Accelerating Energy Transition to Green Electricity through Artificial Intelligence

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Part 1

Challenges in transition to green electricity

Goals of Germany's energy transition

2020

40% less greenhouse gas emissions

2022

Shutdown of the last nuclear power plants

2025

40-45 % share of renewable energies in electricity consumption

2050

50% less primary energy consumption

Electricity mix first semester 2020

Proportion of
green electricity: **57%**

Electricity price in Germany

Electricity price development in Germany

Challenges in adoption of green electricity

Requirements for a functioning energy transition

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How to enable and accelerate energy transition?

Part 2

Digitalization in energy transition

Digitalization dimension

Methods

- Internet of Things
- Artificial intelligence
- Big data computing
- Digital twin
- Blockchain

Applications

- Data analysis
- Operation and regulation
- Automation

Data storage and processing

- Local (edge computing)
- Centralized (cloud computing)
- Mixed

Application fields

- Energy industry
 - Generation
 - Network
 - Consumption
- System component in manufacturing

Cross sectoral digitalization of energy transition

Standardization
for cross-sector digitalization of energy transition

Cluster 1

**Smart Metering/
Sub Metering**

Flexible tarif,
multidisciplinary
measurements

Cluster 2

Smart Grid

Feed-in, load,
and energy
management

Smart Mobility

Charging station
infrastructure,
charging
management

Cluster 3

**Smart Home/
Building**

Housing
management

Smart Services

Assisted living,
Value added services

Secure SMGW communication platform for different application sectors

Smart Meter: the required digitalization infrastructure

Image: discovery.com

Image: devolo

Energy management system using smart meter

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**How to make consumers
take part in energy
transition ?**

Part 3

Demand response and dynamic price

Demand Response

“**Demand Response** is **changes in electric usage** by **end-use customers** from their normal consumption patterns in **response to changes in the price of electricity** over time, or to **incentive payments** designed to induce lower electricity use”

(Federal Energy Regulatory Commission)

Why Demand Response?

- The goal of **Demand Response** is to shift the peak demand (**red**) to the peak time of availability of renewable energies (**yellow**).
- The power consumption is shifted from **red** to **green**, (**green**) shows the decrease of energy waste.

DR has the potential to access **160 GW** of flexible capacity by **2030**. This reduces energy supply costs by up to **50 billion euros**.

The transformation of generation-consumption relationships

Automated demand response

Time variable electricity tarif

a lot of wind

a lot of available electricity

cheaper electricity

Dynamic price implementations in different countries

Image: fsr.eui.eu

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**How to implement DR
and what are the roles of
artificial intelligence?**

Part 4

The roles of data analytics in demand response

Project concept

Solution approach

Green electricity index

<https://corrently.de/l/gruenstromindex.html?plz=2875>

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Forecast of green electricity generation

Deep Neural Network (DNN)

Wind

Solar

Long Short Term Memory (LSTM)

Forecast of green electricity generation

Convolutional neural network

Wind

Solar

CNN-LSTM-DNN Hybrid

ANN Model Evaluation

ANN Model	MSE (Short-term forecast)	MSE (Long-term forecast)
DNN	<ul style="list-style-type: none">▪ Wind : 24e3▪ Solar : 58e2	<ul style="list-style-type: none">▪ Wind : 50e8▪ Solar : 78e7
LSTM	<ul style="list-style-type: none">▪ Wind : 17e4▪ Solar : 46e6	<ul style="list-style-type: none">▪ Wind : 71e9▪ Solar : 48e12
CNN	<ul style="list-style-type: none">▪ Wind : 18e4▪ Solar : 11e3	<ul style="list-style-type: none">▪ Wind : 73e9▪ Solar : 83e8
CNN-LSTM-DNN Hybrid	<ul style="list-style-type: none">▪ Wind : 10e3▪ Solar : 12e3	<ul style="list-style-type: none">▪ Wind : 46e8▪ Solar : 15e8

**How to utilize data to
enable energy transition
on a larger scope?**

Part 5

The roles of data management in smart energy systems of smart cities

Cambridge, UK

Seville, Spain

Lizzanello, Italy

DAREED: Smart energy platform

A platform for main actors of energy management in cities and communities

Citizen

Policy maker

Energy provider
and related industry

Platform = Data sharing + Integrated GUI and Single Sign-on + continuous/integrated process + individualized applications

Continuous data flow in the platform

DAREED applications

City monitoring

Energy Performance Tool (EPT)

Awareness Tool

RES Introduction Simulation

Energy Tariff Simulation

Marketplace

Thank You!

Do you have any questions?

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