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Transformation des Gebäudeparks Schweiz – ein ganzheitlicher Ansatz

ZIG Planertag

Dr. Peter Richner, Empa
Leiter SCCER Phase I
22. März 2017

In cooperation with the CTI

Energy funding programme
Swiss Competence Centers for Energy Research

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

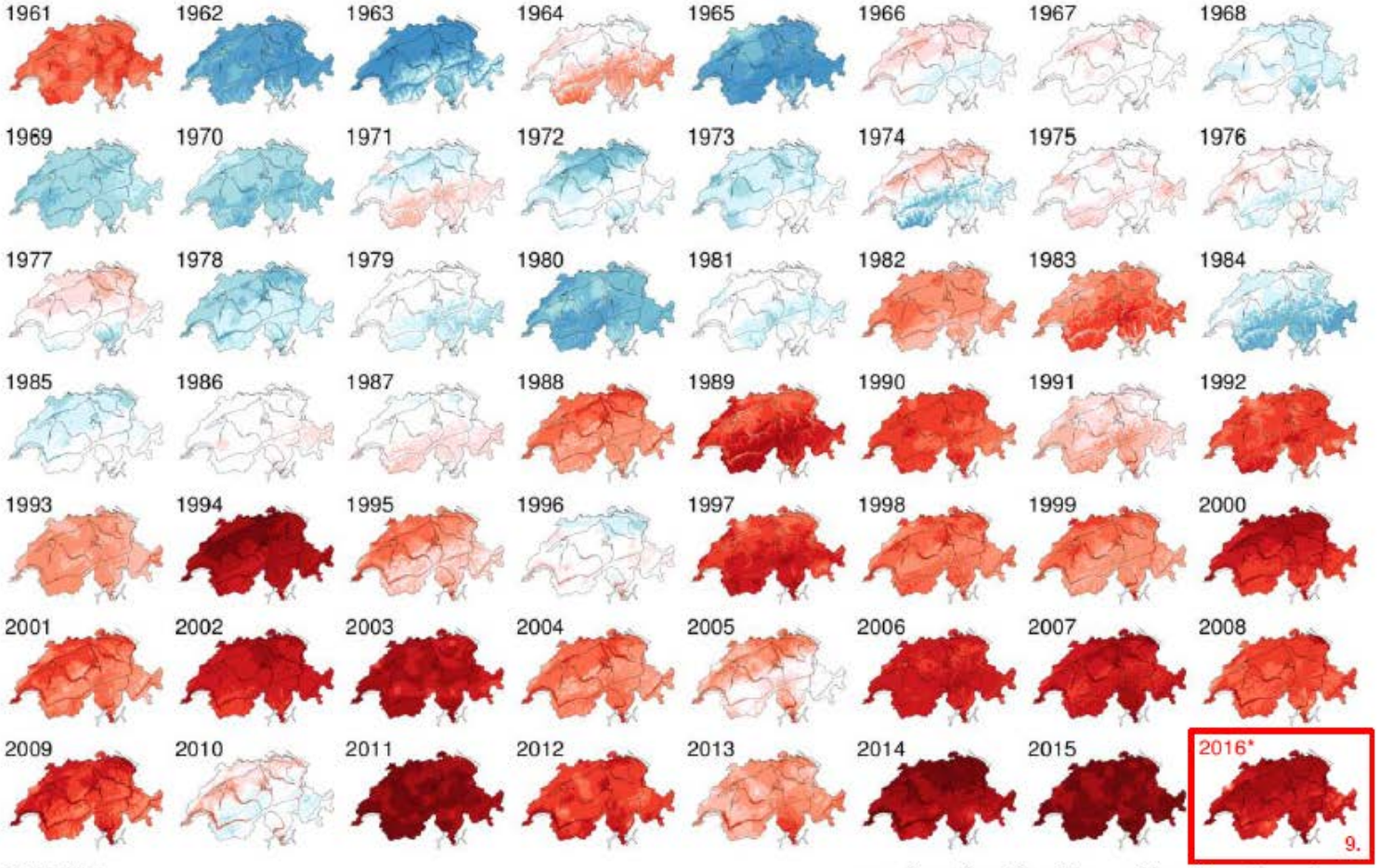
Swiss Confederation

Commission for Technology and Innovation CTI

Empa Materials Science and Technology
UNIVERSITÉ DE GENÈVE
ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
Lucerne University of Applied Sciences and Arts HOCHSCHULE LUZERN Technik & Architektur
Fachhochschule Nordwestschweiz

Temperatur Schweiz 1961-2016

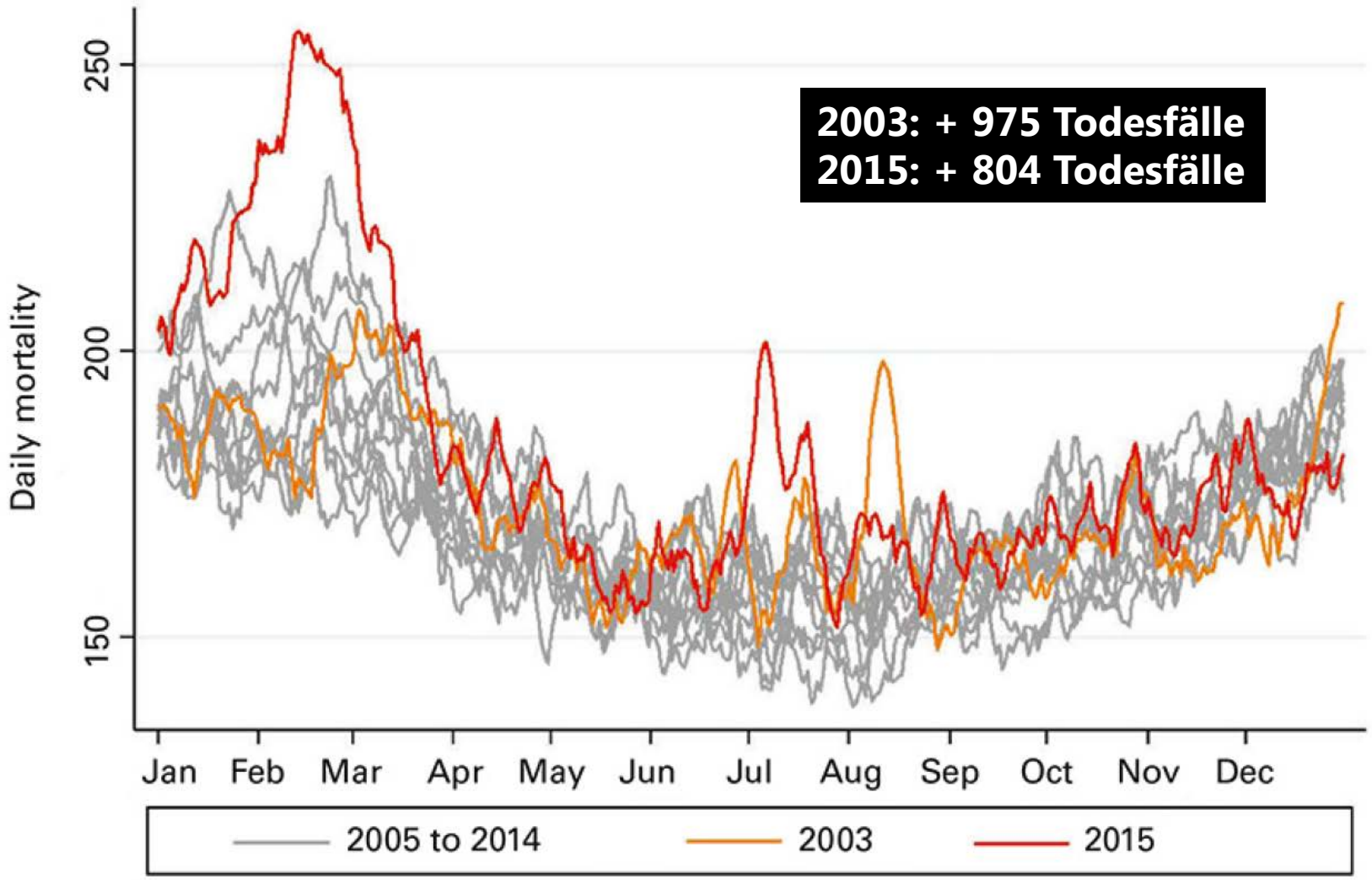
Temperaturzunahme seit 1900: ca. +1.9°C



Abweichung von der Norm 1961-1990 [°C]

MeteoSchweiz

Exzessmortalität während der Hitzewellen 2003 und 2015



A. Vicedo-Cabrera et.al.; Swiss Medical Weekly, 2015

SCCER Future Energy Efficient Buildings & Districts Phase I 2014-2016

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6 akademische Partner (Lead Empa)

20+ Industriepartner

Budget 26 Mio. CHF (2014-2016)

In cooperation with the CTI

Energy
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n|w Fachhochschule Nordwestschweiz

Vision FEEB&D

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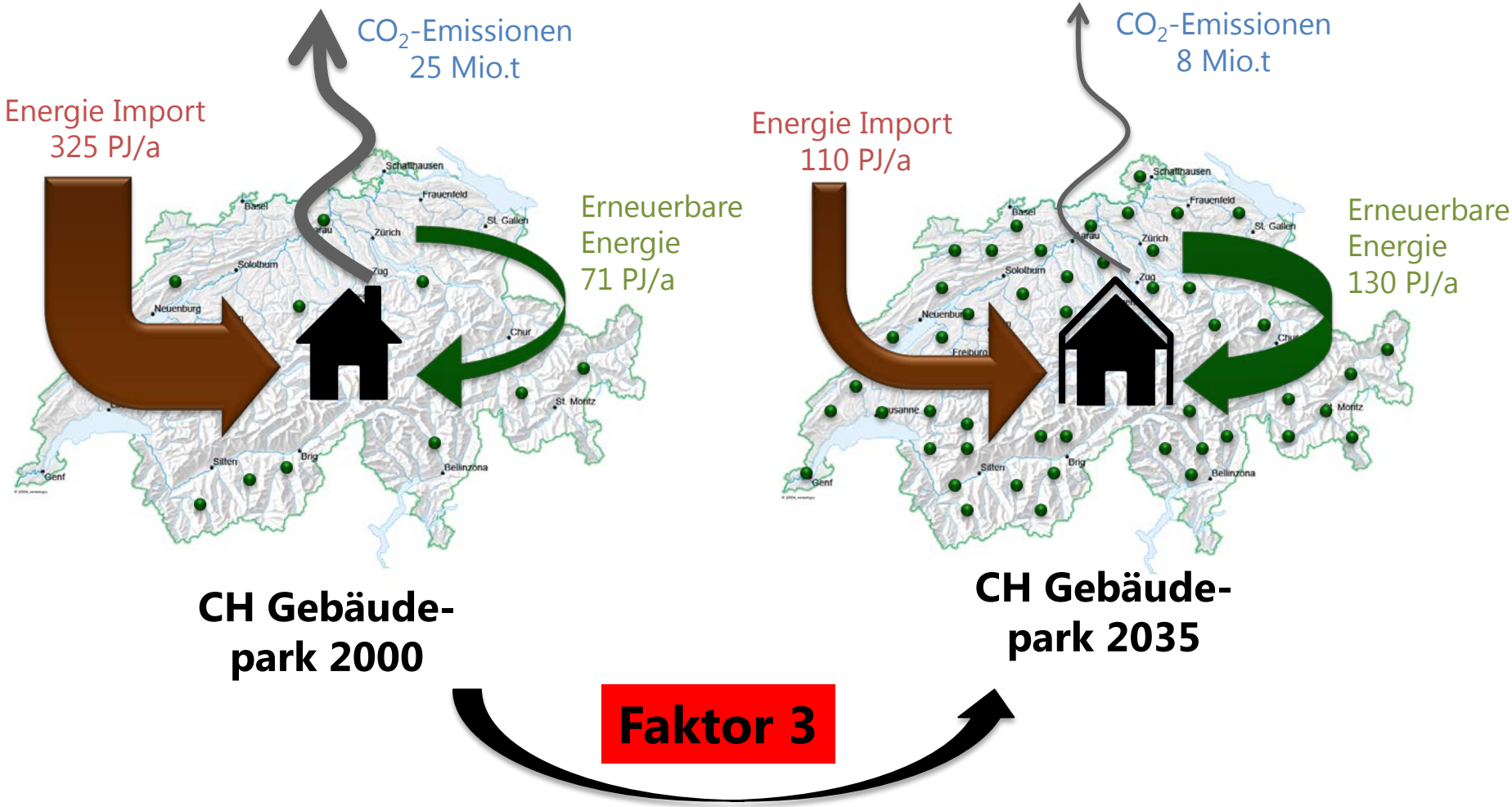

Kaya-Identität für Gebäude

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$$CO_2 = \frac{CO_2}{E} \times \frac{E}{A} \times A$$

E Energiebedarf der Gebäude

A Energiebezugsfläche

$C0_2$/E Kohlenstoffintensität des Energiesystems [$kgCO_2/kWh$]

E/A Energieintensität [kWh/m^2a]

Mavromatidis et al. 2016

Kaya-Identität für Gebäude

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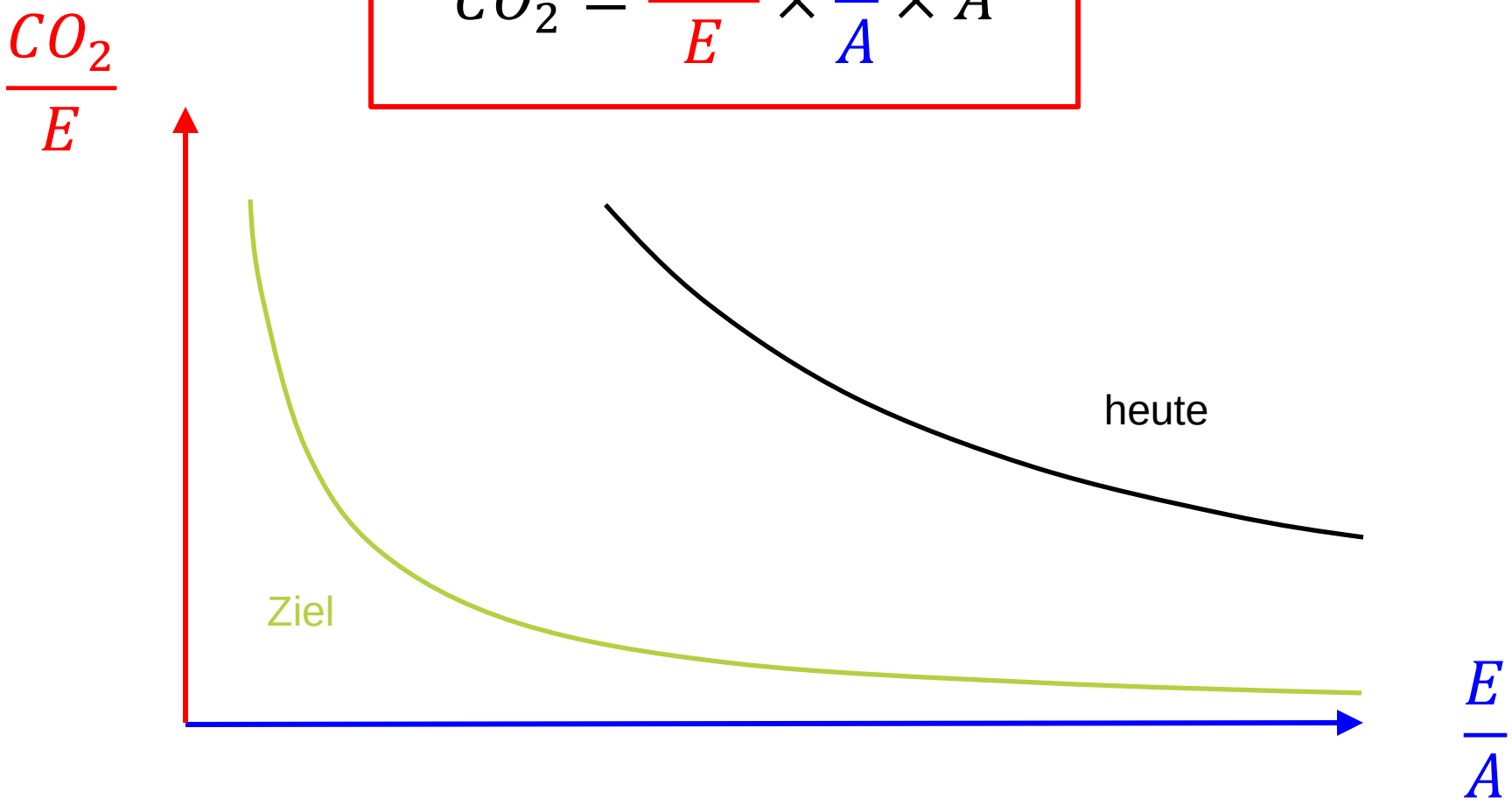

Vision FEEB&D

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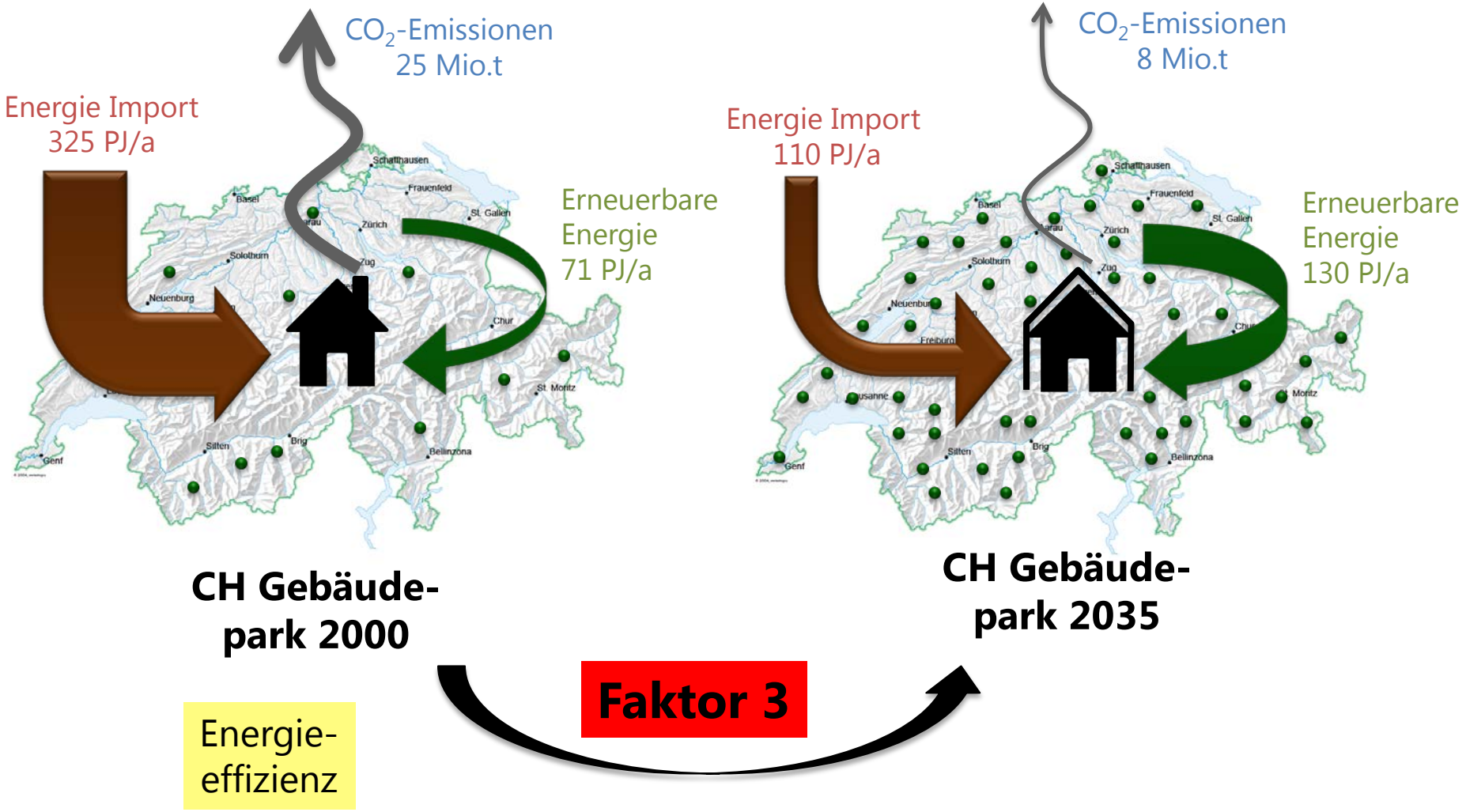

Energieeffizienz auf Gebäudeebene

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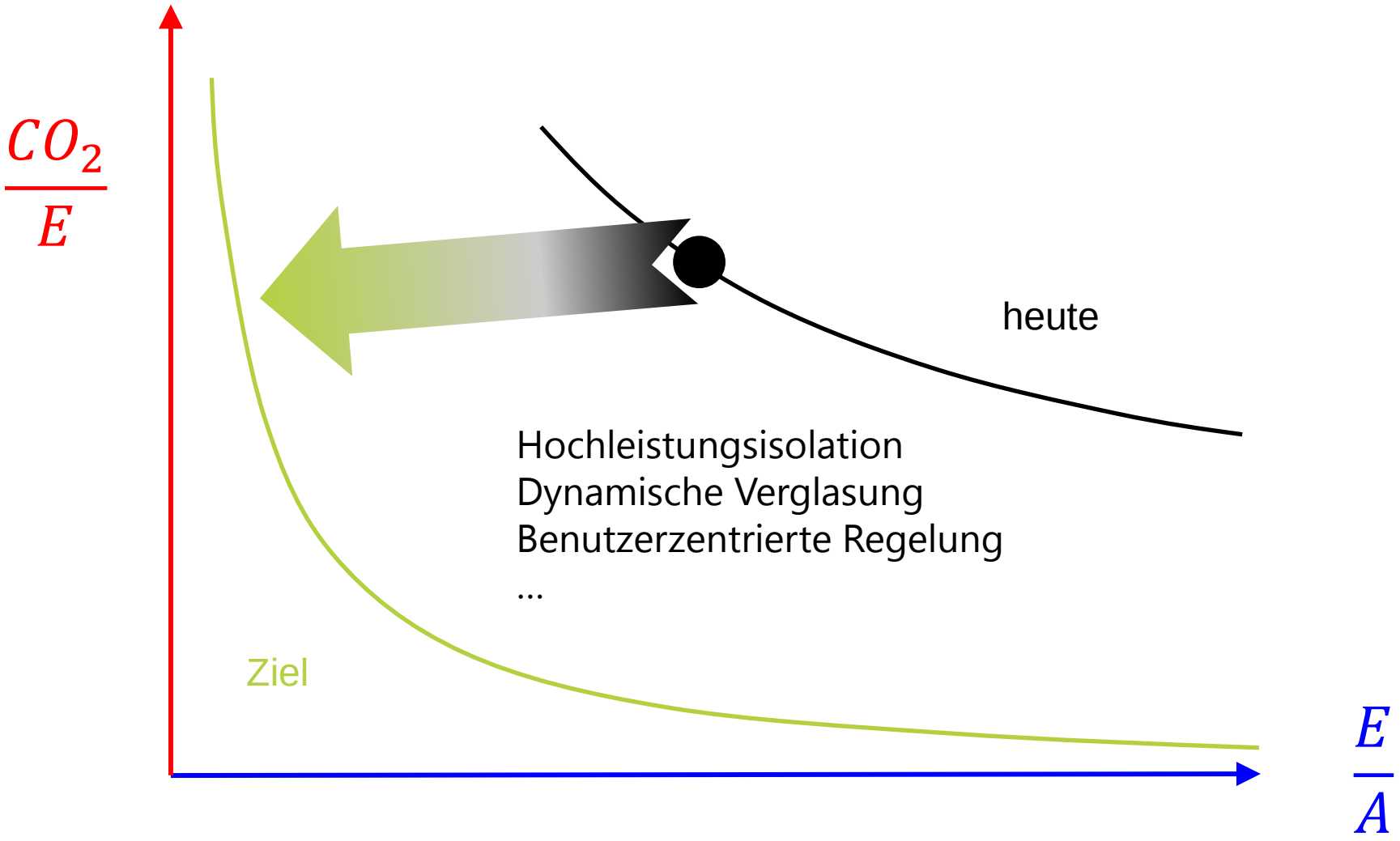
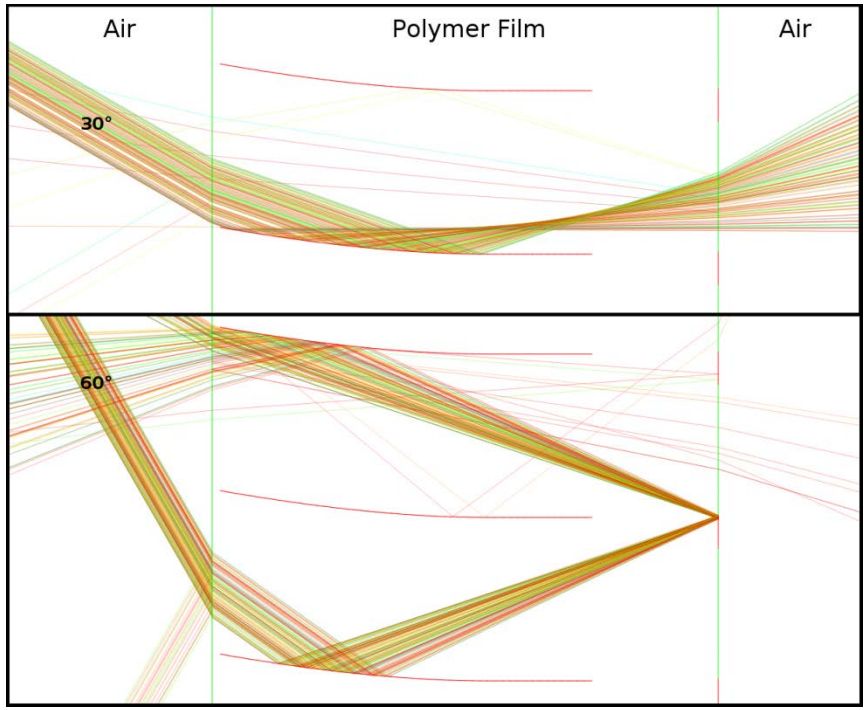


Novel optical microstructures

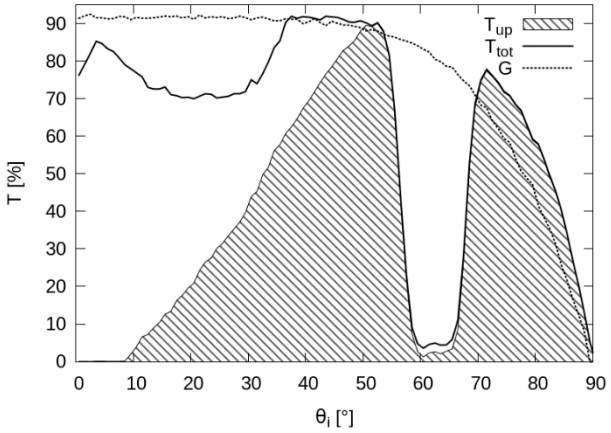
Winter

Summer

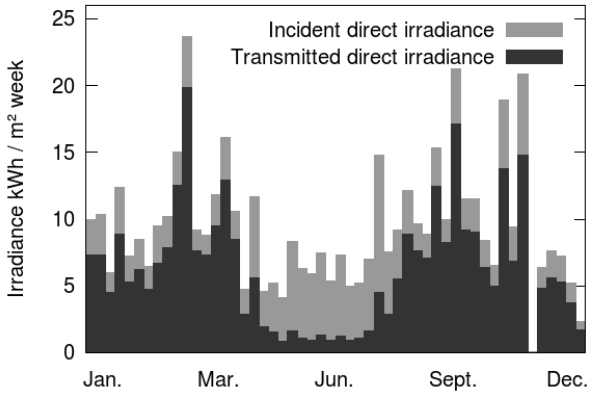


A. Kostro, A. Schüler, EPFL/LESO-PB
Patent granted
Industrial partner: BASF Switzerland

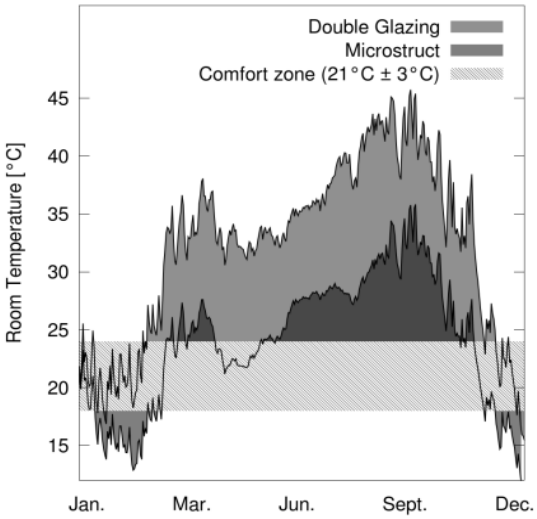
Simulations of thermal performance



Angle-dependent transmission



Solar heat gains



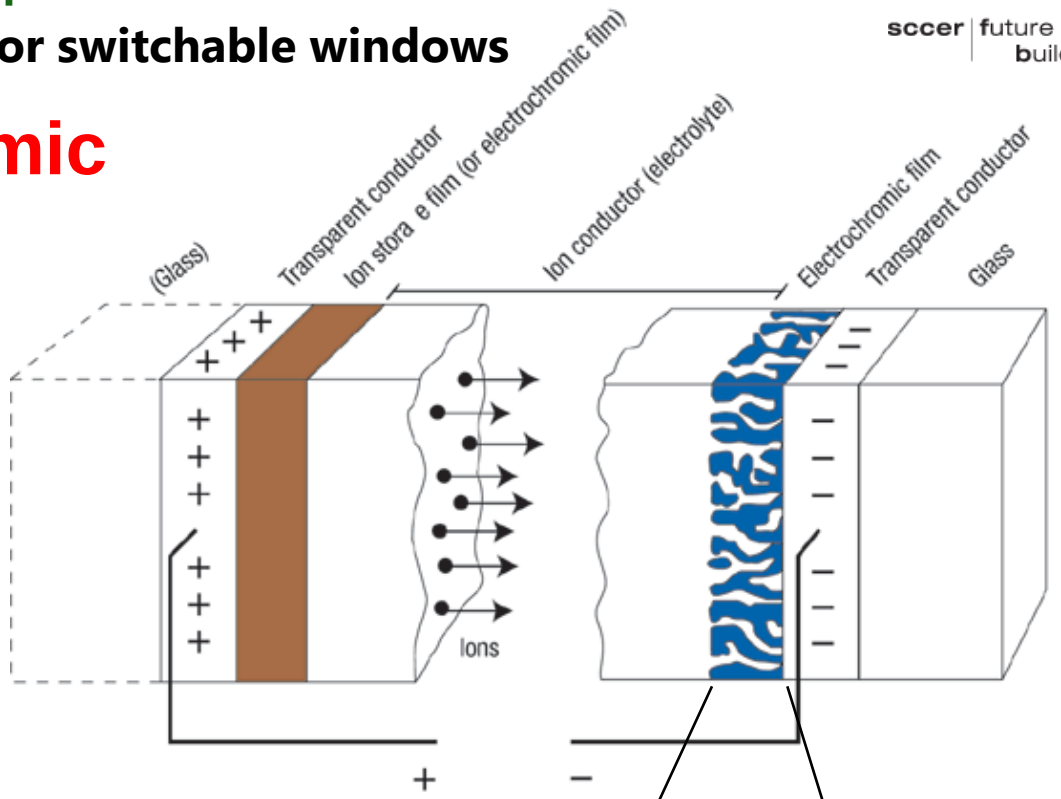
Thermal comfort

A. Kostro, J. Gong, A. Schüler, EPFL/LESO-PB

T1.2.2 Novel materials for switchable windows

Electrochromic windows

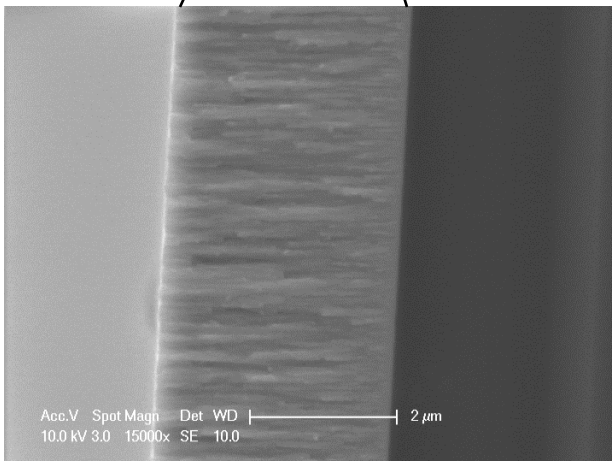
Working principle
after C.G. Granqvist



Coating EPFL/LESO-PB
O. Bouvard

clear state

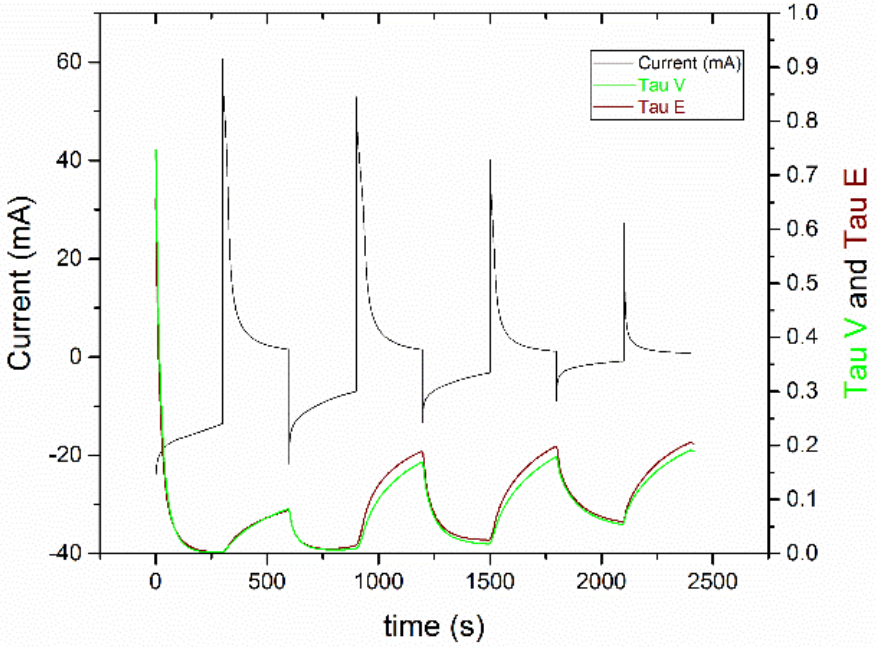
dark state



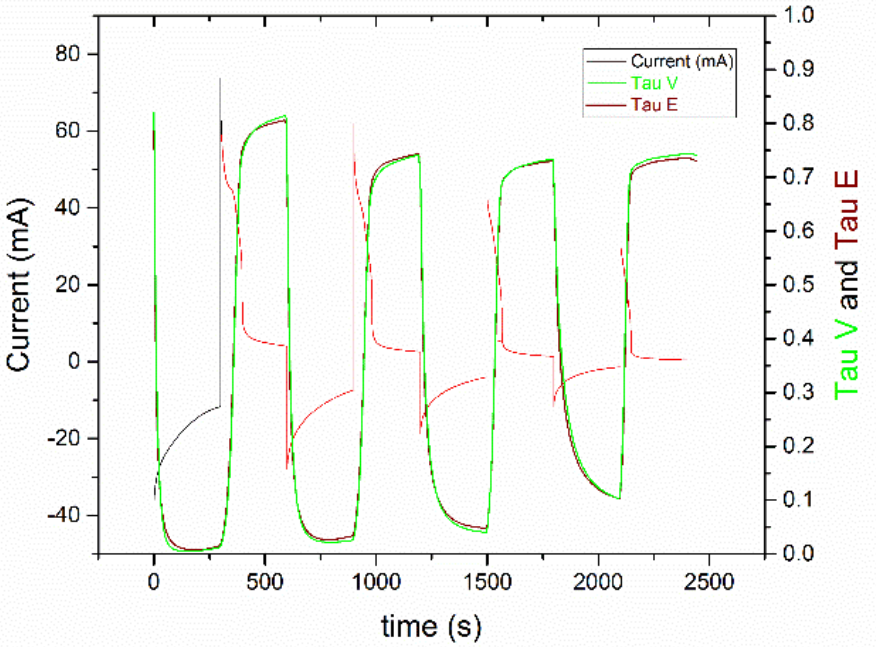
T1.2.2 Novel materials for switchable windows

Porous electrochromic layers

Dense WO_3



Nanoporous WO_3



Nanoporosity favours:

- Internal interfaces
- Channels for ion conduction

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

D. Mansour, O. Bouvard, A. Schüler

Vision FEEB&D

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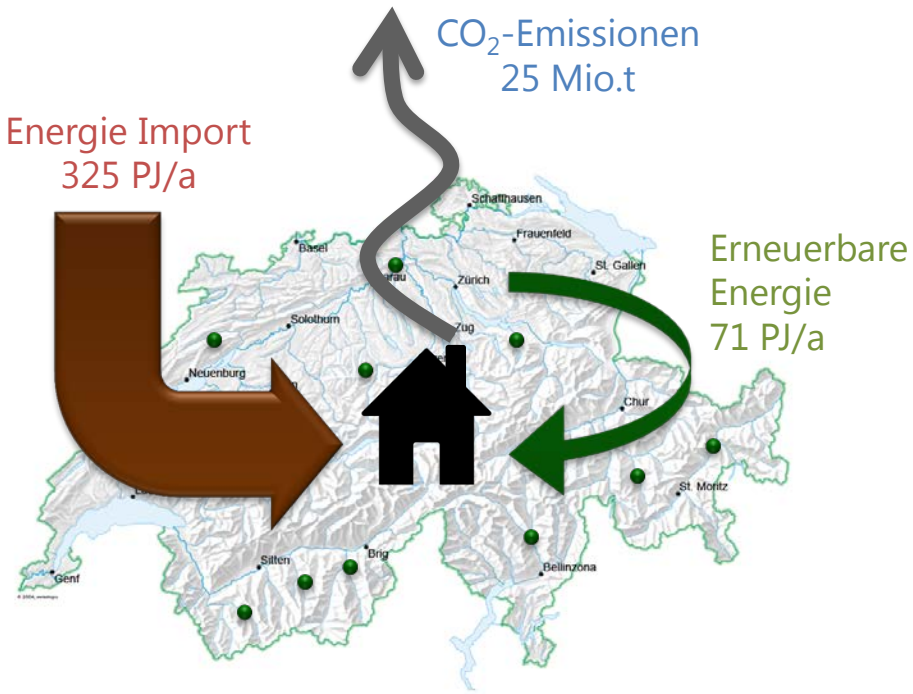
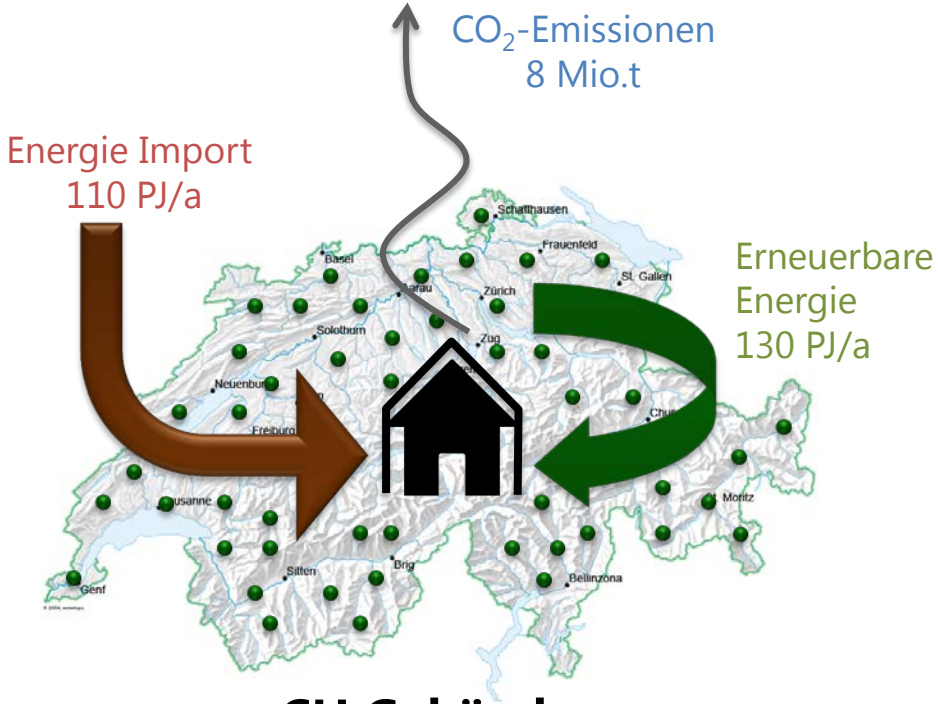


CH Gebäude-park 2000



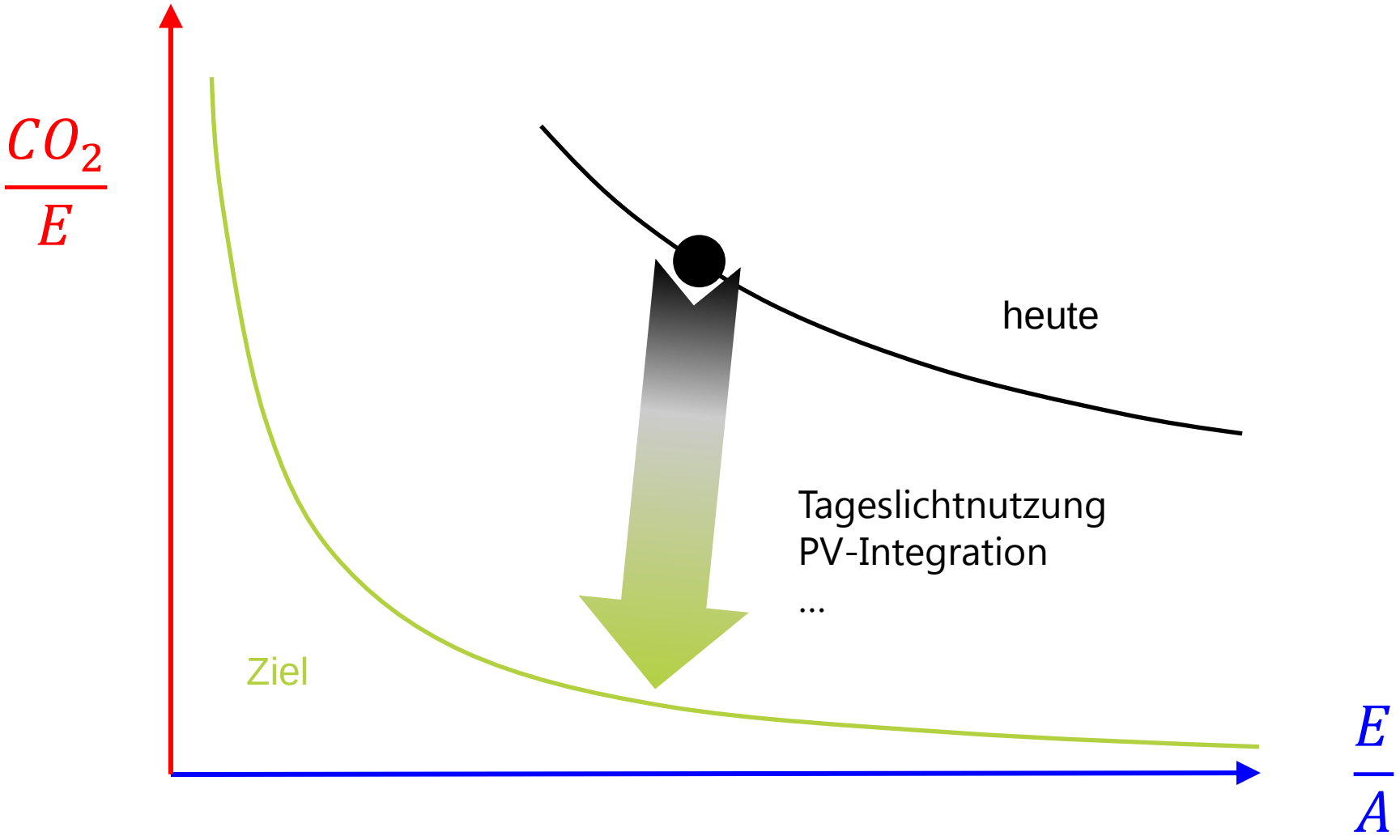
CH Gebäude-park 2035

Faktor 3

Energie-effizienz

Erneuerbare Energie

Erneuerbare Energie



CH Solarpreis 2016

Empa
Materials Science and Technology

1

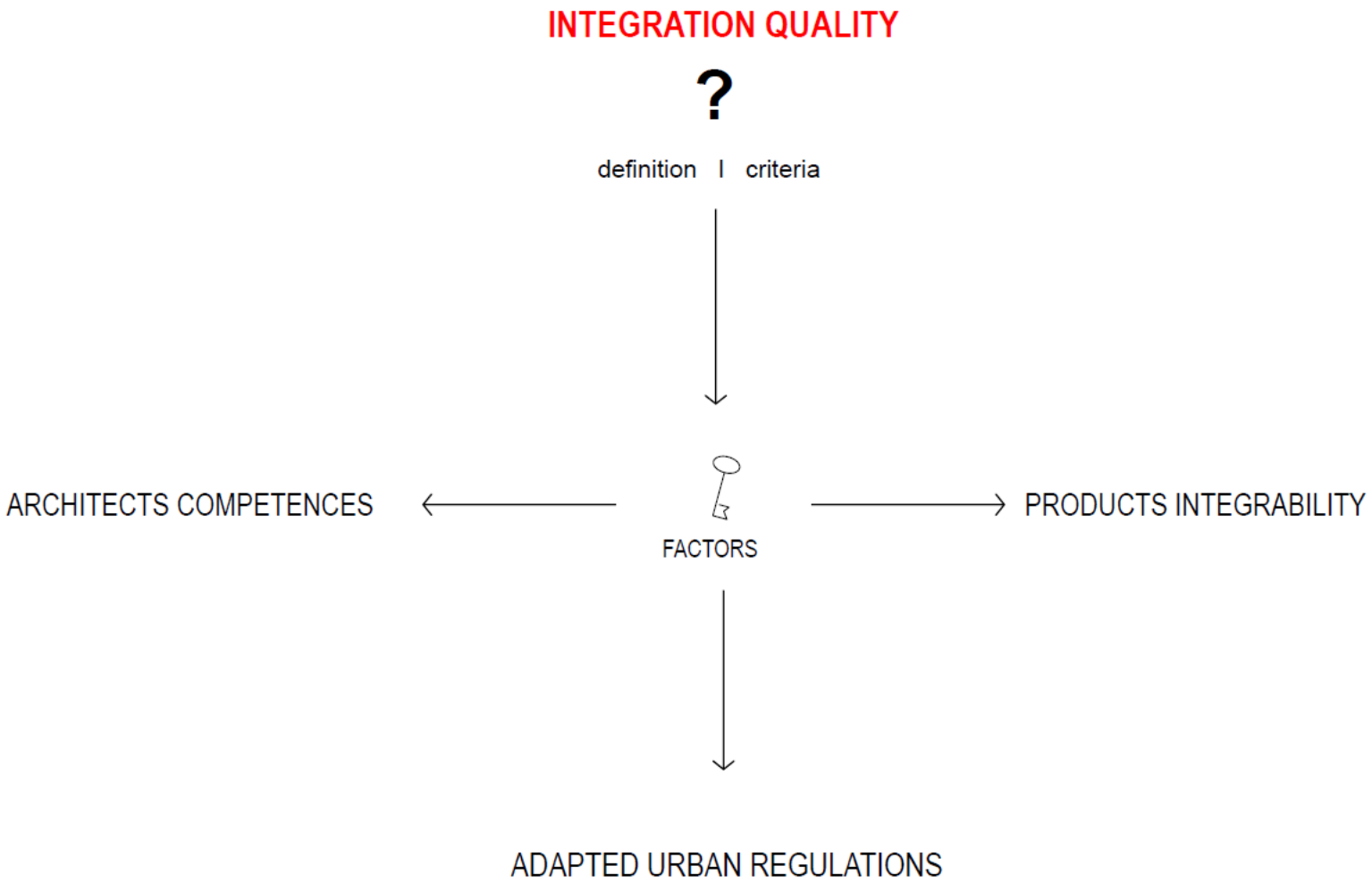
2

1 Vor der Sanierung verbrauchte das MFH 130'000 kWh/a und emittierte über 46 t CO_2. Heute ist es ein PEB mit 0.0 t CO_2-Emissionen und Solarüberschüssen.

2 Nordostansicht der ersten Jugendstil-MFH-Sanierung in Europa dank Min.-P-Dämmung und Solarnutzung. Der Energiebedarf sank um 88% von 130'000 kWh auf 16'400 kWh/a. Zugleich erzeugt das PEB 19'400 kWh/a Solarenergie.

Jugendstil-MFH Culmannstrasse, Zürich

Sonnenschloss Walbeck

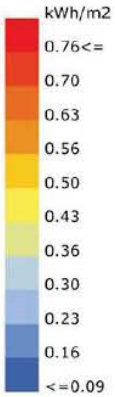

INTEGRATION QUALITY
?
definition I criteria
ARCHITECTS COMPETENCES
FACTORS
PRODUCTS INTEGRABILITY
ADAPTED URBAN REGULATIONS

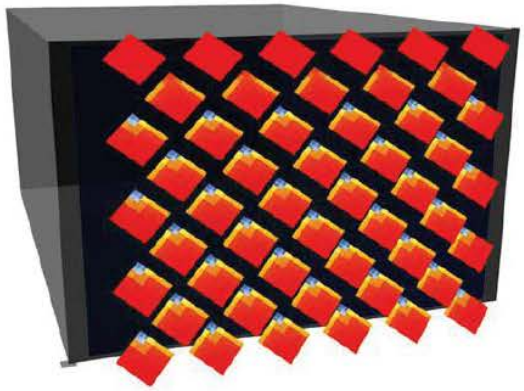
Coupling of PV and Building Energy Performance

Kinetic envelope for heating cooling and light comfort + PV generation

Case Study

- Single Zone Office
- Zurich Weather Data
- 50 Panels in a Single Cluster
- Heating COP: 4
- Cooling COP: 3
- Lighting Load: 11.74 W/m^2



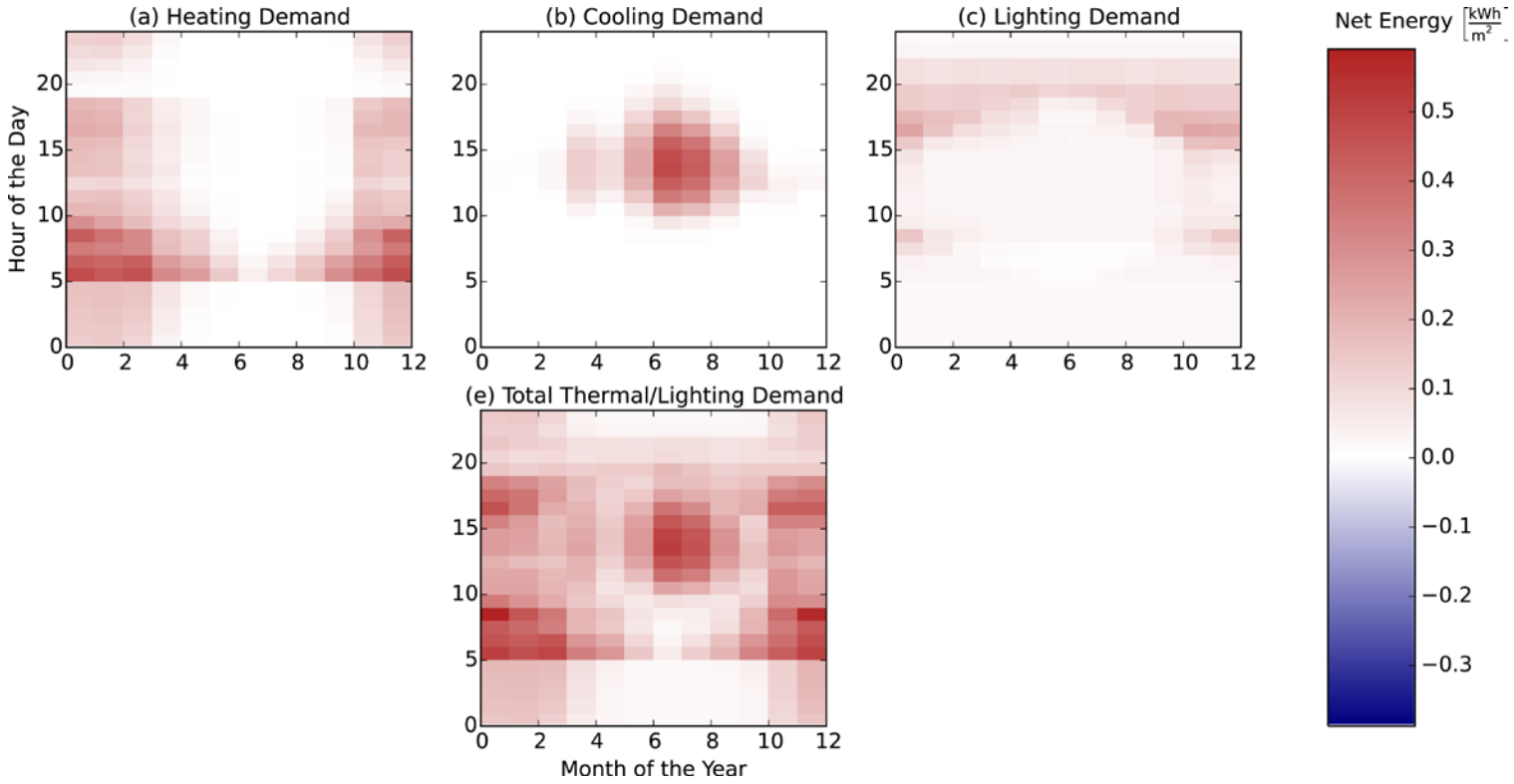


6DO.8.5 Energy Performance of PV Modules as Adaptive Building Shading Systems
J. Jayathissa, J. Schmidli, J. Hofer & A. Schlueter
ETH Zurich, Switzerland

Source: European PV Solar Energy Conference (https://www.photovoltaic-conference.com/)

Coupling of PV and Building Energy Performance

- Infer optimum module orientation minimizing net-energy demand
- PV electricity compensates for ca. 40% of the energy demand of the office behind the facade during the course of the year.



Source: Jayathissa et al., EU PVSEC 2016

Vision FEEB&D

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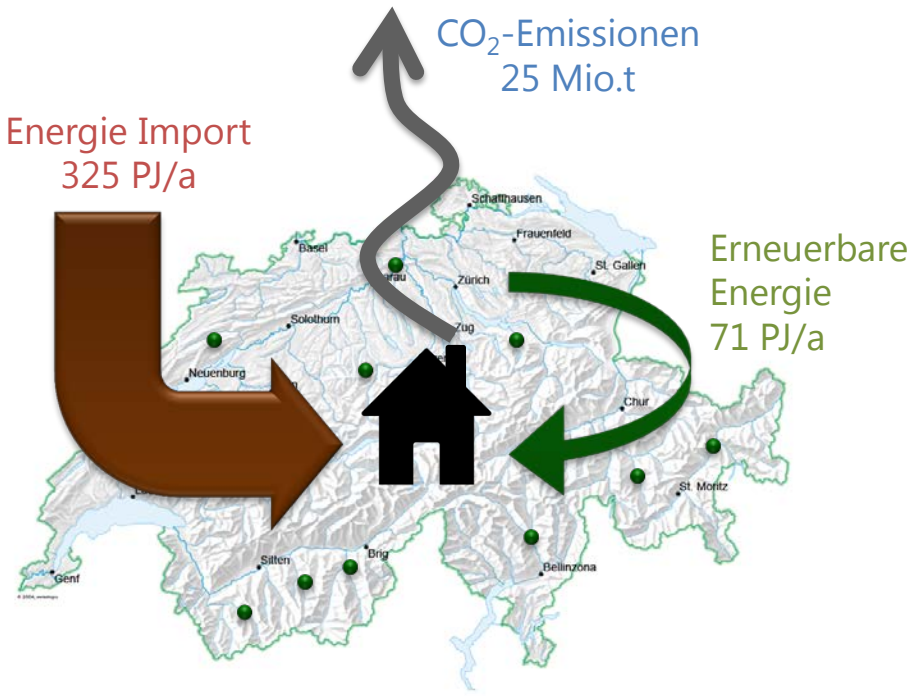
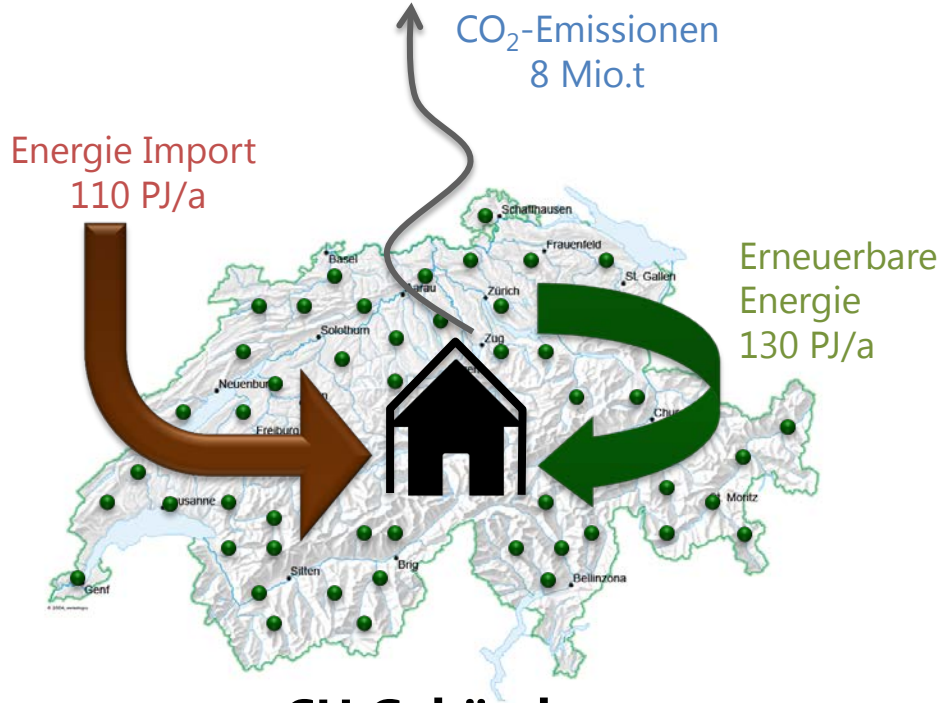


CH Gebäude-park 2000



CH Gebäude-park 2035

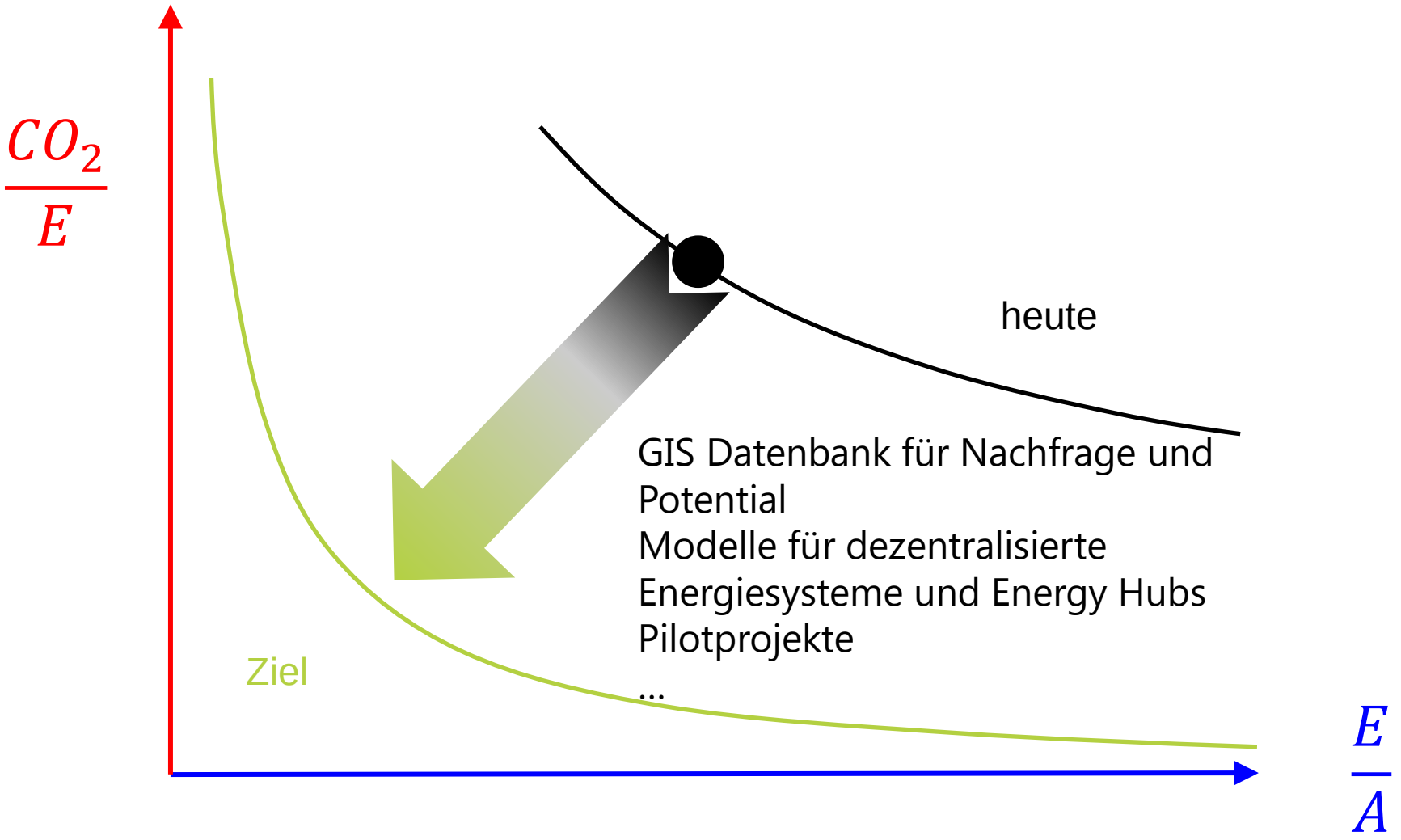
Faktor 3

Energie-effizienz

Erneuerbare Energie

Dezentralisierte Energiesysteme

Dezentralisierte Energiesysteme



Holistic Urban Energy Simulation (HUES) Platform

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Andrew Bollinger, Empa UES

An ecology of open source computational resources to support DES design and control.
https://hues-platform.github.io/

Includes:

- Models & algorithms
- Modeling tools
- Data
- Code

Model repository

Model name	Author	Tags	Accessible to
Dynamic carbon factor tool	Alice Chevrier	Carbon factor Switzerland	Public
Bidirectional massflow LTN (IDA ICE)	Thomas Schluck Philipp Kräuchi (base models)	District heating Low-temperature network IDA ICE	Public
District heating network routing			
GenFC load generator tool			
Generic Energy Hub YALMIP			
Generic energy hub (VB.NET)			
Generic energy hub model ILOG-CPLEX			
Multi-agent reinforcement learning-based energy hub model			
Rheinfelden energy hub thermal storage			
Simple office building EnergyPlus			
Unidirectional massflow LTN (IDA ICE)			
Energy hub model for design, sizing and operation of an energy sys of buildings			
Simple building energy model Rheinfelden			
Generic energy hub (Pyomo)			
Sequential Optimisation		Computational time	
EnergyPlus: Typical Residential Buildings in a Swiss Alpine Village	Raphael Wu		Empa UES
Mechanism design for the energy hub dispatch: case study	Marc Hohmann		Empa UES
Demand management of random consumption profiles	Marc Hohmann		Public
Occupancy profile generator	Ralph Evins	Building occupancy	Public

Model:Multi-agent reinforcement learning-based energy hub model

To edit the entries in this page, select "Edit with form" in the "Page tools" menu at the top of the page.

General information

Description	This is a multi-agent-based implementation of an energy hub model, loosely based on the generic energy hub model configuration. The model identifies an optimal dispatch schedule for technologies in a distributed multi-carrier system. The model was developed to test the implementation of a multi-agent reinforcement learning-based approach to energy hub modeling as a possible alternative to MILP under certain conditions. The model implements two different reinforcement learning algorithms, a Q-learning algorithm and a Continuous Actor Critic Learning Automaton (CACLA) algorithm. Both the Q-learning and CACLA implementations of the model are able to identify near-optimal dispatch solutions for the case without storage. For the case with storage, neither approach is able to identify a near-optimal solution.
Download URL	https://bitbucket.org/hues/multi-agent-reinforcement-learning-based-energy-hub-model/get/HEAD.zip
Authors	Andrew Bollinger
Required software	Python 3
Related publications	L.A. Bollinger and R. Evins. 2016. Multi-agent reinforcement learning for optimizing technology deployment in distributed multi-energy systems. EG-ICE Workshop. Krakow, Poland.
Licence type	MIT License
Tags	Energy hub model, Agent-based model, Reinforcement learning
Accessible to	Public

Documentation

Documentation may be uploaded, linked or directly entered into the wiki.

Documentation URL(s):	
Documentation file:	File:EGICE Bollinger Evins.pdf
Documentation page:	

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Includes:

Models & algorithms

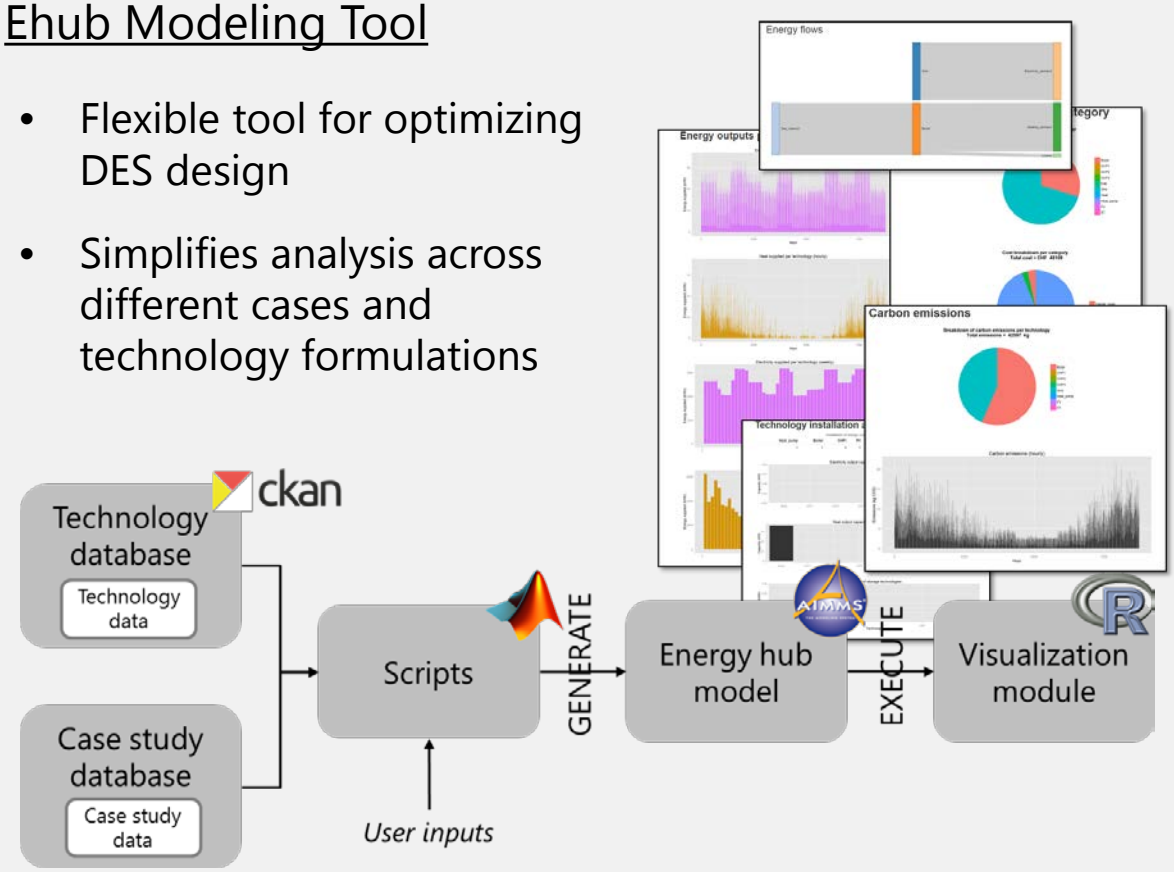
Modeling tools

Data

Code

Ehub Modeling Tool

- Flexible tool for optimizing DES design
- Simplifies analysis across different cases and technology formulations



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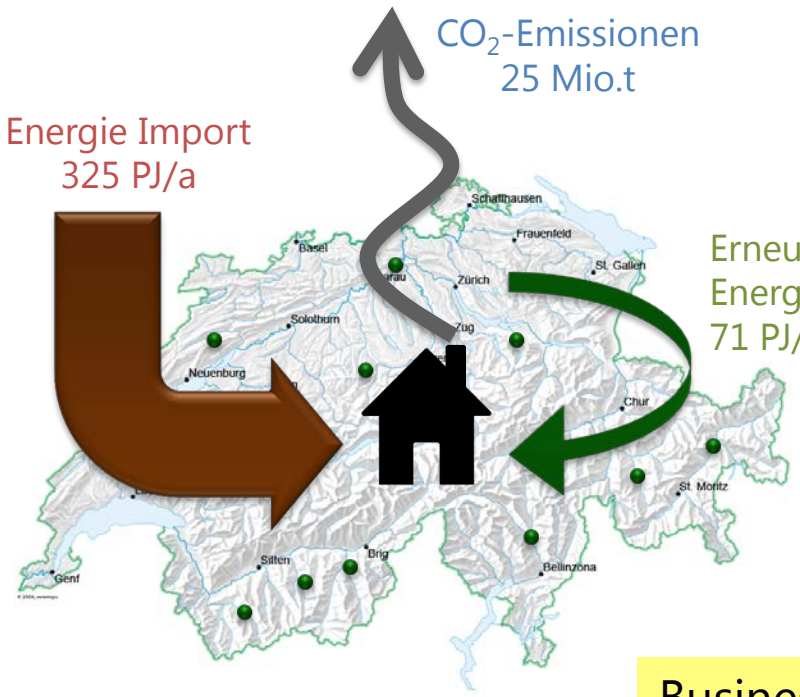


CH Gebäude-park 2000

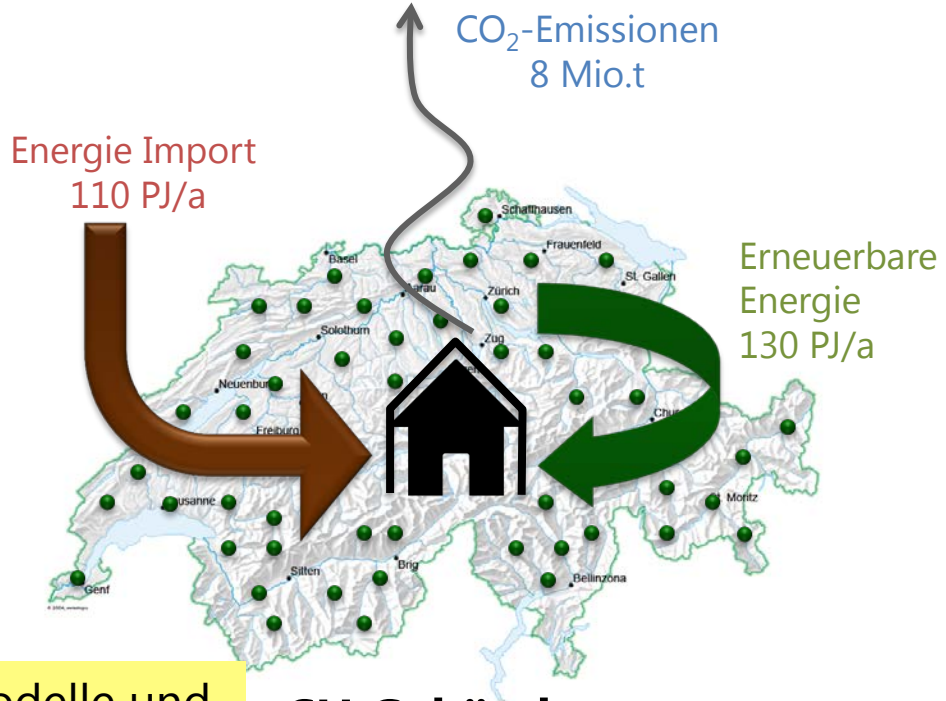
Business Modelle und Technologie Diffusion

Faktor 3

Energie-effizienz

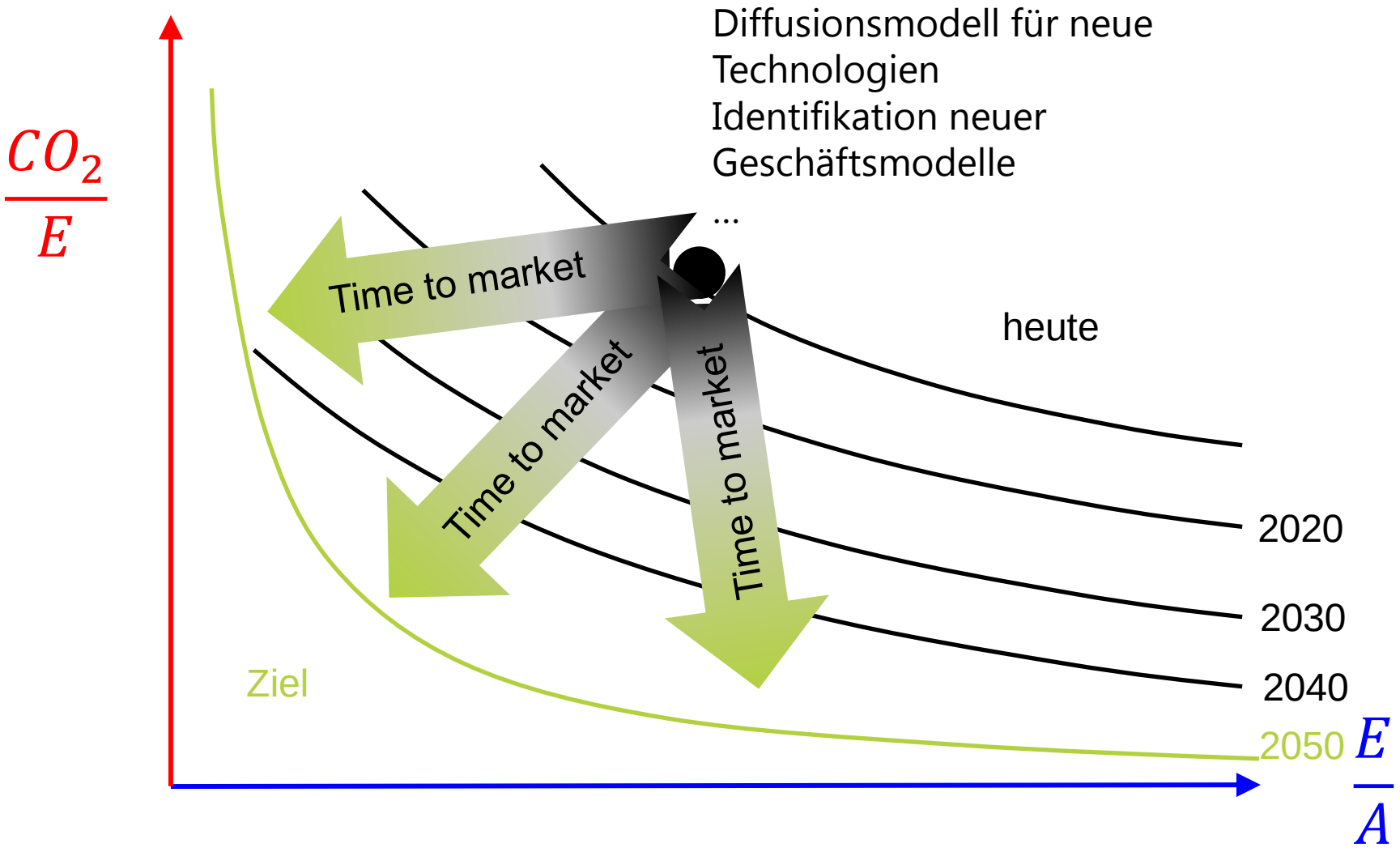
Erneuerbare Energie

Dezentralisierte Energiesysteme

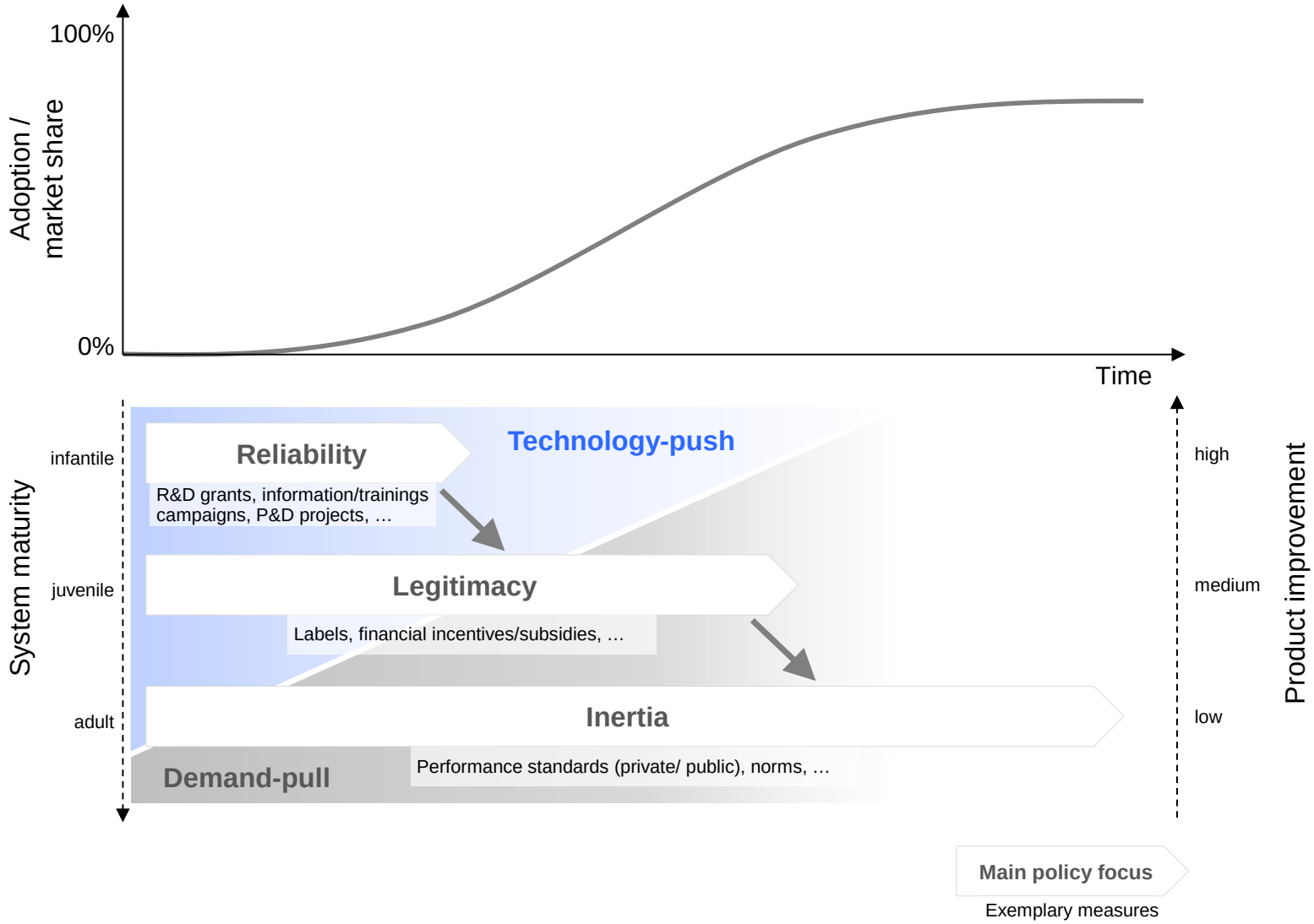


CH Gebäude-park 2035

Diffusion von FEEB&D Technologien



Policy instruments need to be tailored to system maturity to accelerate diffusion of low-carbon innovations



Outlook Phase II 2017 – 2020
Efficiency at Building Scale

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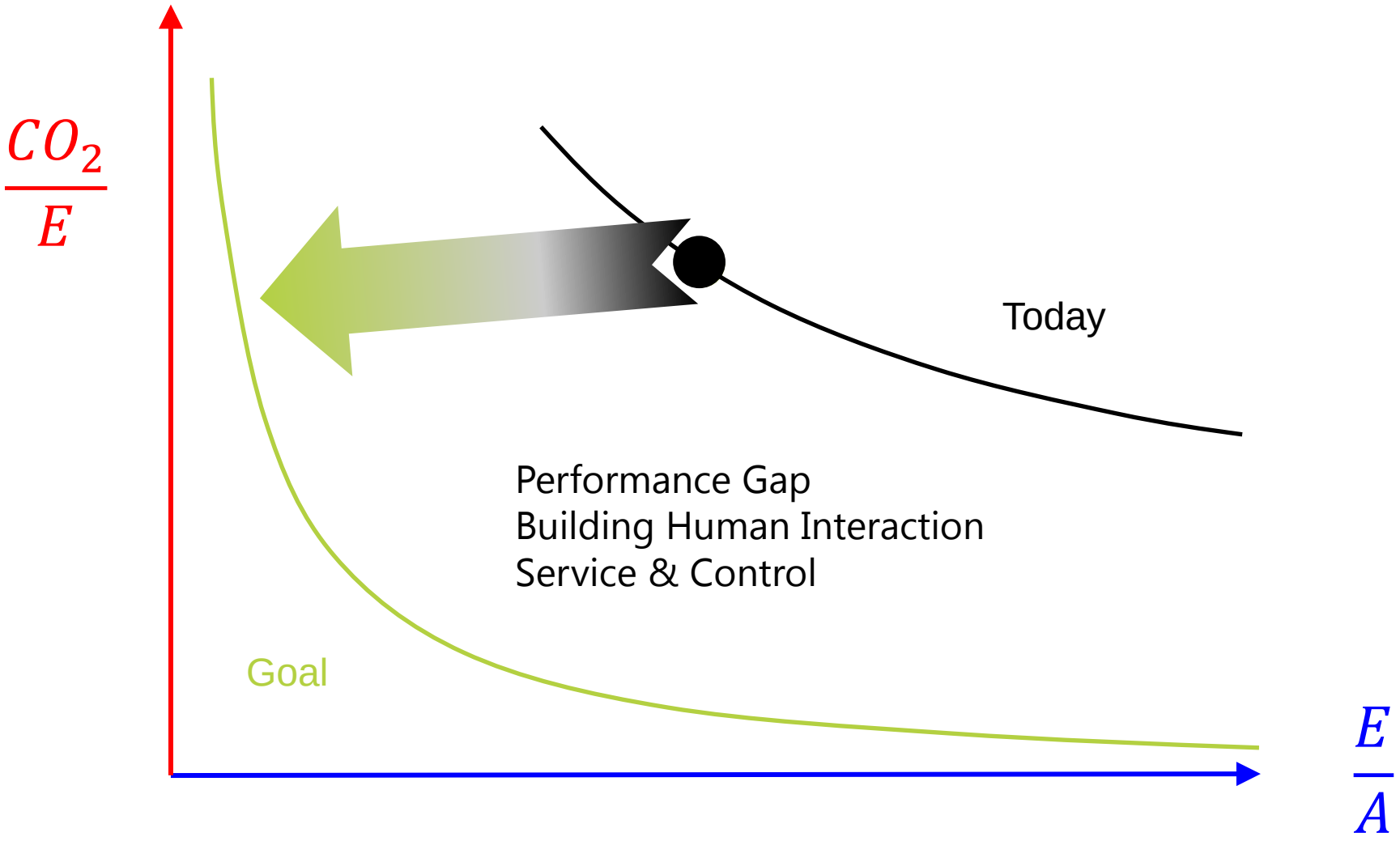
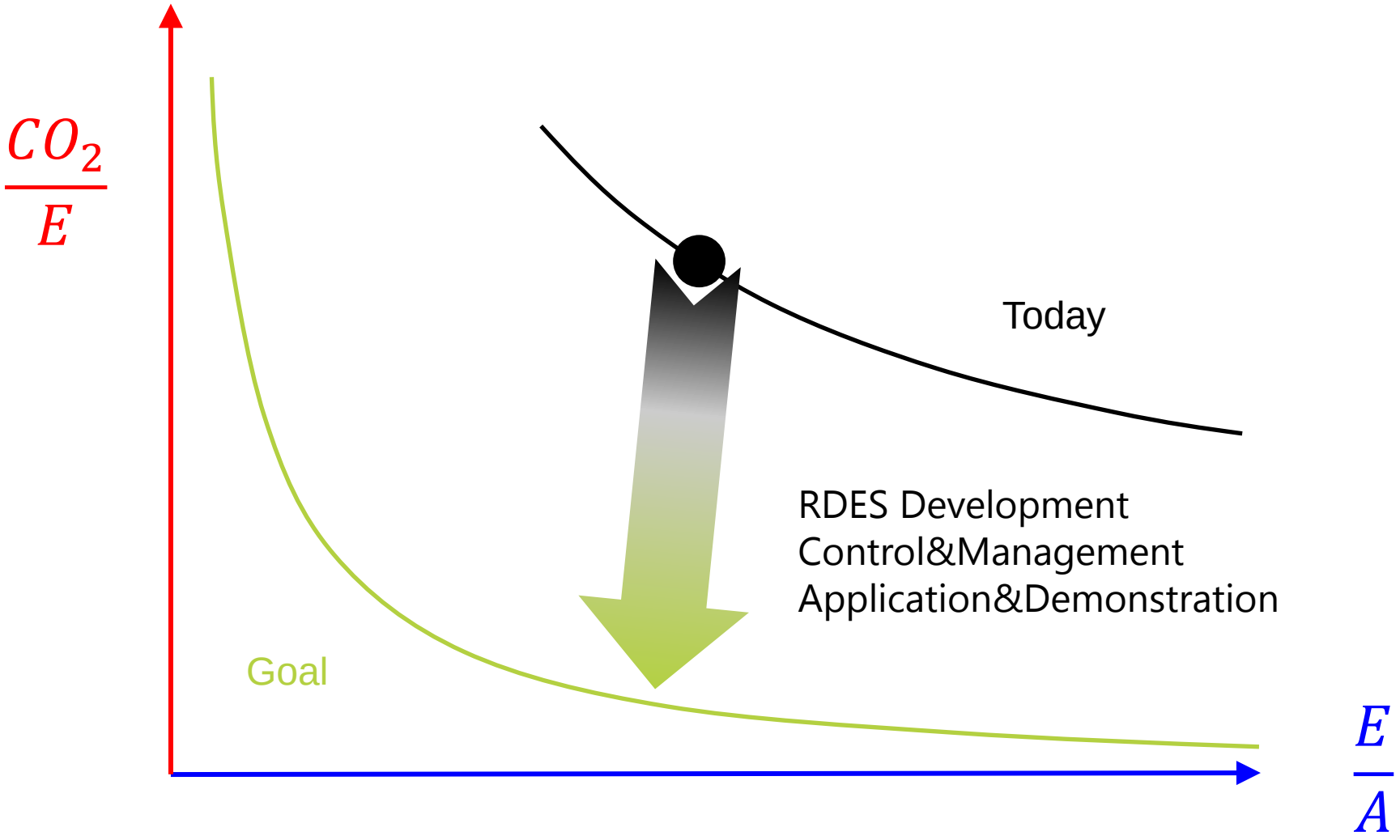


Outlook Phase II 2017 – 2020
Renewable Energy Systems



Outlook Phase II 2017 – 2020
Energy Performance at Regional and National Scale

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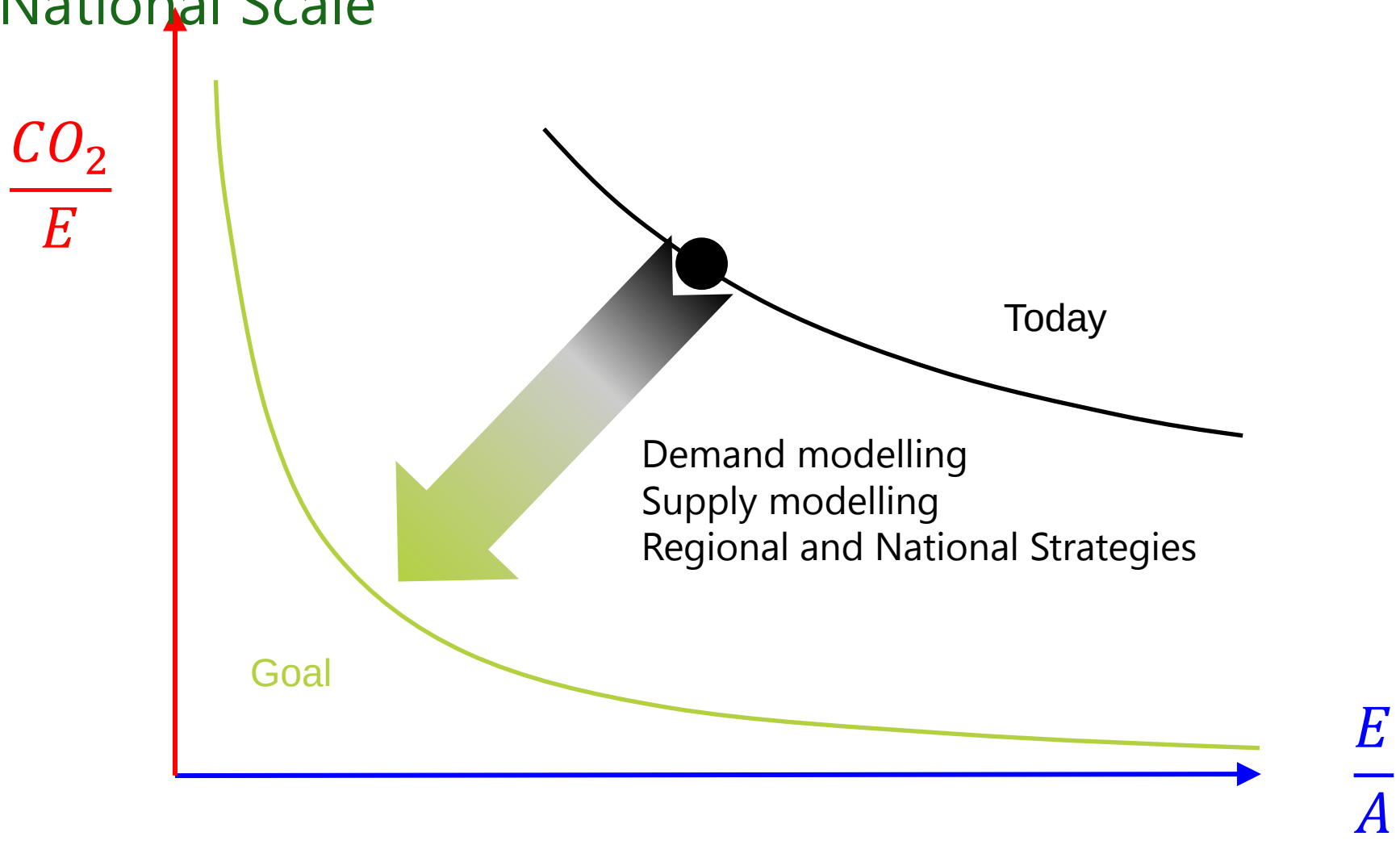
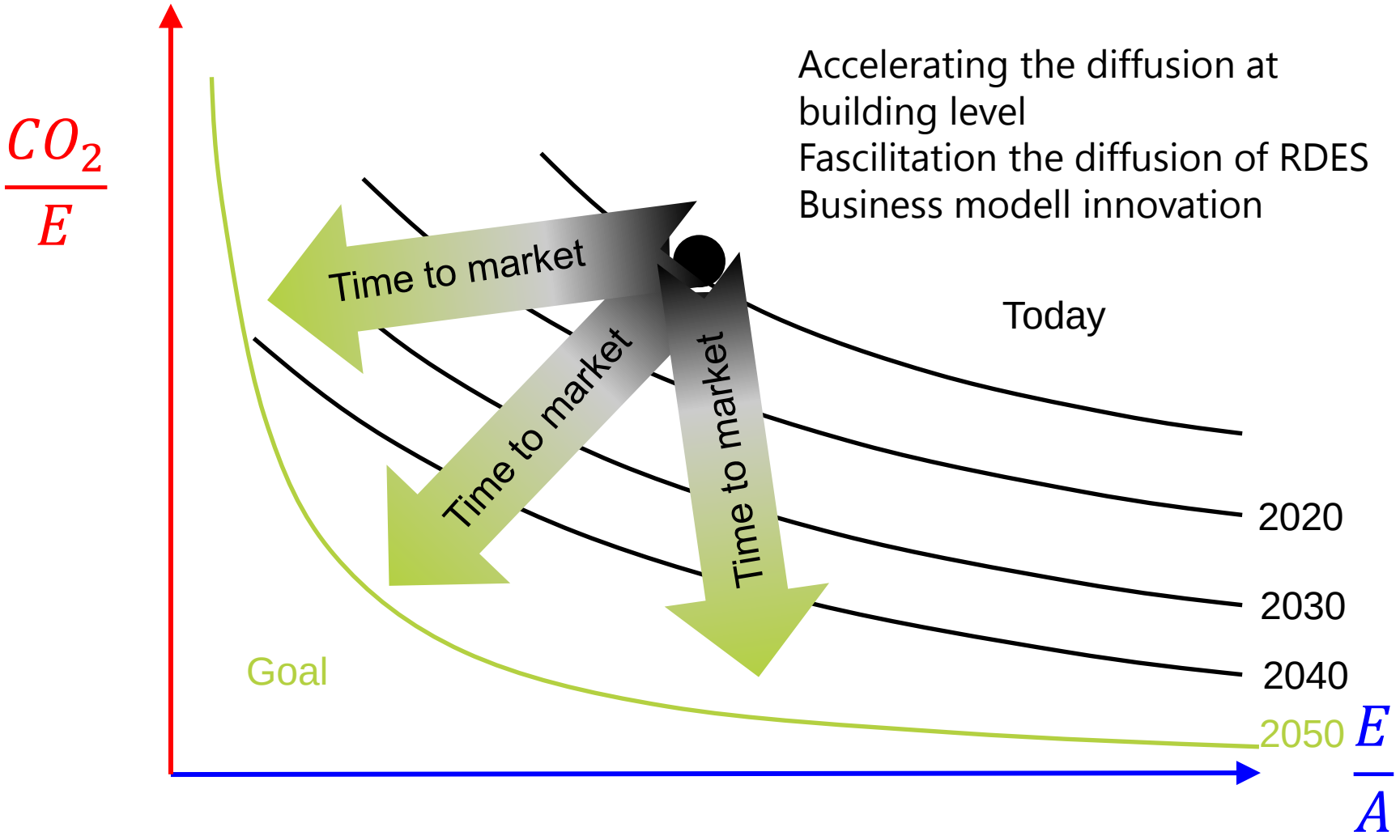


Outlook Phase II 2017 – 2020
Diffusion of FEEB&D Technologies



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Mavromatidis et al. 2016

Ist Suffizienz ein Thema
der Energieperspektiven?
(Umfang: 904 Seiten)

«Suffizienz»: 0 Nennungen

«Suffizient»: 0 Nennungen

«Suffizienstrategie»: 4 Nennungen

«Suffizienzeffekt»: 1 Nennung

Für nachhaltige Bauwerke, die

- Dauerhaft und solide sind

- Nützlich und funktionell

- Anmutig und schön

Vitruvius (1. Jahrhundert v. Chr.)