Energy Storage Systems for Industrial Production

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Fraunhofer Institute for Machine Tools and Forming Technology IWU
Germany
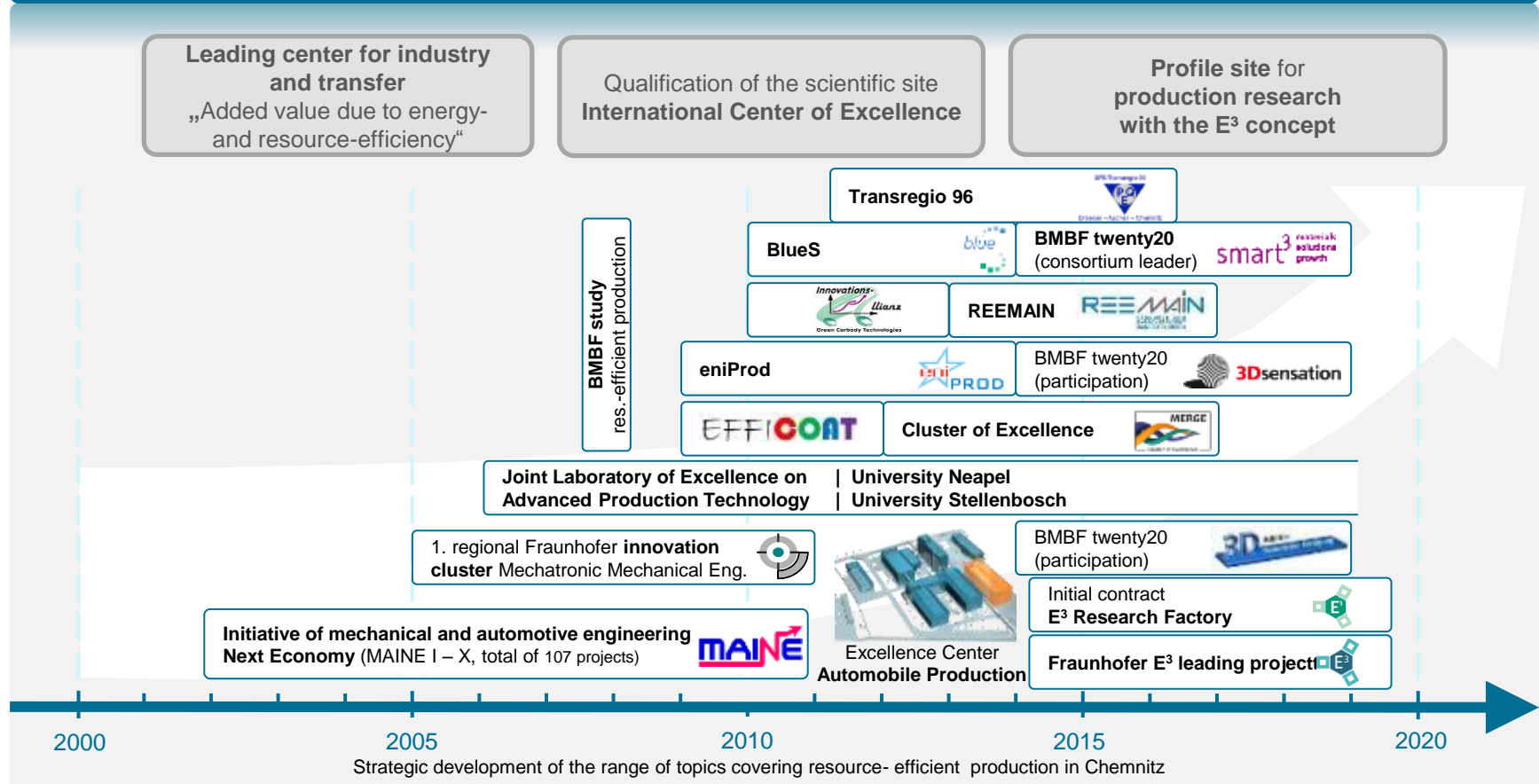
HPC 2016
7th CIRP Conference on
High Performance Cutting

ICMC 2016
International Chemnitz
Manufacturing Colloquium

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Fraunhofer IWU Strategy "Resource-Efficient Production"
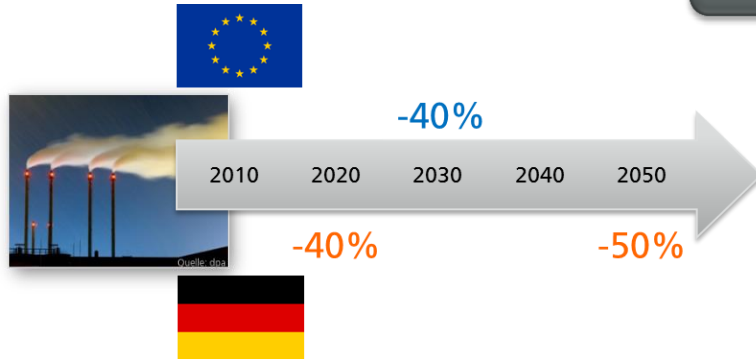## Initiatives and Large Projects

Development of the IWU locations Chemnitz-Dresden-Augsburg-Zittau

Center of Excellence "Energy- and Resource-Efficiency in Production"

Leading center for industry and transfer
„Added value due to energy- and resource-efficiency"

Qualification of the scientific site **International Center of Excellence**

Profile site for **production research with the E³ concept**

BMBF study res.-efficient production

Transregio 96

BlueS

BMBF twenty20 (consortium leader)

smart³ materials solutions growth

Innovations-allianz Green Carbody Technologies

REEMAIN

REEMAIN

eniProd

PROD

BMBF twenty20 (participation)

3Dsensation

EFFICOAT

Cluster of Excellence

MERGE

Joint Laboratory of Excellence on Advanced Production Technology | **University Neapel** | **University Stellenbosch**

1. regional Fraunhofer **innovation cluster** Mechatronic Mechanical Eng.

BMBF twenty20 (participation)

3D

Initiative of mechanical and automotive engineering Next Economy (MAINE I – X, total of 107 projects)

MAINE

Excellence Center **Automobile Production**

Initial contract **E³ Research Factory**

E³

Fraunhofer E³ leading project

2000   2005   2010   2015   2020

Strategic development of the range of topics covering resource- efficient production in Chemnitz

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Motivation

Reduction of CO$_2$ emissions

-40%

2010 2020 2030 2040 2050

-40%   -50%

Quelle: dpa

Legislator

Percentage of renewable energies

2014
27.8%

2015
32.5%

extension range

50

45,0
40
40,0

Percentage of renewable energies

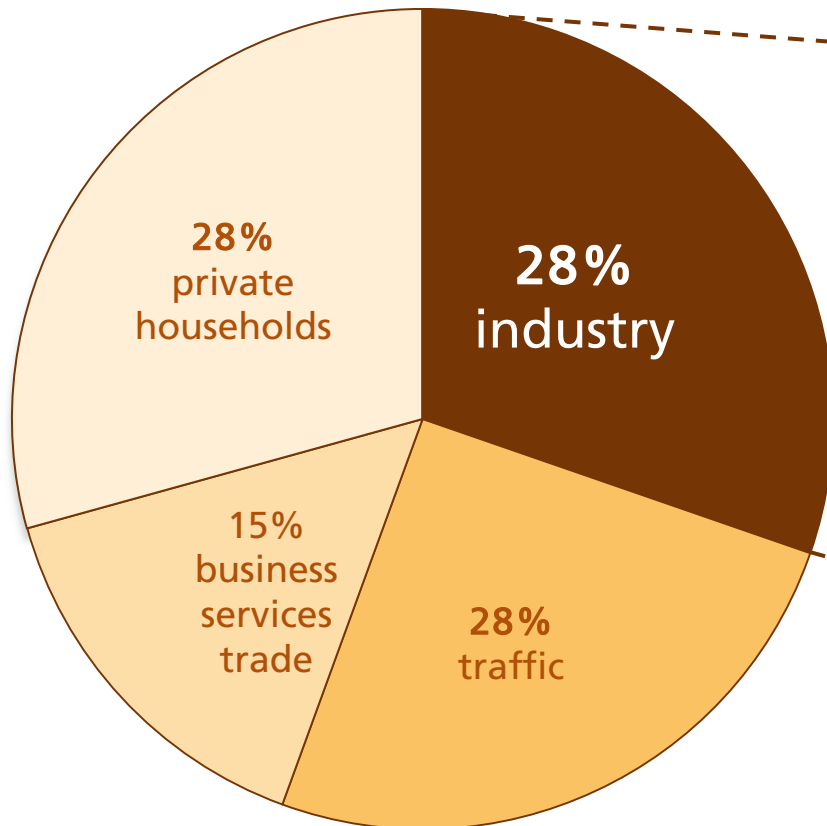25,3

30

17,0

20

10,2

10

6,2

2000   2005   2010   2015   2020   2025
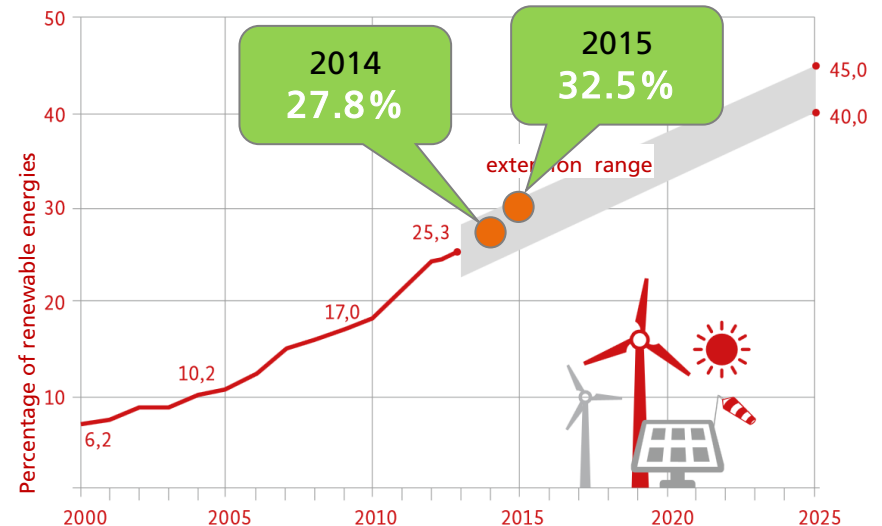
Percentage of renewable energies of gross electricity consumption until 2014 and target range until 2025
Source: ZSW nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat)

IMAGE
sustainability is a significant factor in the public image

BLUE EFFICIENCY

Green Technology **inside**

Think Blue. Factory.

Sources: Mercedes   Bosch   Volkswagen

COST

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Energy consumption in Germany assorted in ...

sectors
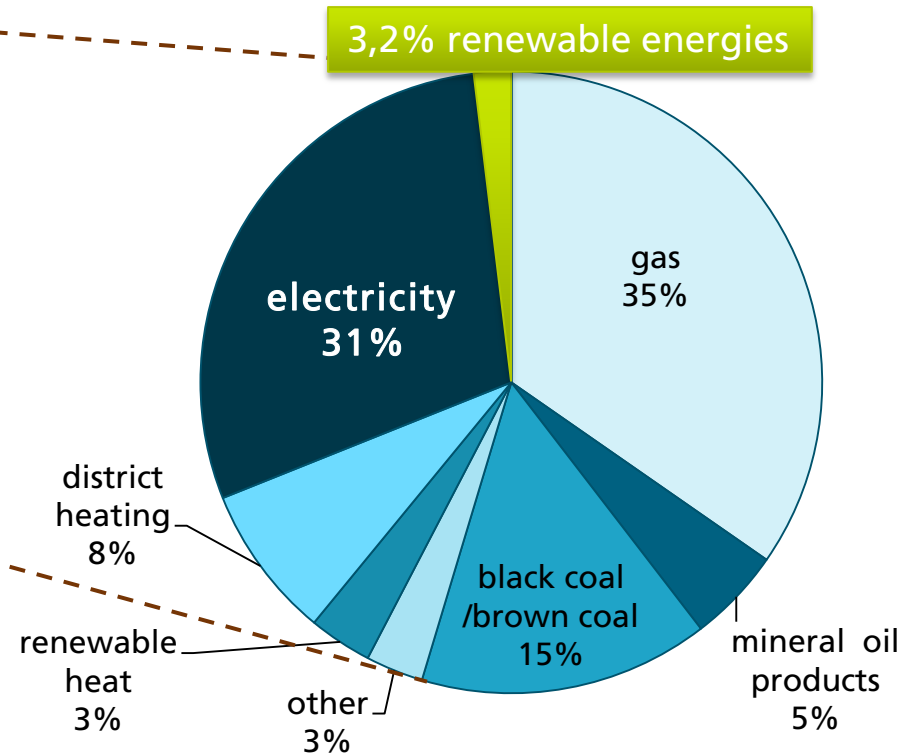
- 28% private households
- 28% industry
- 15% business services trade
- 28% traffic

energy sources

- 3,2% renewable energies
- gas 35%
- electricity 31%
- district heating 8%
- renewable heat 3%
- other 3%
- black coal /brown coal 15%
- mineral oil products 5%

4

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Energy Cost for Industry
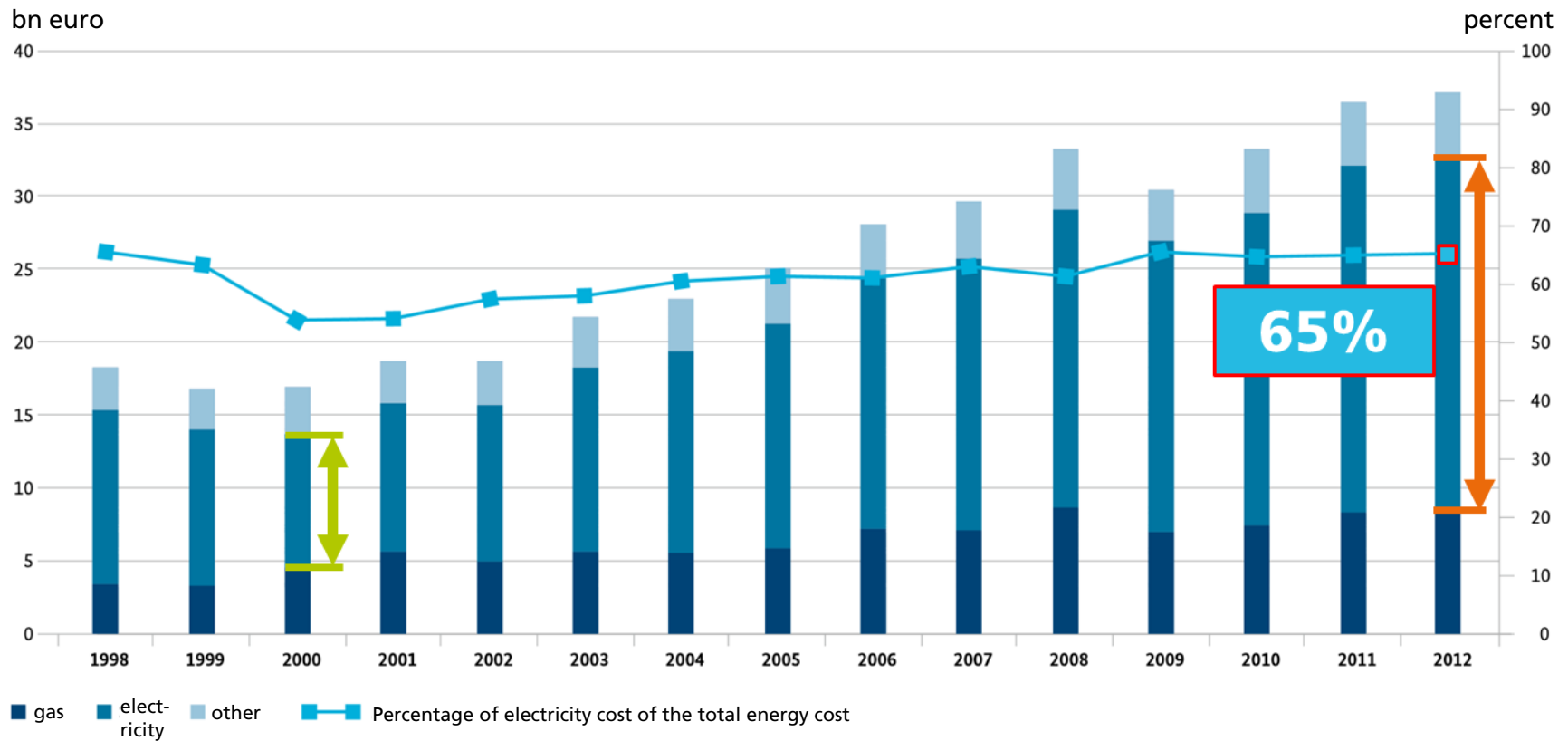
Reduction of energy requirements (or power input) at any given time does not necessarily imply a reduction of cost!

Increase in Energy Efficiency
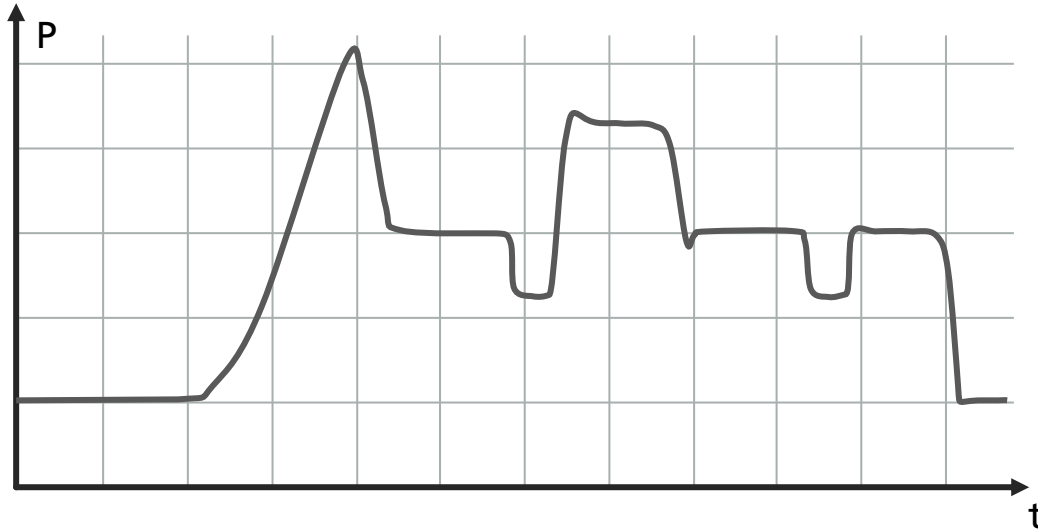
If you can't measure it, you can't manage it.

Transparency!

- Evaluating consumption
- Pointing out potentials
- Process optimization
- Predicting needs
- Creating key performance indicators (KPI)
- Managing energy flows

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Increase in Energy Efficiency

Energy requirements of production plants

- 72% drives
- IT
- light
- heating/water
- process heat
- electrolysis

9%
9%
1%
5%
4%

Transparency!

Energy efficient components

e.g. Ecodesign Directive 2009/125/EC (EU)

IE2 / IE3 Motors

Increase in efficiency of **up to 7%** (above all, in part loads)

Source: SIEMENS

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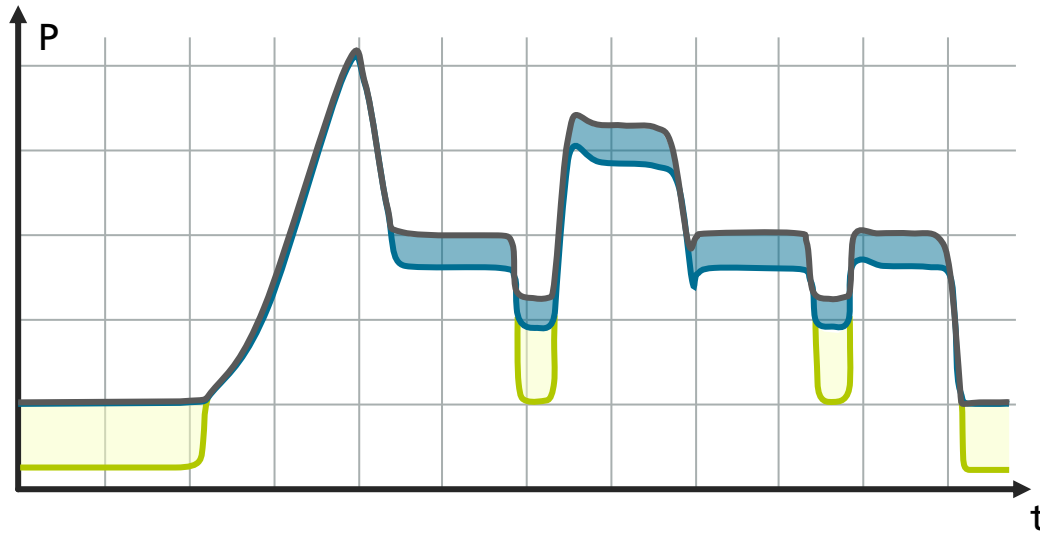
Increase in Energy Efficiency

Transparency!

Energy efficient components

Production shut down

Shutdown in
non-productive times
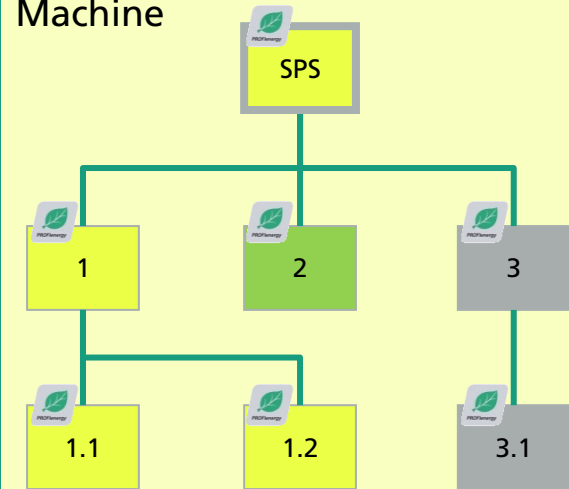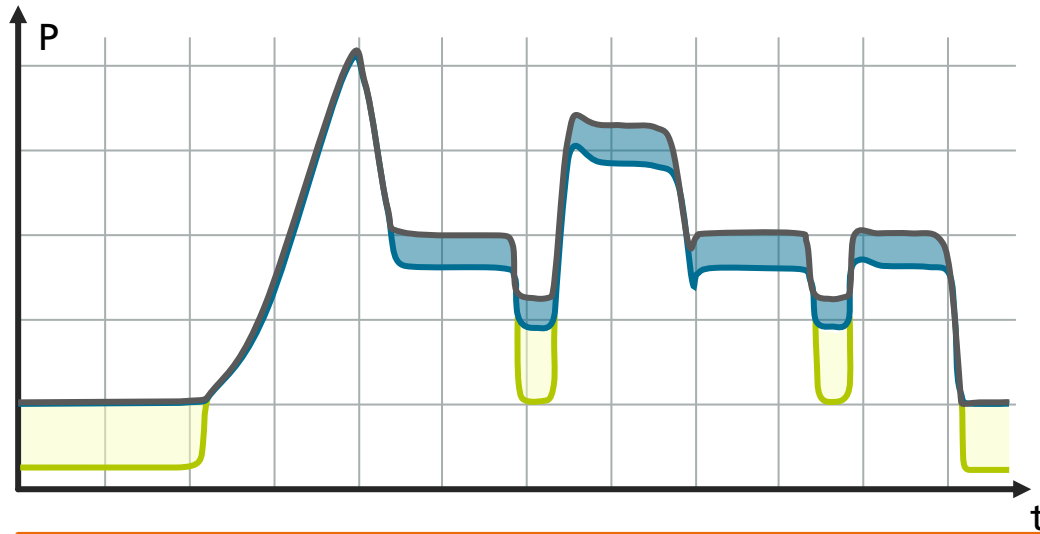
Source: KUKA

Sleep   wake on

PROFIenergy

Machine

SPS

1   2   3

1.1   1.2   3.1

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Increase in Energy Efficiency

Transparency!

Energy efficient components

Production shut down

P

t

Energy Controller

Model Simulation
switching commands

Describe
• Components
• Dependencies

Parameterization
• Energy
• Time

Automatic optimization
• Power require ments

bis zu 15%

Energy

20%

65%

■ production ■ non-productive ◩ potential
Energy / Year

MES

PLC Plant

PLC Sub Plant

Machine

Machine

SPS

SPS

1.1

1.2

2.1

1.1.1

1.1.2

2.1.1

2.1.2

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Increase in Energy Efficiency

Source: directindustry.de

Transparency!

Energy efficient components

Production shut down

Peak loads

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Increase in Energy Efficiency

Energy-optimized control of the production

- Production planning and control
- Infrastructure of manufacturing
  (air, heating, cooling, water)
- Central building control system
  (energy supplier, gas, heat, water, RE)
- **Energy storage**
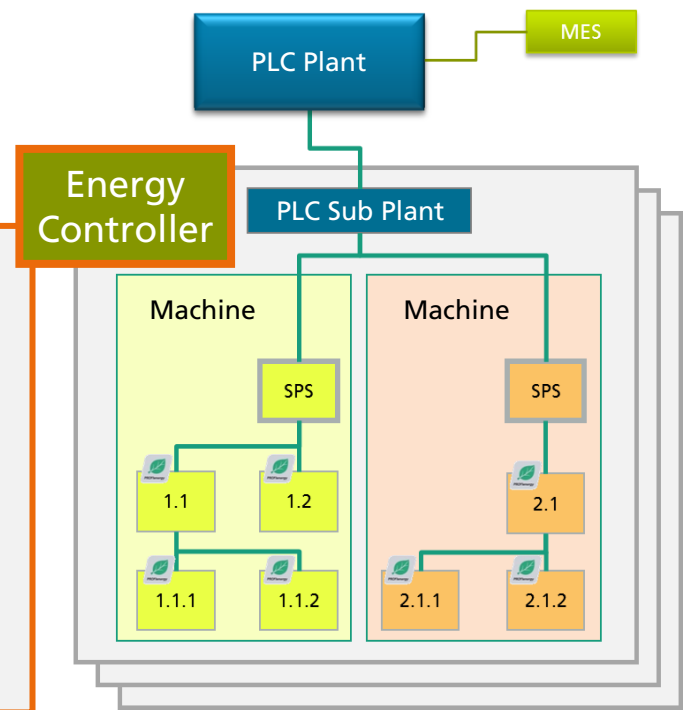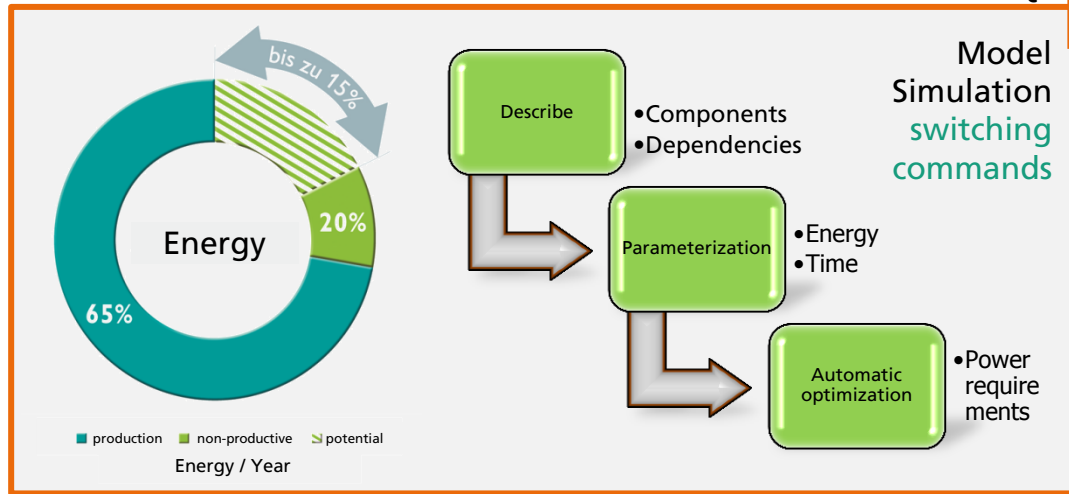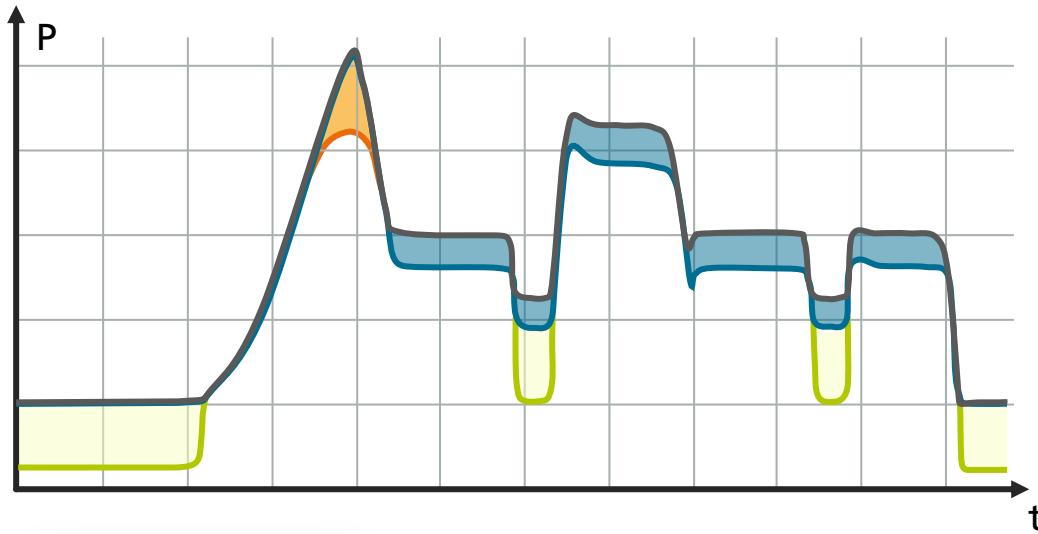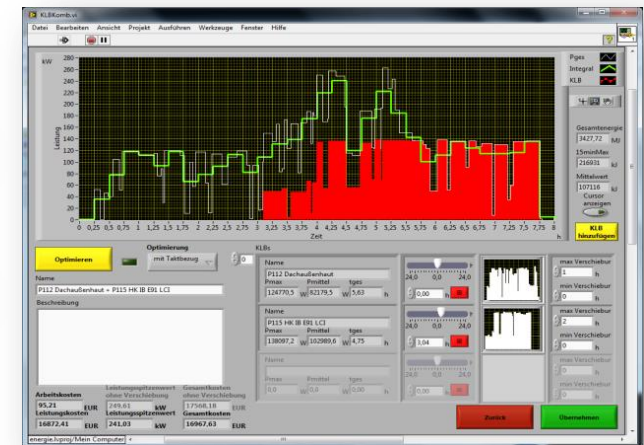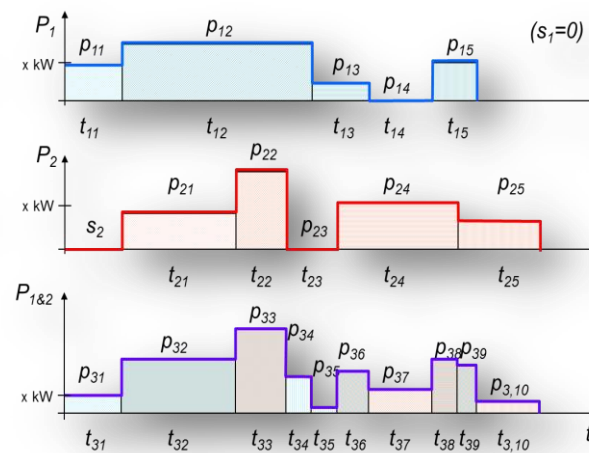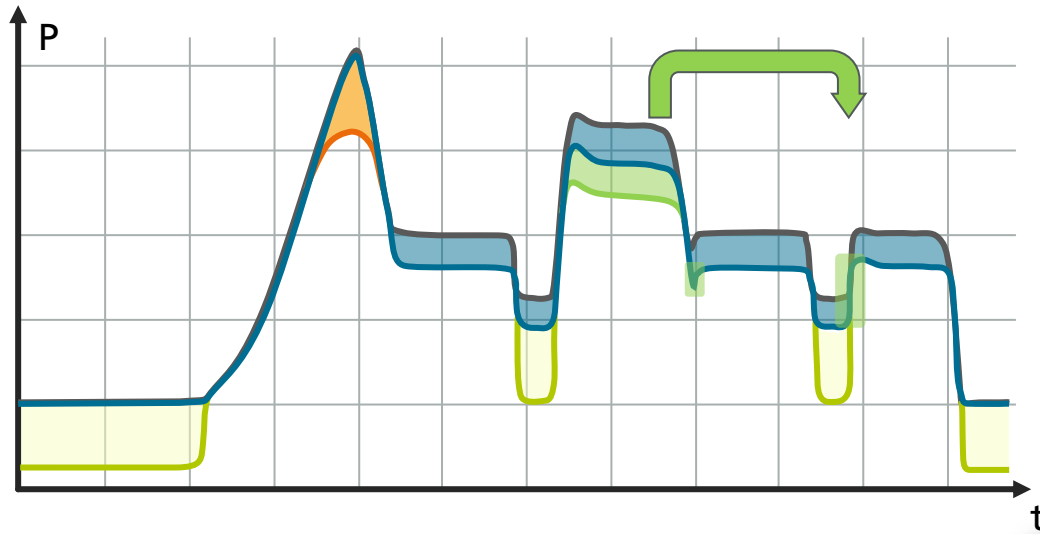
Transparency!

Energy efficient components

Production shut down

Peak loads

Energy management

Energy Storage in Production

Example 1: machining center

- 12 SuperCap MC 50F/56V
- C = 4.2 F
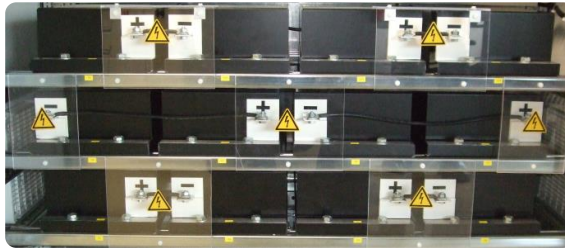
Energy storage based on EDLC

DECKEL MAHO DMP 45V linear
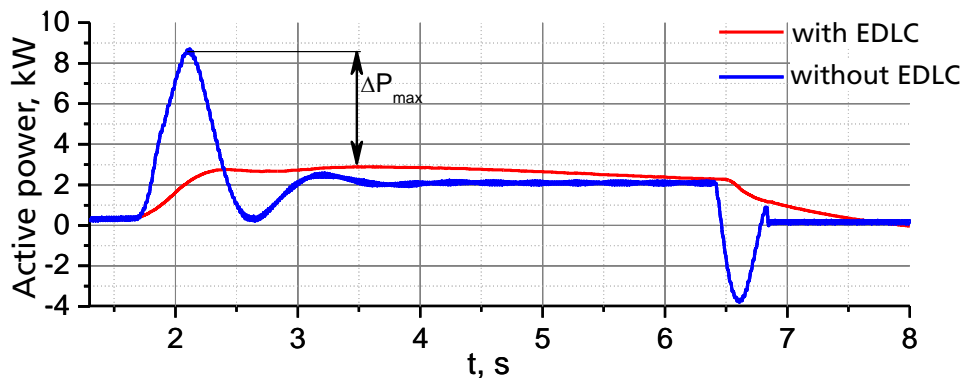
Active Line Module Sinamics S120

Reduction of peak loads approx. 67%

Energy Storage in Production

Example 2: process chain powertrain
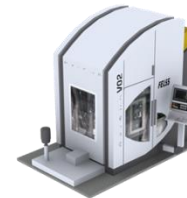

cutting and functional surfaces

Acsys Orca μ   GMX linear 250s

cold bulk metal forming and precision forming
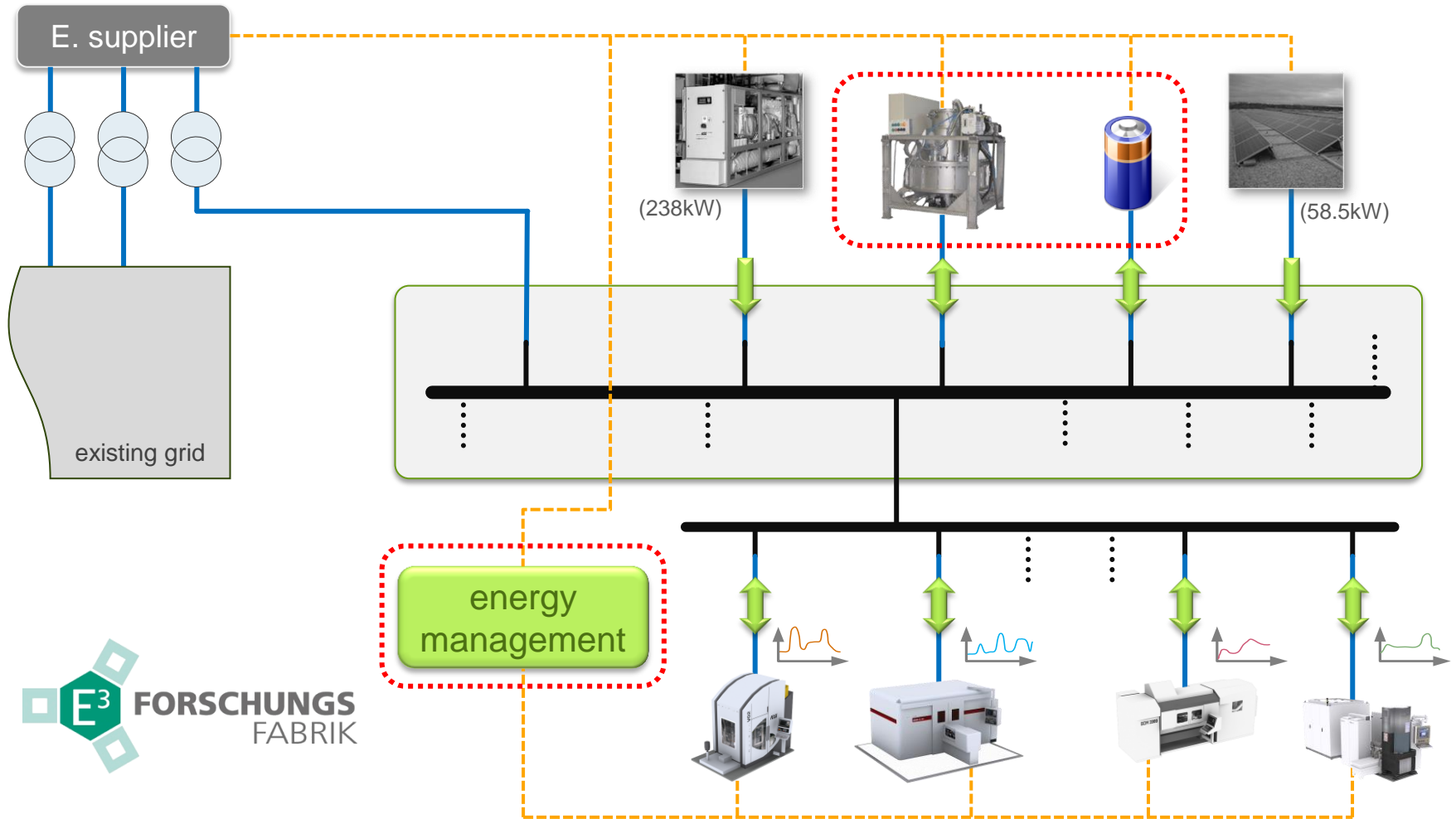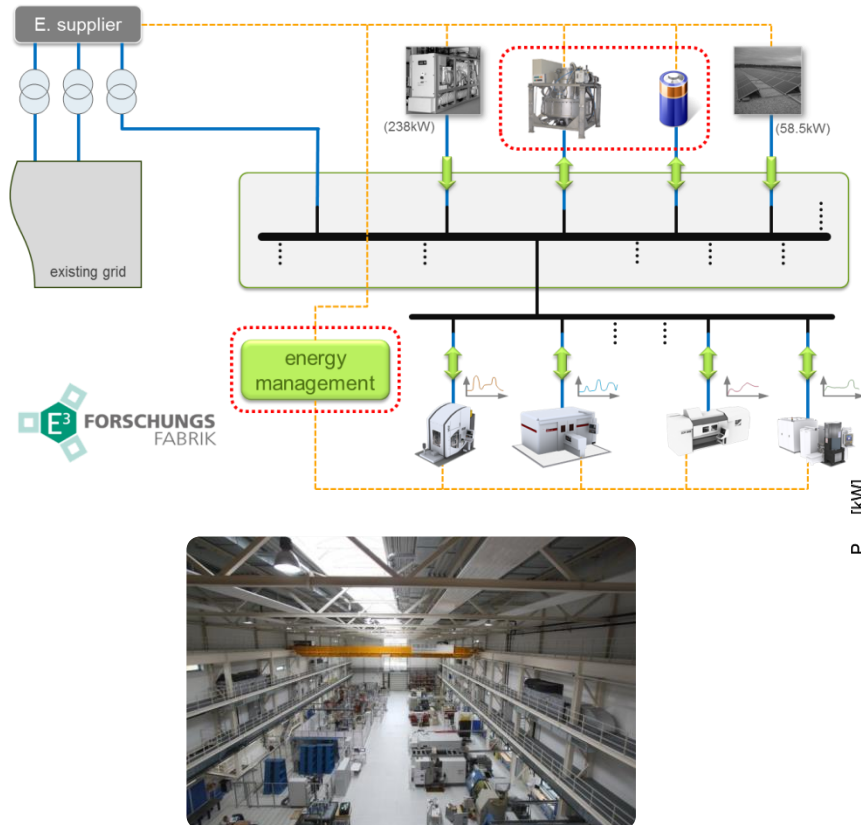

Rollex XL HP   Aximus V02   PWZ Spezial

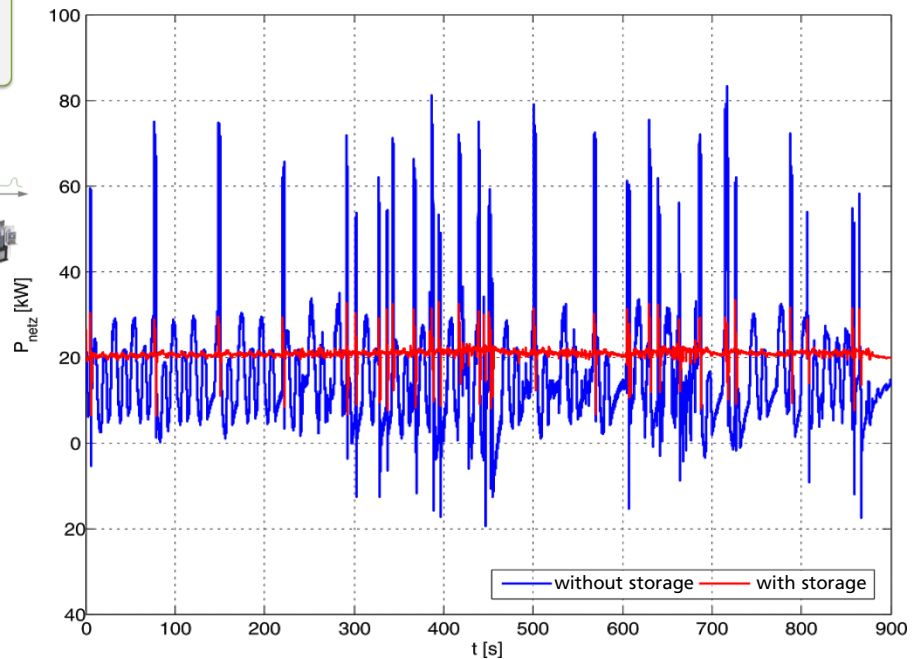# Energy Supply E³ Research Factory

Energy Storage in Production
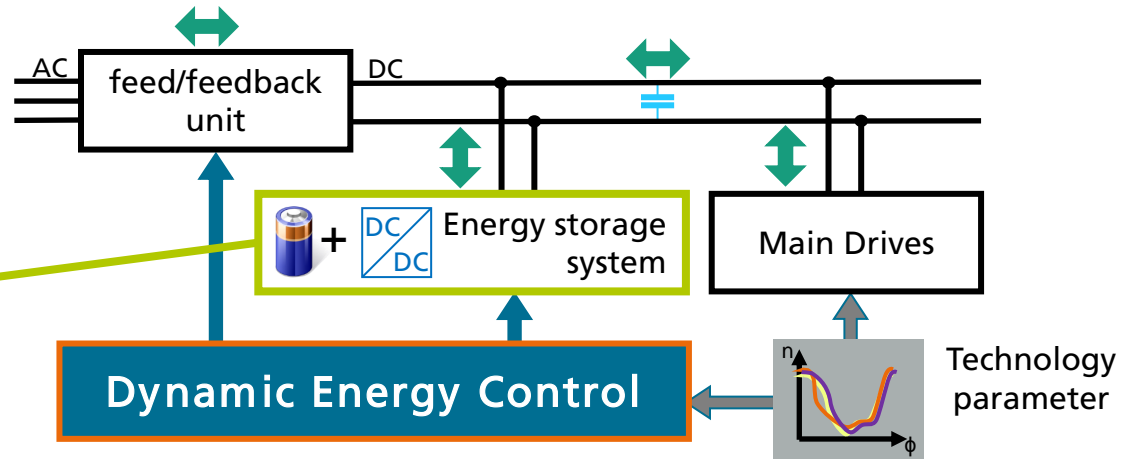
Example 2: process chain powertrain
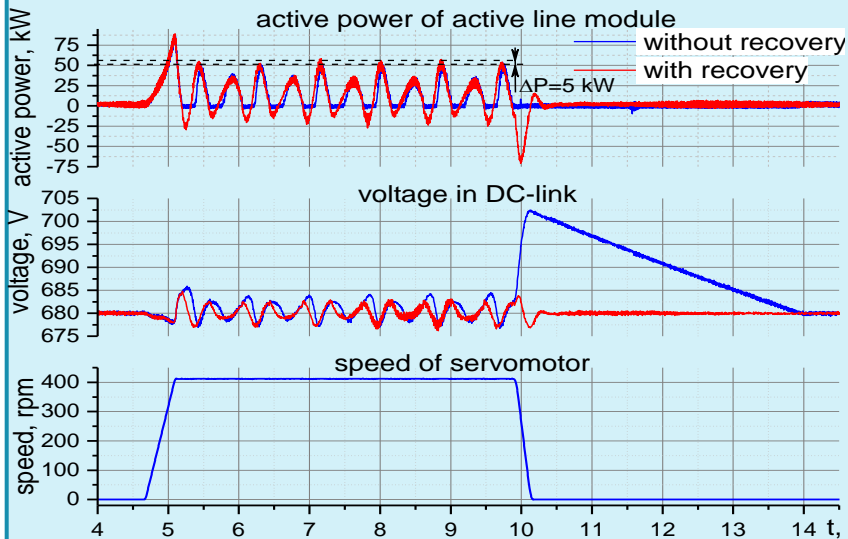

supply of electric power from the grid

Reduction of peak loads approx. 80%
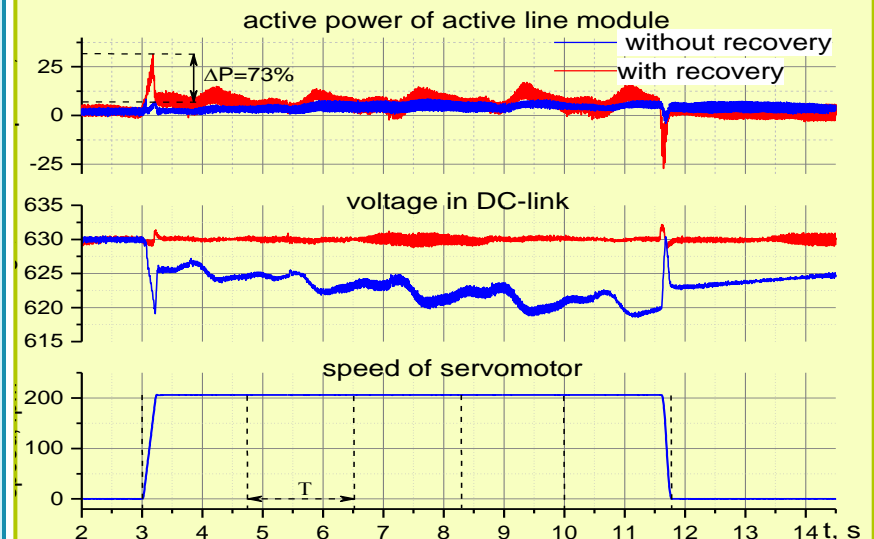
Energy Storage in Production

Example 3: servo press

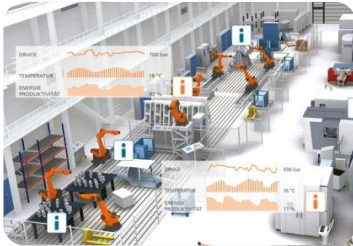# Energy Efficiency in Production – Levels
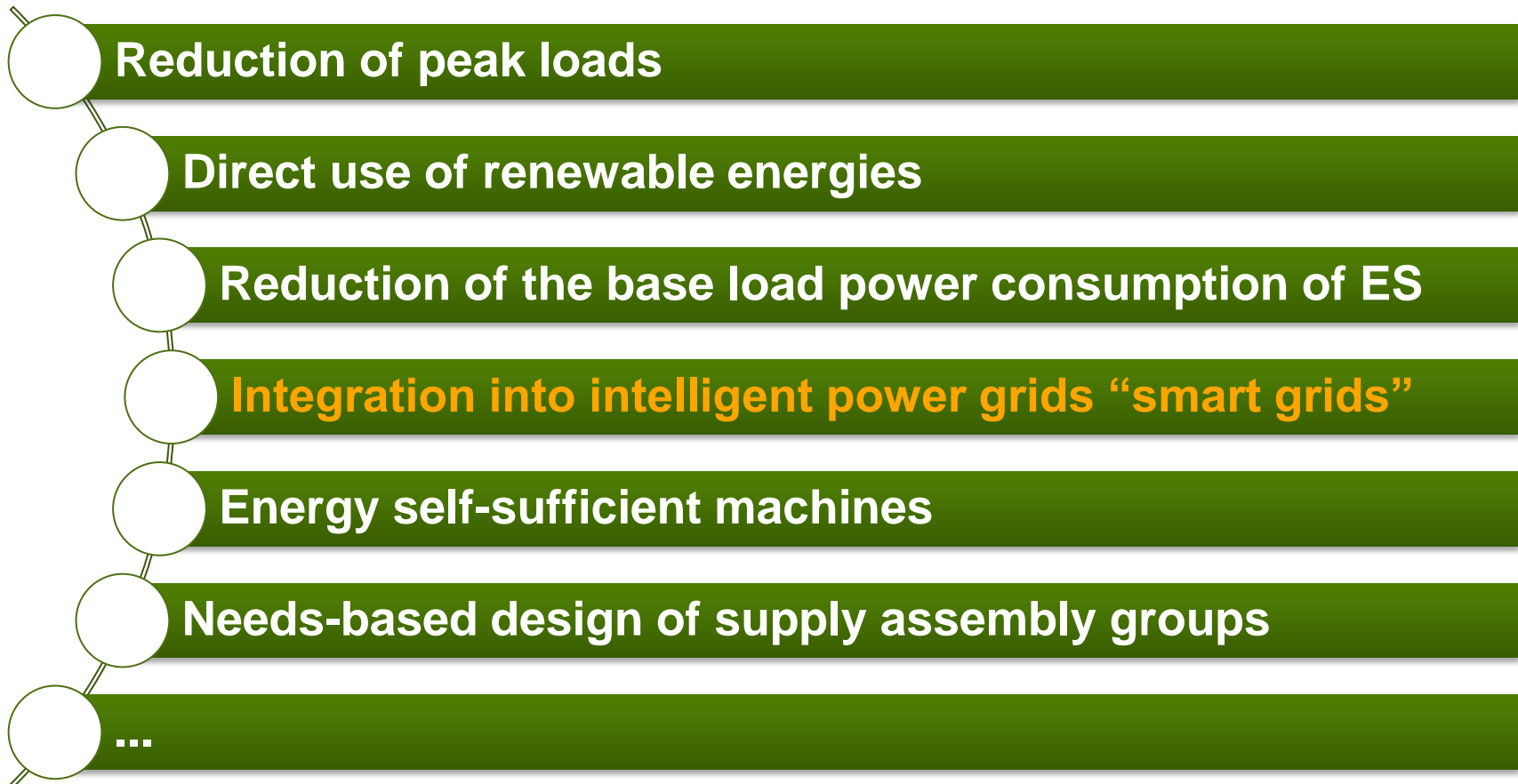

workshop

plant

machine

component

Hypothesis

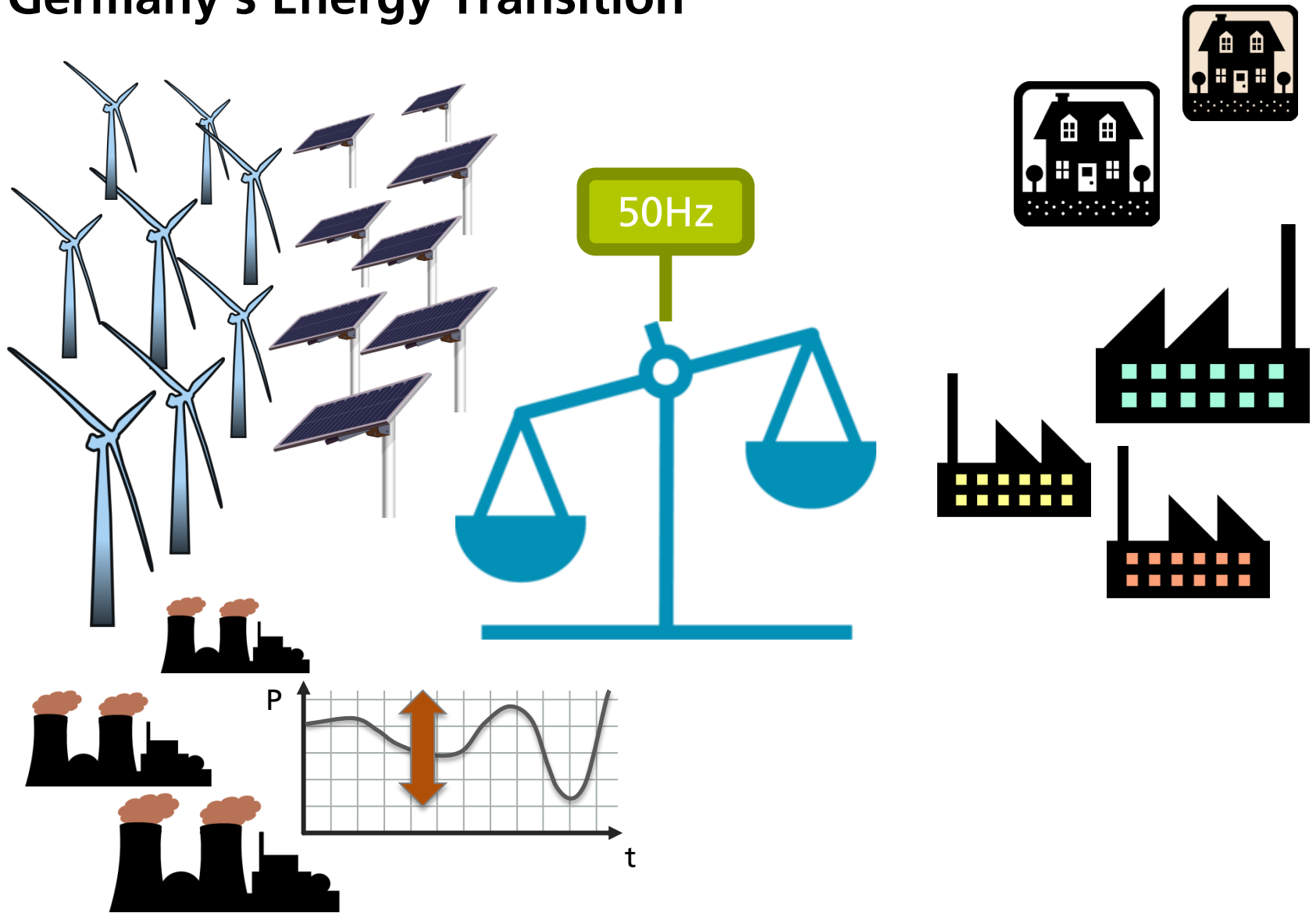**Production technology offers high potentials for the use of energy storage systems in numerous areas …**

however, it requires the consideration of specific boundary conditions.

Use of Energy Storage System in Production Technology

Objectives:

- **Reduction of peak loads**
- **Direct use of renewable energies**
- **Reduction of the base load power consumption of ES**
- **Integration into intelligent power grids "smart grids"**
- **Energy self-sufficient machines**
- **Needs-based design of supply assembly groups**
- **...**
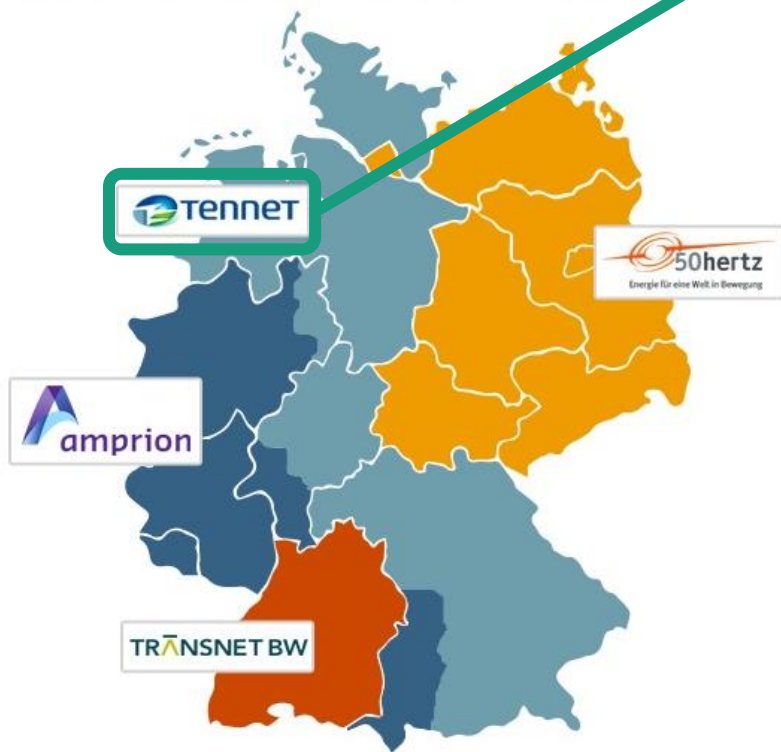
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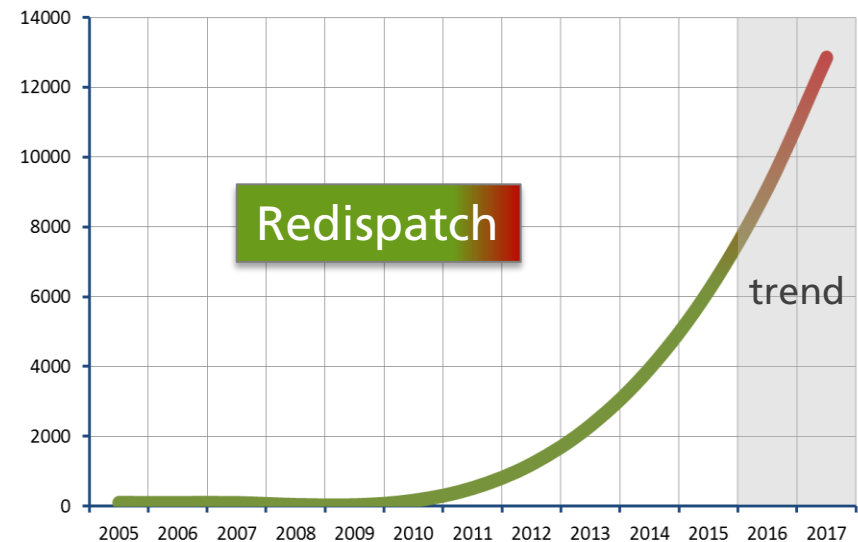
Germany's Energy Transition

50Hz

P

t

Germany's Energy Transition

Transmission System Operators for Electricity in Germany
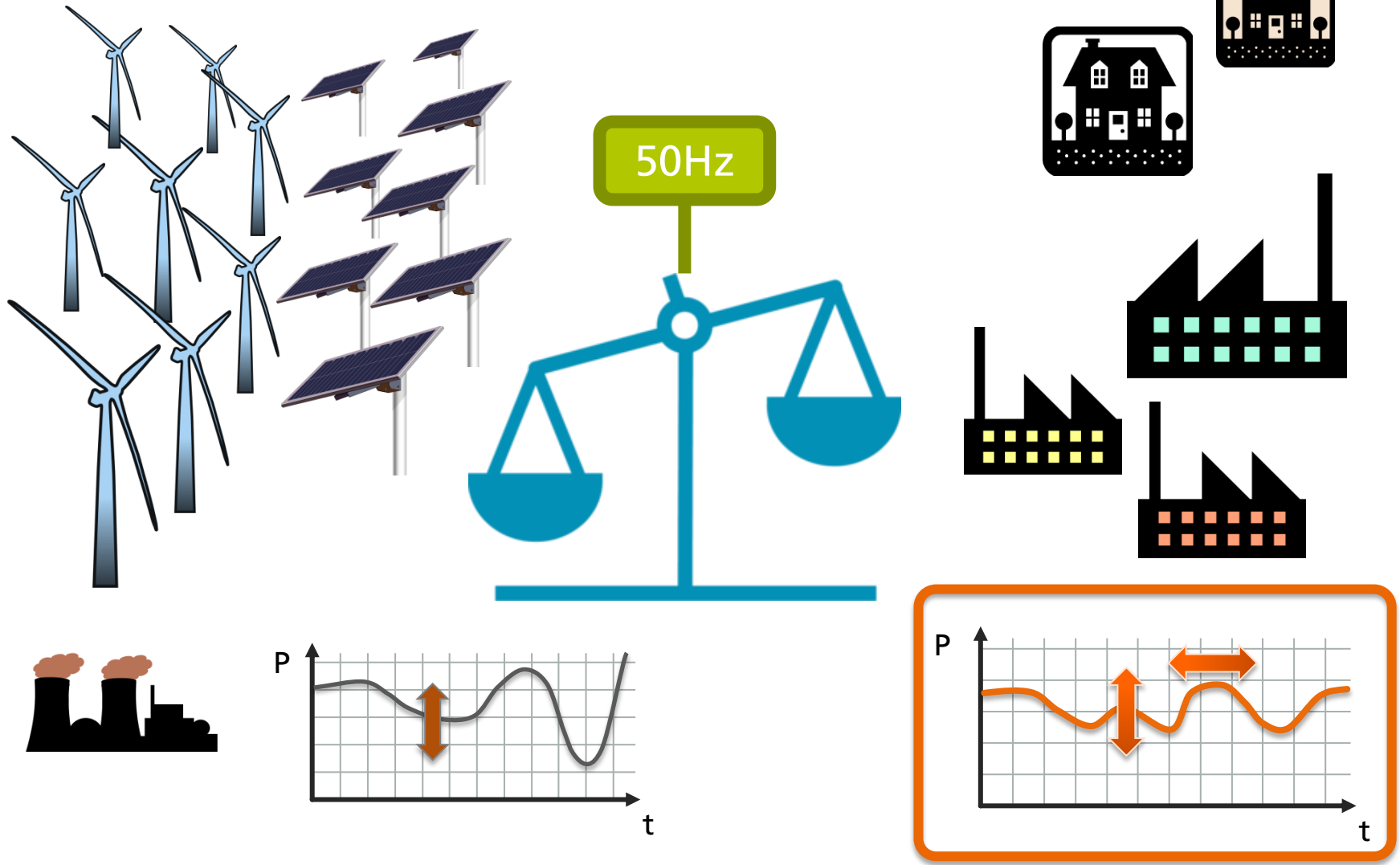

Source:
Bundeszentrale für politische Bildung, 2013
www.bpb.de

Measures to prevent »black outs« costs approx. EUR 700 Mio. (2015)*

- 225 Mio. (2014: 74 Mio.) power plants up/down
- 52 Mio. (2014: 92 Mio.) Power Reserve
- 329 Mio. (2014: 128 Mio.) Emergency shut wind turbines

* Source: www.faz.net
„Kampf gegen Stromausfälle so teuer wie noch nie", 17.1.2016

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Germany's Energy Transition

50Hz

P

t

P

t

Innovative energy storage concepts for industrial production

Results

- Enormous interest in this topic → approx. 300 participants

- Numerous new contacts from **various fields of expertise**

- Continuation of the platform due to new working group of "Energy Saxony" on "energy-efficient production"

Results

Integration Capacity

- Installation conditions
- Power electronics
- Integration of DC/AC
- Brown / green field

System Level / Storage Technology

- Classification of storage technologies
- Various use cases

Simulation / Design

- Type of storage
- Dimensioning
- Control

Economic Efficiency

- Centralized vs. disseminated
- One/several tasks
- Acquisition, operating cost, remuneration, funding

Operations Management

- Various "business cases"
- Integration of EE, peak-shaving
- Coupling of USV
- production sites in the smart grid

Technical Availability

- Robustness, margin of error
- Maintenance, exchangeability
- Management of energy / charging
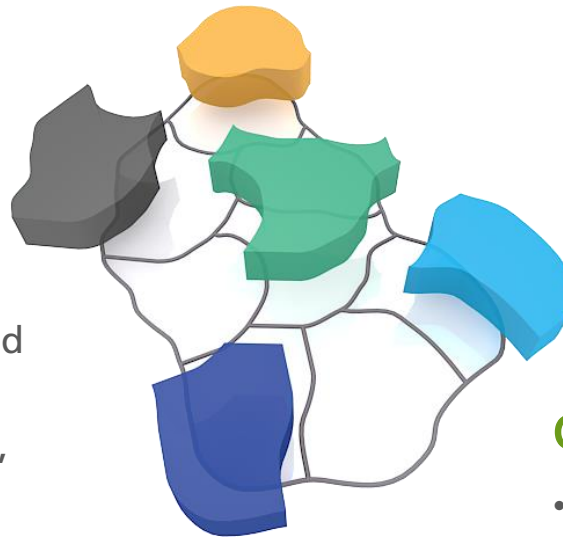
TESLA POWERWALL

Source: Screenshot via teslamotors.com

Mercedes-Benz Energy Storage System

Use solar energy even when the sun is not shining.

Quelle: Screenshot via https://www.mercedes-benz.com

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Vision

Energy storage for industrial production

Energy supplier

EM

Office

EM

Machine

Plant

EM

Workshop/site

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WindNODE

showcasing smart energy systems from northeastern

Legend:
- Wirtschaftspartner
- Forschungspartner

Diagram labels: grids, generation, use, market, 50 Hz
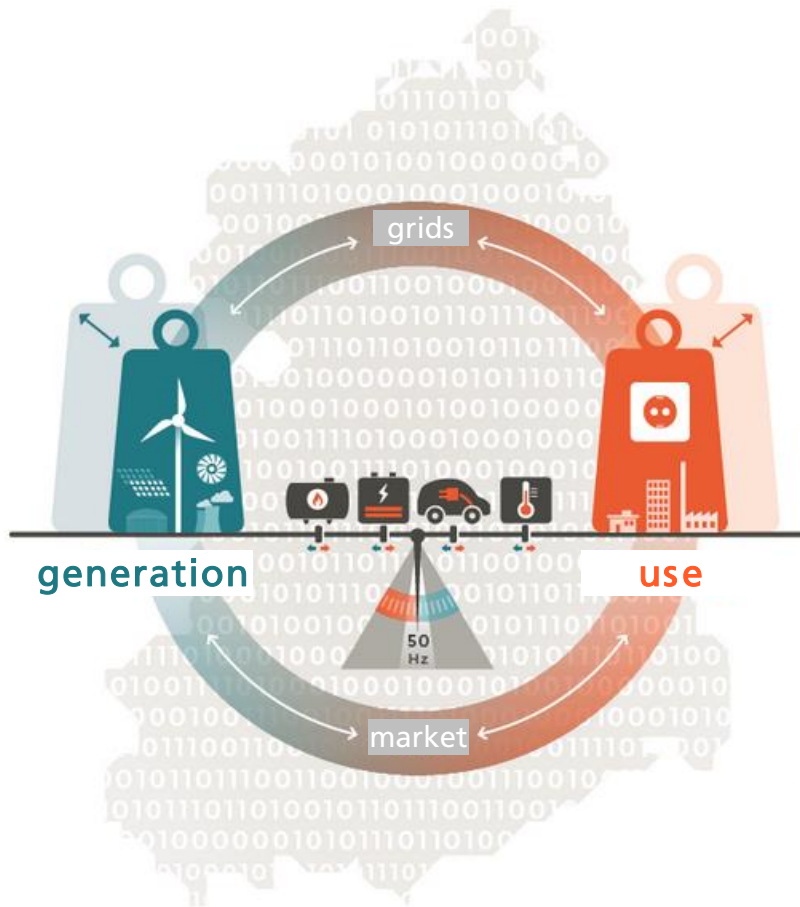
Source: www.windnode.de

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Funding Program
"Shop Window" for Intelligent Energy – Digital Agenda for the New Energy Revolution (SINTEG)"
Call for proposals by the Ministry for Economic Affairs and Energy (BMWi) in spring 2015
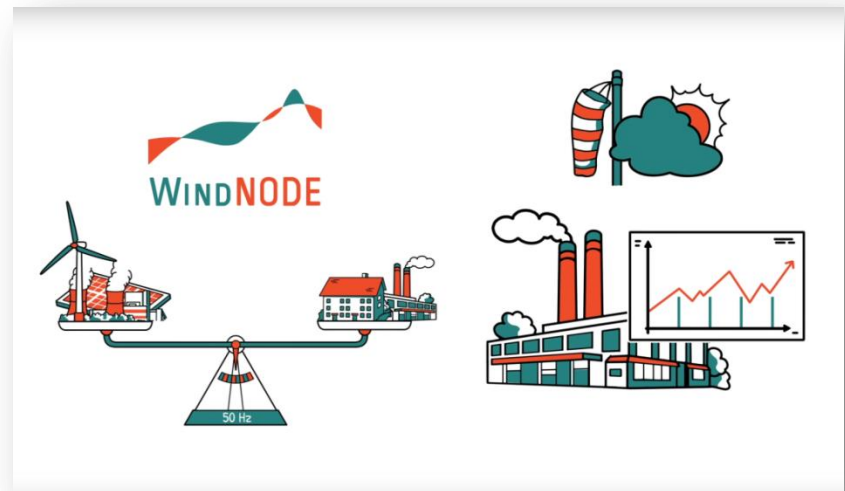
Objective: ...to develop and demonstrate standard solutions in large model regions ("shop windows"), suitable for mass markets to ensure environmentally friendly, reliable and efficient energy supply with a high percentage of fluctuating power generation by wind and solar energy. Topics include intelligent linking of generation and consumption, system integration, **flexibility**, security of supply, system stability and energy efficiency.

- Planned duration: 09/2016 – 08/2020
- Approx. 50 joint partners, 9 sub-projects
- Sub-project TP 7 "Flexible industrial loads"

"ZIEL"
Algorithmen und Methoden
für ein **Z**ukunftsfähiges **I**ntelligentes
Energie- und **L**astmanagement

WindNODE - showcasing smart energy systems from northeastern

Source: www.windnode.de

Kopernikus Projects for the Energy Transition

Technological and economic solutions for modifying the energy system

1. New grid structures

2. Storage of surplus electricity (Power to X)

3. Industrial processes

4. System integration

SynErgie

Synchronized and energy adaptive production technology for flexible design of industrial processes regarding fluctuating energy supply.

05.04.2016 | PRESSEMITTEILUNG: 033/2016

Sicher, bezahlbar und sauber

230 Partner starten größte Forschungsinitiative zur Energiewende / Wanka: "Erneuerbare Energieversorgung ohne Wohlstandsverlust ist machbar"

Vorstellung der vier ausgewählten "Kopernikus-Projekte: Bundesforschungsministerin Johanna Wanka gibt die vier Kopernikus-Projekte bekannt.
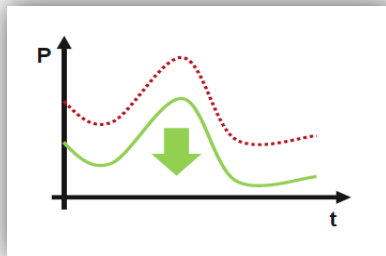© BMBF

Source: https://www.bmbf.de/de/sicher-bezahlbar-und-sauber-2624.html

Bundesministerium für Bildung und Forschung

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Kopernikus Project "SynErgie"
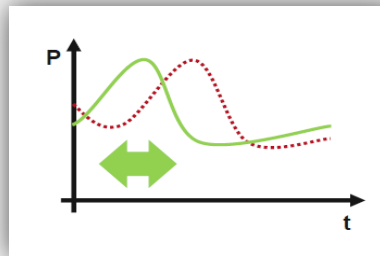
Synchronized and energy adaptive production technology for flexible design of industrial processes regarding fluctuating energy supply
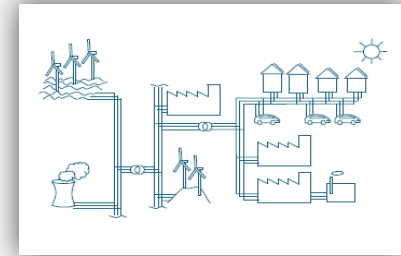
| Efficiency	Synchronization	Collaboration
Efficient energy input and energy recovery	**Monitoring and management of energy**	**Energetic interaction**

adjusting lever

Efficiency
- Machines, components
- Production processes/-technologies
- …

Synchronization
- Production processes
- **Energy storage systems**
- Planning, forecast
- …

Collaboration
- Production system, building
- Industrial park, distribution grid
- Market
- …

Energetic Flexibility

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Thank you for your attention.

Who needs oil
when you have rain?
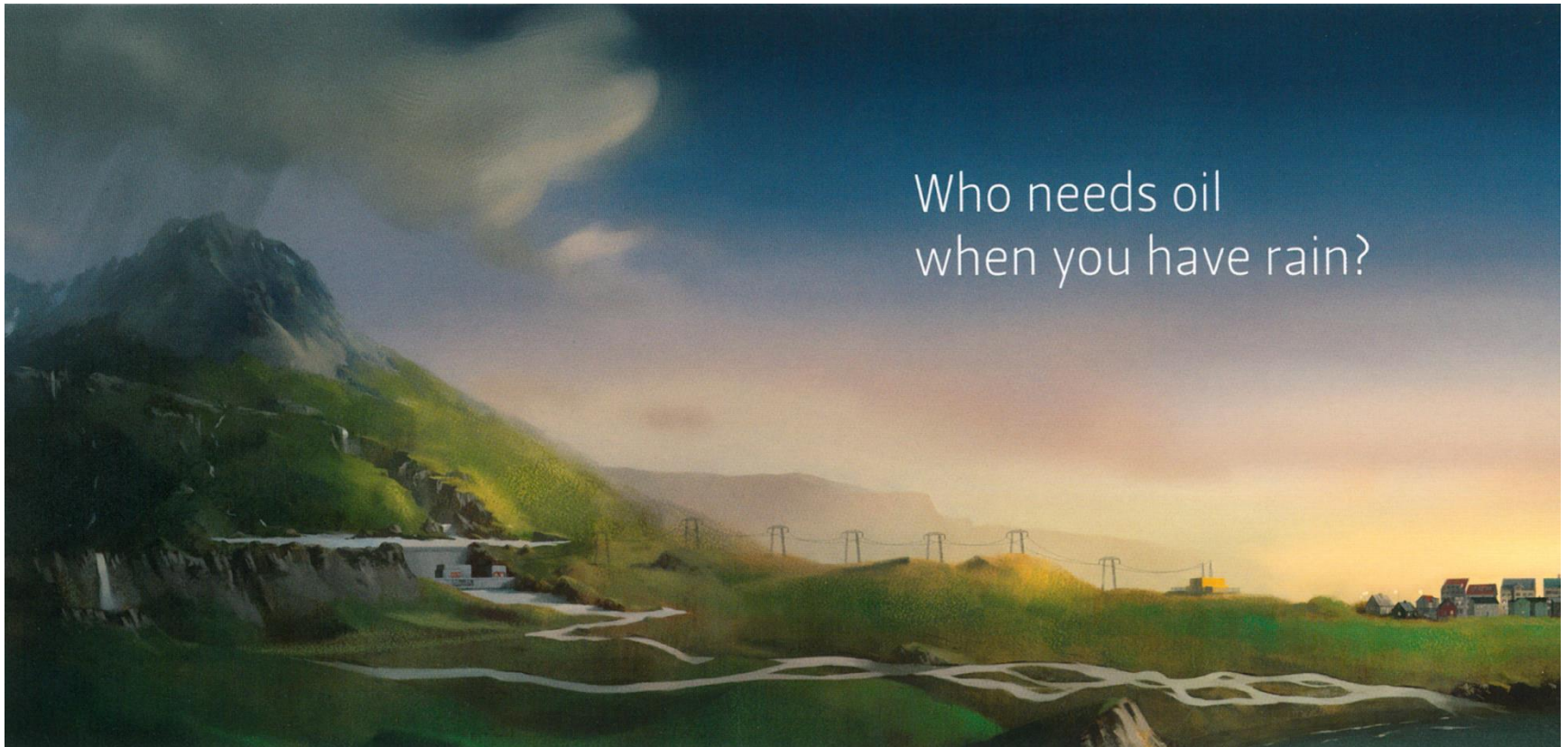
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