

# ECOFYS

sustainable energy for everyone



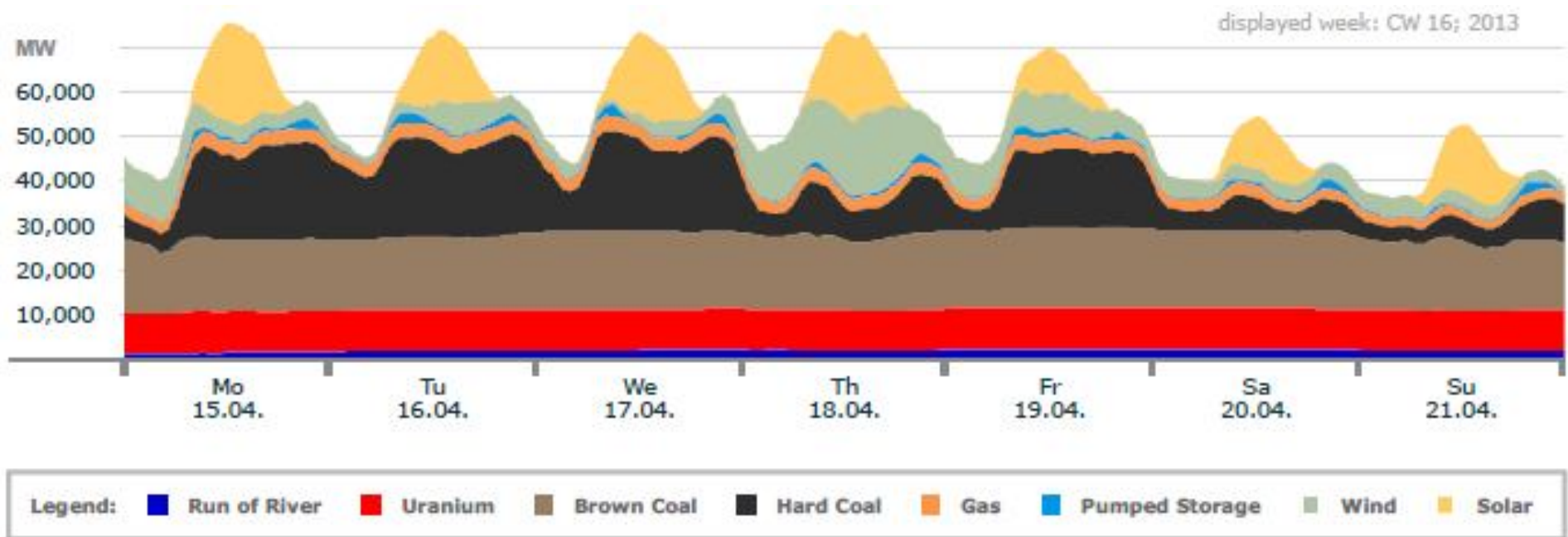
100% duurzame energie in 2050 –  
hoe matchen we vraag en aanbod?

Kornelis Blok

24/04/2014

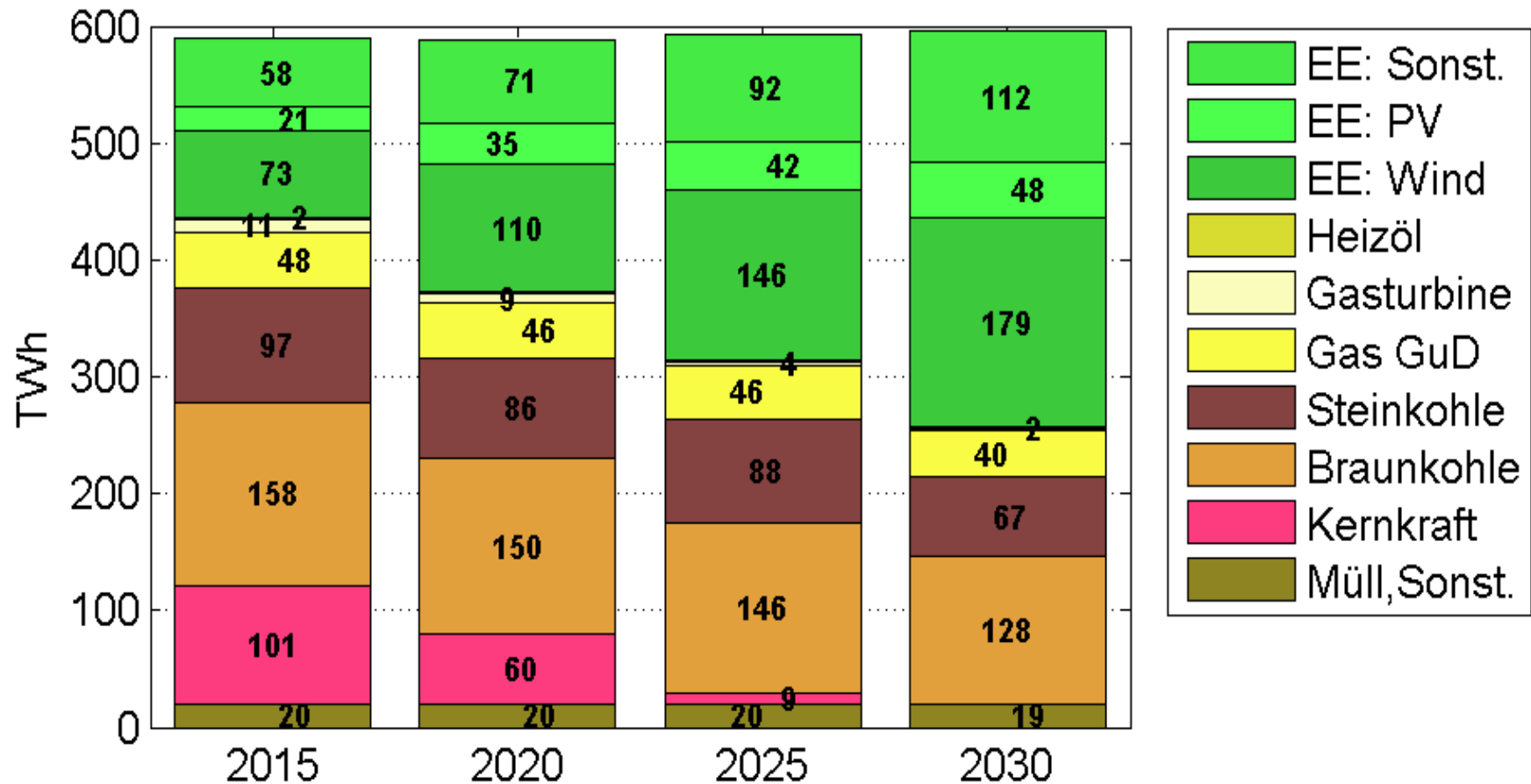
# Inzet elektriciteitscentrales in Duitsland

(derde week april, 2013)



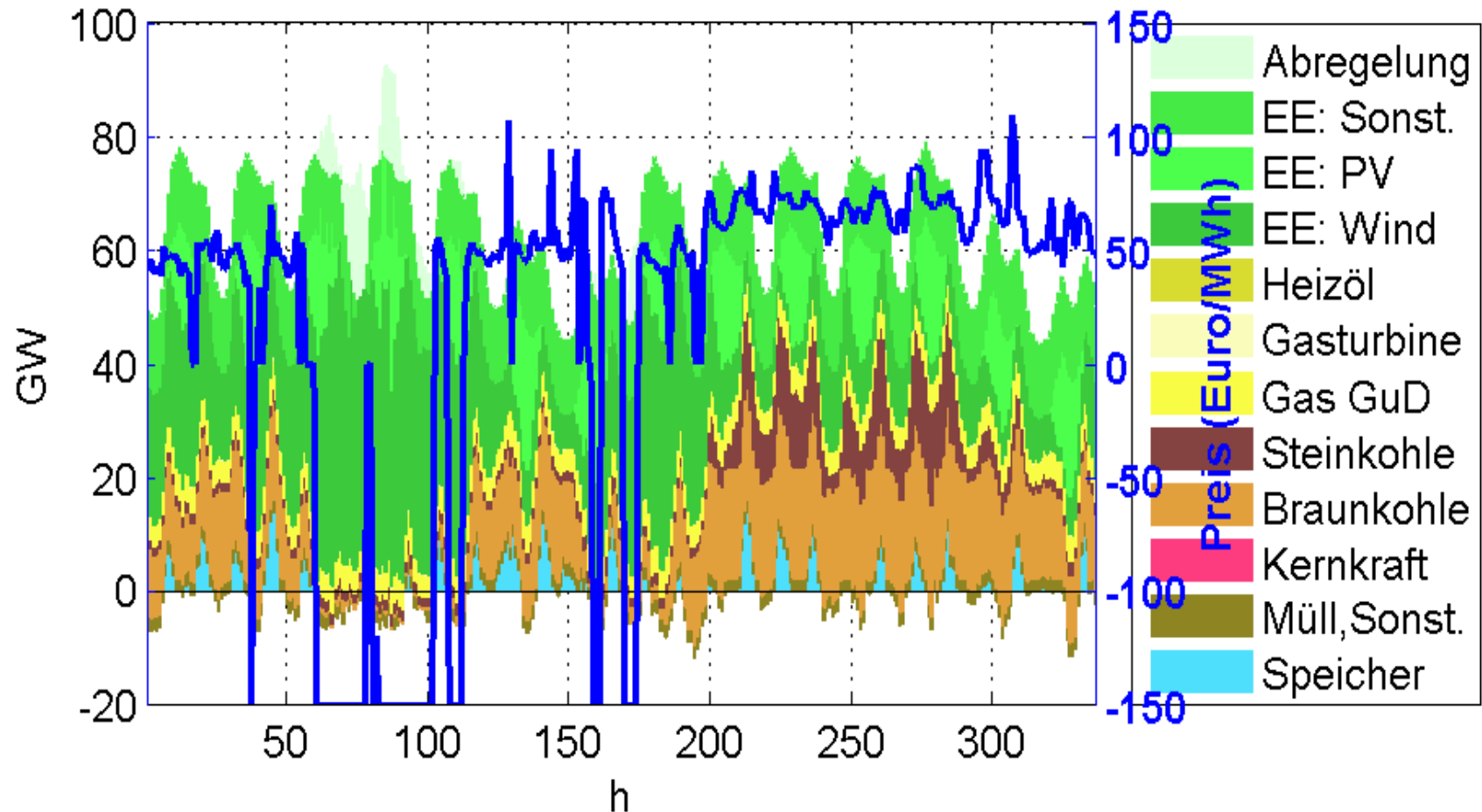
Source: Bruno Burger, Fraunhofer ISE, 2013

## A scenario for 2030 (Germany)



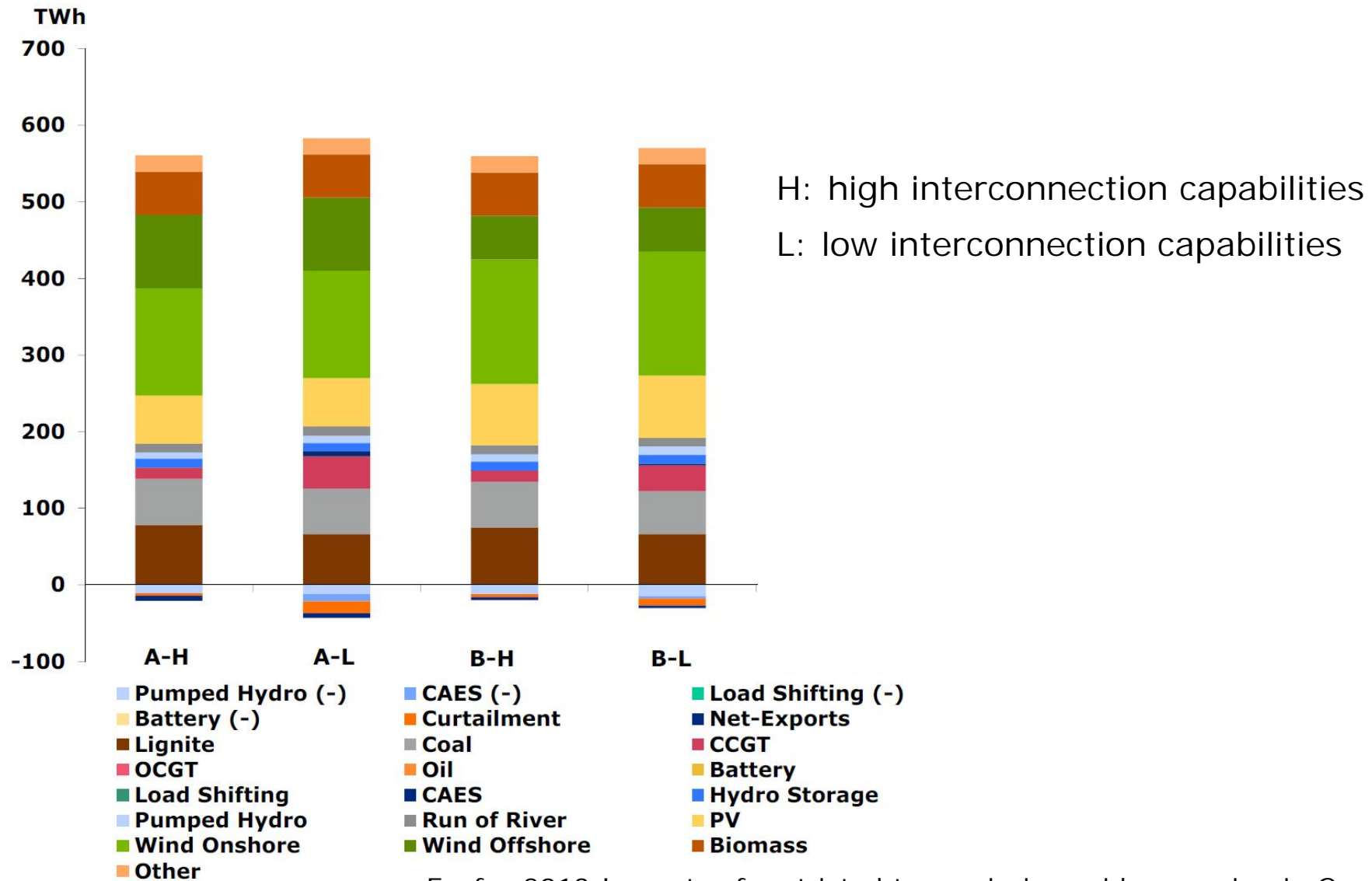
Nabe et al., Ecofys, 2012, Preisauswirkungen der Erneuerbaren Energien auf den deutschen Strommarkt

# Power plant dispatch and prices in 2030 (week 35/36)



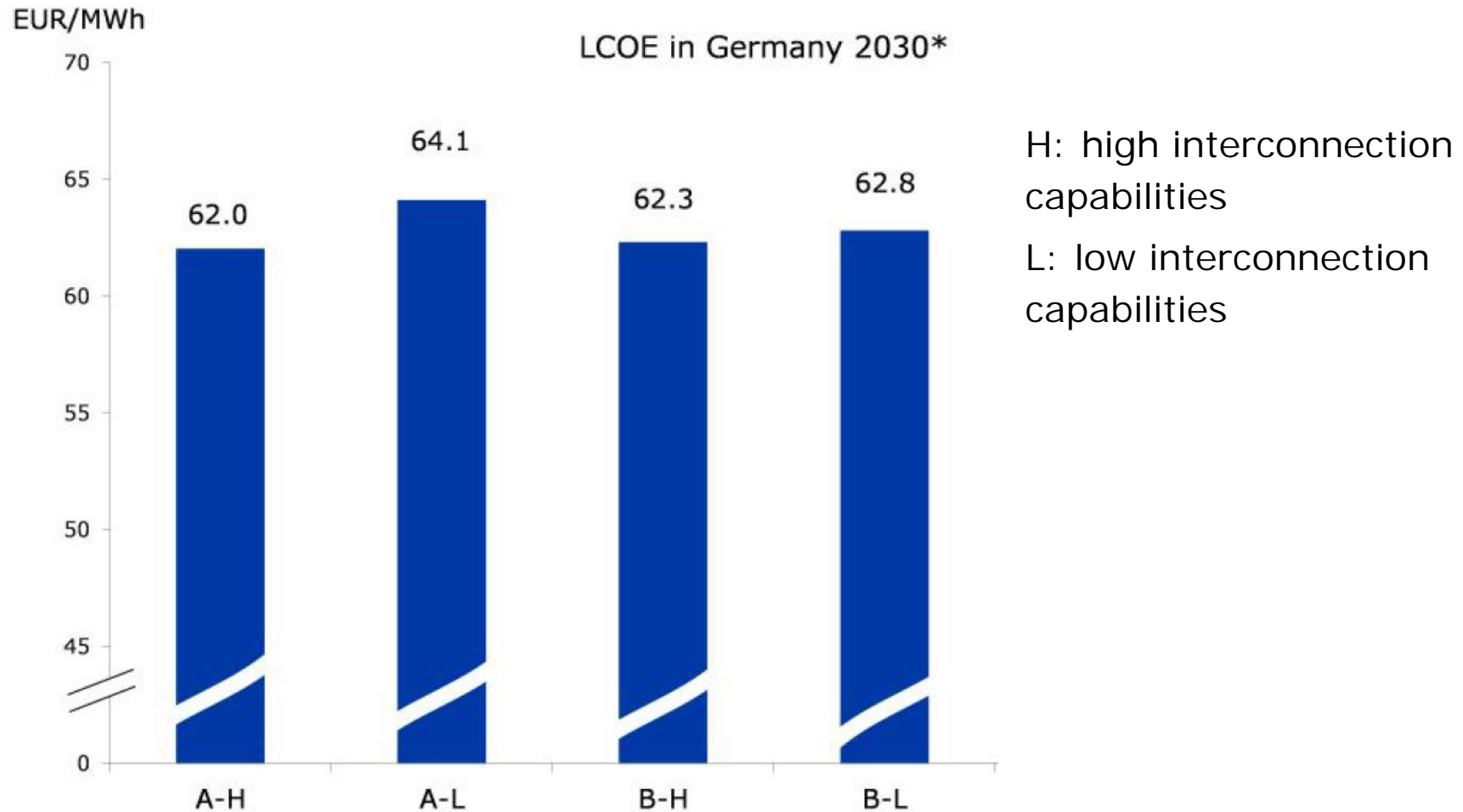
Nabe et al., Ecofys, 2012, Preisauswirkungen der Erneuerbaren Energien auf den deutschen Strommarkt

# Impact of limited grid expansion in Germany 2030



Ecofys 2013 Impacts of restricted transmission grid expansion in Germany

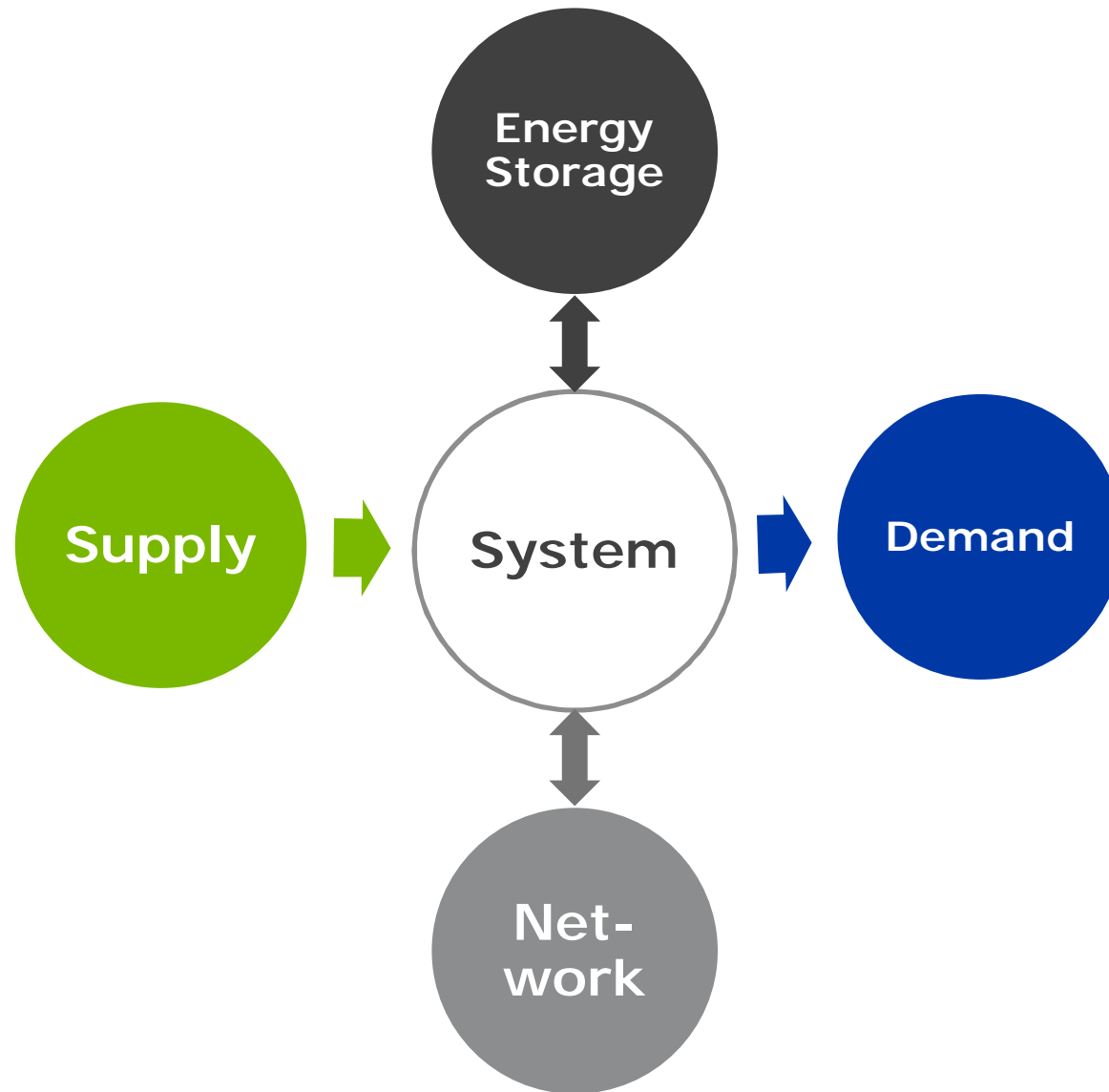
# Impact of limited grid expansion in Germany 2030



Ecofys 2013 Impacts of restricted transmission grid expansion in Germany

# Flexibility options for power systems

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# Two case studies for 2050

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## 1. Germany only

- using excesses for hydrogen and methane production
- By Fraunhofer IWES, Kassel

## 2. Europe wide

- making maximum use of a strong European grid
- By Fraunhofer ISI, Karlsruhe



# Two case studies for 2050

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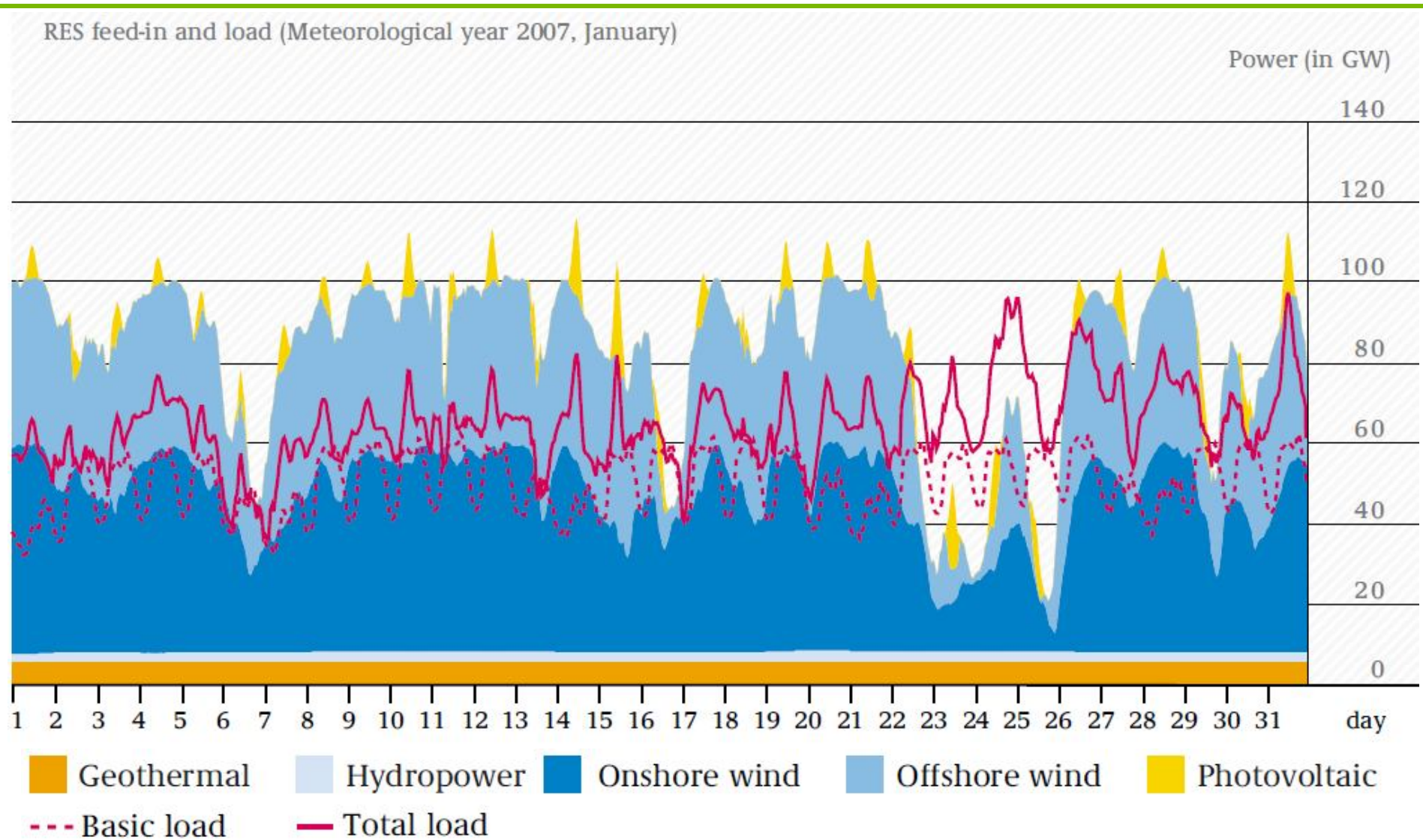
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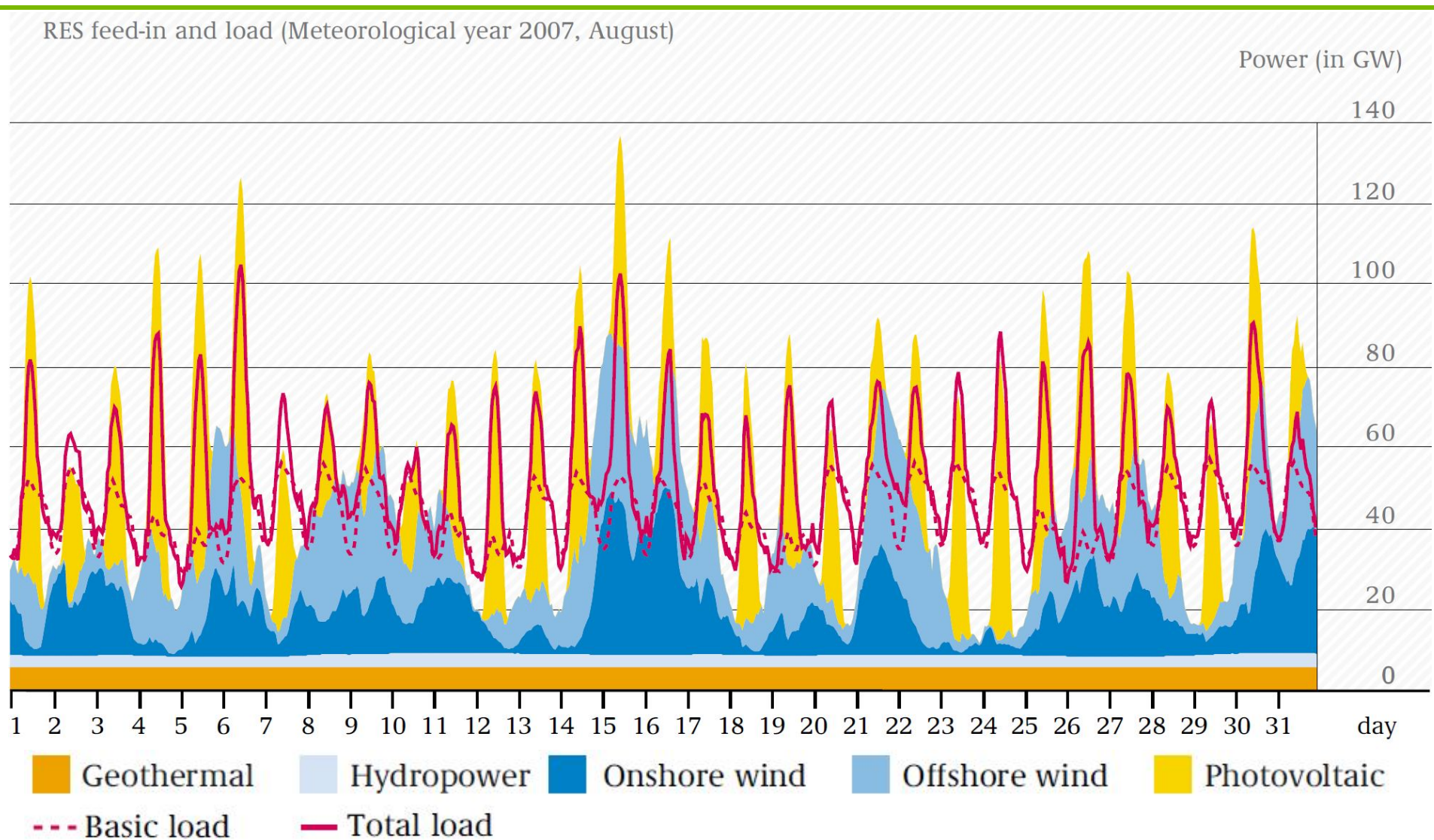
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# Renewable energy production and load pattern



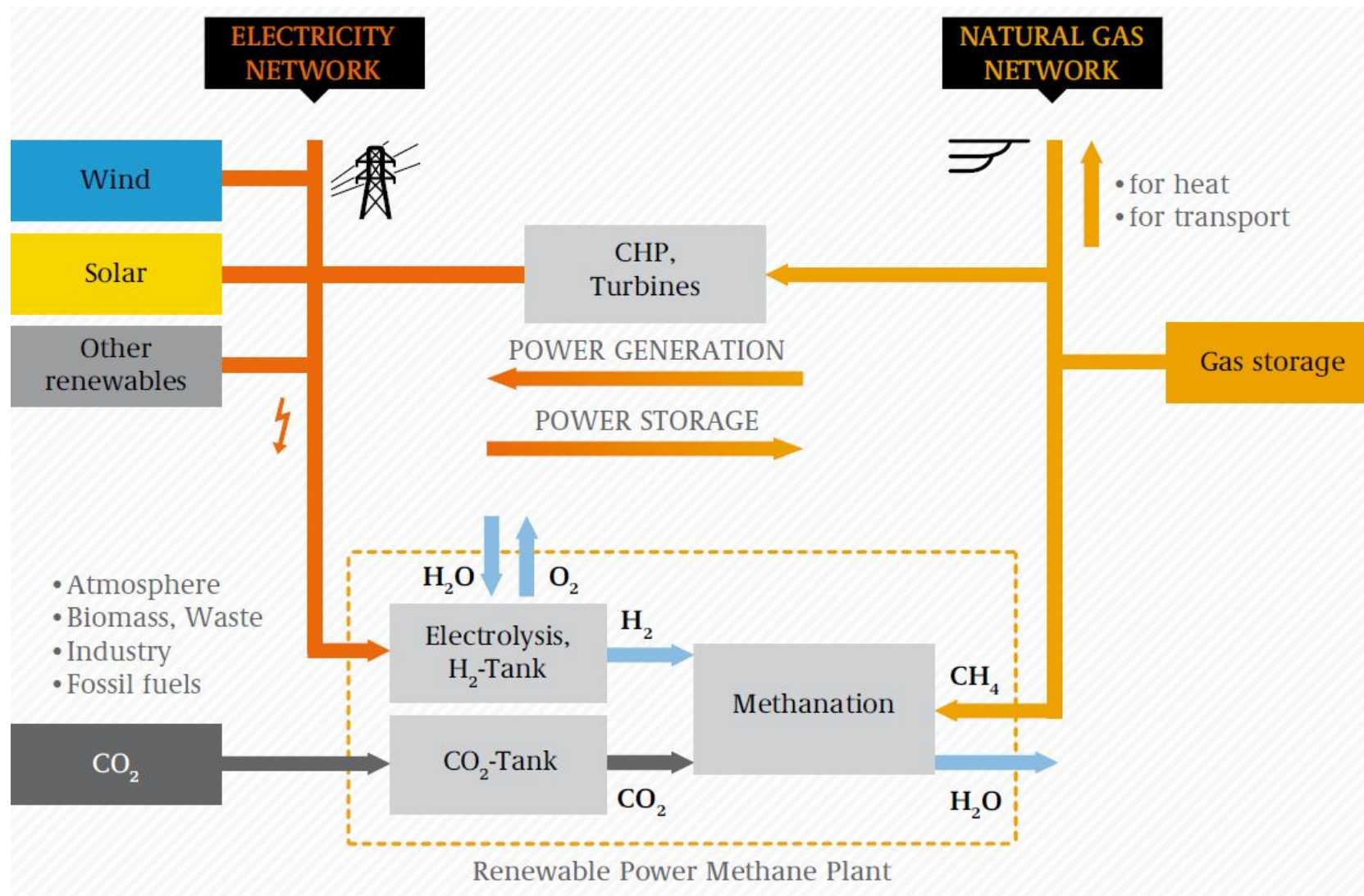
Energy Target 2050: 100% Renewable Energy Supply, Fraunhofer-IWES, 2010

# Renewable energy production and load pattern



Energy Target 2050: 100% Renewable Energy Supply, Fraunhofer-IWES, 2010


# German power system, 2050



Energy Target 2050: 100% Renewable Energy Supply, Fraunhofer-IWES, 2010

# Electricity balance 2050

	2006	2007	2008	2009	Average
<b>Generation</b>					
Total RES (259.9 GW)	523.5	555.3	544.6	514.1	534.4
Pump storage (turbine)	5.8	5.9	6.1	6.1	6.0
Reconversion H <sub>2</sub>	45.1	31.1	30.4	45.7	38.1
Imports	26.0	19.7	20.7	24.9	22.8
<b>Demand</b>					
Basic load	401.0	401.0	403.3	401.0	401.6
Air-conditioning	13	8.9	8.9	9.3	10.0
e-personal vehicles	50	50.0	50.0	50.0	50.0
Heat pumps	44	34.6	38.2	43.3	39.9
Pump storage (pump)	7.7	7.9	8.1	8.2	8.0
Electrolysis	84	108.3	92.8	77.4	90.5
<b>Curtailment of excess supply</b>	<b>1.8</b>	<b>1.4</b>	<b>0.4</b>	<b>1.2</b>	<b>1.2</b>



Energy Target 2050: 100% Renewable Energy Supply, Fraunhofer-IWES, 2010

# Two case studies for 2050

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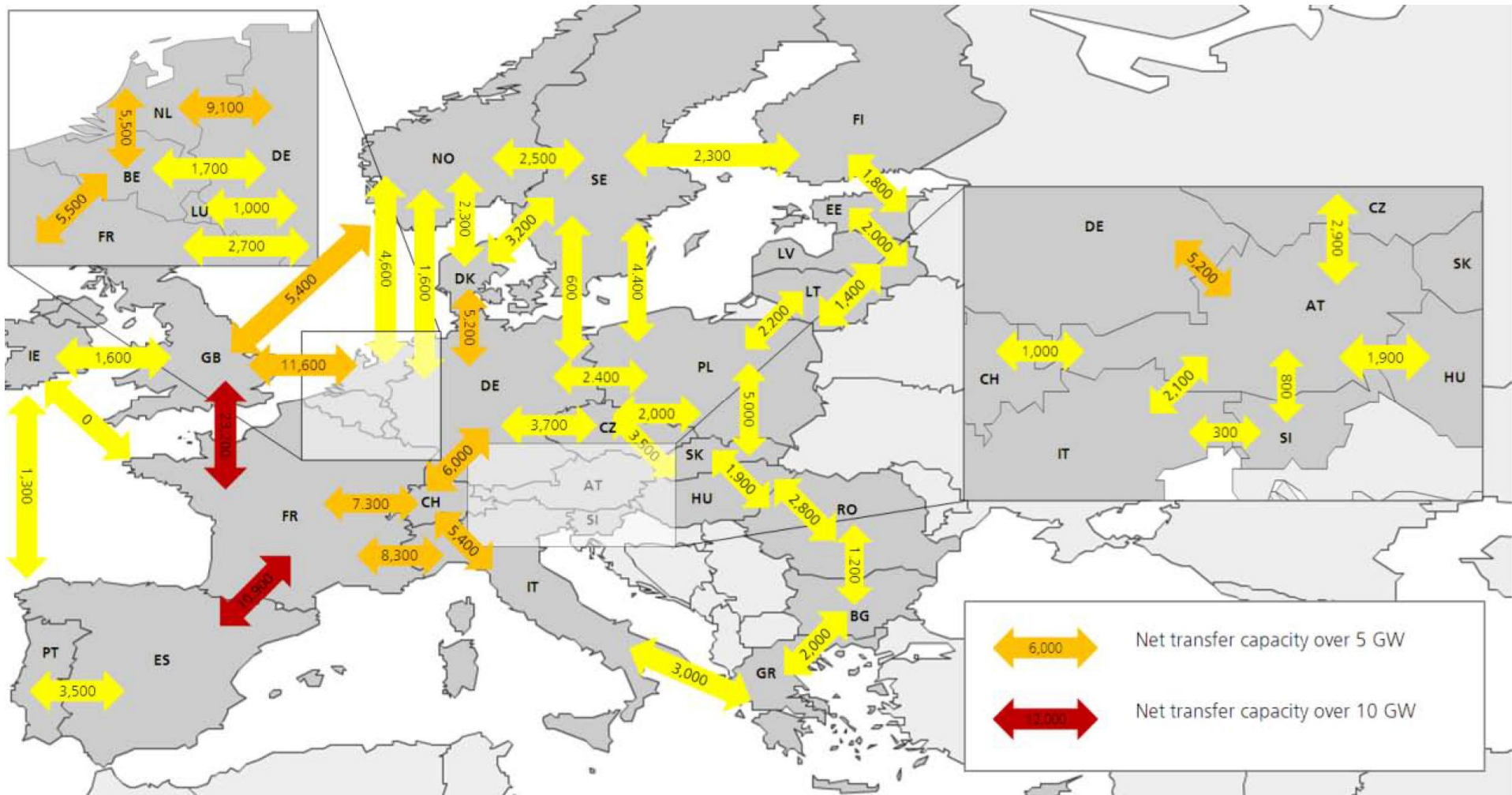
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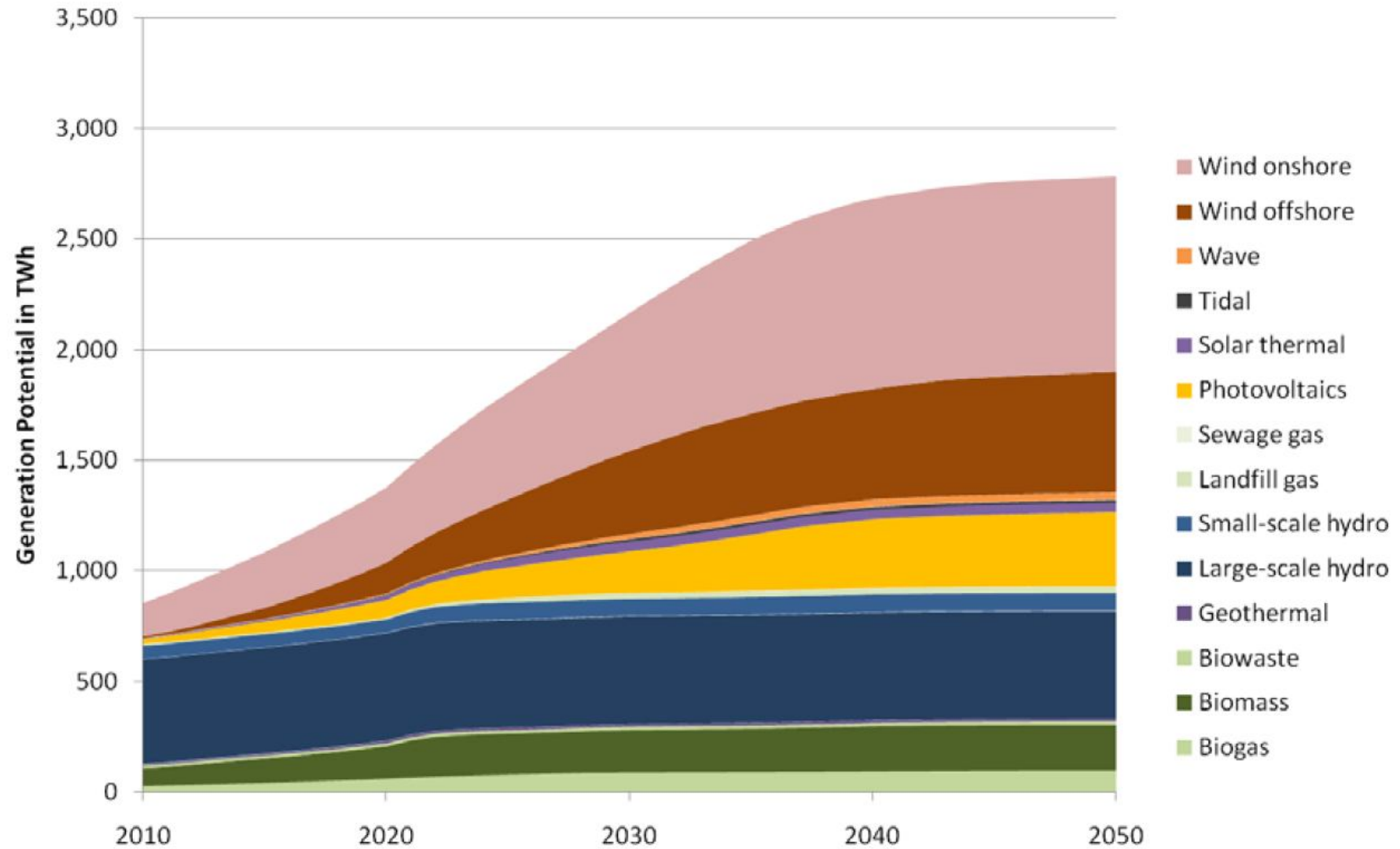
- making maximum use of a strong European grid
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# Additional interconnector capacity (scenario A)



Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

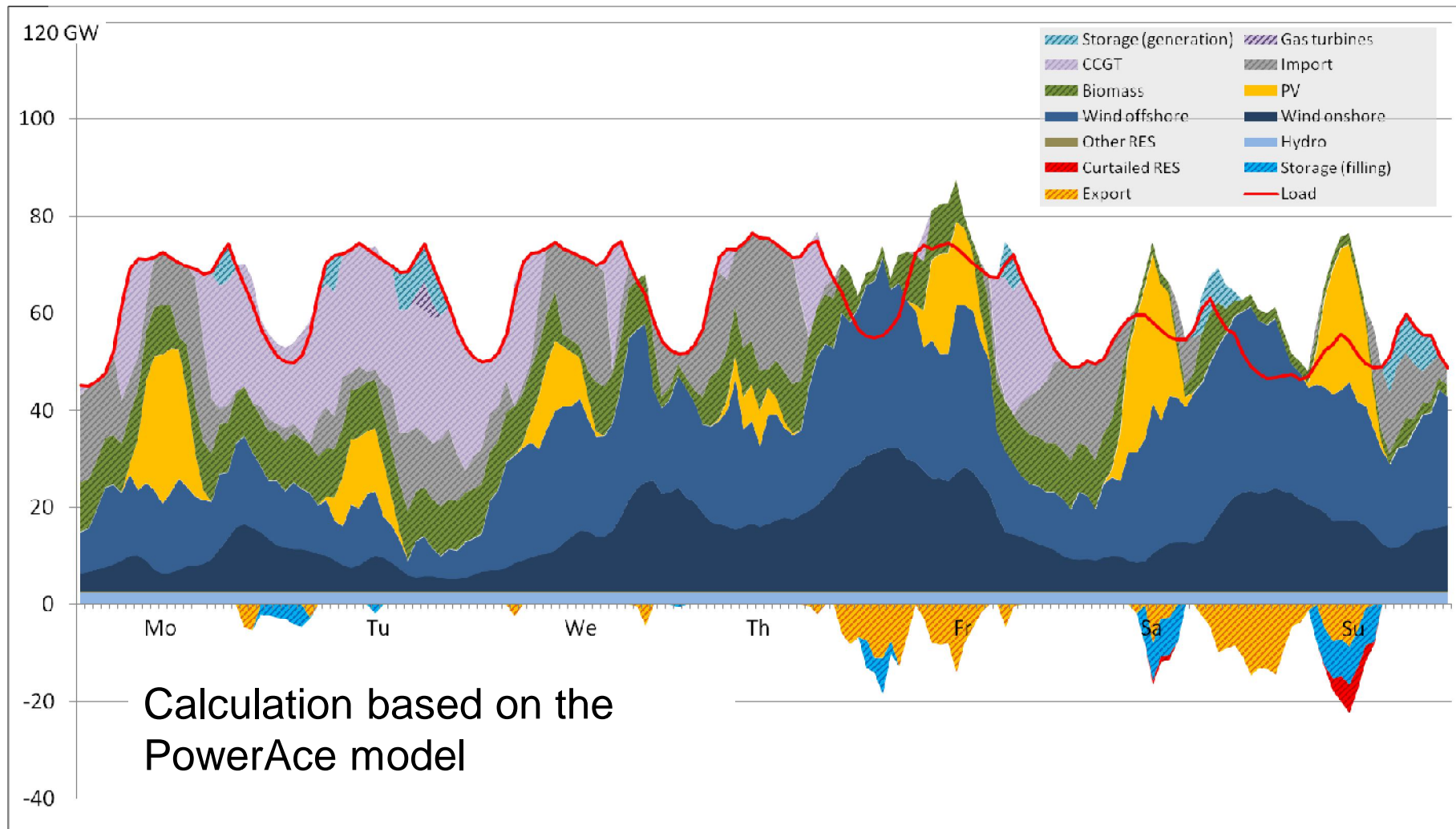
# Generation potential of renewables in the EU



Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

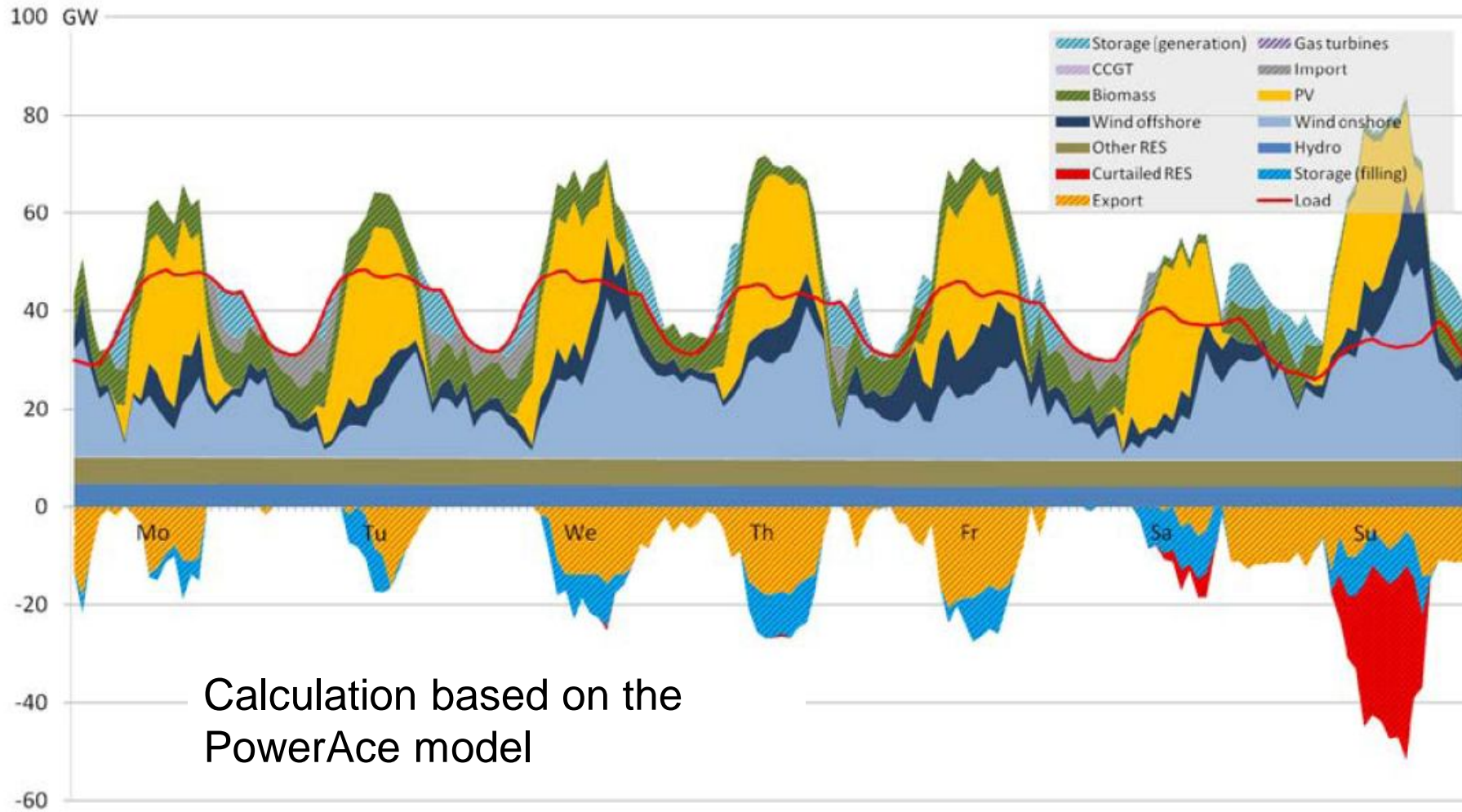


# Germany's (possible) load curve and supply in 2050, Week 42



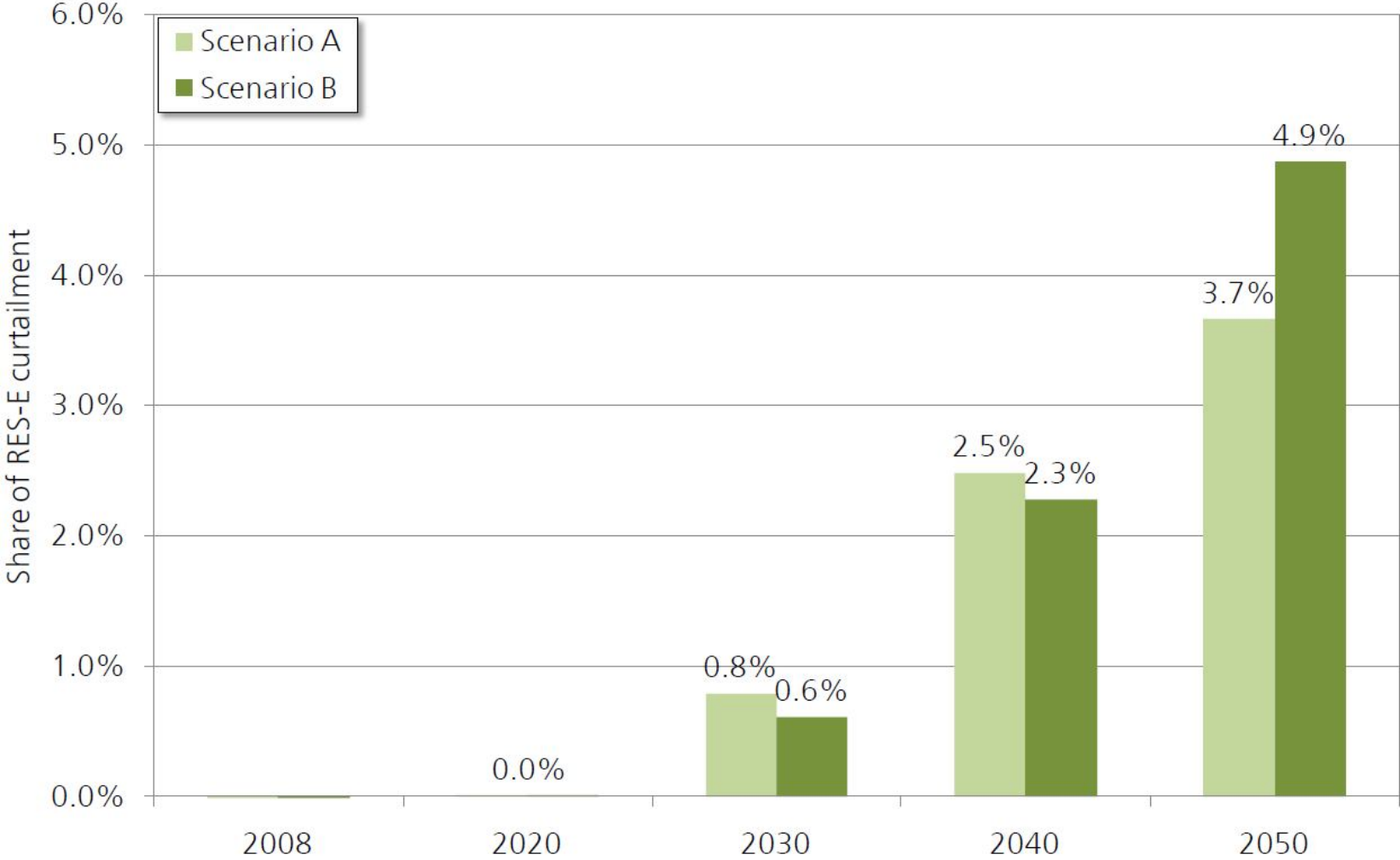
Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Spain's (possible) load curve and supply in 2050, Week 27



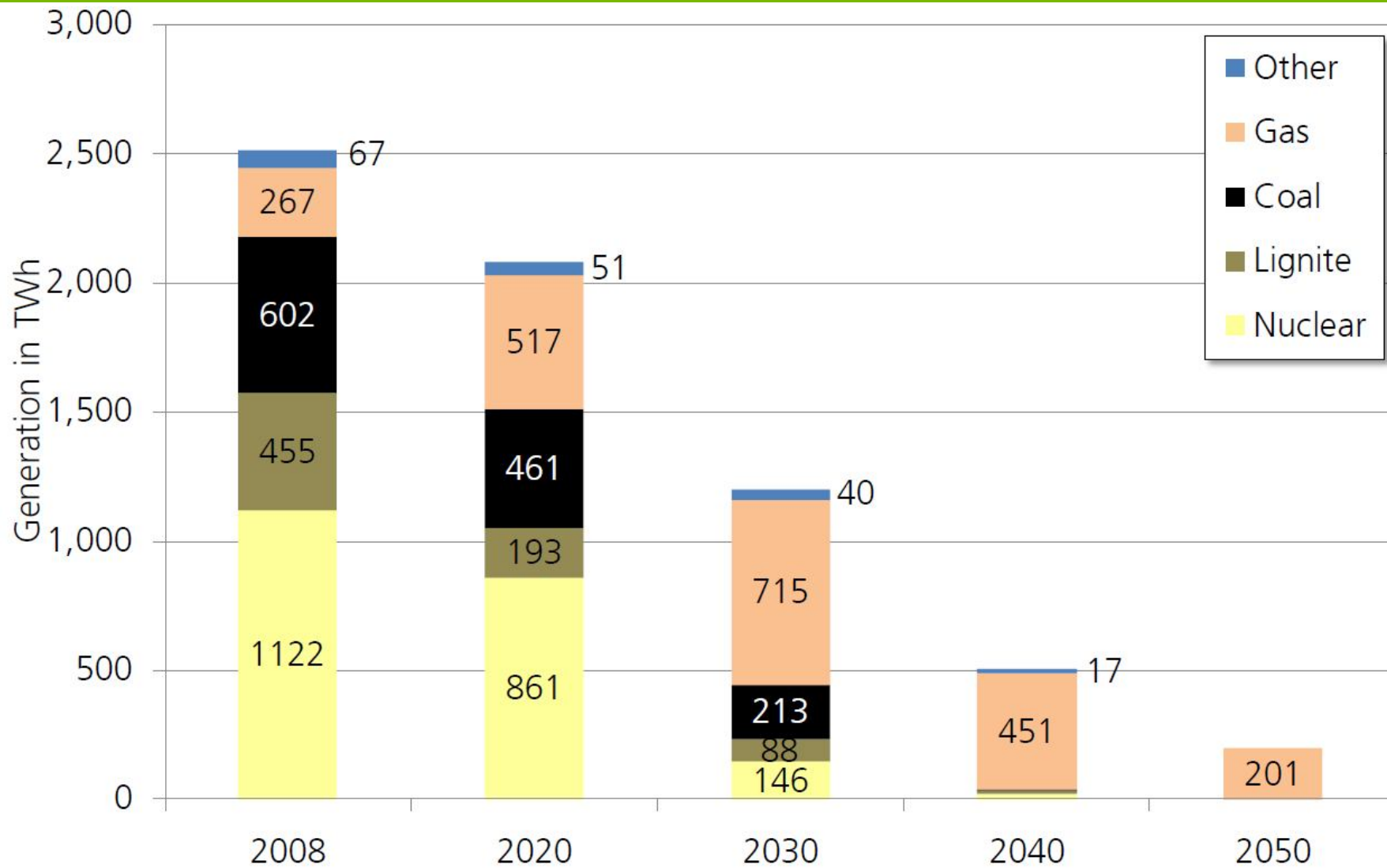
Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Development of renewable electricity curtailment



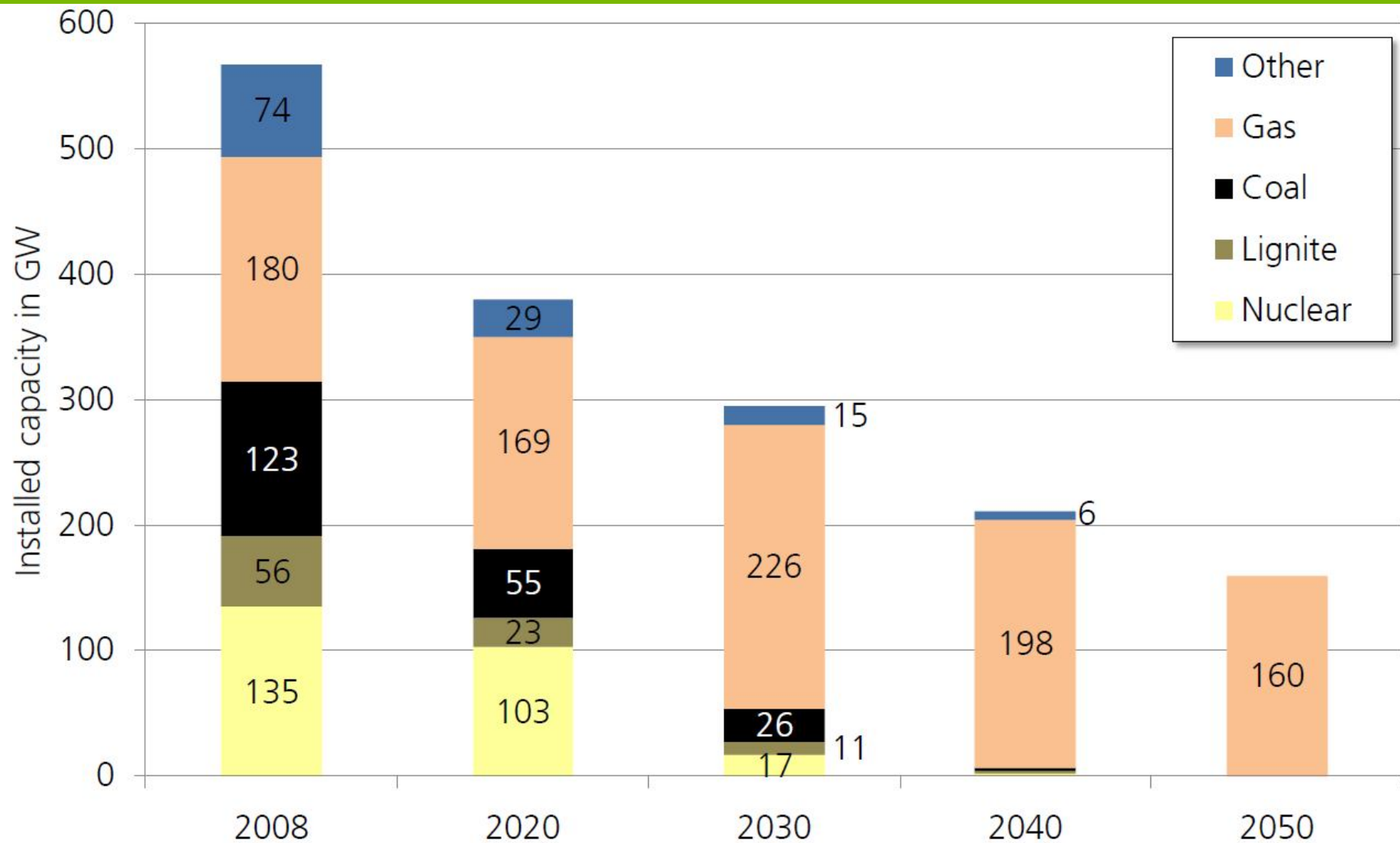
Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

## Development of conventional generation (scenario A)



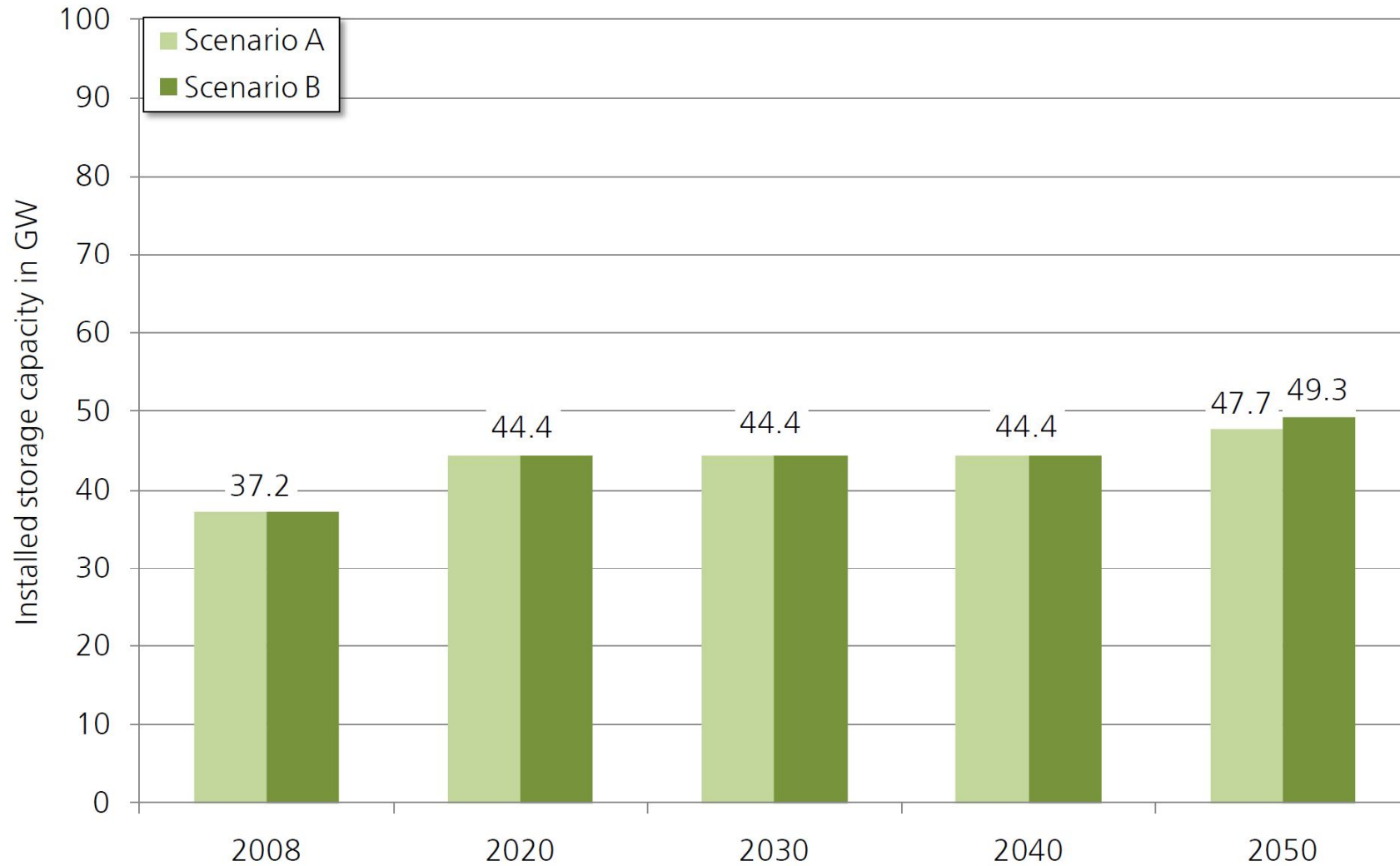
Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Development of installed conventional capacity (scenario A)



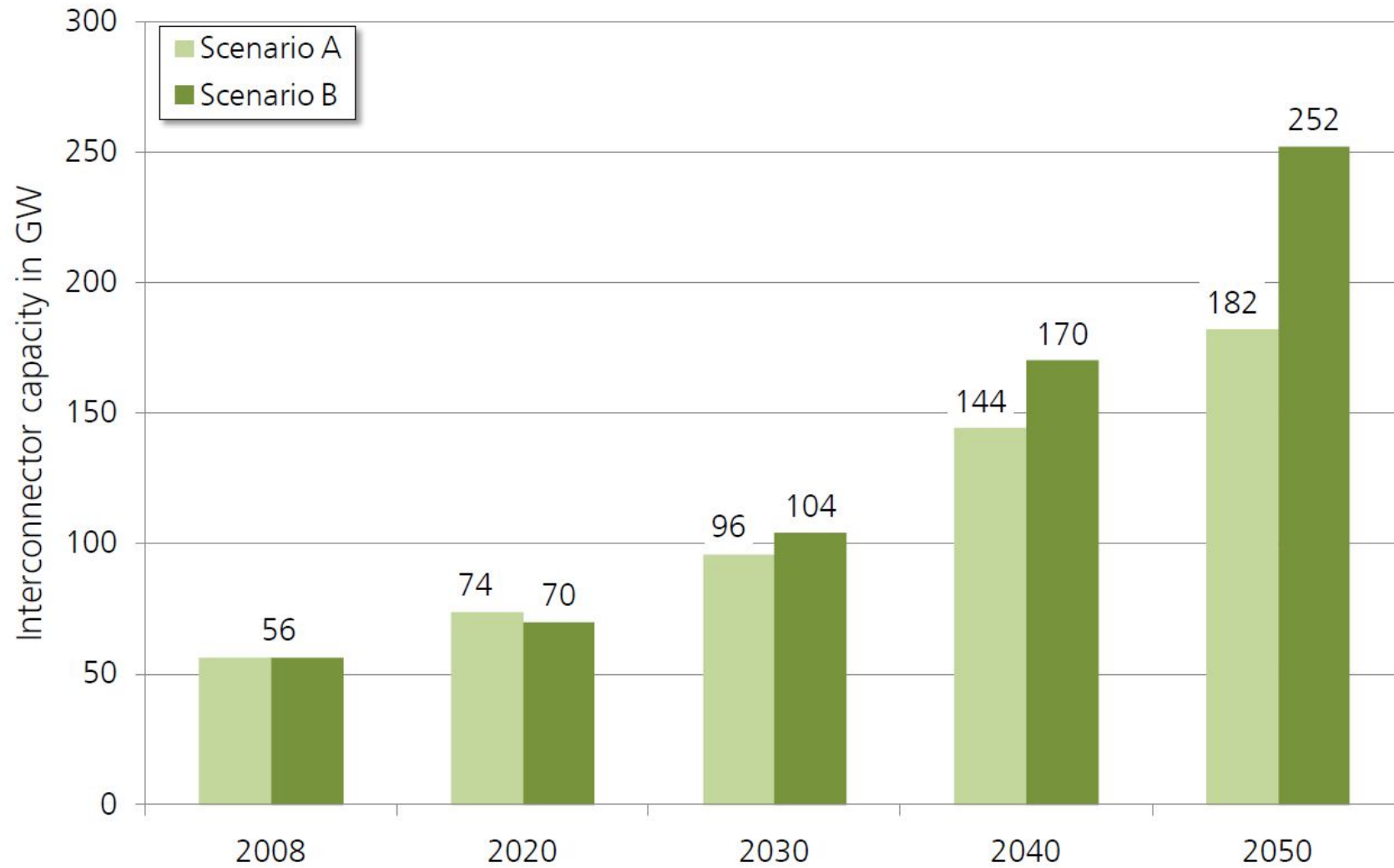
Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Development of storage capacity



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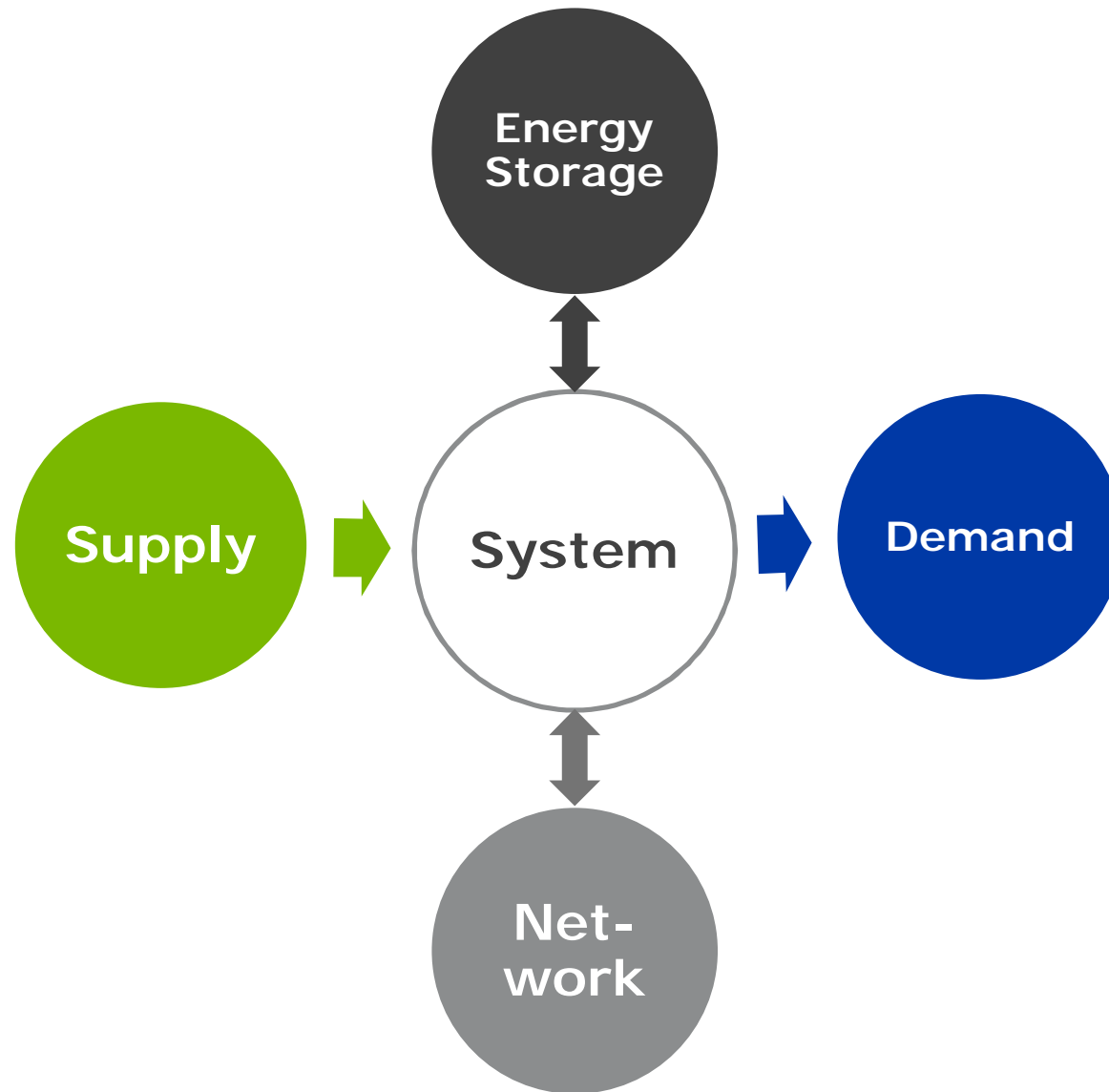
# Development of interconnector capacity



Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Flexibility options for power systems

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Thank you!

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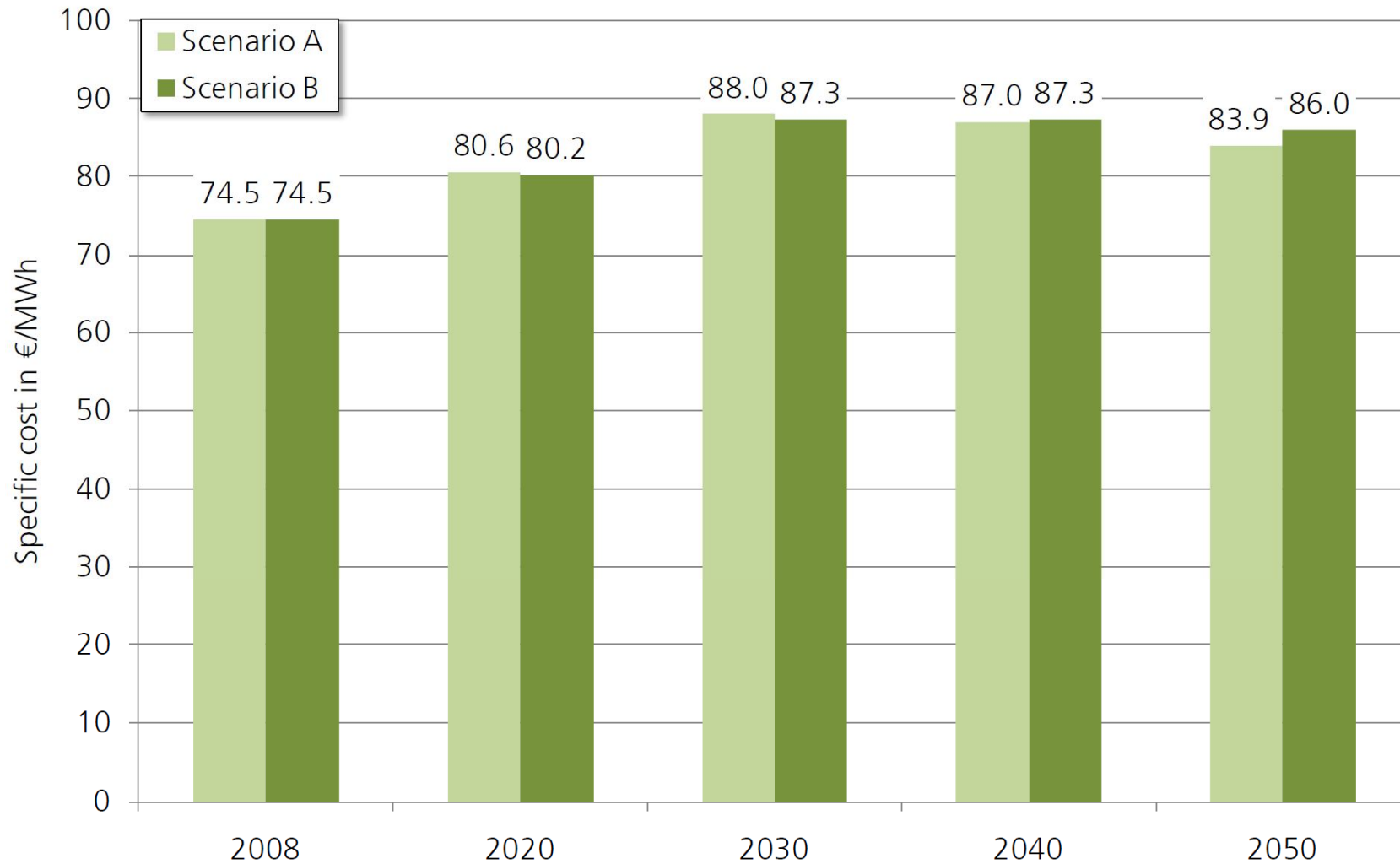
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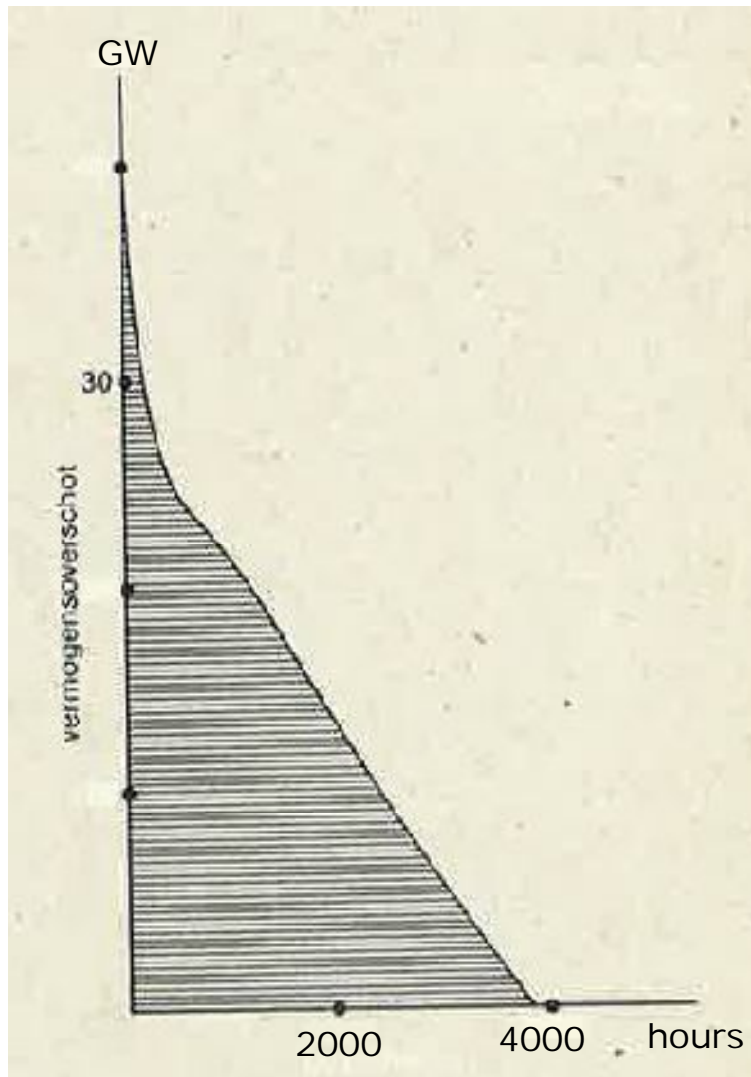
# sustainable energy for everyone

# Development of average electricity production costs



Fraunhofer ISI 2011, Tangible ways towards climate protection in the EU

# Vermogensduurkromme elektriciteitsoverschot



K. Blok 1984, Onbeperkt houdbaar, Stichting Natuur en Milieu