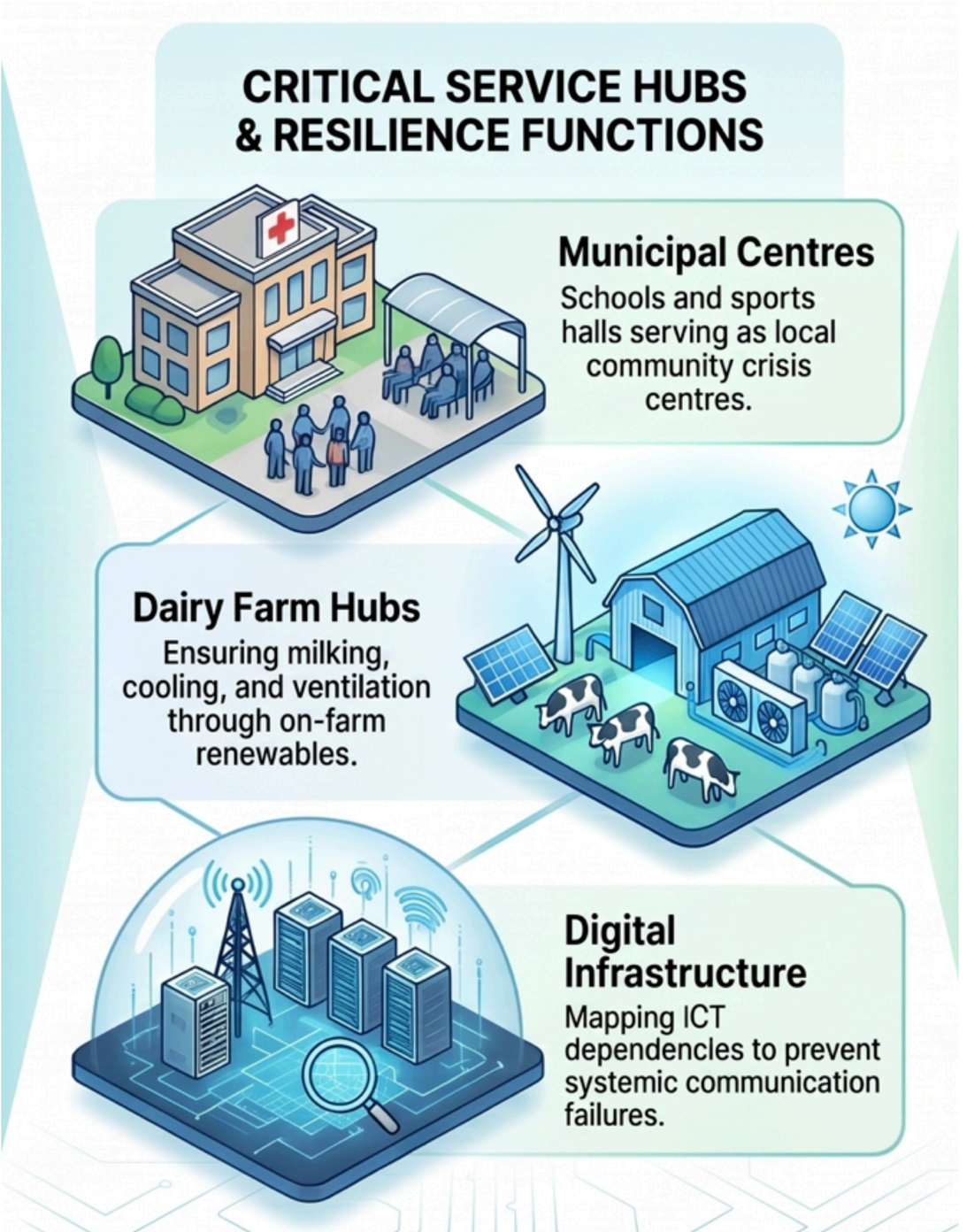
UNIVERSITY OF OSLO

Ekomkonferansen 22Sep2026, Oslo

Ekom som samfunnets digital grunnmur

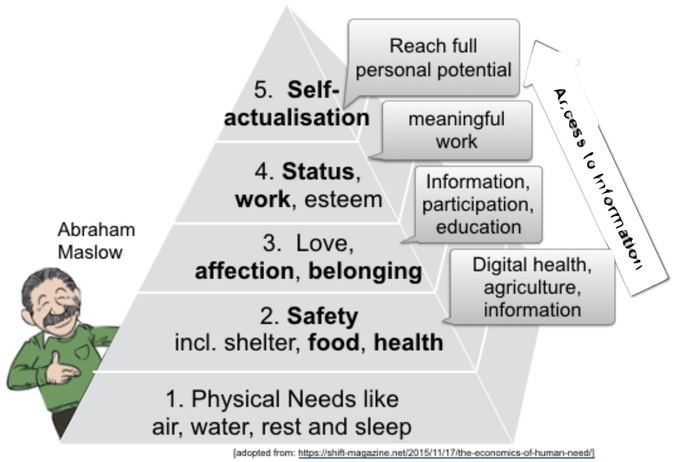
Josef Noll

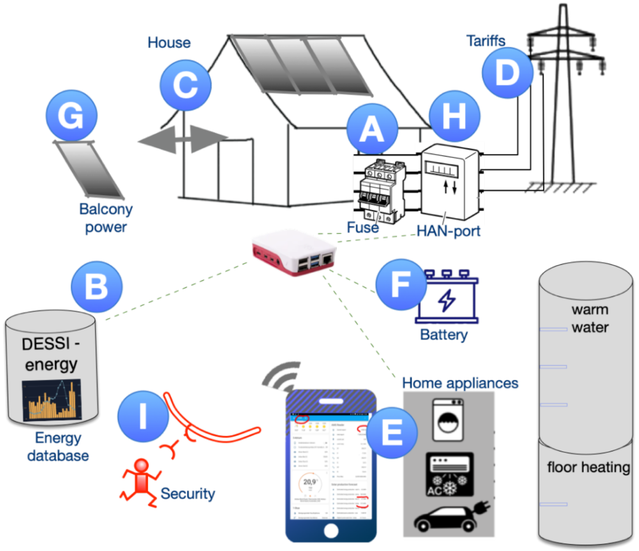
Professor, University of Oslo,
Department of Technology Systems
Kjeller, Norway, m: +47 9083 8066



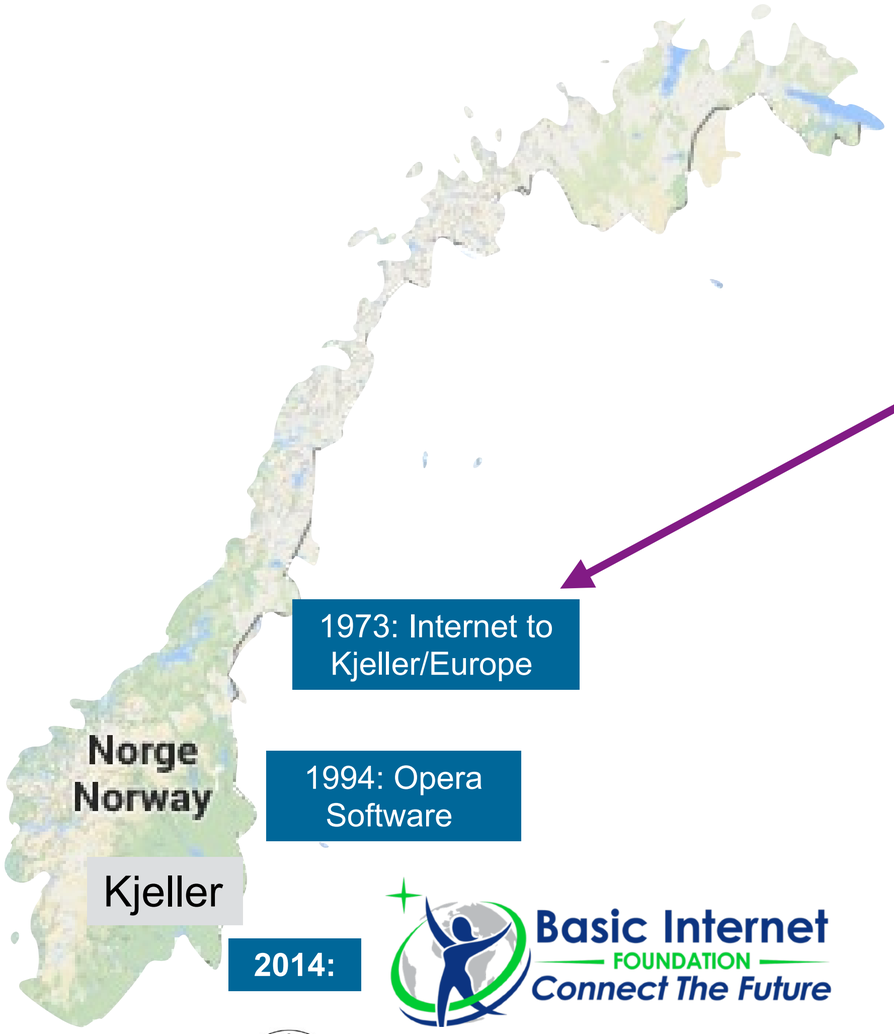
Outline

- "Why Norway"
- Societal Security - needs
- Electricity growth (demand)
  - central grid contribution
  - edge/behind the meter
- Distributed Energy
  - from techno-economic
  - to systemic model
- Research challenges





eKom and the role of the Internet



1973: Internet to Kjeller/Europe

1994: Opera Software

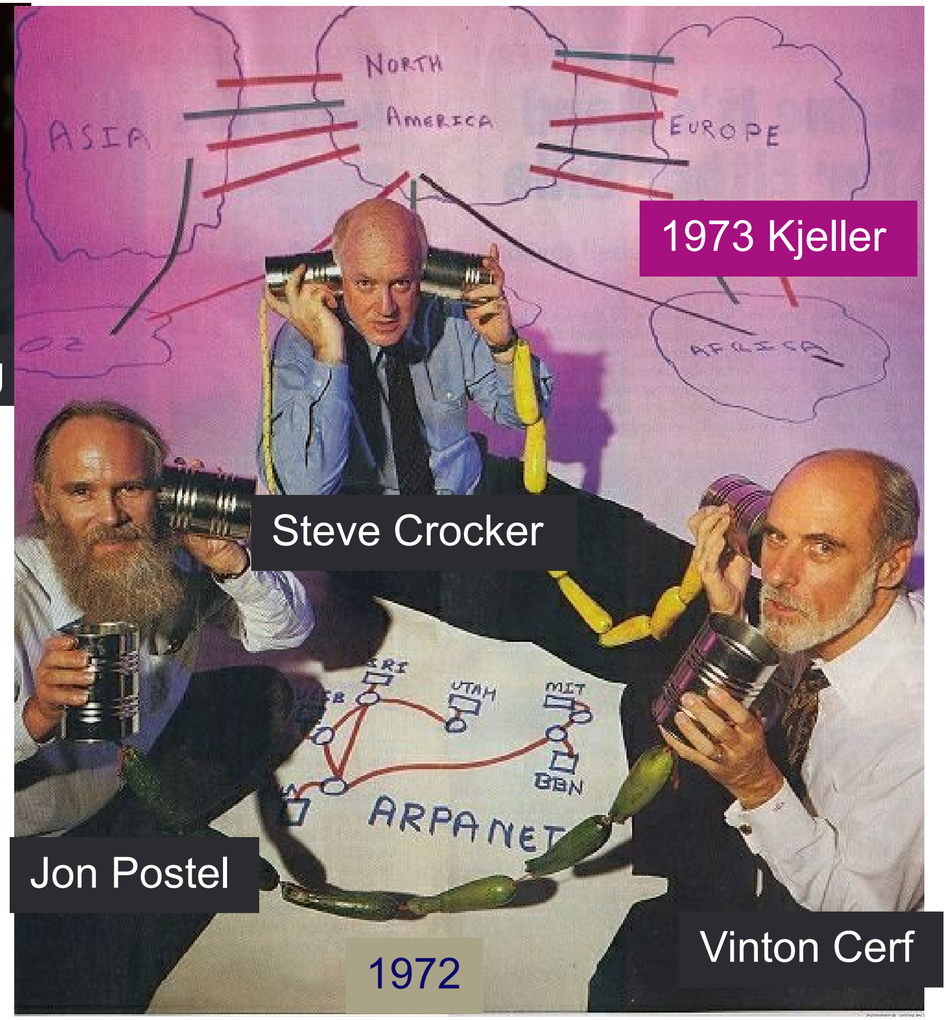
2014:

Basic Internet FOUNDATION Connect The Future

UNIVERSITY OF OSLO

KJELLER INNOVASJON





.php, OpenSource, Linux, Skype, Spotify
Opera Software, FAST search
Nokia, Ericsson
GSM
GovStack.global, X-Roads

Source: http://www.michaelkaul.de/History/history.htm

From Academia to Mobile Broadband
understanding the business

Jun1973: NO (Kjeller) & GB connected

Jun1986: RARE/TERENA…GEANT (NRENs in Europe)

1993 - **privatisation** of 2G (GSM)

1999 - 3G (UMTS): 3 x ROI expectation, Uni co-dev

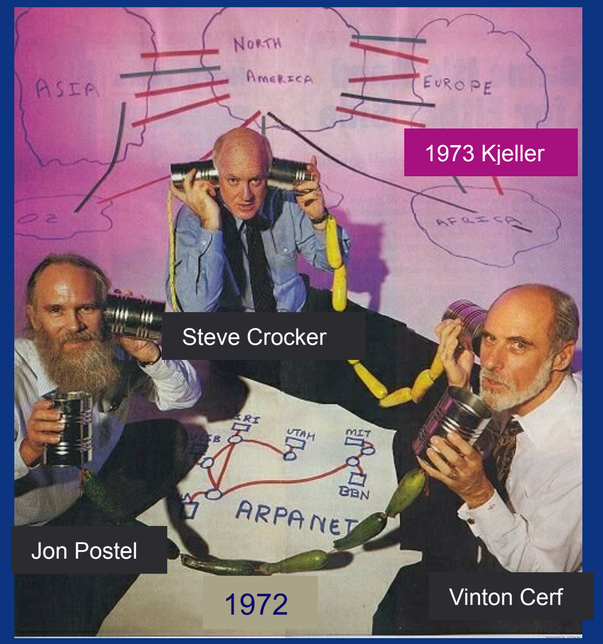
2004 - 4G (LTE): 120 km range, Supplier dev

"The mobile

Aug2003: Reykjavik "Cybersecurity"

Jun2020: UN "Digital Cooperation" recommendations

Basic Internet Foundation:
"The walk on the Internet"



Source: http://www.michaelkaul.de/History/history.html



Vint & Sigrid, Nordunet 2003

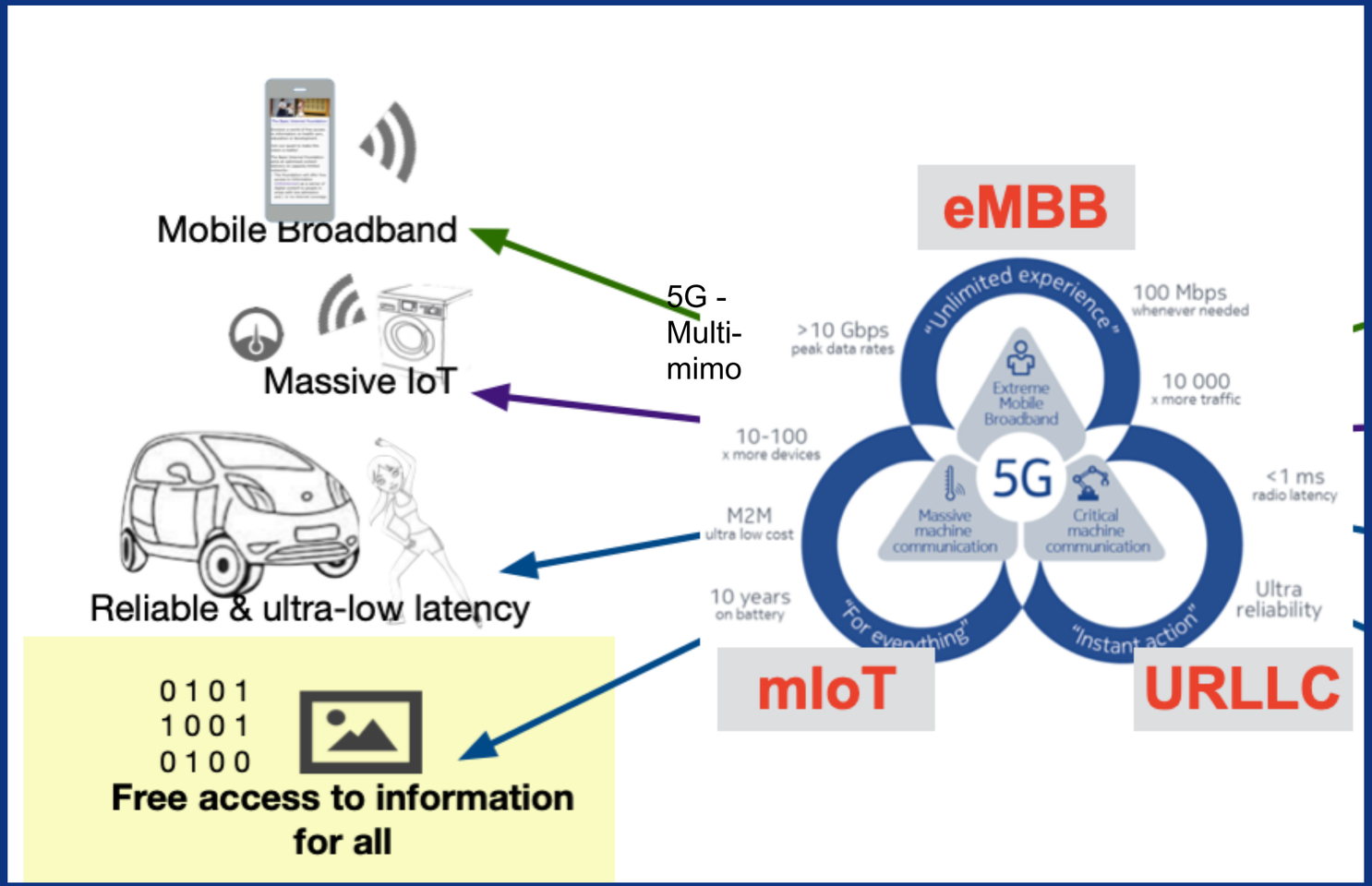
UN Panel, 2019-2020



Revisit Access

Road model: pedestrians & cyclists

Digital pedestrians, digital cyclists vs digital cars (broadband)



Internet Lite
as a Digital Public Good (DPG)

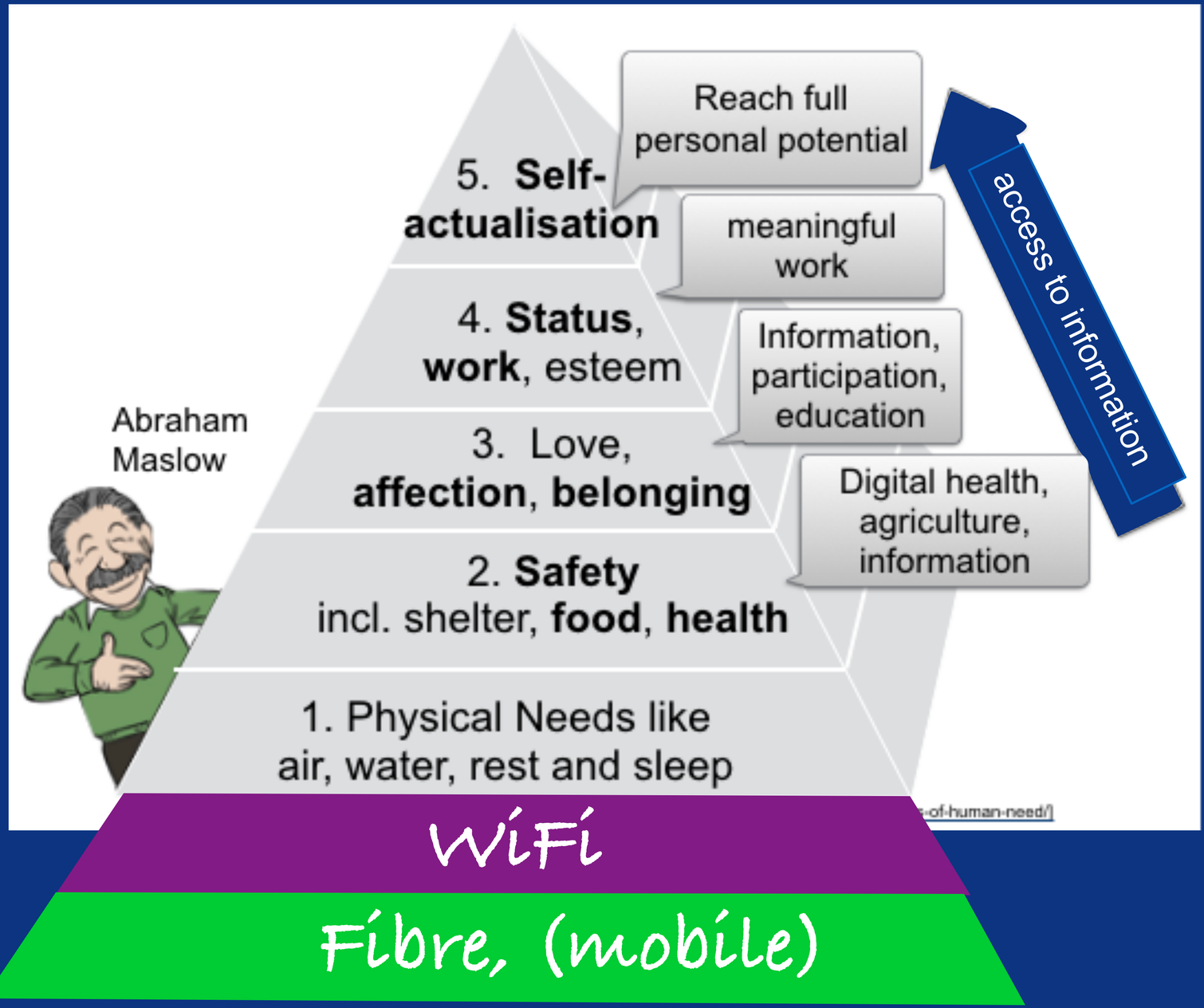
5G/6G large cells
to achieve coverage

Societal transformation

Digital Transformation, Resilient Communities, Empowered People

Digital Inclusion

Societal Empowerment



Norway Agenda 2030 - 2050:

Resilience & Energy transition

needs a Societal transition

we picked the low-hanging fruits (Norway: 97% of new cars are electrical)

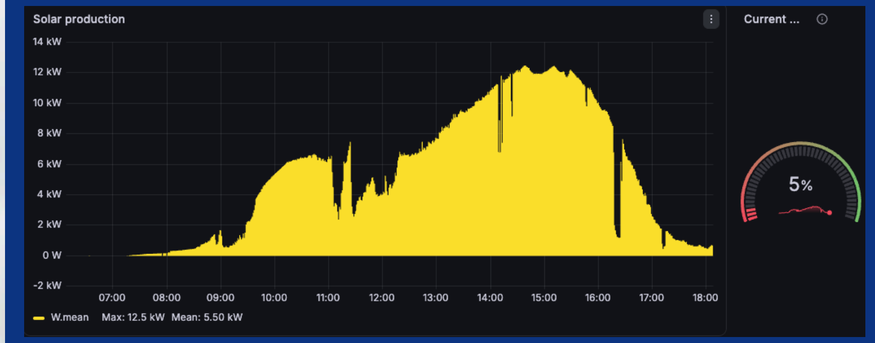
to reach 95% CO2 reduction by 2045 requires societal changes

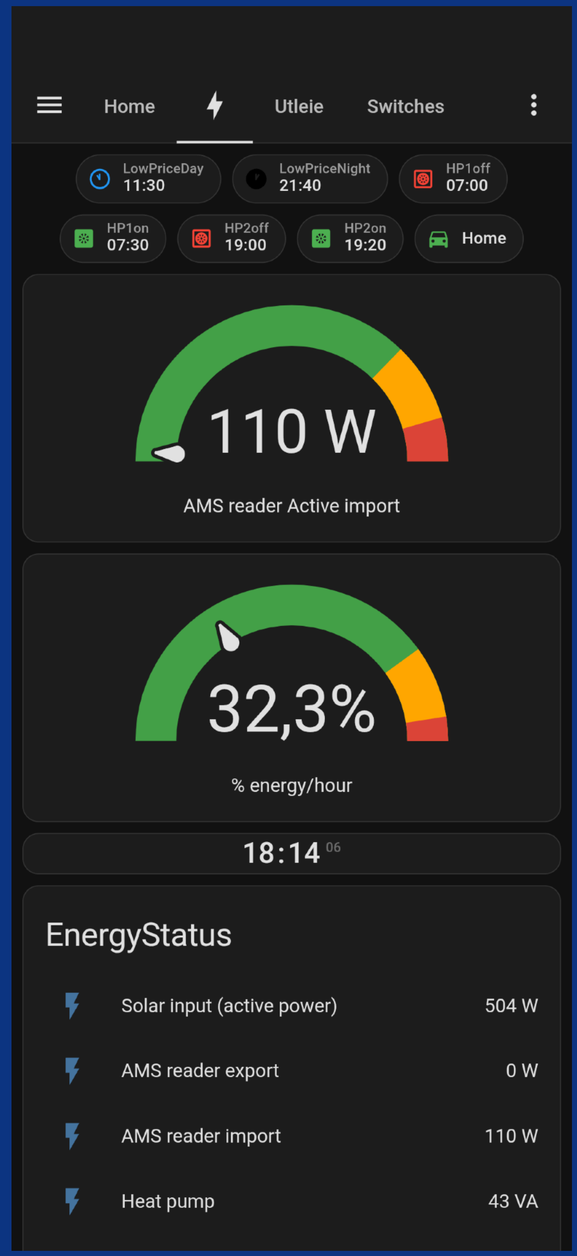
we lack the incentives for resilience and quality

Energy & Digital



[Source: TU Oct2024, Willy Kramer]





from balcony power → to solar yield → to digital usage

Power Grid resilience

US electric grid growing more vulnerable to cyberattacks, regulator says

By **Laila Kearney**

April 4, 2024 11:48 PM GMT+2 · Updated 9 months ago



A local resident walks by the power grid towers at Bair Island State Marine Park in Redwood City, California, United States, January 26, 2022. REUTERS/Carlos Barria/File Photo Purchase Licensing Rights

https://www.reuters.com/technology/cybersecurity/us-electric-grid-growing-more-vulnerable-cyberattacks-regulator-says-2024-04-04/

Home / 2024 / May / Ukraine blackouts caused by malware attacks warn against evolving cybersecurity threats to the physical world

Ukraine blackouts caused by malware attacks warn against evolving cybersecurity threats to the physical world

May 17, 2024
By Emily Cerf

SHARE THIS STORY:

On a cold winter night in 2016, Ukrainians experienced the first-ever known blackout caused by malicious code (malware) designed to autonomously attack the power grid. One-fifth of Kyiv's citizens were plunged into darkness as attackers used malware to target the capital city's power grid. Six years later, in the early months of the ongoing Russia-Ukraine war, a second attack attempted to combine kinetic and cyber attacks to take down Ukraine's power grid.



Power lines in Ukraine. Photo credit: Mny-Jhee, iStock.

Malware attacks against physical infrastructure have long been a looming threat in the realm of cybersecurity, but these two in Ukraine were the first attacks of their kind, and have received little attention from the academic c… Russian intelligence agency against Ukraine, they warn of th… highlight the need to better understand an…

https://news.ucsc.edu/2024/05/ukraine-cybersecurity.html

how to we achieve resilience in eKom and Grid?

Distributed and decentralised



[Source: TU Oct2024, Willy Kramer]

DE: 1.6 Million
+ 5 Million roofs





Syria: 10x growth solar
PK: #1 PV/person

BG: #1 battery = 16% of energy production

https://www.thenationalnews.com/business/energy/2026/07/06/syrias-solar-boom-is-redefining-middle-easts-energy-model/

Example: Bulgaria

- 16% of the production capacity of the country is available as battery capacity
- 1/3 public, 2/3 privat funded
  - Lowetsch: 500 MWh
- result: el. price 5-10 EUR/MWh cheaper than in surrounding countries





https://www.mdr.de/nachrichten/welt/osteuropa/politik/energiewende-solarenergie-pv-anlagen-,bulgarien-batteriespeicher-rekord-100.html

Examples:
Syria & Pakistan

- Pakistan
  - PV largest energy producer
  - 25% of total production in 2025
  - ~2.8 GW not metered rooftop installation
  - net-metered 5.3 GW
- Syria
  - off-grid growth: 0.25 GW (2022), 1.5 (2024), 2.06 (2025) - 10x in 3 years



https://www.reuters.com/markets/commodities/pakistans-solar-surge-lifts-it-into-rarefied-25-club-2025-06-17/



https://www.thenationalnews.com/business/energy/2026/07/06/syrias-solar-boom-is-redefining-middle-easts-energy-model/

Resilience = “minimum energy”

- WiFi: 20-50 W
- Elevator: 4 kW_p(?), 10% duty time
- Cup of coffee: 1.5 kW, 5% duty
- …

Politicians:
- people involvement
- “skattefunn til private”

Regulators:
- incentives & regulations for quality and resilience

People:
- autonomy
- fear
- neighbour

Tesla and Sunrun’s virtual power plant dispatch record 580 MW to California grid

Fred Lambert | Sep 21 2026 - 6:03 am PT

8 Comments



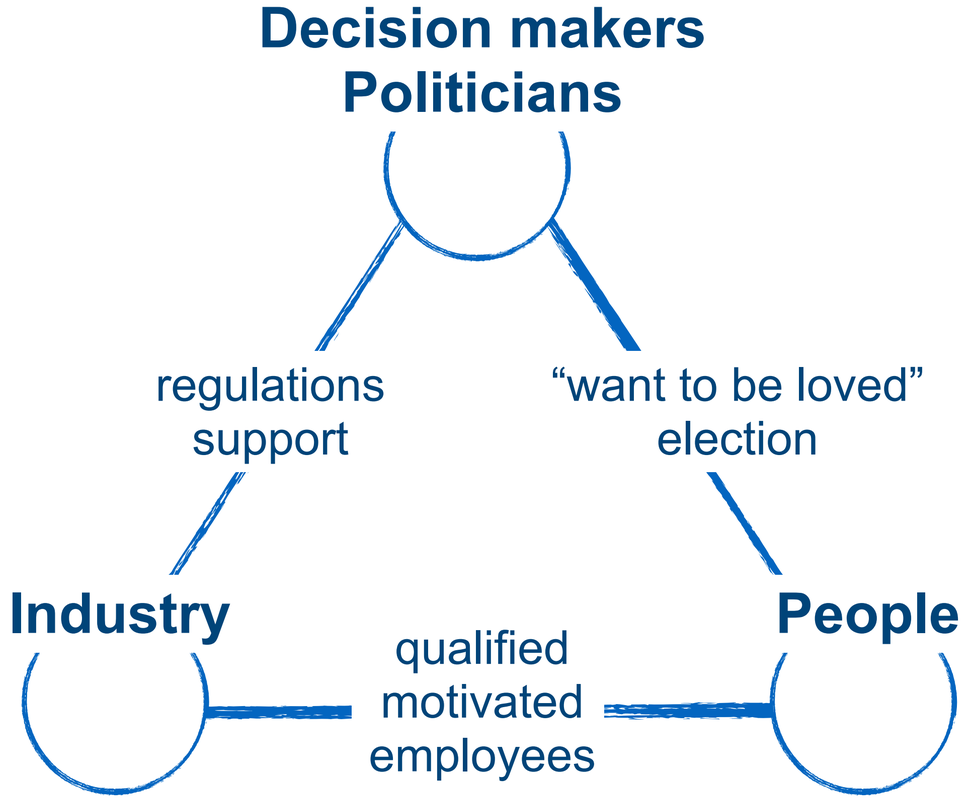
Sunrun and Tesla pulled a record 580 megawatts of power from home batteries onto California’s grid during a heat wave on September 9, the largest residential distributed power plant event ever recorded.

The dispatch pooled more than 140,000 home batteries across the state and ran for a three-hour window in the evening, when the grid was straining under air-conditioning load.

https://electrek.co/2026/09/21/sunrun-tesla-580-mw-california-grid-record/

How to include people & decision makers?

- Politicians & regulators
  - eKom & energy incentives
- Include people
  - Neighbours, fear, incentives, ….
- Pilots driving the transformation
  - neighbour countries



Our future:

The Energy Preparedness Framework: Securing Local Resilience

A systematic approach for transforming local energy vulnerabilities into validated, resilient infrastructure for municipalities and food systems, addressing compound crises through mapped dependencies and tested hubs.

PHASE 1: IDENTIFYING VULNERABILITIES & STRATEGIC PLANNING

Addressing Compound Crises



Mitigating risks from war, cyberattacks, and extreme weather that disrupt food and health.

Mapping Critical Dependencies



Identifying the vital links between energy, ICT, and essential municipal service continuity.

Local Energy & Storage Design



Planning backup capacity and battery storage for schools, sports halls, and farms.

CRITICAL SERVICE HUBS & RESILIENCE FUNCTIONS



Municipal Centres
Schools and sports halls serving as local community crisis centres.

Dairy Farm Hubs
Ensuring milking, cooling, and ventilation through on-farm renewables.





Digital Infrastructure
Mapping ICT dependencies to prevent systemic communication failures.

PHASE 2: VALIDATION, TOOLS, & SOsocietal IMPACT

Validated Crisis-Centre Concepts



Testing schools and farms as energy-independent hubs during simulated and real outages.

Data-Driven Decision Support



Using 0.1s load data and GIS mapping to size PV-battery-biogas systems accurately.

National Scaling & Policy Impact

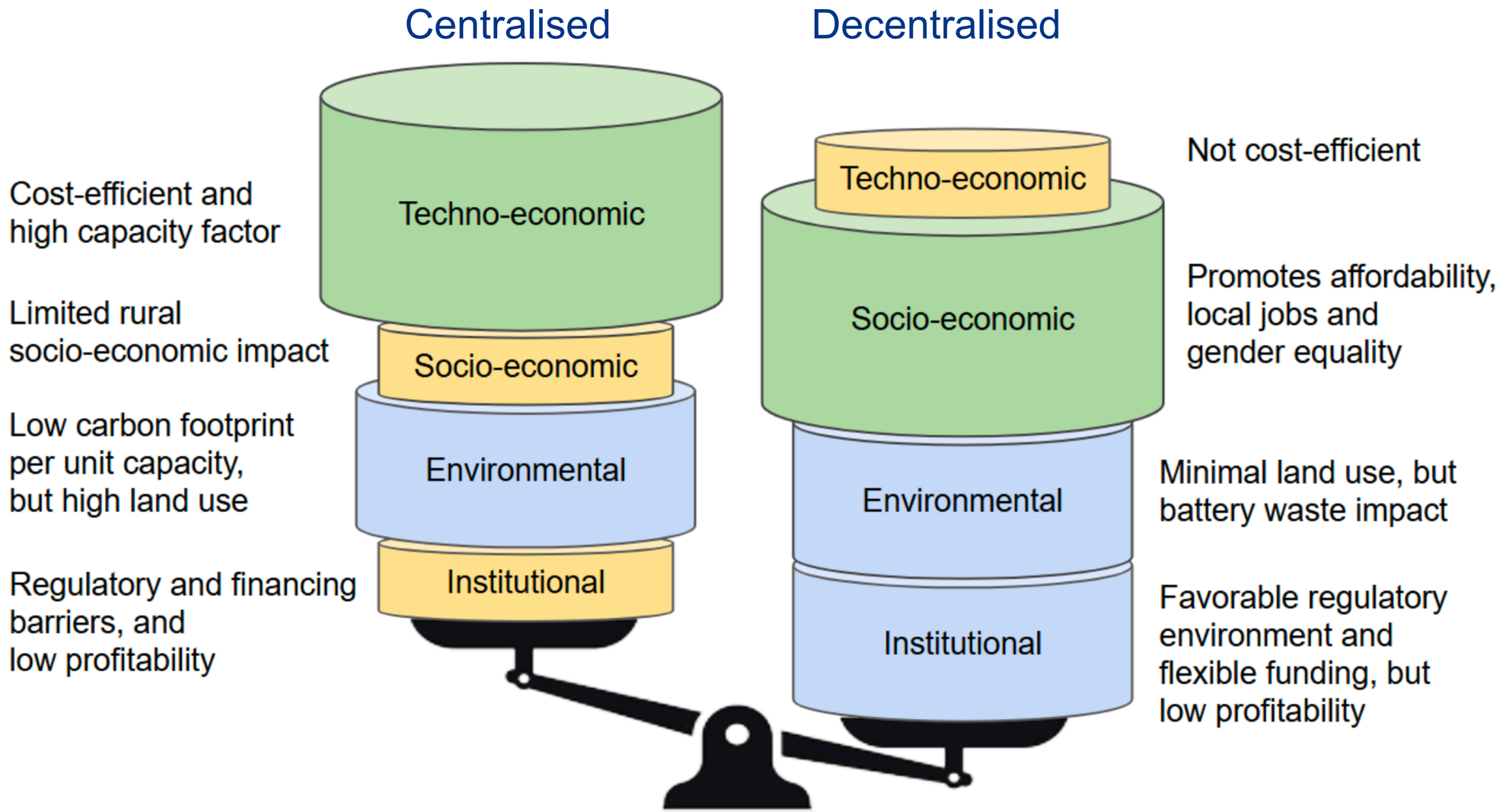


Establishing governance models and preparedness guidelines to reduce crisis costs and build trust.

Supplementary slides

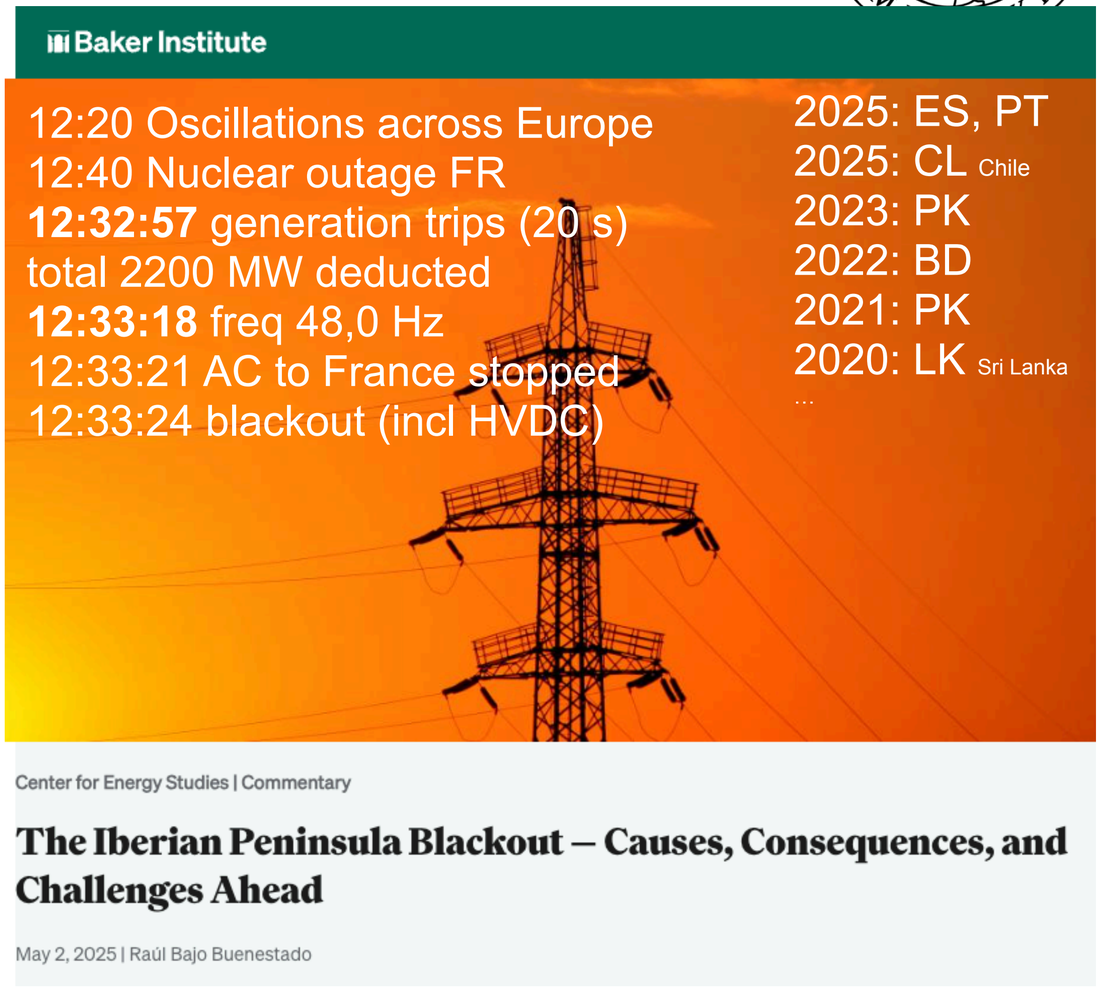


Resilient infrastructures



28Apr2025 Spain & Portugal blackout

- Cause:
  - 60% solar energy,
  - 1. solar park switched off, 1.5 s later 2. solar park
  - interconnection to France stopped (f < 48,0 Hz)
- Conventional: inertia (rotating generators)
- Solar: sudden death (DC/AC converters)
- Challenge:
  - distributed respond to grid fluctuations



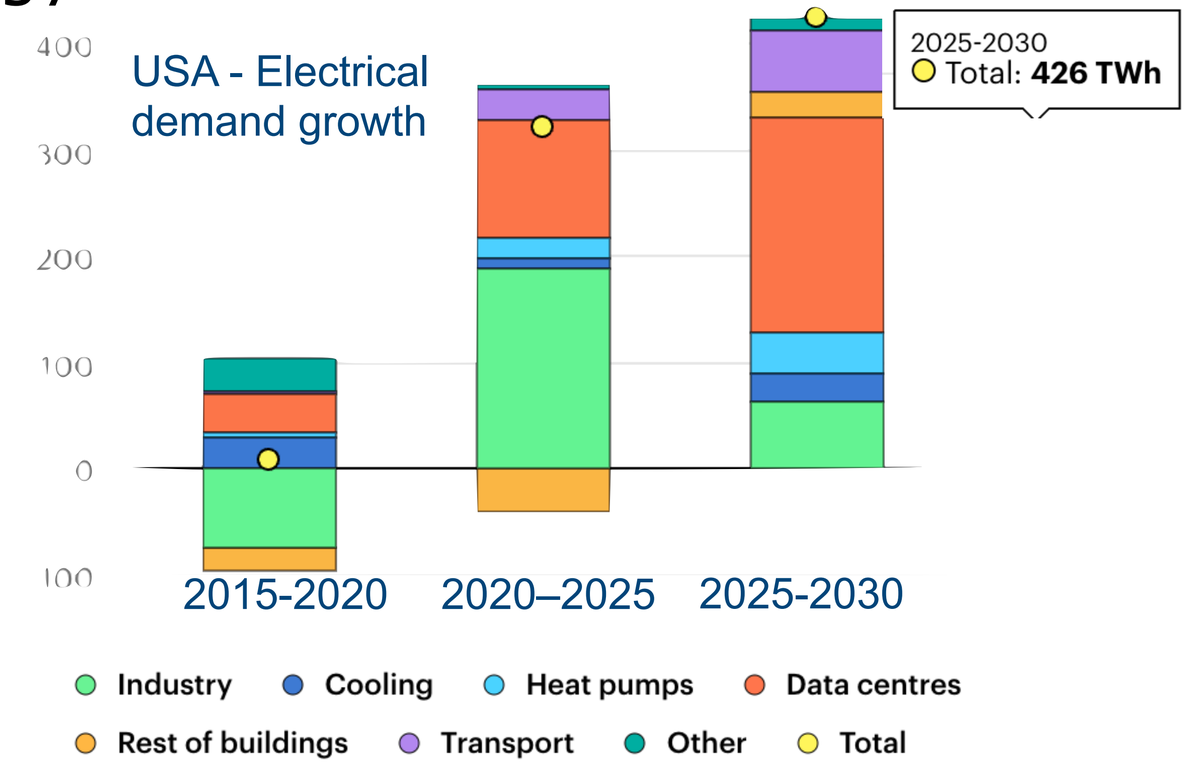
https://www.entsoe.eu/news/2025/05/09/entso-e-expert-panel-initiates-the-investigation-into-the-causes-of-iberian-blackout/

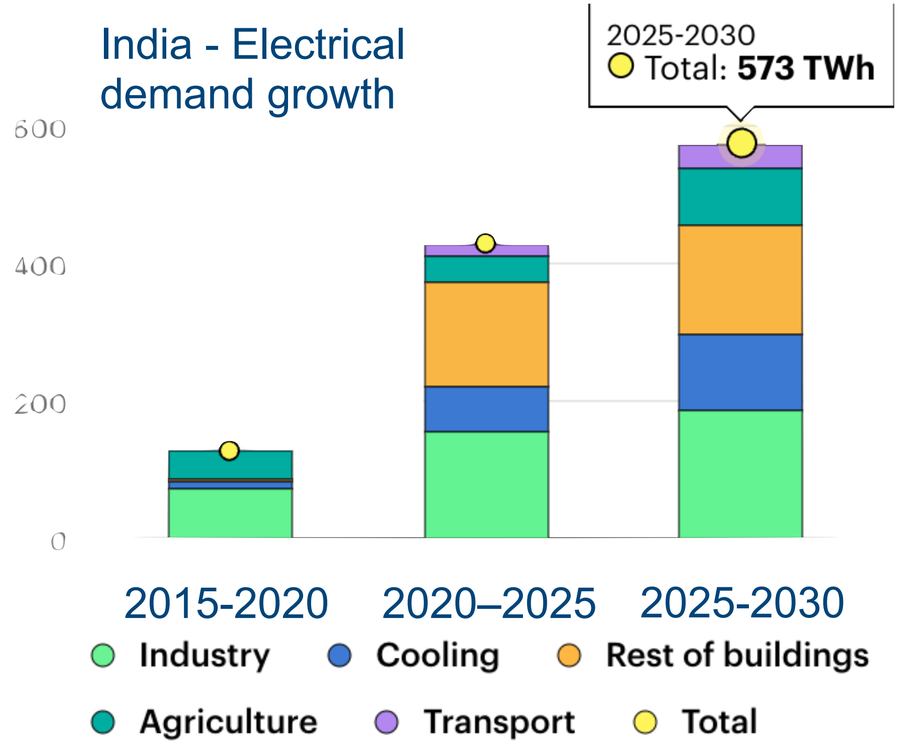
https://www.bakerinstitute.org/research/iberian-peninsula-blackout-causes-consequences-and-challenges-ahead

https://en.wikipedia.org/wiki/List_of_major_power_outages

International Energy Agency (IEA, 2026)

- "all electric" Electrical energy demand is 2.5 times other energy demand
- ~3.6% el. energy growth/year 2026-2030





IEA (2026), *Electricity 2026*, IEA, Paris https://www.iea.org/reports/electricity-2026 ,

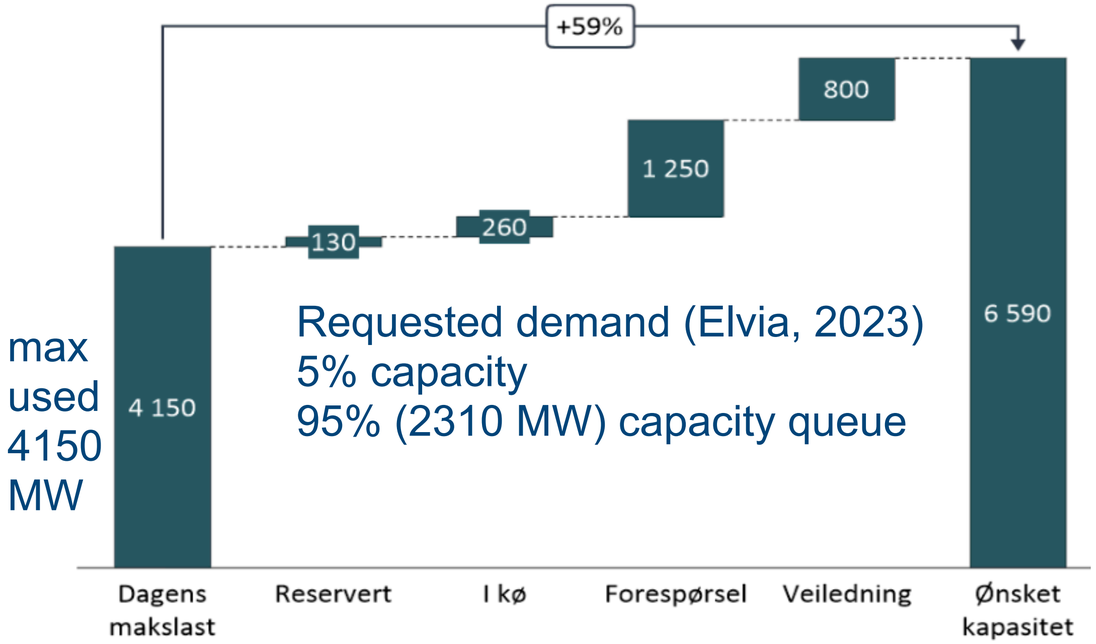
Limited Grid-capacity

[SSB, http://ssb.no/stabank/table/10314/]

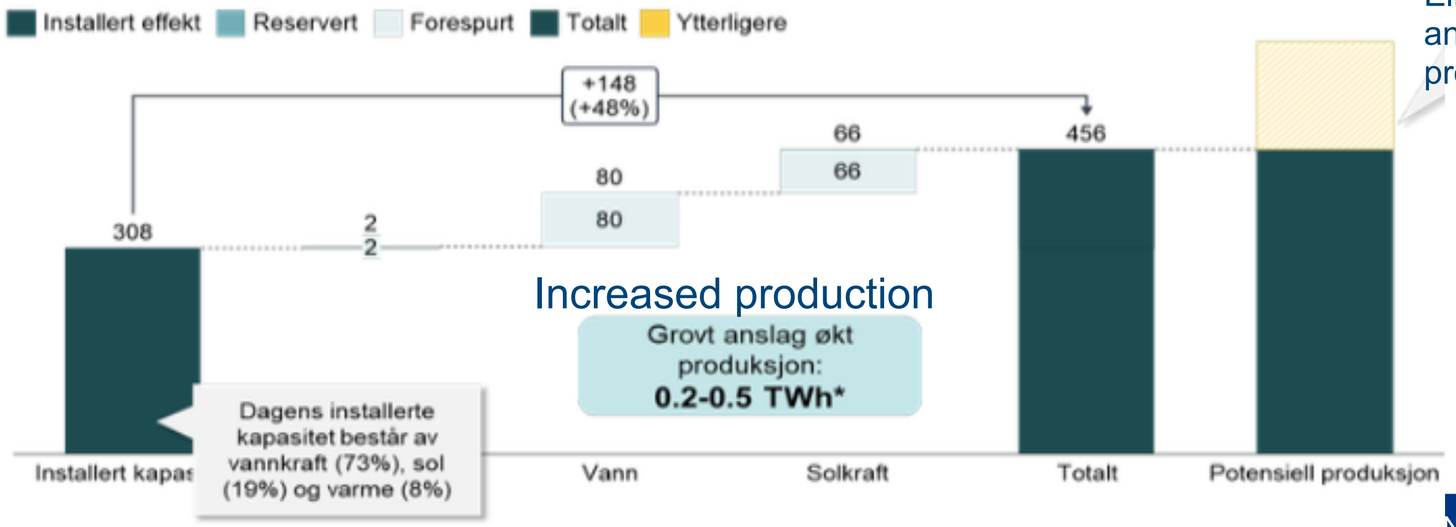
- "No capacity for new usage in Oslo, Østfold and Akershus until 2030-2035"

[Kraftløftet Oslo Akershus, LO & NHO, 2023]

- Green business development?



51% requested capacity increase



Eliva: 1180 MW and other future production