh IRR has a minor impact on the viability of RES but significant impact on nuclear (IRR 8% → 3%).

System operation
- paradigm shift but challenges can be overcome
- biggest challenge ⇒ maintaining frequency & voltage stability

→ loss of system inertia .. ? Henry? (6)

⇒ needed: infrastructure investm^t (phase shifting transformers)
grid managem^t & regulations
regulatory / market design (stronger locational pricing).

Black start provided by wind / solar ⇒ SI ?

? LOL

Market design

- How to finance firm capacity that will be used rarely?
- reducing investm^t risks
- free market price signals
- empower customers to decide on their own reliability level & how much they want to pay for it.
- energy only should work but risk that security of supply is not ensured without additional measures.
  ⇒ risk of market intervention + unwillingness to accept high prices.
  ↳ additional capacity remunera^o mechanisms likely to be needed.

Bl3. 95 → Figure 8.1. Key features of a future proof electricity market.

Germany: Kapazitätsreserve: TSO contracts a certain volume of capacity resources which is kept in reserve outside the electricity market and receives annual payments for being available.

Costs for strategic reserve ⇒ grid connection charges.

• CRM should be techn. neutral (+ incl. cross border plants ???)

Smart meters need to be equipped with load limiting devices.
(Germany → 2024 start with smart meters. NL → 80%, but no LLD).

Demand follows price signals
- significantly higher capacity from industrial DSR
- market need to be designed to 1) unlock the existing potential of DSR 2) ensure new demand resources are as flexible as possible 3) provide greater access to real time pricing 4) allow aggregators to optimize flexibility from EVs & HPs.

Driver for consumers → reduce overall cost of energy (+ opportunity costs for not consuming electricity).

existing industrial demand less designed to use flex cap.
↳ opportunity costs @ a level much higher than the peak prices of last decades and current day ahead price cap of 4,000 €/MWh.

kolen centrale uren van leveren warmmaken . olie → 400 € / MWh. (7)
↳ Hoogovens afschakelen (Nedstaal) → Aldel.
→ stoppen is een ding maar opstarten is een issue.
→ walsprocessen is electrisch.

voor 2.000 ⇒ vergoeding om afgeschakeld te kunnen worden.
(bedragen?)

⚠ high prices in 2022 prices in the range of 200 - 600 € / MWh → several industries significantly reduced their electricity demand (blz 100).

power 2x : - enorme elektrolyse capaciteit niet zonder PPA's
↳ wind, electrolyse, afnemer.
- 1 elektrolyser op 2 wind meters
- verdeeld: van leveren (on site)
deel flexibel meer regelt.
- P2H → krankzinnig.

Spot Markt: Mandatory? Alles via de spotmarkt (electricity pool).

ook voor EV/HP → zorgen dat ze bijdragen ipv in gevaar brengen van system adequacy. Aggregate + optimise flexibility.

Unbiased price signals:
- early enough in place for the transition to work.
- adjusted in gradual way to not destabilise the market.
↳ bijv. increasing ETS prijs.

- drive market for PPA
- RES → NO "produce and forget strategy" but full exposure to market prices.
↳ capacity based payments ⇒ NO payments by neg. prices
↳ contract for difference.
↳ spatial steering.

- integrated electricity markets.
- bidding zones → industry in Drenthe. Hunnebedden in raffinaderijen.

Market is +/- 20 jaar oud.
- price volatility → trigger for new investment in battery
- record for RES viability → price signals for investment has never been so strong (! ⚠ windvogel vertellen).

⇒ market intervention.