

Current and Future energy systems

Future Energy Systems

- Sustainable ("green") energy
- Huge amounts of (small) generators and 'intensive' devices
 - Solar panels, wind turbines
 - Electric cars, heat pumps, data centers
 - Heat, cold, storage
- Use plenty of energy *when* there is plenty of energy
 - Flexibility of users



Energy consumption and production

- Solar and wind (volatile production)
- Flexible consumption in time and space
 - E-vehicle charging
 - Supermarket cooling, home heating
 - Data centers
- Integrated energy systems
 - Electricity, hydrogen, heat







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- Solar and wind (volatile production)
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- Integrated energy systems
 - Electricity, hydrogen H2, heat
- Infra-structure usage
 - Can be overloaded
 - Management & expansion
- Maintenance needed
 Old(er) systems
- Users to be supported







NLAIC: AI as an Accelerator of the Energy Transition Opportunities for a carbon-free energy system

Importance of AI for future energy systems (1)

- Support for strategic decision-makers
 - Electricity network expansion planning, scenario simulation, data analysis
- Management, operations and control of energy networks



- Operations and control, congestion management, power flows, forecasting, sensing and data processing
- Managing supply, demand, and flexibility in energy systems
 - Decentralised markets, congestion management, forecasting, incentivizing

NLAIC: AI as an Accelerator of the Energy Transition Opportunities for a carbon-free energy system

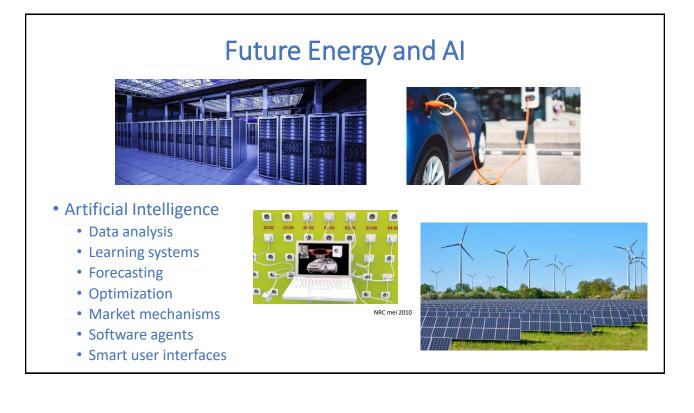
Importance of AI for future energy systems (2)

• Supporting users in the energy system

- Automated user support for local production and consumption, automated bidding in markets, participation in cooperatives, HCI
- Maintenance
 - · Forecasting and scheduling in maintenance management of assets

and

- Energy-efficient AI
 - AI that is (co) optimised for using less energy





Al Opportunities and Needs for Energy Systems

- We do have several available tools and results in AI
 - Forecasting, optimization, (deep) learning techniques, agents
 - General techniques
 - Several dedicated approaches for AI in energy systems
- We don't have all the required (AI) technologies or best practices yet
 - For a stable and reliable energy system, efficiently used
 - Everywhere and always
 - Challenges: practical or fundamental
- All the topics need (further) research on AI in energy systems
 - For good/better/best practical application in energy systems
 - Every little last detail counts, especially for electricity systems
- We do have roadmaps and ideas how to get to a sustainable energy system
 Many activities and results in research, development and deployment
- We *will* get in the future e.g.
 - Nearby expected results (e.g. improved t-prognoses, 1-4 year)
 - · Longer-term expected results (e.g. decentralized market solutions, 4-8 years)



Decentralized Energy Markets and Flexibility

- Automated market mechanisms
 - For the many users in the energy system
 - Decentralized markets for supply/demand
 - Congestion markets and mechanisms
 - 1-to-1 contracting (P2P)



Stascade, ADREM, HaPSISH, SES-BE, .. projects

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• Al-techniques and approaches

- Market mechanism design (it does what you want, emergence, part of AI)
- Software agents (software acting on behalf of users)
- Learning techniques (learn the markets, the user(s) and, environment)
- Simulation (experience market behaviour)

Stascade, ADREM, HaPSISH, SES-BE, .. projects

Decentralized Energy Markets and Flexibility

• Aspects

- Incentivize flexibility
- Handling uncertainty and risks
- Service level agreements (SLAs, P2P)
- Fairness by design
- Multiple energy carriers (electricity, hydrogen H2, heat,..): system integration



Stascade, ADREM, HaPSISH, SES-BE, .. projects

Optimal Use of Electricity Networks

- Optimal usage of the capacity of the transmission (HV) network
- T-prognoses: expected supply/demand of electricity to be transported
 - Better t-prognoses increase the available network capacity

• Al techniques for forecasting

- At connection points of transmission network
- Research on improvement; diversity of fuels, reactive power, dynamic pricing, ...
- For DSOs and big actors,...



AIFES PoC project

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- Reduce bottlenecks in the network: currently urgent
 - Companies have to wait 8-10 years for connections...
- Proof-of-Concept project at NLAIC/AINED: AIFES

AIFES PoC project

AI and ICT Themselves..

• Al uses energy itself

- More AI demands more energy
- Learning techniques that are energy efficient
 - Spiking neural networks
- Al can reduce energy usage elsewhere



Data centres and energy

- Energy-efficient computation and data handling by AI
- Providing energy flexibility in time or place
- Dynamic pricing for carrying out computing/data tasks



