THE ROLE OF HEAT PUMPS IN THE TRANSFORMATION OF NATIONAL ENERGY SYSTEMS – EXAMPLE GERMANY

Hans-Martin Henning

Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany

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Rotterdam/
The Netherlands

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Nations Approve Landmark Climate Accord in Paris

New York Times (December 12, 2015)

COP21, Paris
December 2015

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Outline

GHG emissions and targets in Germany and Europe

Optimization of transformation – methodology

Results for selected scenarios

Transfer of results to heat pump technology

Summary & conclusions

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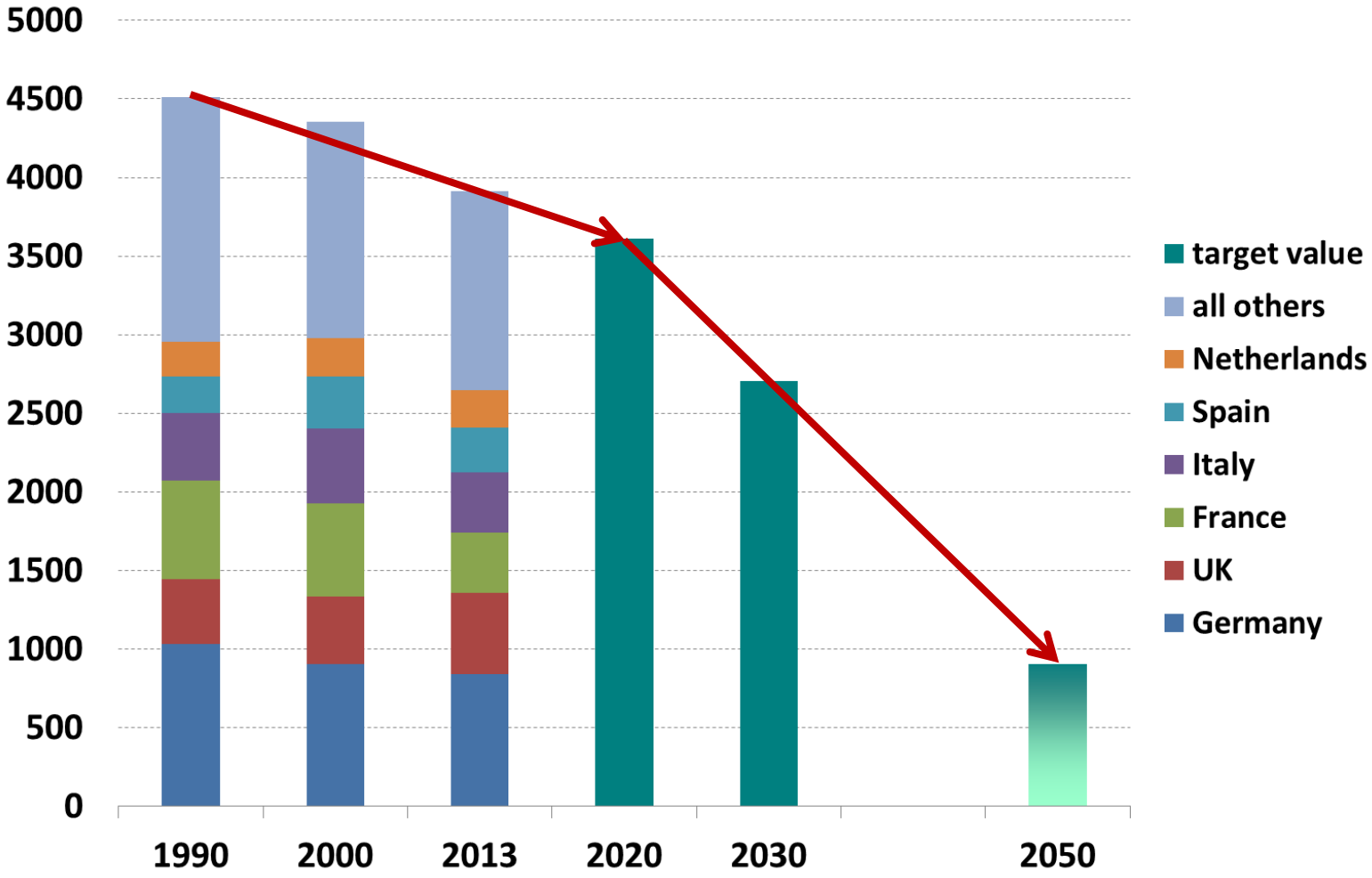
EU energy related CO_2 emissions – history and targets

Million tons



Based on data from: „Zahlen und Fakten. Energiedaten. Nationale und internationale Entwicklung – Überprüfungsdatum 2015-09-22“, BMWi 2015

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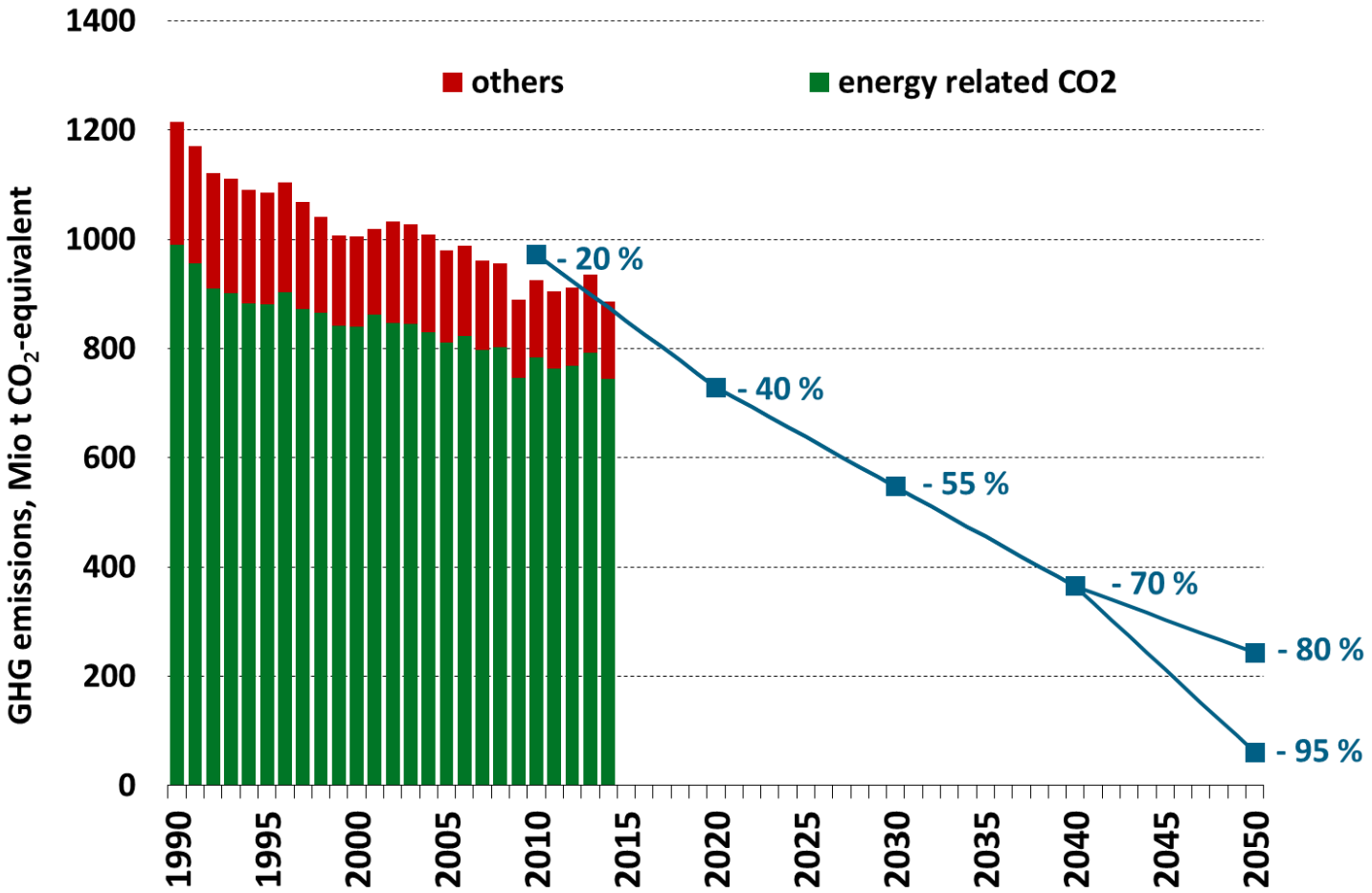
German GHG emissions

Historical values 1990-2014 and target values until 2050



Based on data from: Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen. Umweltbundesamt (UBA) Dessau, 29.5.2015

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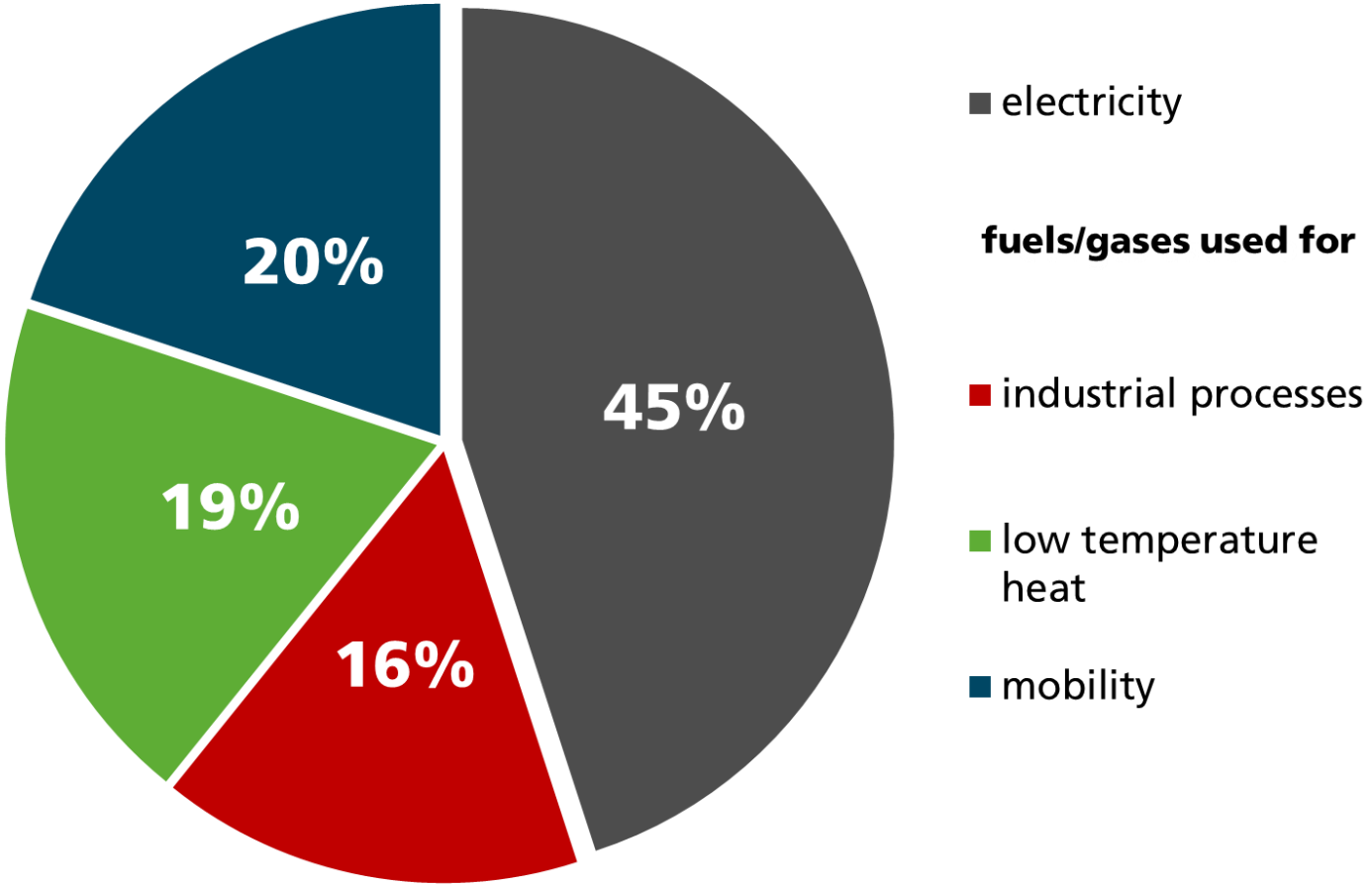
Energy related CO_2 emissions – Germany 2013



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Guiding question

What is the best, i.e. cost-optimized pathway to achieve

- the transformation of the energy system
- with consideration to all energy sources and all end-use sectors
- under the condition that the declared climate targets are met in the target year 2050 and in every year until 2050?

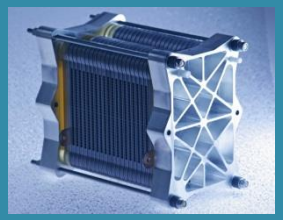
Renewable Energy Model »REMod«

Mimimize total annual costs →

Strictly model-based *techno-economic optimization of energy system transformation pathways* based on comprehensive simulation of national energy systems (hourly time scale) including all end-use sectors

Electricity generation and storage

Fuels (including biomass and synthetic fuels from RE)



Mobility (incl. all possible concepts including hybrid)

Heat (buildings, incl. Storage and district heating)

Processes in industry and tertiarty sector

Source:
https://www.ise.fraunhofer.de/en/publications/studies/what-will-the-energy-transformation-cost.html

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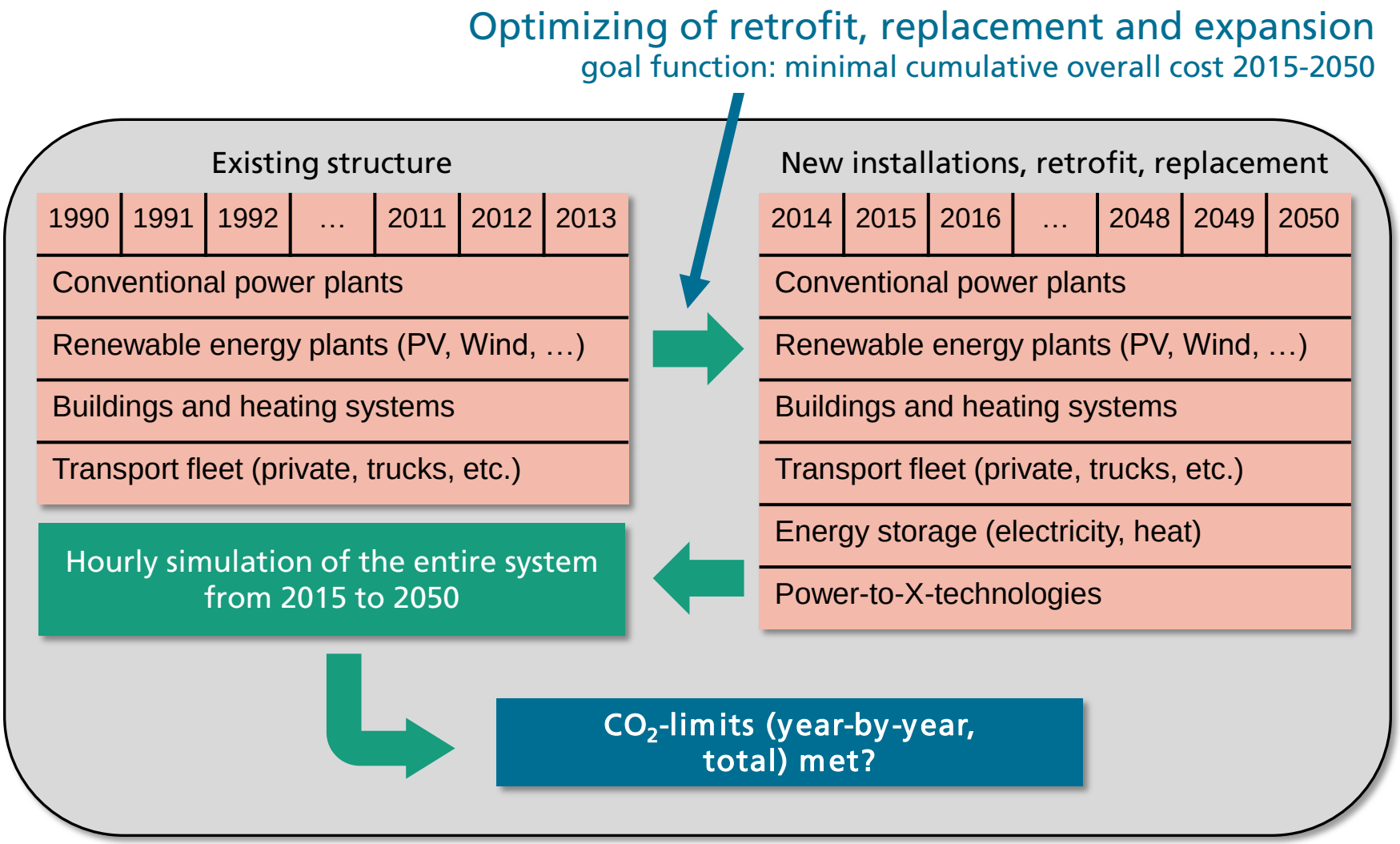
Methodology



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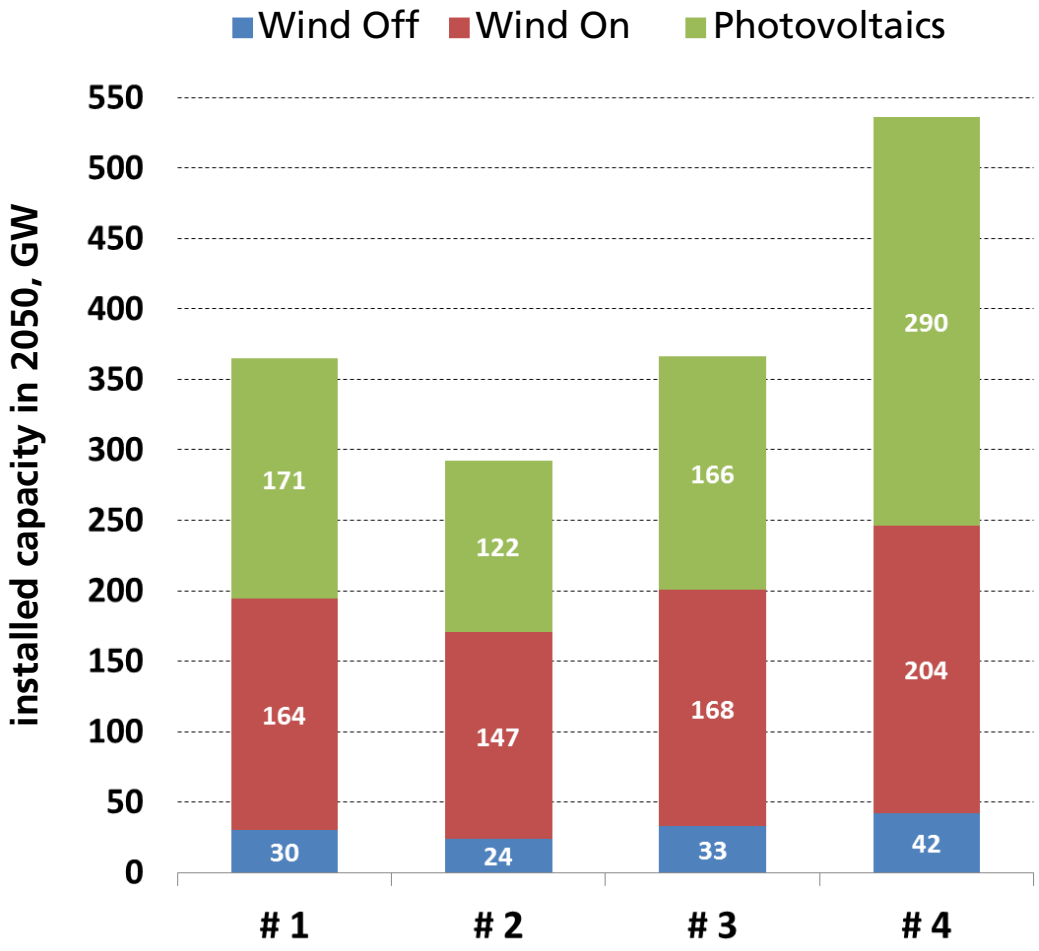
Scenario results (Germany)
Wind and PV in the year 2050



#1 -80 % CO_2, phase-out of coal not accelerated

#2 -80 % CO_2, phase-out of coal accelerated

#3 -85 % CO_2, phase-out of coal accelerated

#4 -90 % CO_2, phase-out of coal accelerated

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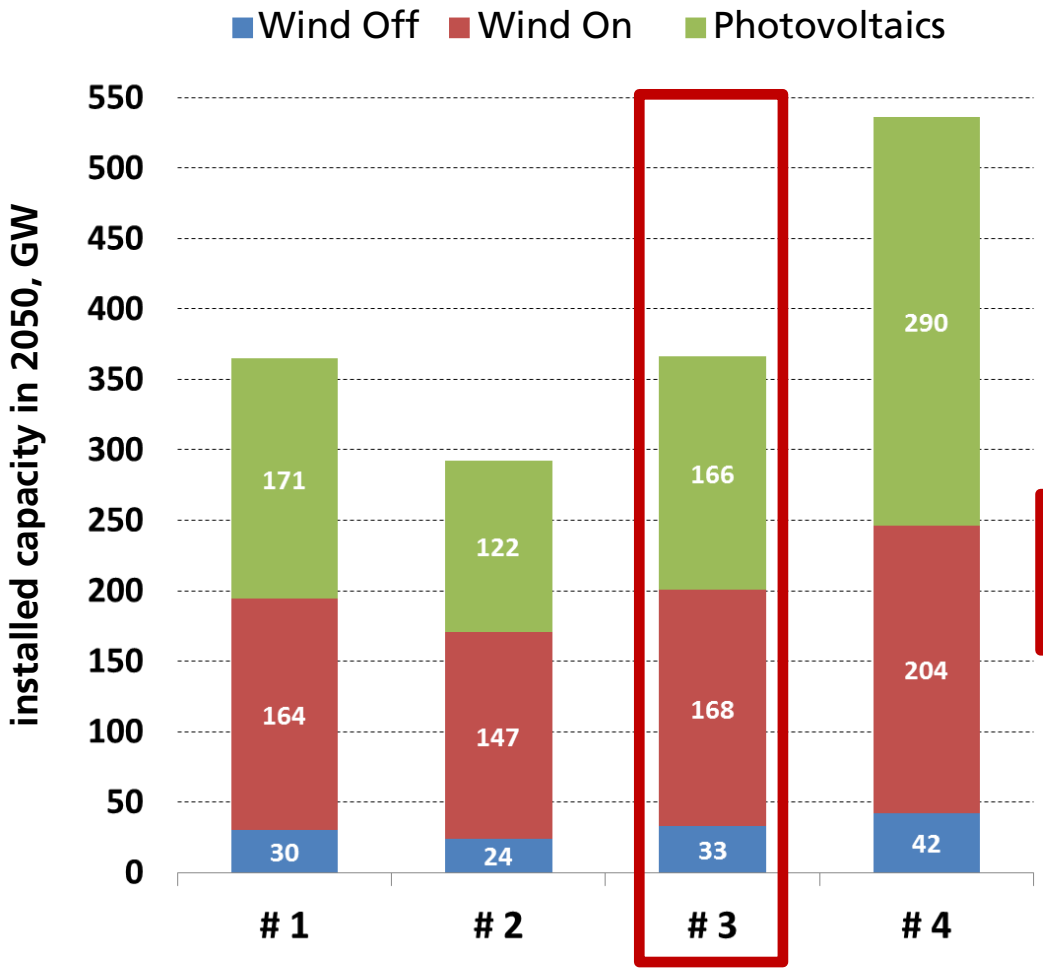

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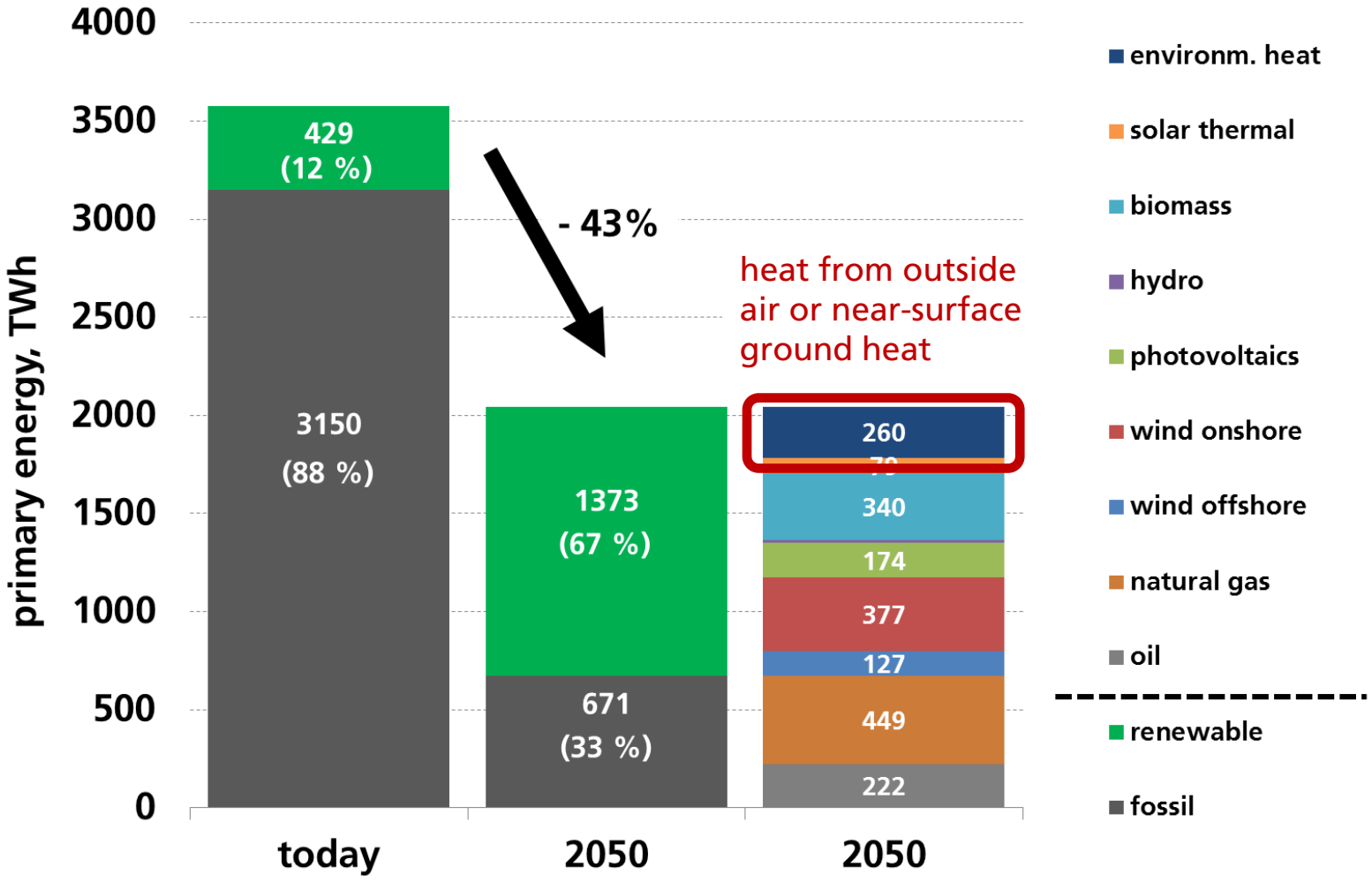
Primary energy 2050 (compared with 2013)
– 85 % - Scenario



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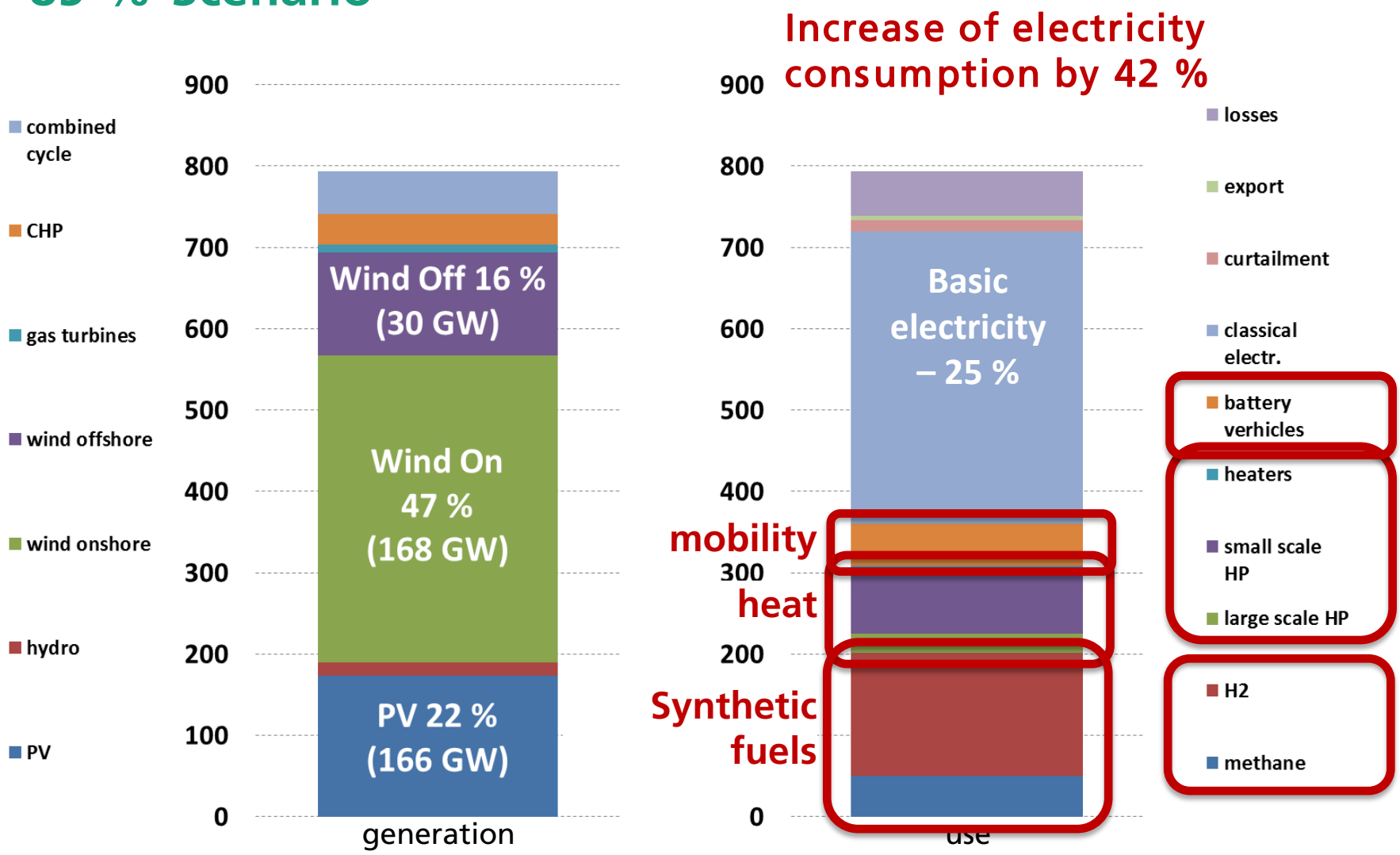
Electricity generation and use
– 85-%-Scenario



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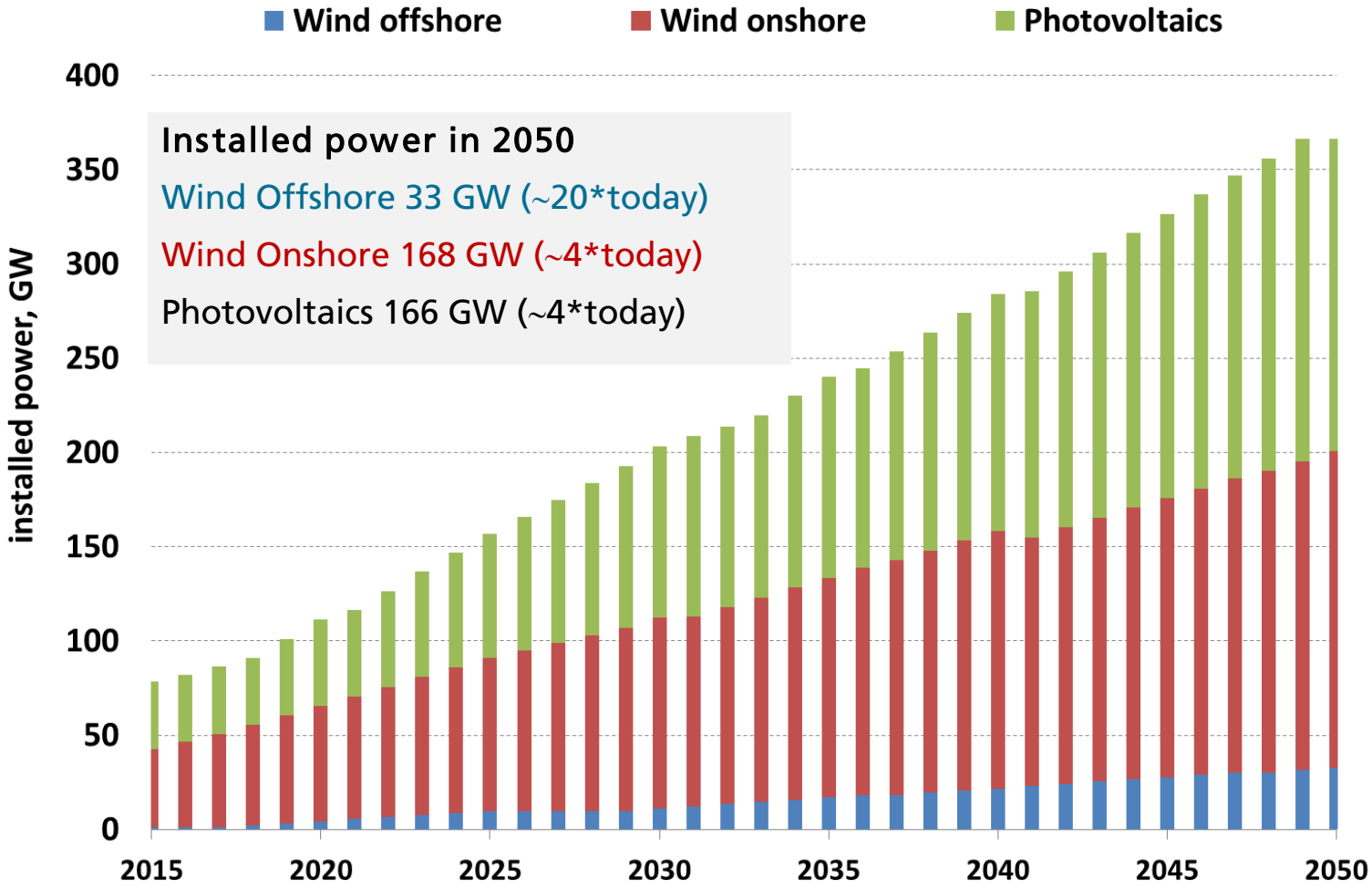
Wind and PV
– 85-%-Scenario



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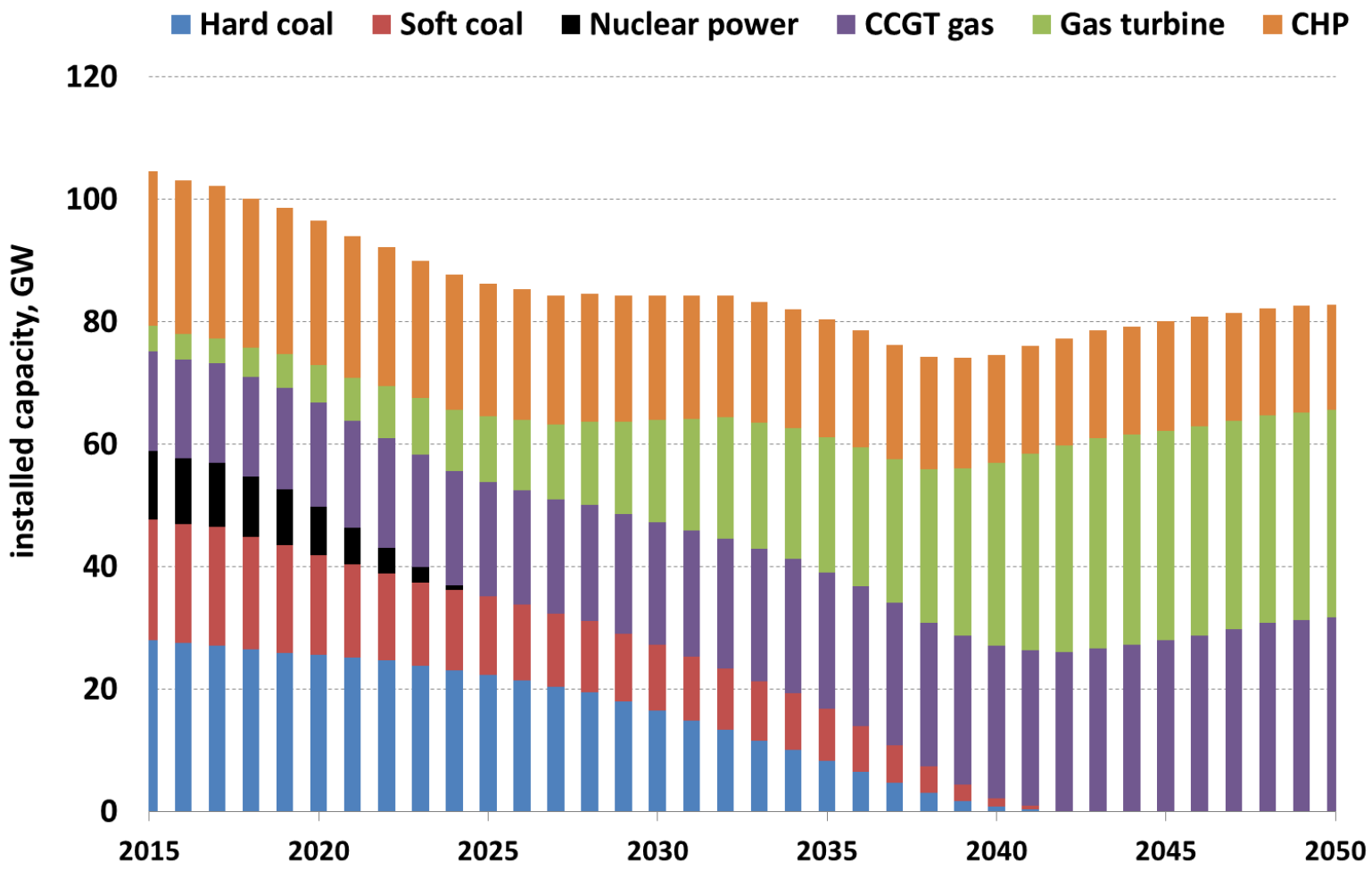
Conventional power plants and CHP
– 85-%-Scenario



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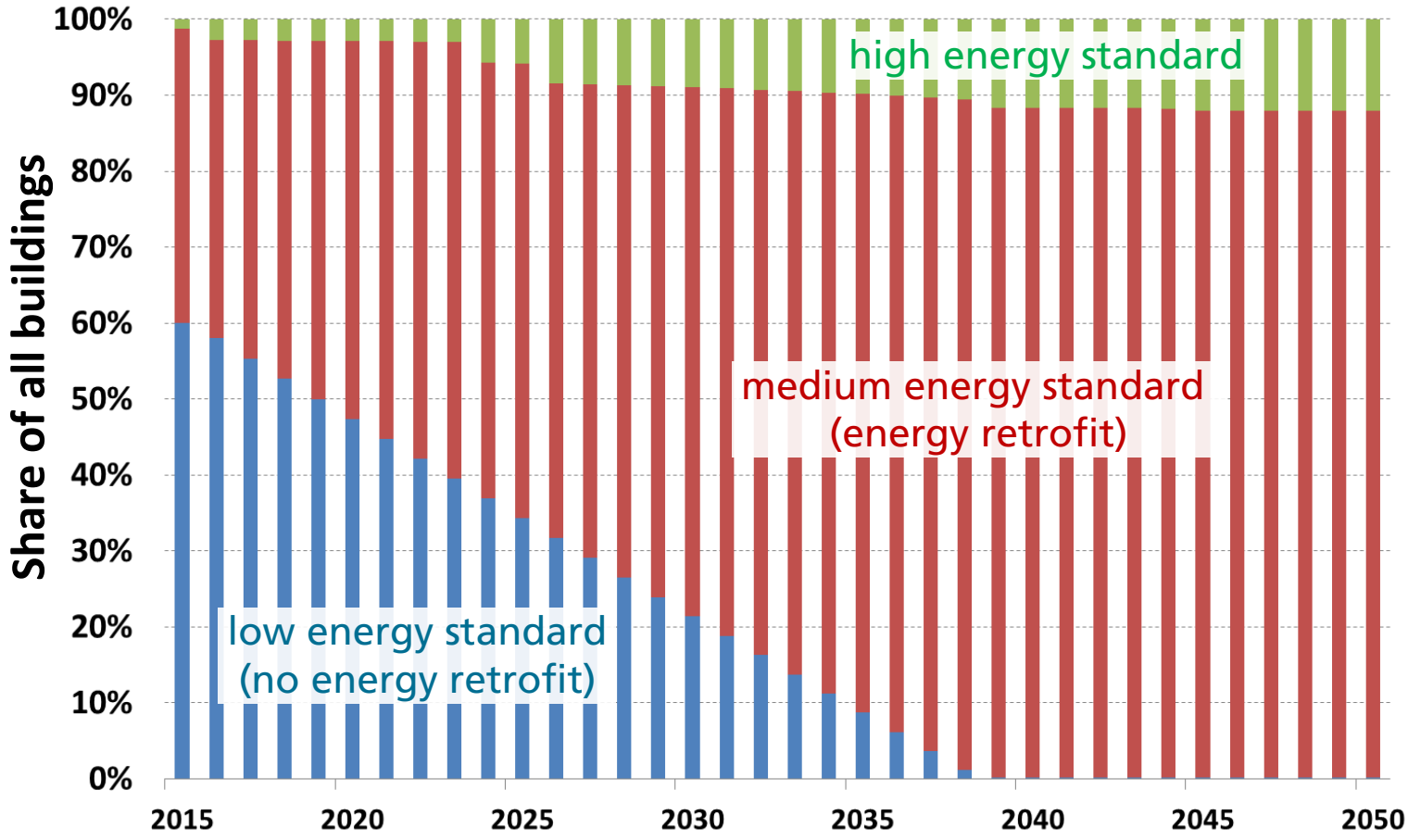
Energy standard of buildings
– 85-%-Scenario



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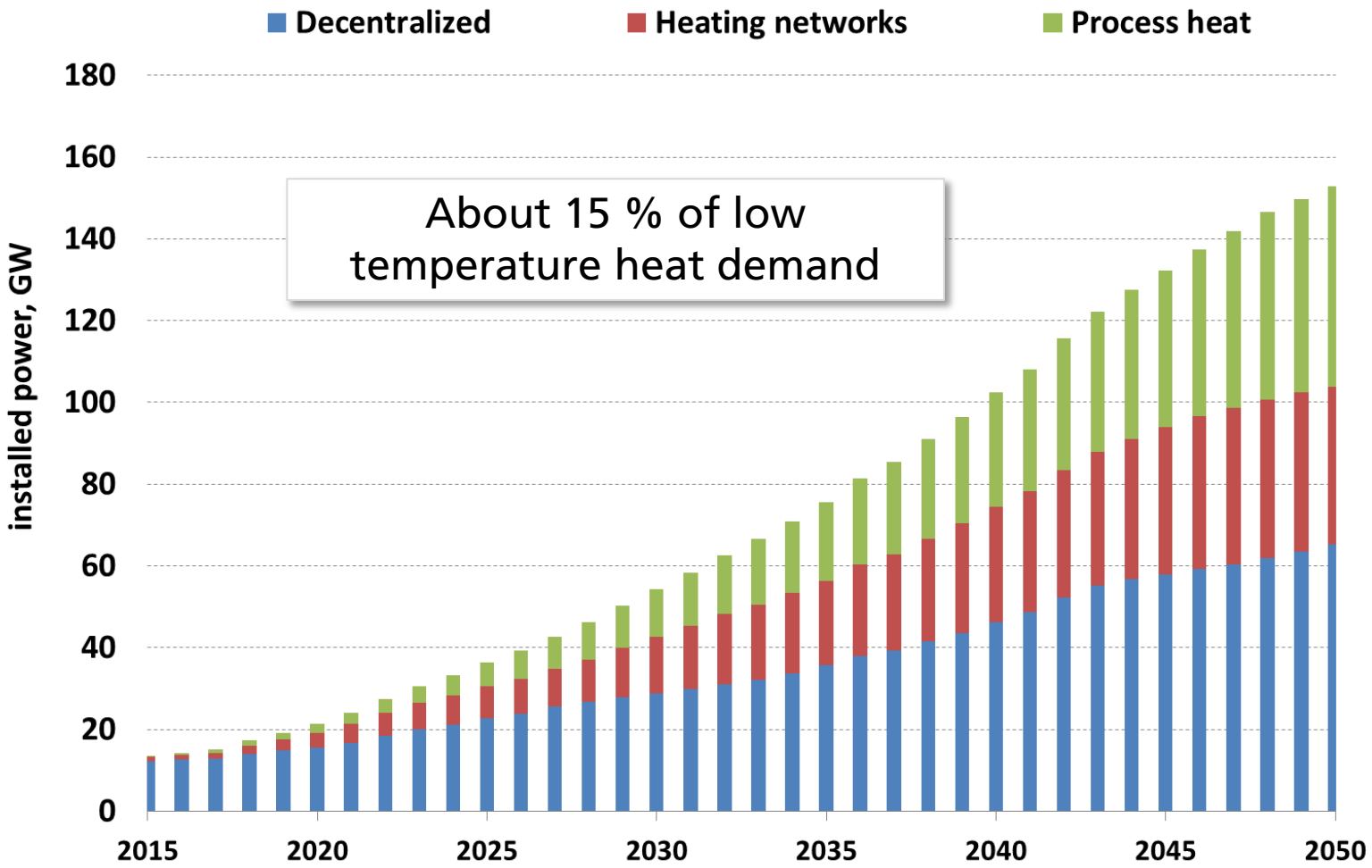
Low temperature solar thermal
– 85-%-Scenario



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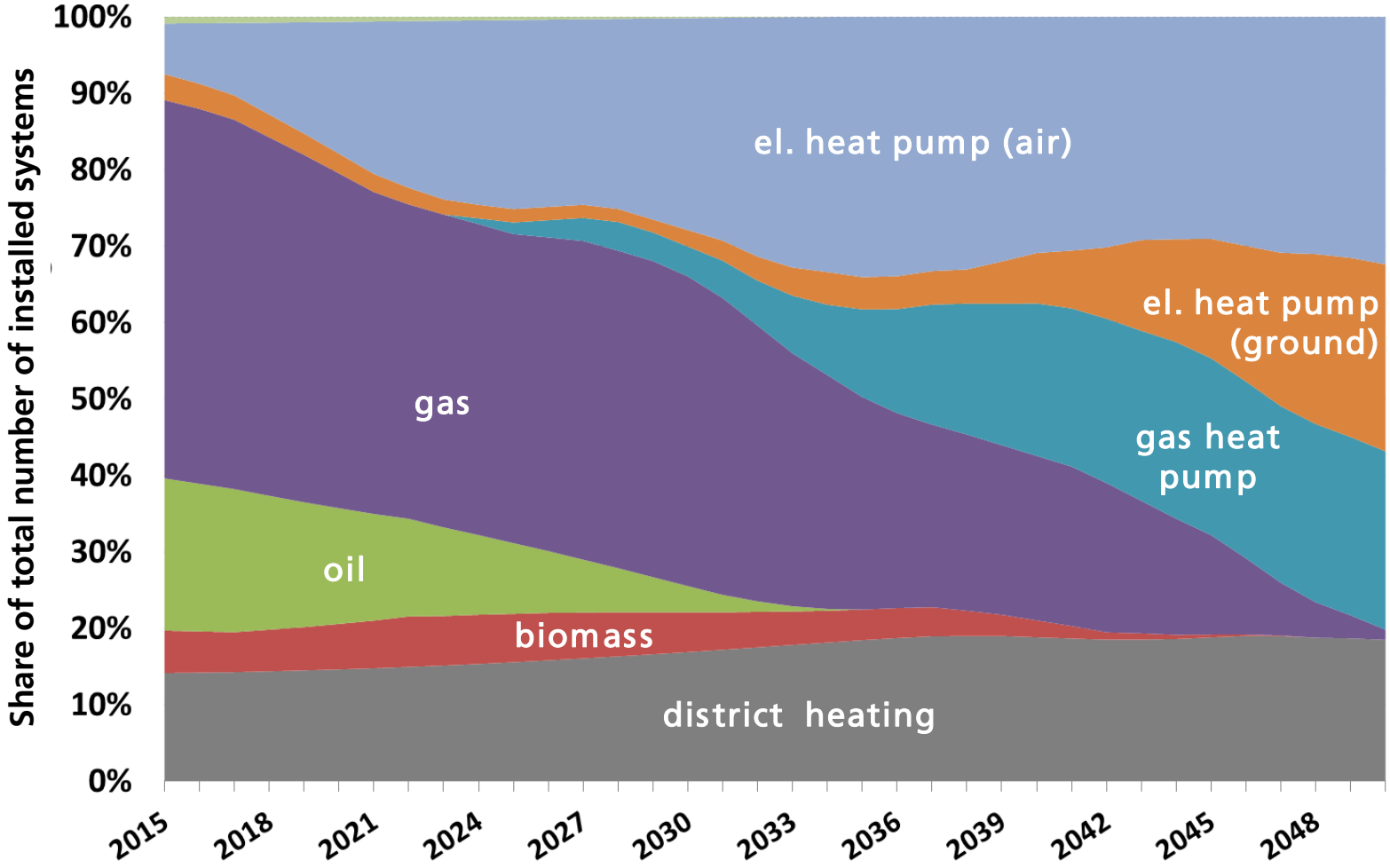
Heating technologies
– 85-%-Scenario



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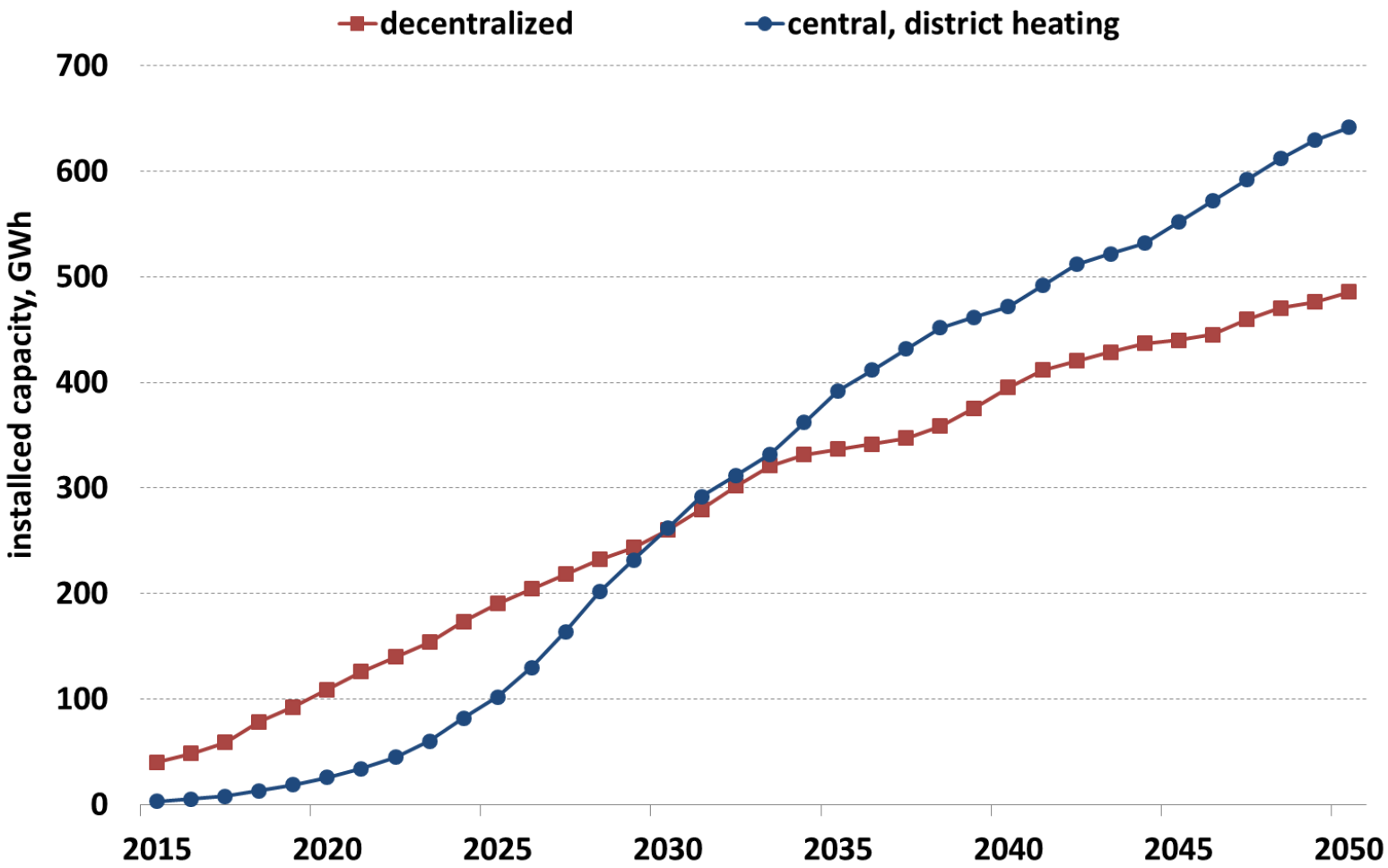
Heat storage
– 85-%-Scenario



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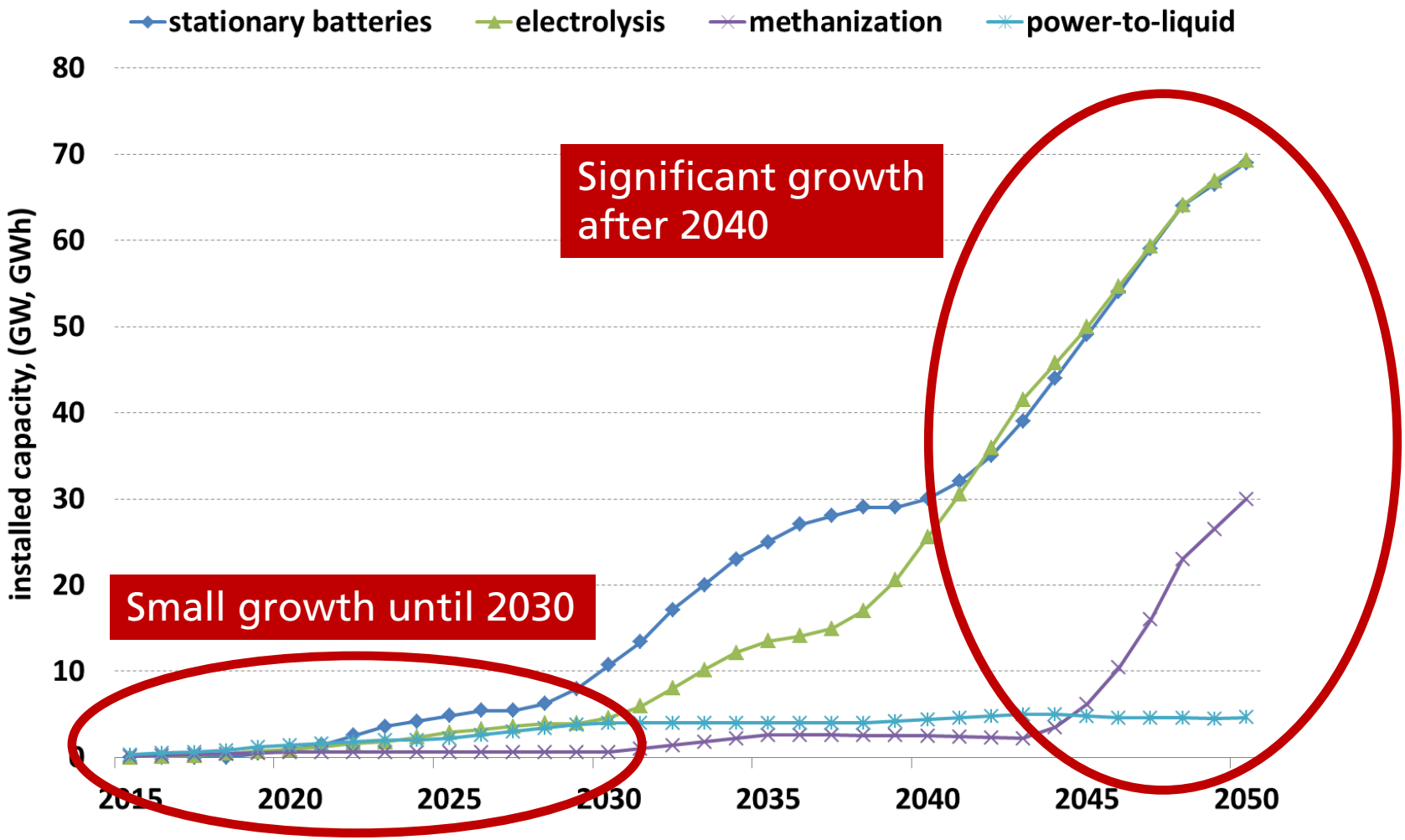
Stationary batteries and power-to-fuel converters

-85% Scenario



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Transfer of results to heat pump technology

- An increased integration of energy sectors is required in order to achieve GHG targets (i.e. electrictiy & heat, electricity & mobility)
- From a overall system perspective heat pumps should be the dominating future heating technology
- However, many barriers, threats and challenges exist, that hamper such development
- Measures have to be taken in order to support an increased, sustainable market deployment of heat pump systems

Barriers/threats/challenges and how to adress them /1/

Temperature levels and related efficiency drops	■ Heat pumps are priority in new buildings ■ HPs in existing buildings after energy retrofit with lowering of supply Temp's ■ High efficient, high temperature HPs

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Temperature levels and related efficiency drops	■ Heat pumps are priority in new buildings ■ HPs in existing buildings after energy retrofit with lowering of supply Temp's ■ High efficient, high temperature HPs
In the next years HPs still rely on large amounts of electricity from fossile sources	■ Assuring high quality of electric heat pumps ■ Hybrid heat pumps ("fuel" switch)
Maximum (residual) peak capacity on cold winter days; electricity grid limitations	■ Heat storage ■ Hybrid heat pumps ("fuel" switch) ■ Gas heat pumps

Barriers/threats/challenges and how to adress them /2/

F-gases regulation (phase down of HFCs)	■ Natural refrigerants (e.g. hydrocarbons for domestic HPs) ■ Reduction of refrigerant charge

Barriers/threats/challenges and how to adress them /2/

F-gases regulation (phase down of HFCs)	■ Natural refrigerants (e.g. hydrocarbons for domestic HPs) ■ Reduction of refrigerant charge
High quality; high customer satisfaction; sustainable market deployment	■ Large-scale monitoring campaigns ■ Guaranteed results schemes ■ Large campaigns for installer education

Barriers/threats/challenges and how to adress them /2/

F-gases regulation (phase down of HFCs)	■ Natural refrigerants (e.g. hydrocarbons for domestic HPs) ■ Reduction of refrigerant charge
High quality; high customer satisfaction; sustainable market deployment	■ Large-scale monitoring campaigns ■ Guaranteed results schemes ■ Large campaigns for installer education
Heat pump solutions required for district heating networks	■ Flexible, dynamic operation of large capacity heat pumps ■ HP-CHP (combined heat & power) hybrid solutions

Barriers/threats/challenges and how to adress them /3/

New markets: multi-family houses, tertiary buildings	■ Medium and large capacity heat pumps ■ Special solutions for sanitary hot water ■ Solutions for dense urban spaces (e.g. heat source, acoustics)

Barriers/threats/challenges and how to adress them /3/

New markets: multi-family houses, tertiary buildings	■ Medium and large capacity heat pumps ■ Special solutions for sanitary hot water ■ Solutions for dense urban spaces (e.g. heat source, acoustics)
Need for smart solutions (smart grids; grid-friendly building operation)	■ Variable tariffs for stimulating load shifts ■ Application of storage ■ Hybrid heat pumps (“fuel” switch)

Barriers/threats/challenges and how to adress them /3/

New markets: multi-family houses, tertiary buildings	■ Medium and large capacity heat pumps ■ Special solutions for sanitary hot water ■ Solutions for dense urban spaces (e.g. heat source, acoustics)
Need for smart solutions (grid-friendly buildings); avoiding winter peak loads	■ Variable tariffs for stimulating load shifts ■ Application of storage ■ Hybrid heat pumps (“fuel” switch)
Uneven taxes and other fees for electricity and fossil fuel (oil, natural gas)	Implementation of policies that imply a cost burden for all energy sectors strictly linked to GHG emissions (e.g. EU ETS, taxes)

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- Transformation of energy systems in line with GHG emission reduction targets technically feasible and cost competetive once transformation concluded
- Renewable energies (solar, wind) become dominant for electrictiy generation and importance of electric energy increases
- Technologies which become highly important are: storage (heat, electricity), power electronics, highly dynamic residual electricity generation, electrolysis, carbon capture technologies, synthetic fuel & chemistry technologies, heat pumps
- Although system analysis shows the high importance of heat pumps their increased market deployment is not an automatism
- Many measures are needed in order to assure a long-term sustainable development of heat pump markets and technologies

Many thanks for your attention…

Fraunhofer Institute for Solar Energy Systems ISE

Hans-Martin Henning

www.ise.fraunhofer.de
hans-martin.henning@ise.fraunhofer.de