

# The challenge ahead - deployment scenarios of intermittent renewable power

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# Content

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- Contribution of renewable electricity (RES-E) in different scenarios of European and global energy sector until 2050
- Contribution of different RES-E technologies in EU and globally
- Impact of high share of intermittent RES-E on residual demand for Germany
- Technical options to better match supply and demand

# Scenario overview

Study	Published	Scenario	2 °target?	Geographic horizon	Time horizon	RES-E share (2050)	Nuclear share (2050)	CCS share (2050)
European Commission: ADAM	2009	Reference	no	World / EU	2050	38%	24%	-
European Commission: ADAM	2009	2 ° - 450 ppm	yes	World / EU	2050	74%	18%	-
IPCC: Climate change 2007 and SRES (2001)	2009 & 2001	-	-	World	2100	-	-	-
European Commission: WETO-H2	2007	Reference	no	World	2050	25%	35%	12% (world)
IEA: World Energy Outlook 2009	2009	450 Scenario	yes	World	2030	43% (2030)	30%	6% (EU, 2030)
IEA: Energy Technology Perspectives 2008	2008	Blue Scenario	yes	World	2050	RES-E: 46% (world)	~40% (World)	Coal: 100% Gas: 74% (world)
Greenpeace/ERCEC: energy [r]evolution	2007	[r]evolution	yes	World	2050	80%	0%	0%
Greenpeace/ERCEC: [r]enewables 24/7	2009	[r]evolution	yes	World	2050	RES-E: 80%	0%	0%
ECF: Roadmap 2050	2010	80 % RES	yes	EU	2050	RES-E: 80%	10%	10%
SRU: 100% erneuerbare Stromversorgung bis 2050	2010	Sceanrio 3	yes	EU	2050	RES-E: 100%	0%	0%

# Scenario overview

Study	Published	Scenario	Oil Price (2050)	CO2-Prices	GDP-Growth	Change in GDP through climate protection	EU Electricity demand 2050 (TWh/a)
European Commission: ADAM	2009	Reference	95 €2005/bbl		1.6% avg	–	4.350 TWh/a
European Commission: ADAM	2009	2 ° - 450 ppm	30 €2005/bbl	80 €/t (several variants)	1.6% avg	-1.7 %in total	2.800 TWh/a
IPCC: Climate change 2007 and SRES (2001)	2009 & 2001	-	-	-	-	-	-
European Commission: WETO-H2	2007	Reference	110 \$/bl	-	2.1 -1.4 %	-	8,608 (Europe)
IEA: World Energy Outlook 2009	2009	450 Scenario	115 \$2008/bbl (2030)	110 \$2000/t (2030)	1.6 % (avg. unitill 2050, global)	0%	NA
IEA: Energy Technology Perspectives 2008	2008	Blue Scenario	120-130 \$/bbl including CO2-prices	200-500 \$/t	3.3% (world)	-0.1%/year, -2.4% in total	-
Greenpeace/ERCEC: energy [r]evolution	2007	[r]evolution	110 \$/bbl	50 \$/t	1.7% (2002-2050, Europe OECD)	No change	3,141 (Europe OECD)
Greenpeace/ERCEC: [r]enables 24/7	2009	[r]evolution	110 \$/bbl	50 \$/t	1.7% (2002-2050, Europe OECD)	NA (no change?)	3,141 (Europe OECD)
ECF: Roadmap 2050	2010	80 % RES	90 \$2008/bbl (taken from WEO 2009)	Avg: 20-40 €/t over 40 years	1.8% (Europe)	~0%	4,900 (EU27+NO+C H)
SRU: 100% erneuerbare Stromversorgung bis 2050	2010	Sceanrio 3	NA	70 €/t (Leitstudie Pfad A)	NA	NA	5.400 (EUNA)

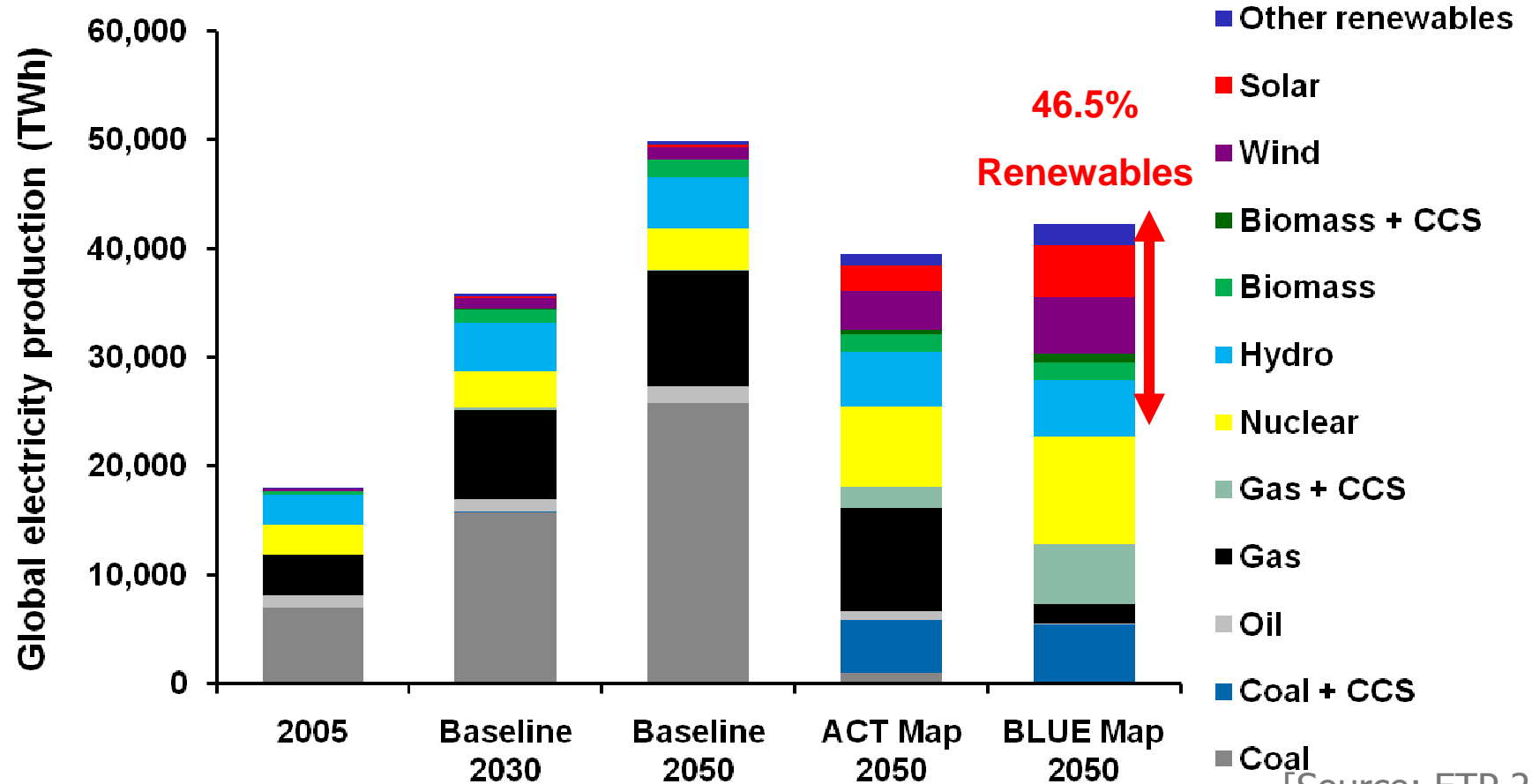
# Scenario overview

Study	Published	Scenario	Compressed Air	Pumped storage	E-Mobility
European Commission: ADAM	2009	Reference	hardly included	hardly included	included in general way
European Commission: ADAM	2009	2 °- 450 ppm	hardly included	hardly included	included in general way
IPCC: Climate change 2007 and SRES (2001)	2009 & 2001	-	-	-	-
European Commission: WETO-H2	2007	Reference	-	-	12 % in 2050 (world)
IEA: World Energy Outlook 2009	2009	450 Scenario	-	-	28% (world, 2030)
IEA: Energy Technology Perspectives 2008	2008	Blue Scenario	-included qualitatively, "novel technology"	-	25 % share in sales in 2050
Greenpeace/ERCEC: energy [r]evolution	2007	[r]evolution	included qualitatively	included qualitatively	only hybrids
Greenpeace/ERCEC: [r]enables 24/7	2009	[r]evolution	hardly included	hardly included	hardly included
ECF: Roadmap 2050	2010	80 % RES	included in general way	included in general way	included in general way
SRU: 100% erneuerbare Stromversorgung bis 2050	2010	Sceanrio 3	included in the model	included in the model	included in general way

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# World

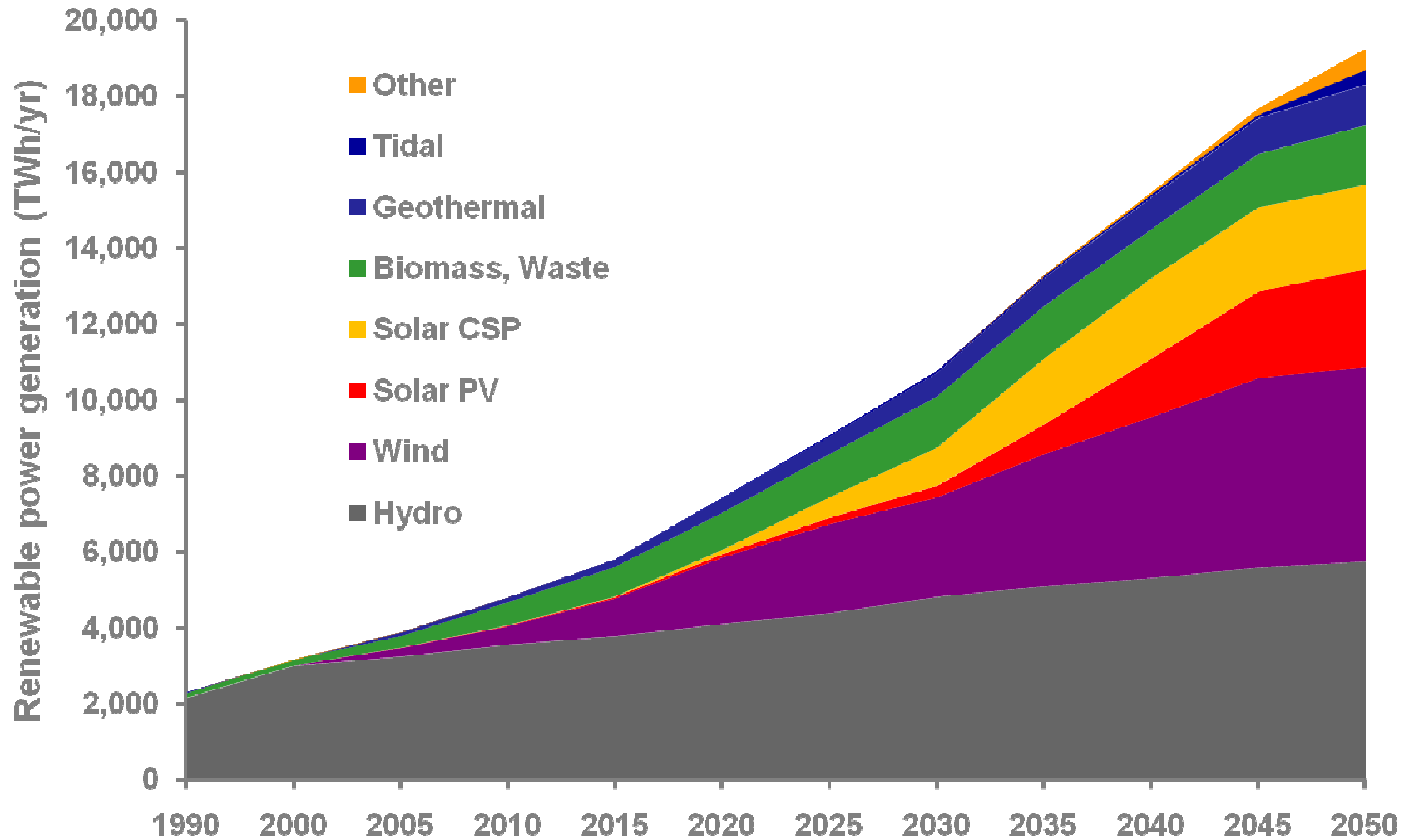
# IEA-Scenarios of global electricity generation



[Source: ETP 2008

Frankl 2008]

# Development of renewable energies in the scenario "blue map" IEA, 2008

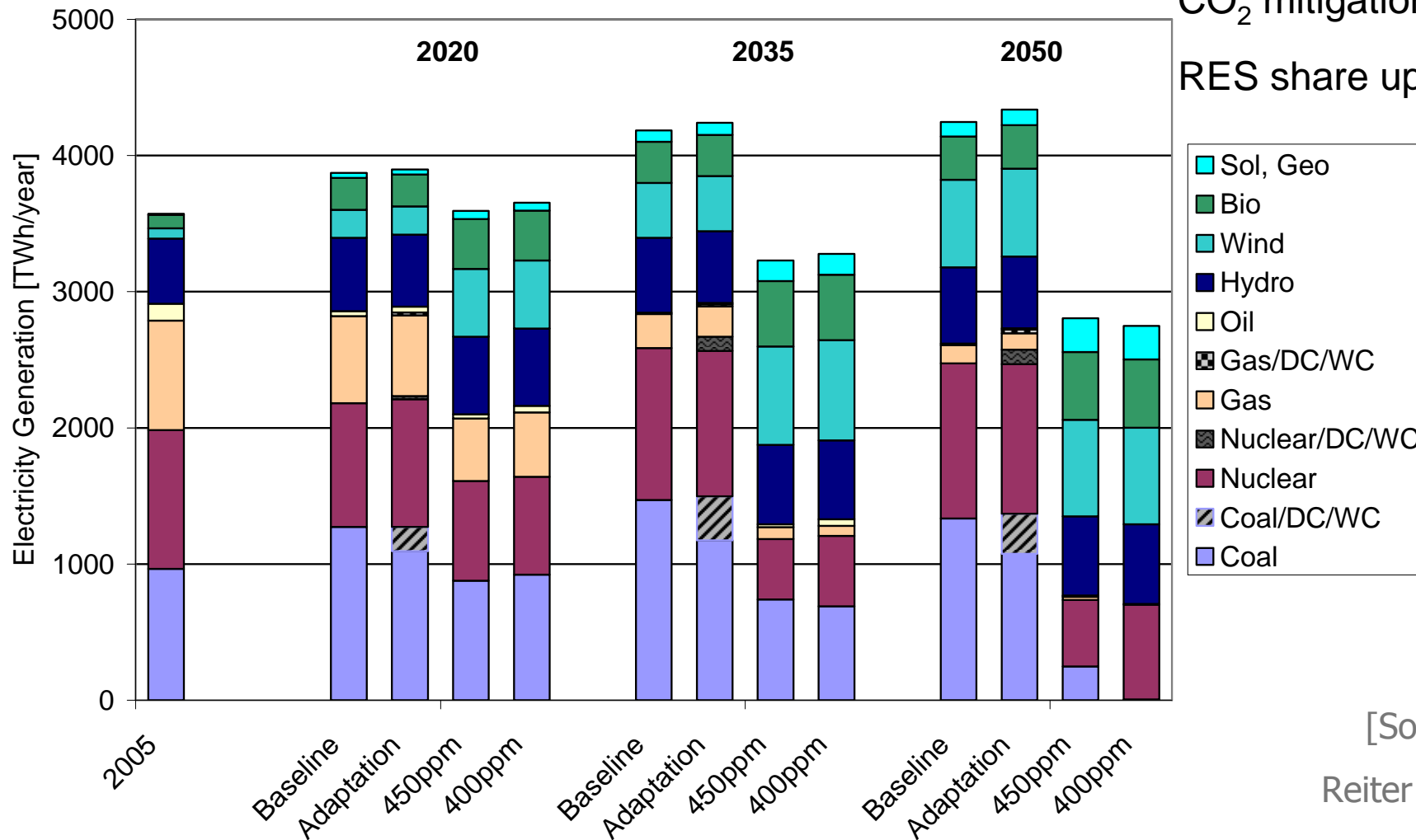




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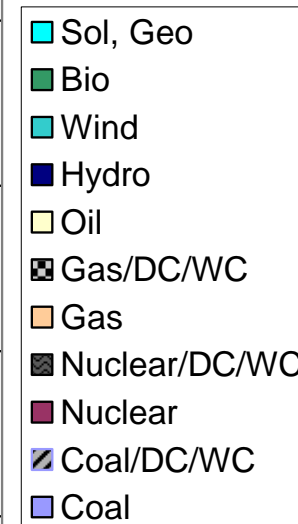
# Europe

# Development of electricity generation in EU-27 until 2050



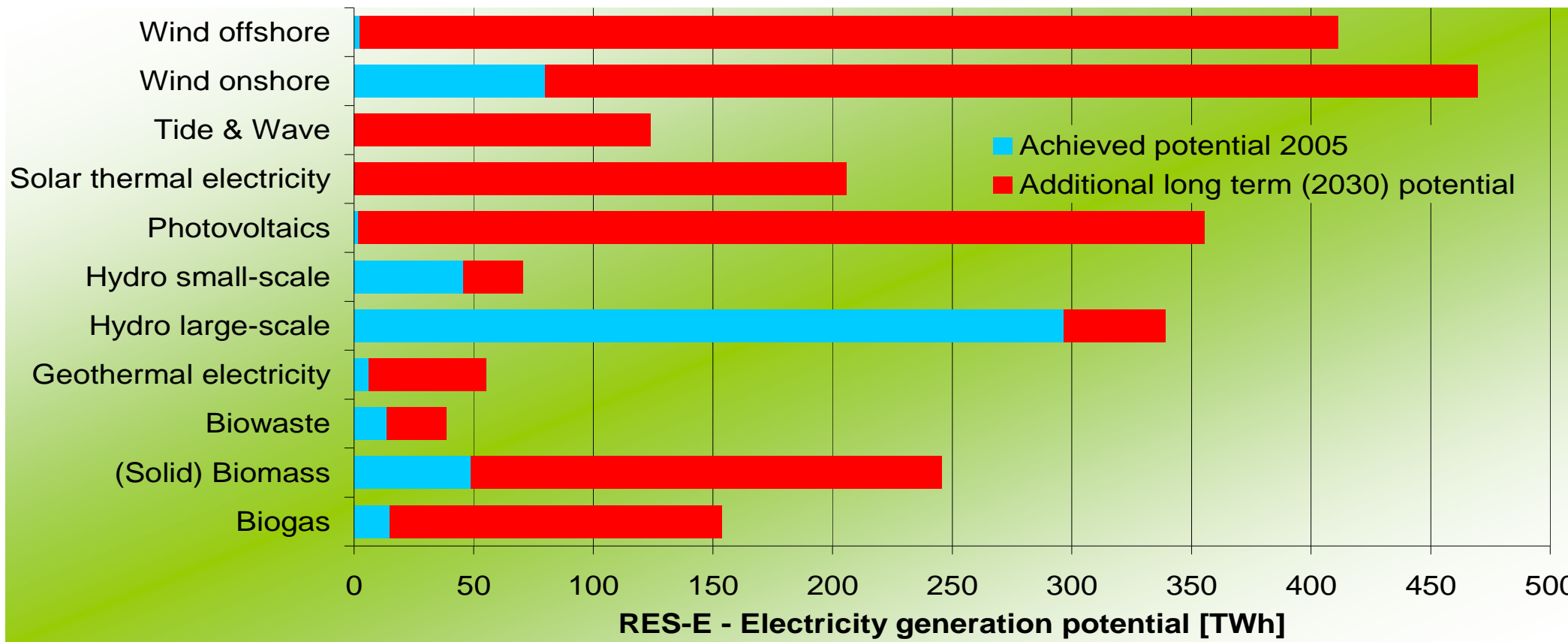
CO<sub>2</sub> mitigation > 90% by 2050

RES share up to 74% in 2050



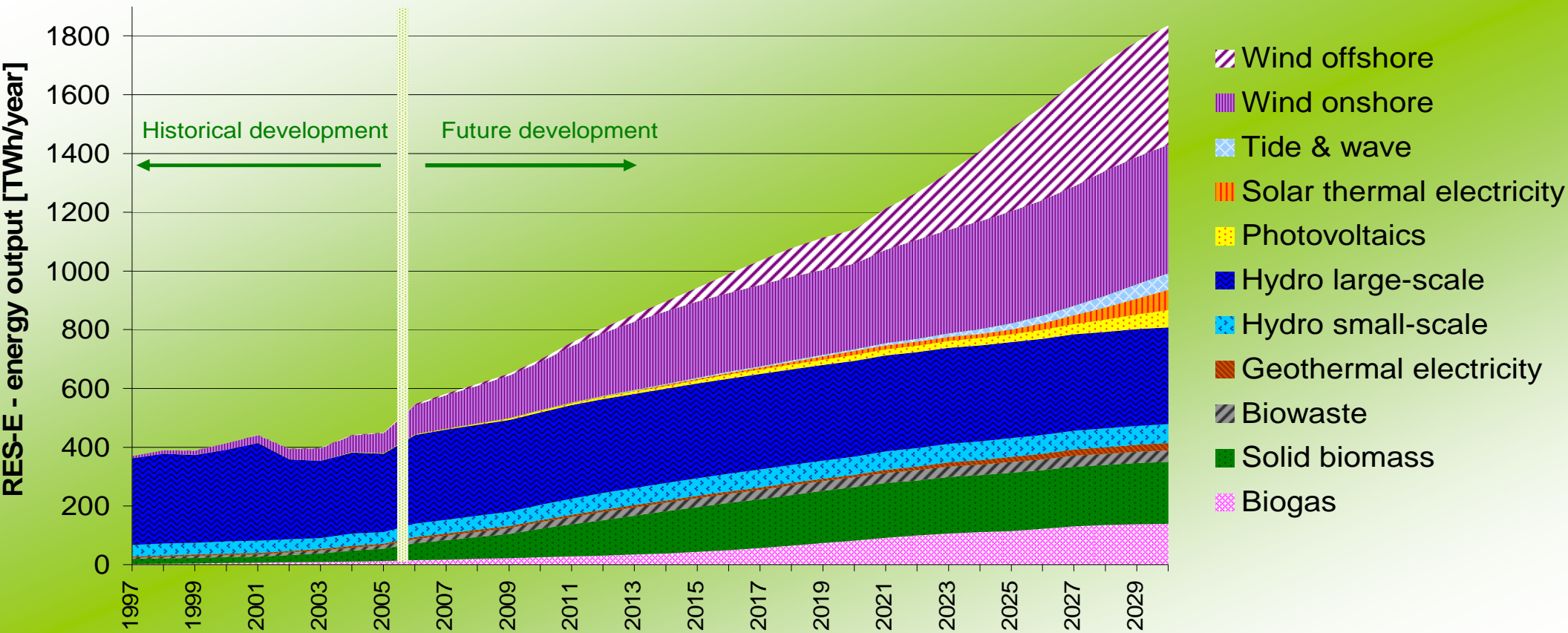
[Source: ADAM project  
Reiter U., Held A. (2009)]

# Realisable RES-E potentials in EU-27 until 2030



Quelle: Green-X (Resch et al)

# Development of RES technologies in EU-27 until 2030



Source: Green-X / Employ-RES

policy scenario - targets of RES Directive will be met

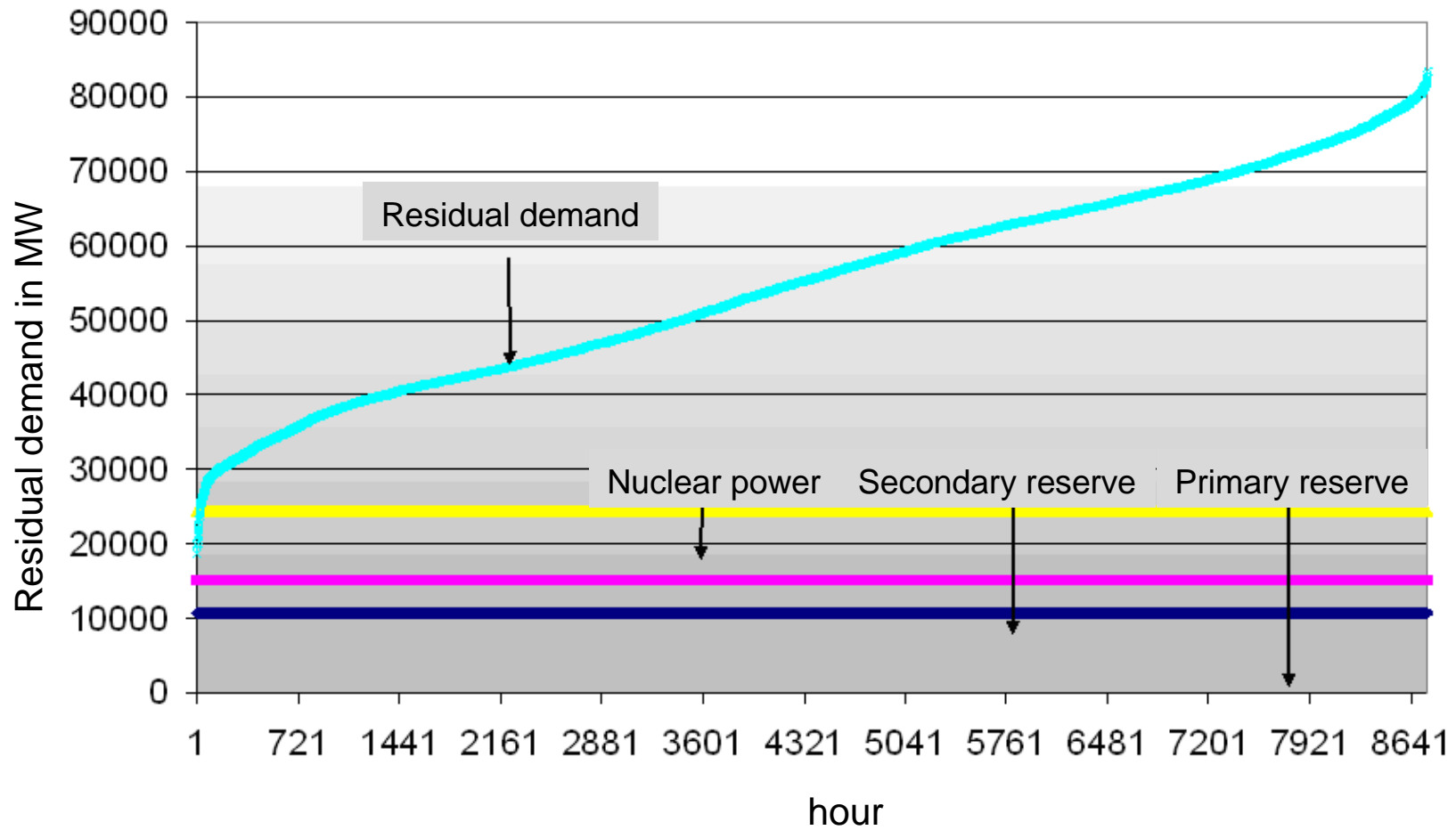
# Germany

## Scenario until 2050 with high share of intermittent RES for Germany\*

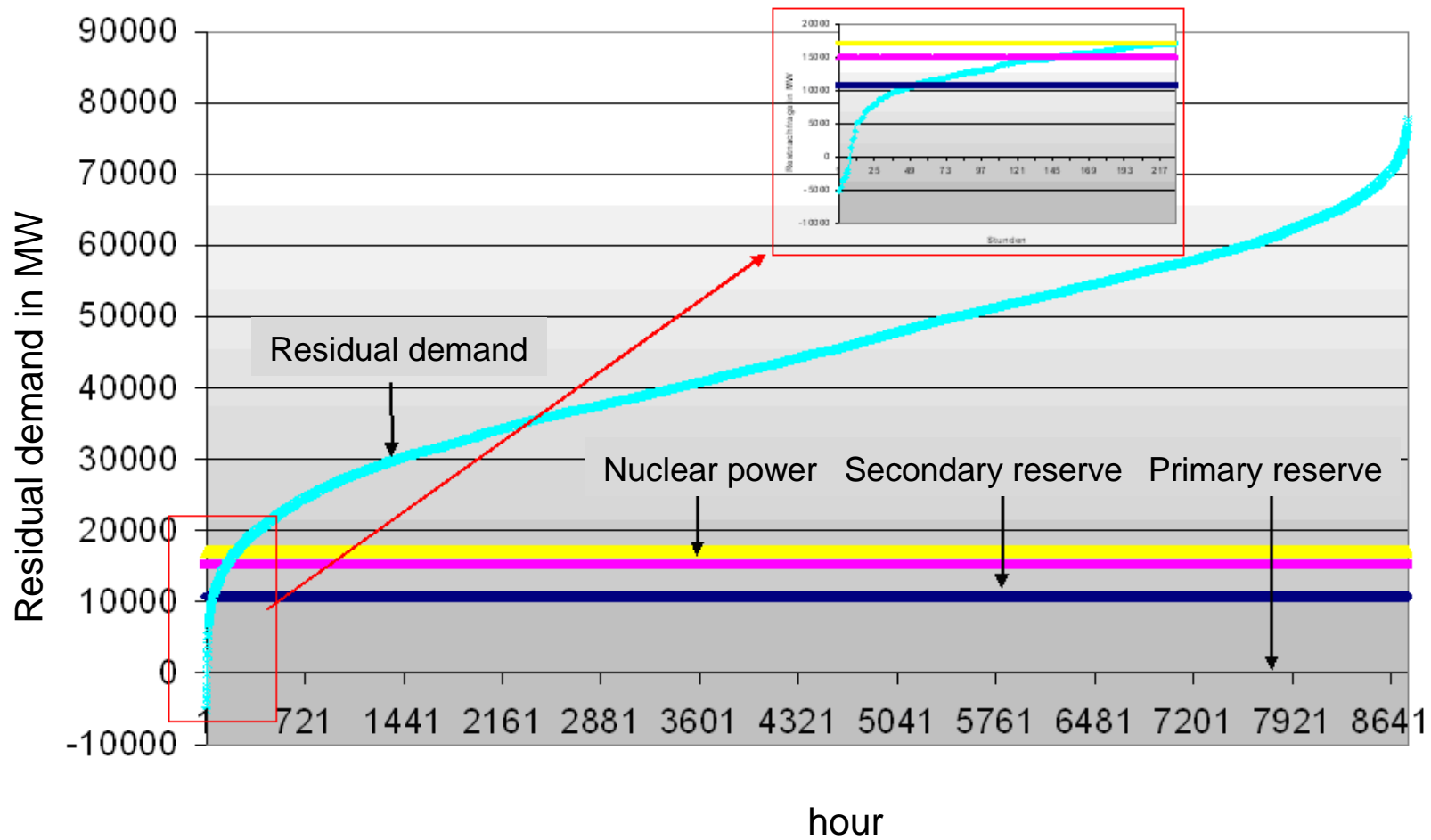
Technologie	2006	2020	2050
	Leistung	Leistung	Leistung
	MW	MW	MW
Wind Onshore	20.600	35.000	48.000
Wind Offshore	0	12.000	50.000
PV	2.800	15.000	52.000
Wasserkraft	4.722	4.722	4.722
Biomasse	1.200	2.000	3.500
Biogas	1.100	2.000	3.920
Geothermie	0	0	3.000

\* Similar to BMU-scenario 2007 – consistent with RES share of 30% in 2020 and 80% in 2050

# Analysis of residual demand in 2006

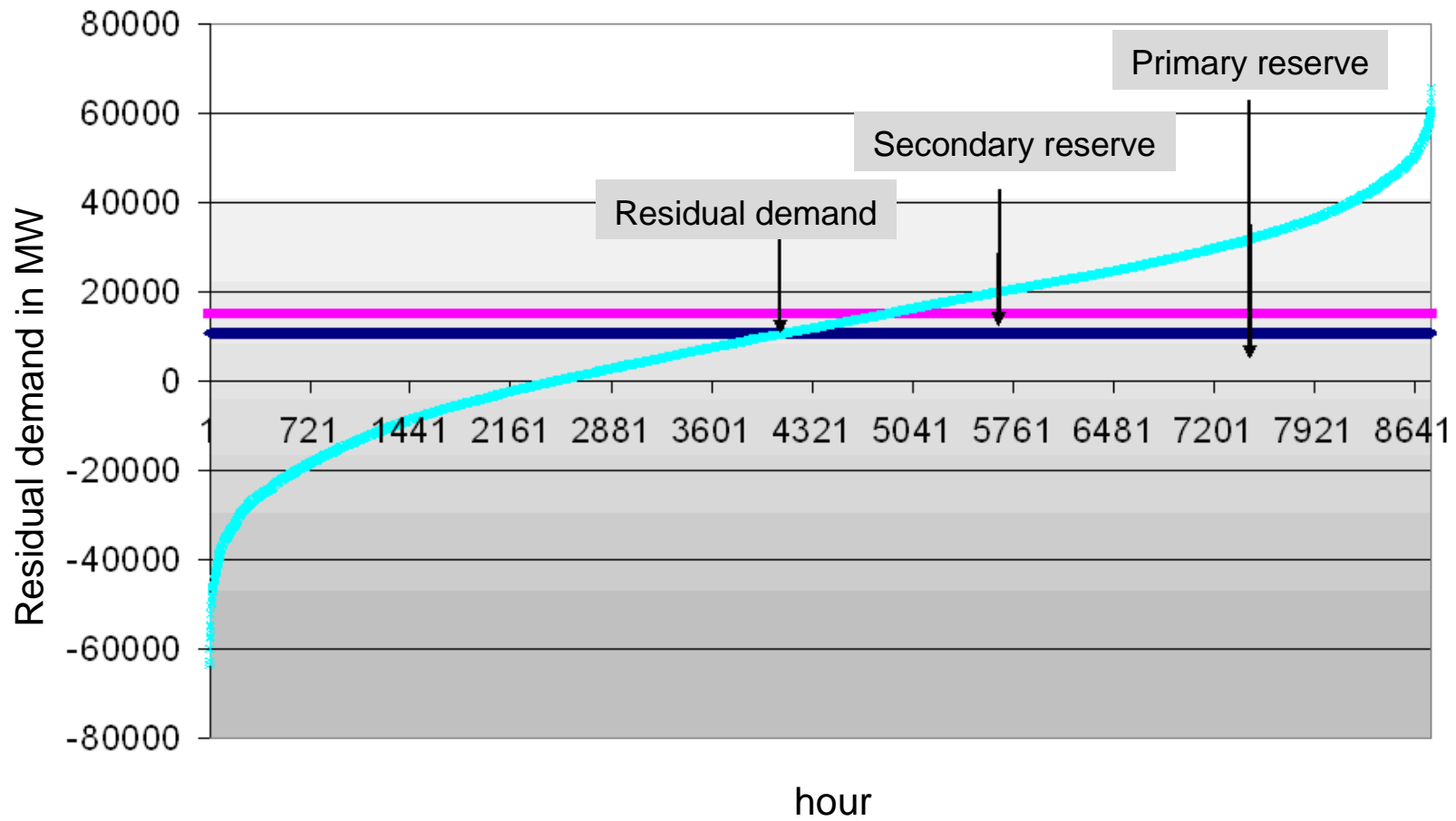


# Analysis of residual demand in 2020

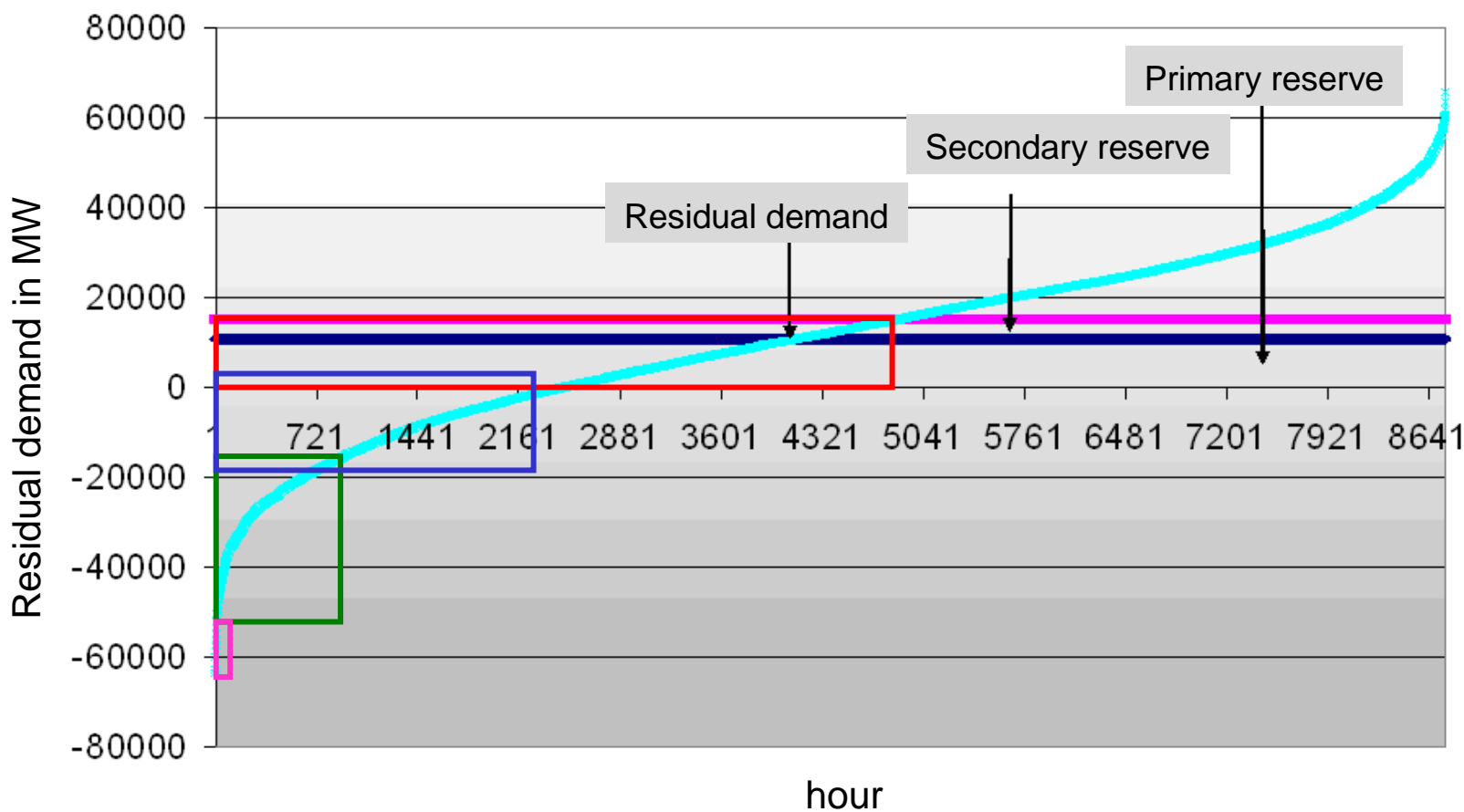




# Analysis of residual demand in 2050



# Analysis of technical solutions to better match supply and demand in 2050



Demand Management  
& RES in  
balancing markets  
Intern. transmission

Demand Management  
& RES in  
electricity markets  
Intern. transmission  
storage

Demand Management  
Electric mobility

Spilling of RES  
generation

# Conclusions

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- Both globally and on EU level most scenarios assume a strongly increasing share of renewable electricity due to emission limits and the needs to increase security of supply
- In terms of newly installed capacity wind power, solar energy and biomass will dominate
- System and market integration will be a major challenge for realising these ambitions
- Besides a number of technical options on the supply and demand side and the reinforcement of the transmission grid a revised power market design will be of key importance

# Contact

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Thank you!