Electrolysis & Electricity Networks – What to do, what not?

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Market Design

TenneT at a glance

16
Interconnectors

25
Directly connected offshore wind parks

42 Mio.
Customers

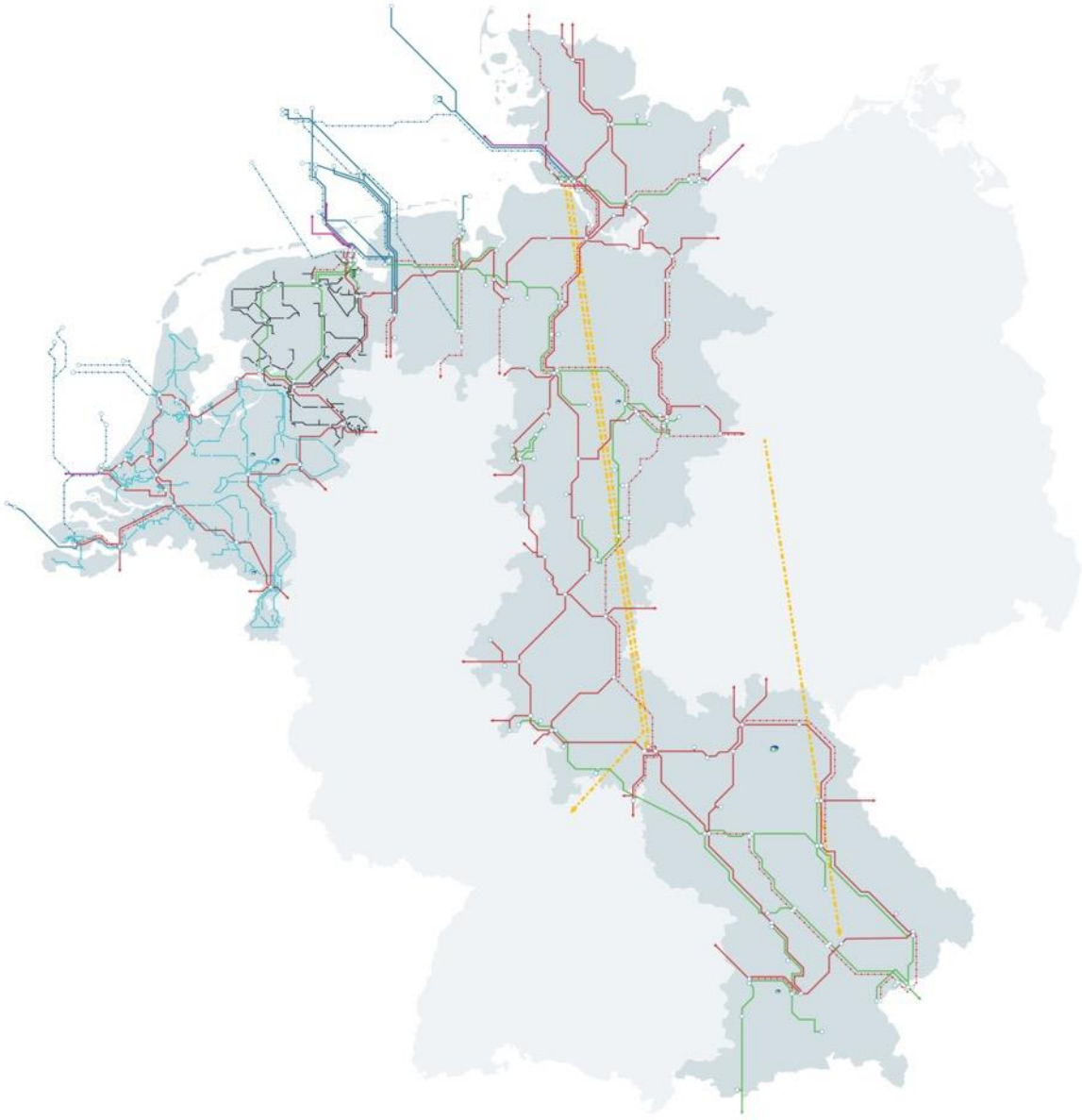
99,99%
Grid availability

24.500 km
Grid length

6.620
Employees

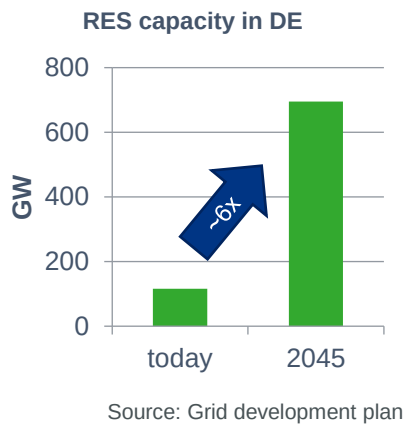
32 Mrd. €
Assets

5-6 Mrd.€
Annual investments



A renewable system comes with challenges…

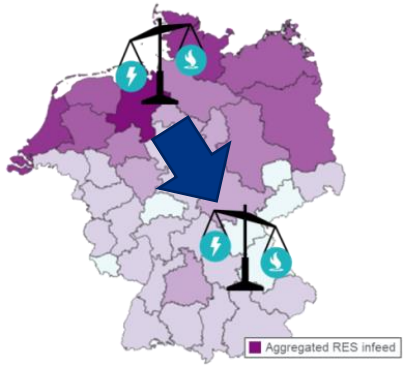
Renewable capacity



Source: Grid development plan

*A **substantial increase of renewable capacities** in acceptable and accepted regions is required.*

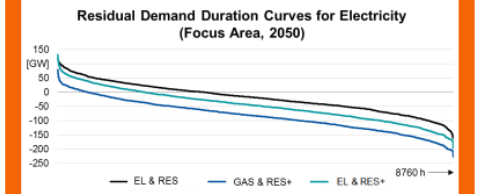
Transporting energies



Source: Phase II

*Effective **transport and distribution of energies** across regions are key for a secure and reliable energy system.*

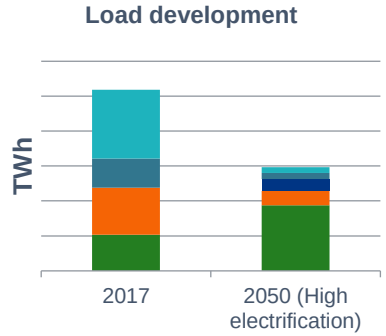
Storage and balancing



Source: Phase II

*Renewable energies depend on fluctuating weather conditions. **Energy storages** are required for daily and saisonal balancing.*

Demand



Source: Phase II

*Substantial change in **demand structure** across energy to volu of cons*

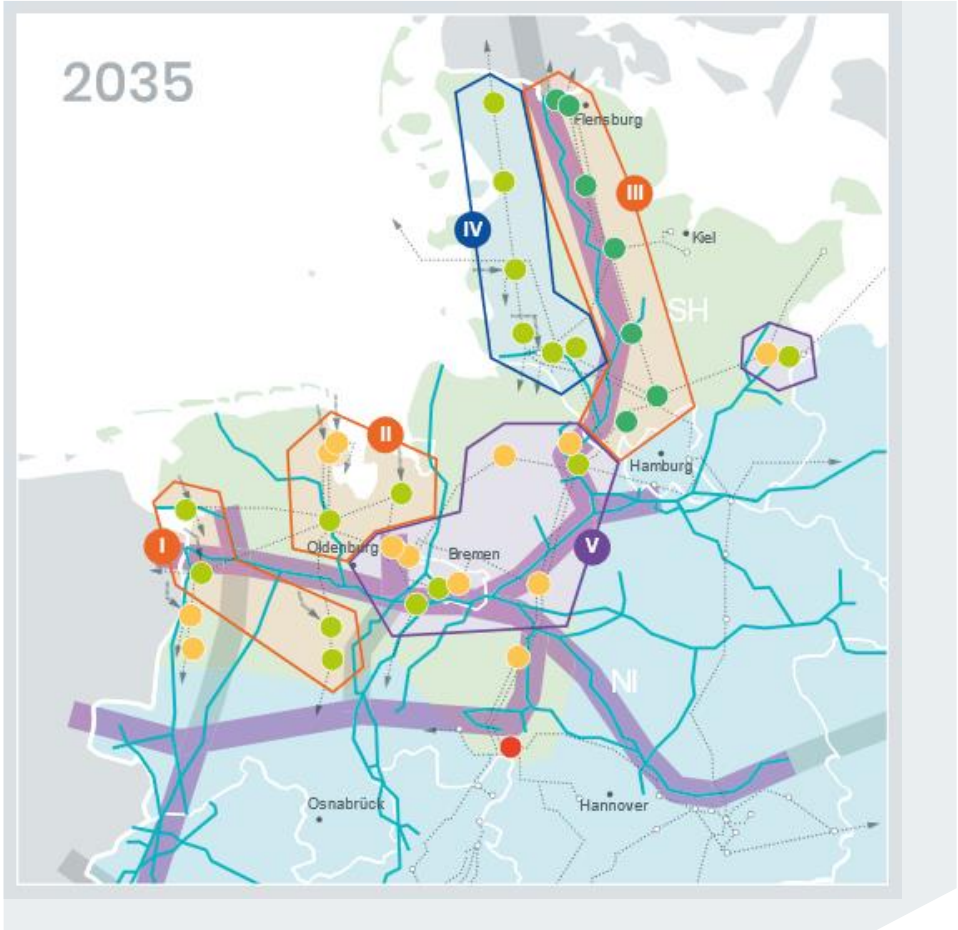
Grid development plan 2023 assumes 50-80 GW of electrolysis by 2045.

Quo vadis, electrolysis? A more integrated planning perspective is required.

- **Joint analysis of infrastructure** potentials and costs up to 2035 with gas network operators Gasunie and ThyssenGas

- **Locations of electrolysis in Northern Germany** attractive due to
  - Lower RES curtailment and redispatch needs, finally lower congestion management costs and additional network expansion needs
  - Accessibility to hydrogen backbone infrastructure as well as storage caverns

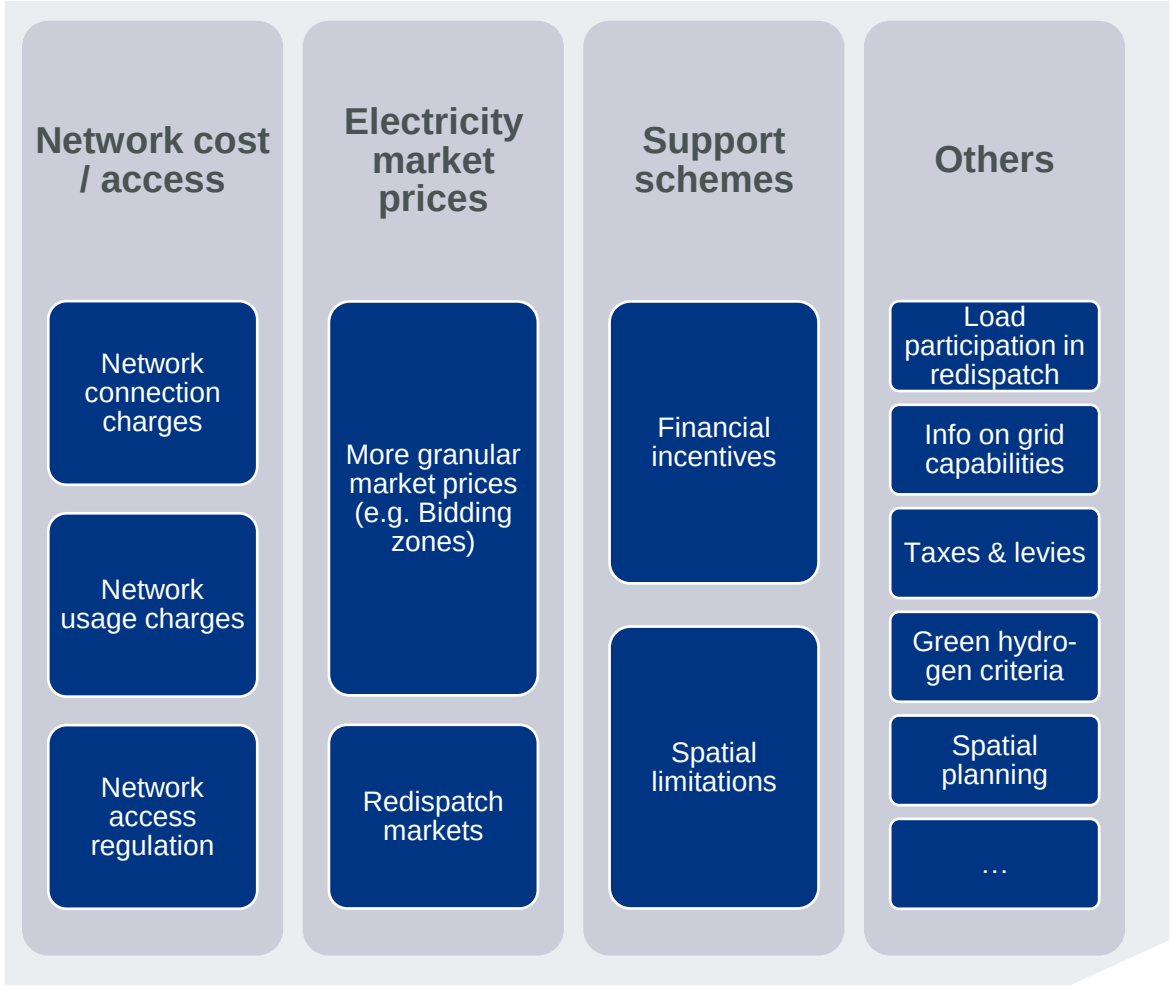
- Recent grid development plan assumes 38 GW electrolysis capacity (~75%) is located system-friendly (Scenario B 2045)
- However, a **more integrated (systemic) planning (Systementwicklungsstrategie)** and **timely built-up of a hydrogen backbone is required** to connect and supply customers in other regions with hydrogen



→ Download available at: www.tennet.eu/fileadmin/user_upload/Company/Innovation/Hydrogen/Quo-Vadis-Elektrolyse_DIN-A4_quer_V8_download.pdf; Okt. 2021

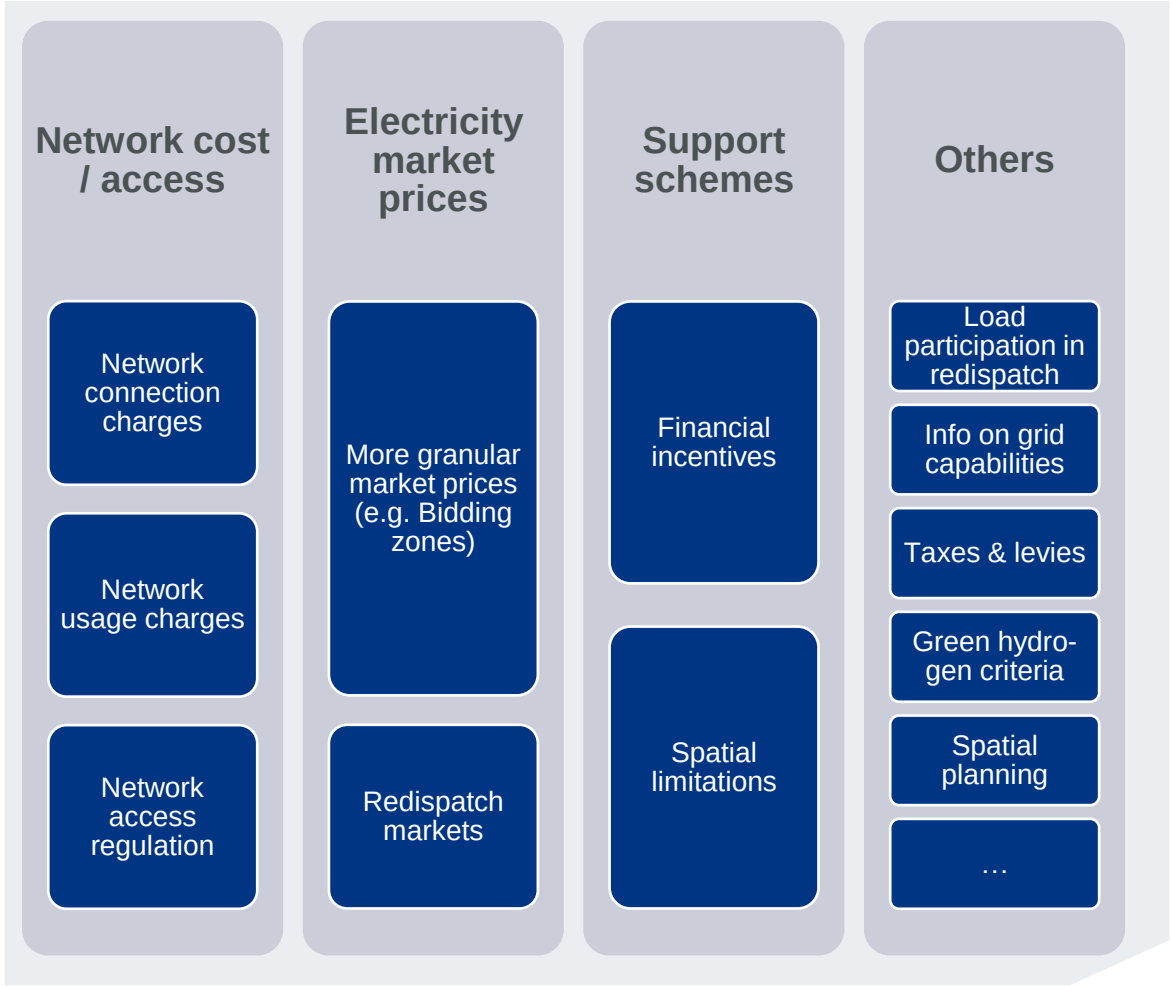
Spatial investment flexibility requires incentives which are subject to some trade-offs.

- **Hydrogen- vs. electricity-related incentives**
  - Challenges and system implications mainly on the electricity side, as well as relevant (OPEX) component for electrolyser
  - Hydrogen-related incentives can be complementary
- **Financial incentives vs. spatial limitations**
  - Spatial limitations more effective for a short-term avoidance of congestions
  - Financial incentives better suited for a long-term efficient spatial coordination of investments with grid infrastructure
- **Investment vs. operational incentives**
  - Adequate incentives to align operation with network capabilities need to be in place and can incentive locational investments
  - Spatial investment incentives can support this esp. if operational incentives are not existent/sufficient
- **Hydrogen market ramp-up**
  - Market development will undergo different phases that potentially needs to adressed by separate instruments, e.g. support needs in mid-term, while liquid market in the long-run
- **Level playing field**
  - Locational incentives ideally market-based to be anticipated also by other (sector coupling) technologies



Locational incentives (or combinations) are to be tailored to different market phase.

- **Short-term perspective**
  - Short-term market ramp-up of hydrogen technology in focus
  - Positive business case only in niches, others need support (e.g. IPCEI)
- **Mid-term perspective**
  - Establishment of the technology and built-up of infrastructures
  - Need for more comprehensive and structured support
- **Long-term perspective**
  - Established and liquid European hydrogen market and technologies



Dispatch Flexibility is important to avoid further adverse system effects.

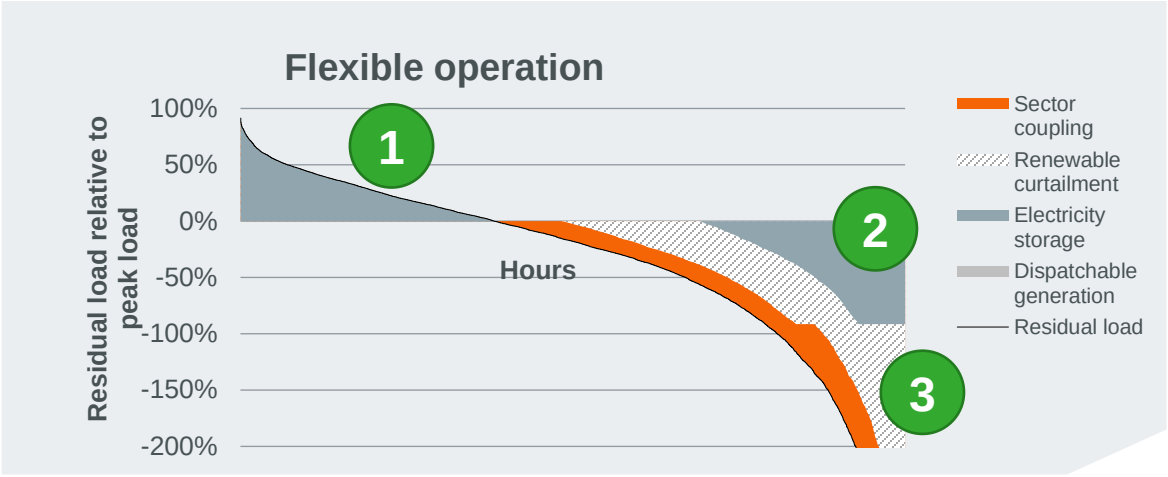
- Sector coupling with low degree of flexibility leads to additional pressure for the electricity system:

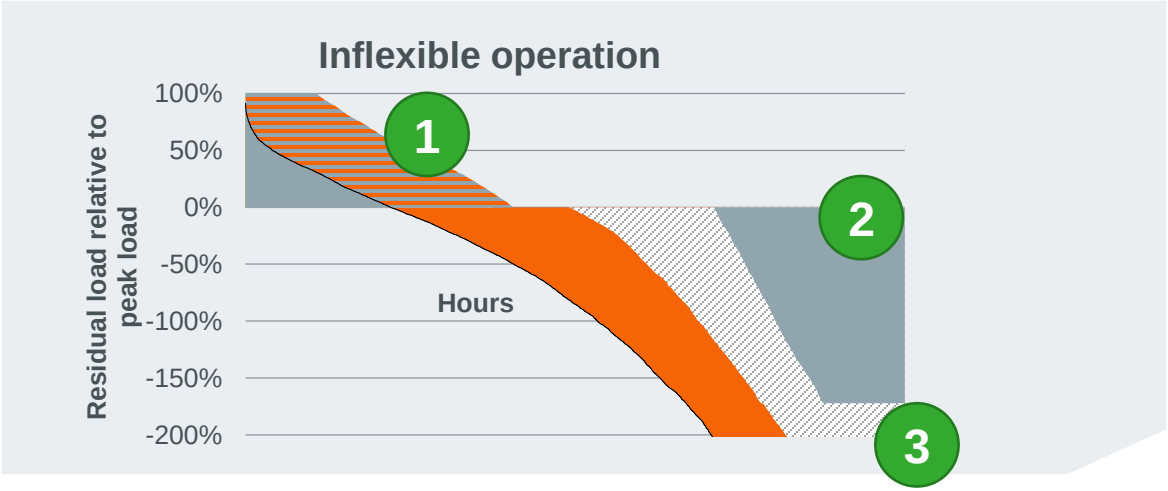
1. **Higher electrical load and esp. peak load** in RES deficit regions and less predictability of behavior

2. Need for **additional dispatchable generation and storage**

3. **Increase of RES capacity requirements and curtailment** due to less flexible dispatch

- Criteria for green hydrogen (DA RFNBO) go in the right direction





Source: Own calculation based on Zerrahn et al. (2018): „On the economics of electrical storage for variable renewable energy sources", Link to Paper & Model

The gas system provides flexibility potential that should be made accessible without seams.

- Electricity and gas/hydrogen systems have quite **complementary features**
- Gas/hydrogen features can **provide flexibility for the electricity system**

- Regulations/energy packages and market rules mainly focus on individual energy carriers/fuels

- **Seamless interfaces between specific regulations** to be ensured to not hinder flexibility provision across sectors
- Mid-/long-term perspective could demand for an **cross-border and cross-sectoral harmonisation of market rules/operation**

	Electricity	Gas/Hydrogen
Controlability of network flows	Low	High
Storability within the network infrastructure	Extremely low	High (linepack)
Matching of supply & demand	Instantaneous, at every instant in time	In certain timeframes (several hours)
Alternative transport options	Limited (Batteries/EVs)	Various (Trailer, tanker, compressed, liquified, LOHC)
Storage options outside the infrastructure	Low (PSP, batteries)	High (gas caverns)
Market dimension	European	International

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