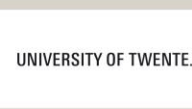


ICT on Energy Transition

Dr. Tarek Alskaif

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Background

- PhD (2016), Statistical Analysis of Networks and Systems, Computer Architecture, Universitat Politècnica de Catalunya, Barcelona, Spain
- Postdoc of Smart Energy Systems, Copernicus Institute of Sustainable Development (2016-2020), Utrecht University
- Assistant Professor of Energy Informatics (2020-present), Information Technology Group, Wageningen University
- Research:
 - Energy Informatics (AI, data science, emerging ICT)
 - Sustainable energy transition



Aging Infrastructure



Edison: light bulbs
Tesla: AC system



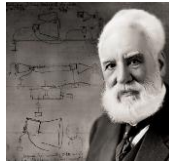
1888

Natural monopolies
Single commodities
Grew rapidly in the 2 world wars

1876



Bell: telephone



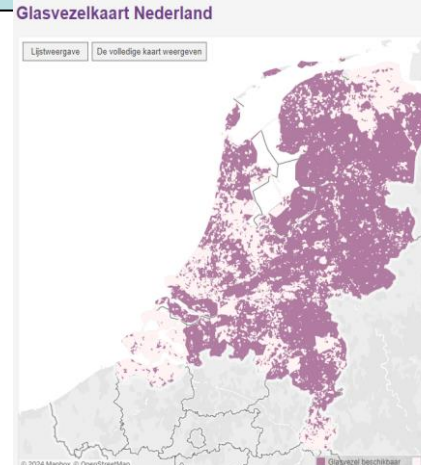
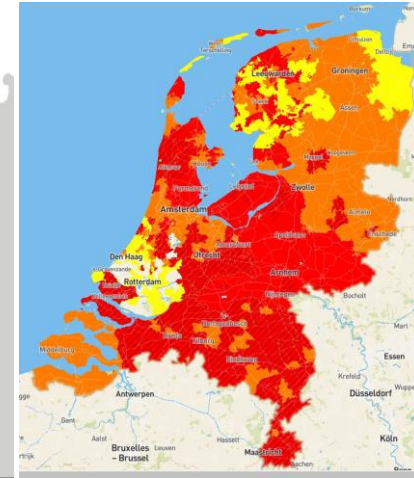
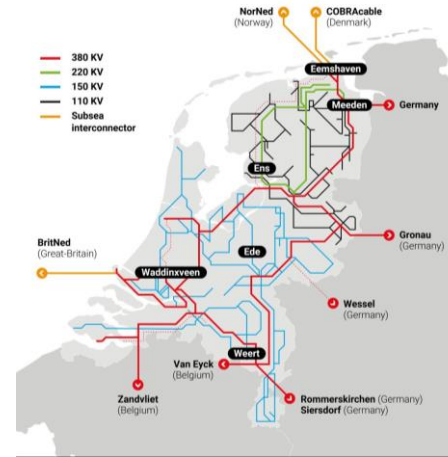
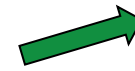
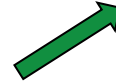
Deregulation started

1980-90s

1980-90s

Deregulation started

1969:
ARPAnet
(Internet)



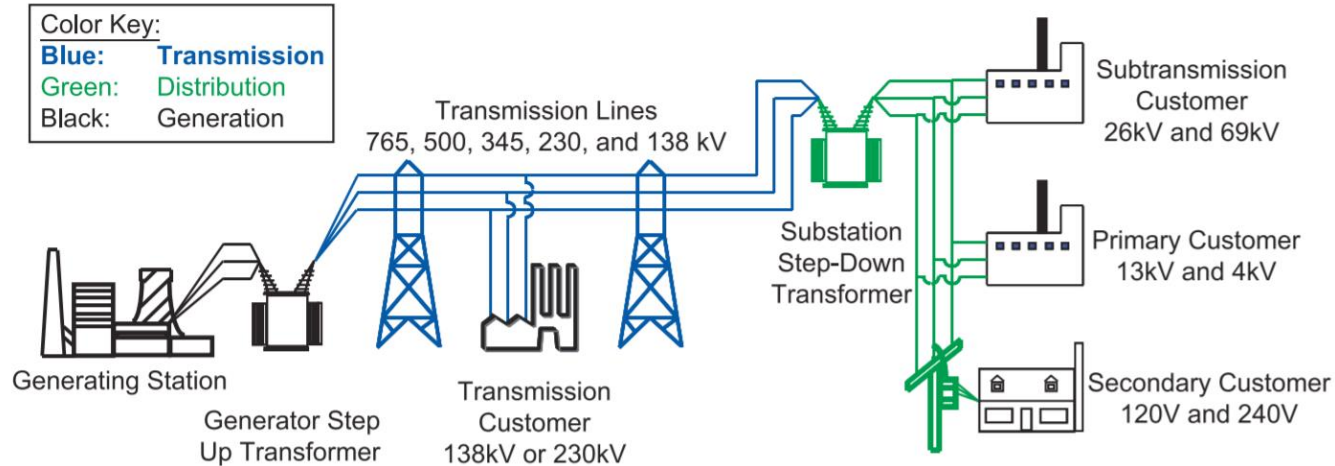
Mobile	Landline	Internet
22.22 million mobile connections	4.26 million landline telephone connections	3.32 million on cable 2.64 million on fiber optic 1.86 million on copper
540 million (GB) mobile data usage	1.21 billion minutes on landline	81,7% has fast internet with 100 Mbps and higher

ACM Telecomonitor

- power outage cost is tremendous
- inadequate system understanding
- prompted Europe to invest billions of Euros for energy

Aging Infrastructure

"Most significant engineering achievement of 20th century" [NAE Report 10]



Source: "Final Report on the Aug. 14, 2003 Blackout in the US and Canada," Apr. 2004.

- 99.97% reliable, but power outages cost billion of euros/year
- environmental concerns
- end-user engagement

A smart grid is

- An effort of advanced infrastructure and information and communication technologies (ICT) to enhance the current power network*



controllable



resilient



efficient



self-restoring



sustainable



monitoring and awareness



green



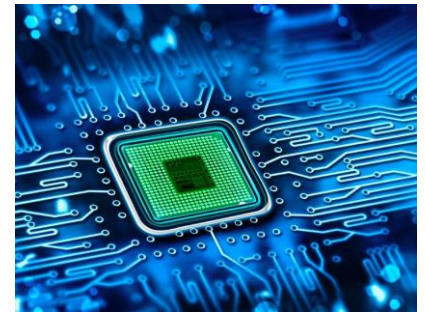
participation



Electric vehicles



distributed generation



Computation and power electronics

Learning, optimization, resource allocation and coordinated decision making



ADVANCED COMMUNICATION NETWORKS

shutterstock.com · 2297865915



Battery storage and heatpumps



Smart metering/sensing

Communication networks

Power system transformation

- Power system is being transformed to a huge network of assets (typically interconnected)
- Power system changing from a central, vertical architecture into a much more decentralized layered-structure architecture

What is driving power network transformation?

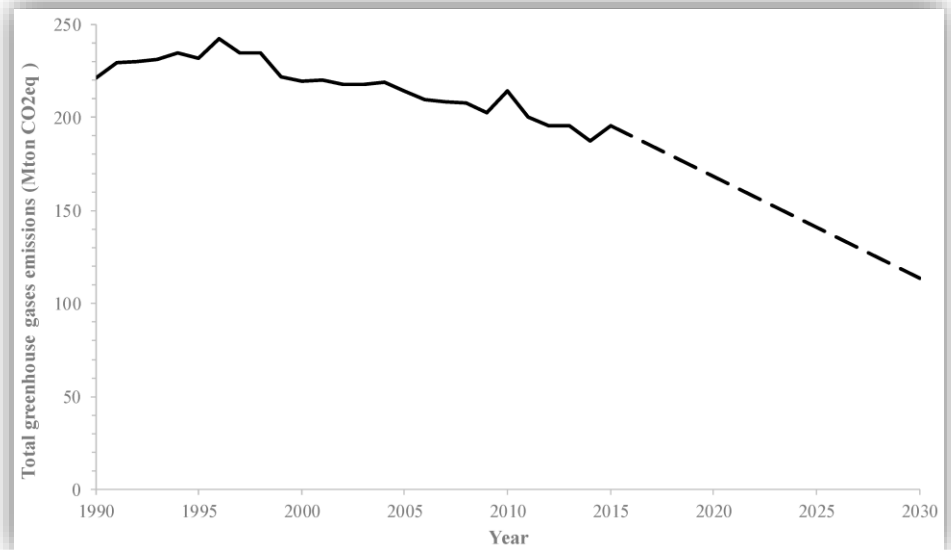
Motivation

Climate change?



Policies

- Paris agreements (global)
- Green Deal (EU)
- Klimaatakkoord (national)



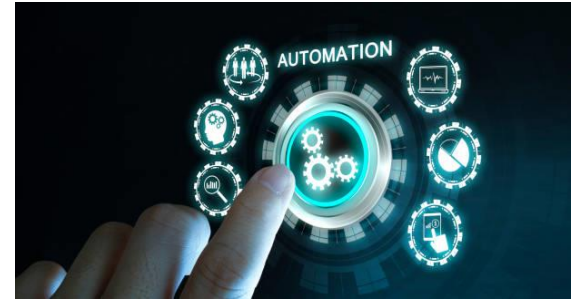
Dutch greenhouse gas emissions: 1990–2015 and 2030 target

Motivation

- Reducing GHG
 - replacing fossil fuels with renewable energy sources (wind and solar, sustainable heat)
 - electrification (- > increase demand, but some assets are flexible)
 - decarbonization
- There is way more renewable energy available than the world would ever need
- Challenges:
 - intermittency and unpredictability
 - non-dispatchable (- > flexibility at the demand side?)
 - engagement of the demand side
 - investments and governance
- Fortunately, these are problems we can solve as scientists and engineers

Where and how ICT can play a role in enabling the energy transition?

Automation



Source: iStock

- ICT to automate various processes within the energy network
 - automated monitoring and control of power generation, distribution, and consumption
 - predictive maintenance and fault detection
- Improve efficiency, reliability, and resilience of the energy network

Flexibility

- Ability to quickly adapt to changes in supply and demand (and fluctuations in renewable energy generation)
- ICT enables flexibility by providing the technologies and analytics
 - energy demand/supply forecasting
 - EV smart charging
 - energy storage management and microgrids
 - demand response and local flexibility markets
- Grid reinforcement, shortage of staff & material



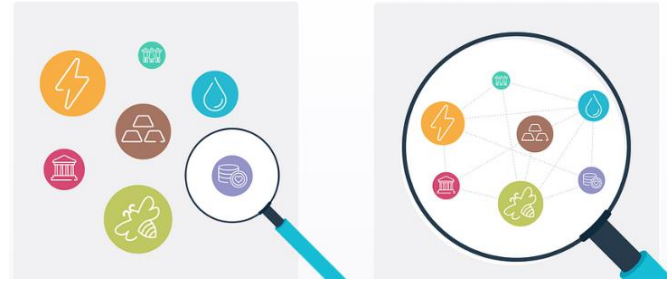
NOS Nieuws • Donderdag 9 maart, 08:48

Knipperende lampen of zelfs uitval: Alliander waarschuwt voor vol stroomnet



[Link](#)

System thinking



Source: Metabolic.nl

- Holistic approach to designing and managing energy systems
- Consider diverse stakeholders and components, requirements and constraints
- ICT provides tools for modeling, simulation, optimization, and decision support
 - enables the design of complex interconnected energy systems

Summary

- Power system transformation to a large network of (interconnected) assets
- Energy transition: an urgent, serious and complex problem of different dimensions and many actors involved
 - Require collaboration across all disciplines
- ICT are key in enabling this transformation
 - Automation, flexibility and system thinking

Thank you