

The challenge ahead - deployment scenarios of intermittent renewable power

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Brussels,
10. June 2010

Content

- 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

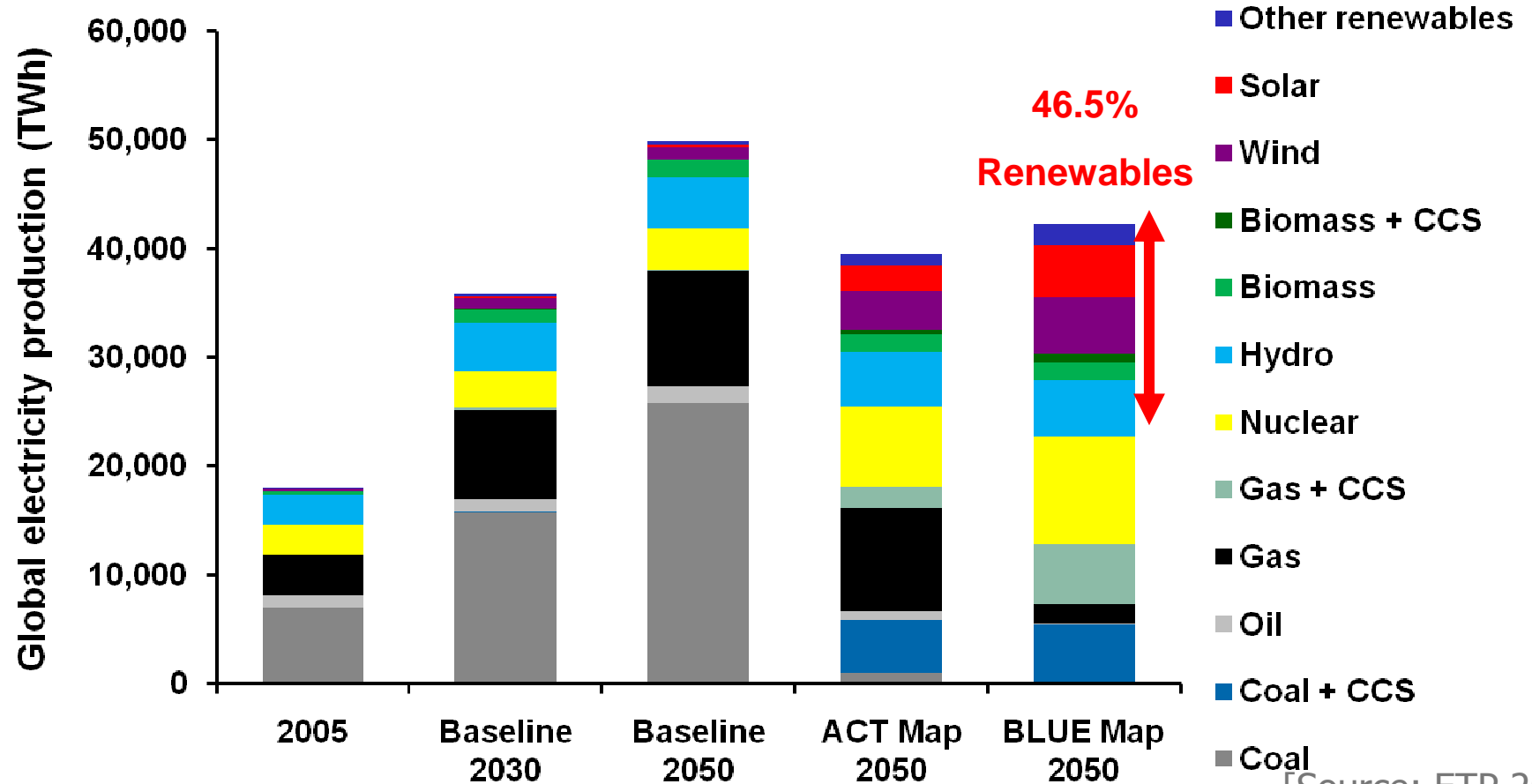
Study	Published	Scenario	Oil Price (2050)	CO2-Prices	GDP-Growth	Change in GDP through climate protection	EU Electricity demand 2050 (TWh/a)
European Commission: ADAM	2009	Reference	95 €2005/bbl		1.6% avg	–	4.350 TWh/a
European Commission: ADAM	2009	2 ° - 450 ppm	30 €2005/bbl	80 €/t (several variants)	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

World

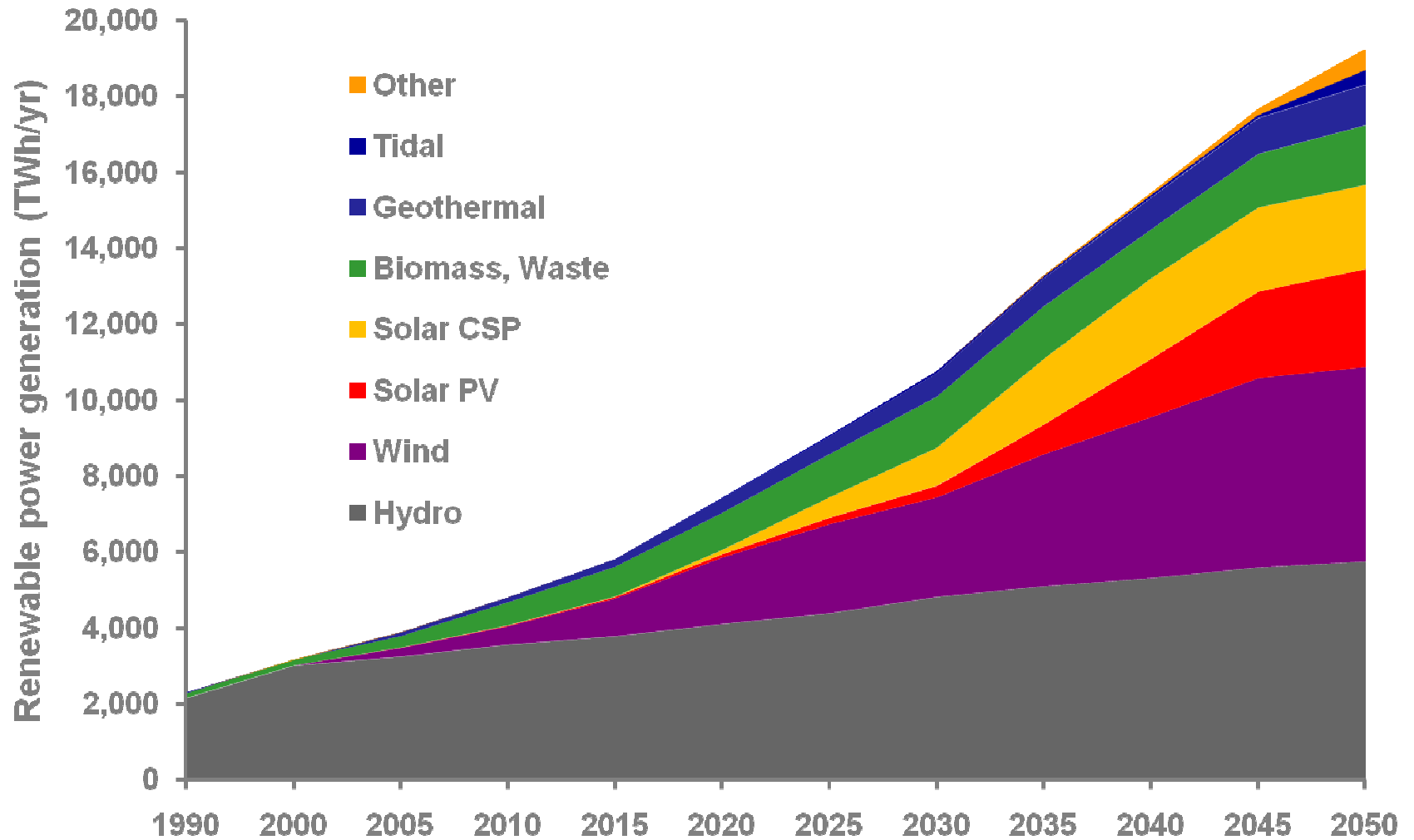
IEA-Scenarios of global electricity generation



[Source: ETP 2008

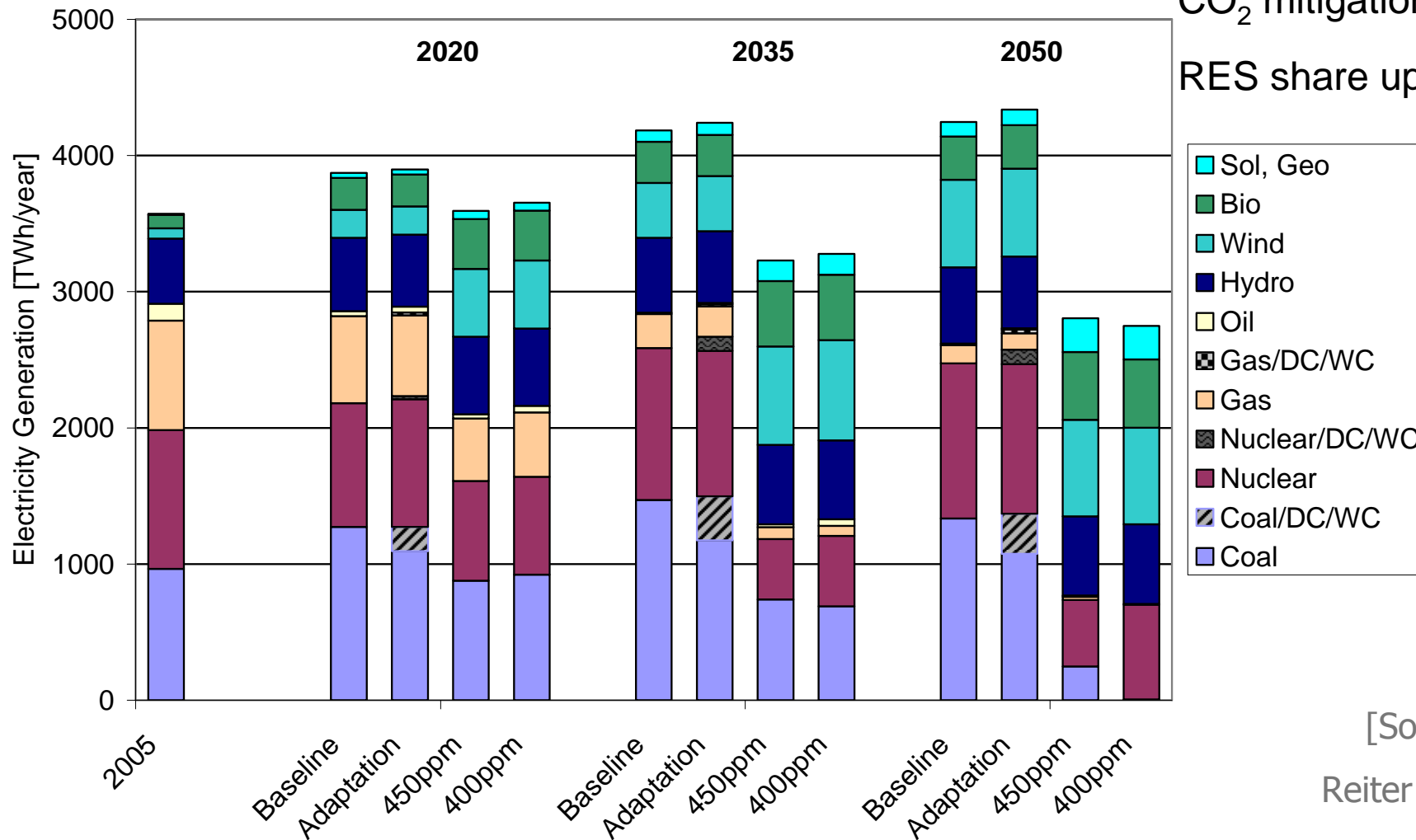
Frankl 2008]

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



Europe

Development of electricity generation in EU-27 until 2050



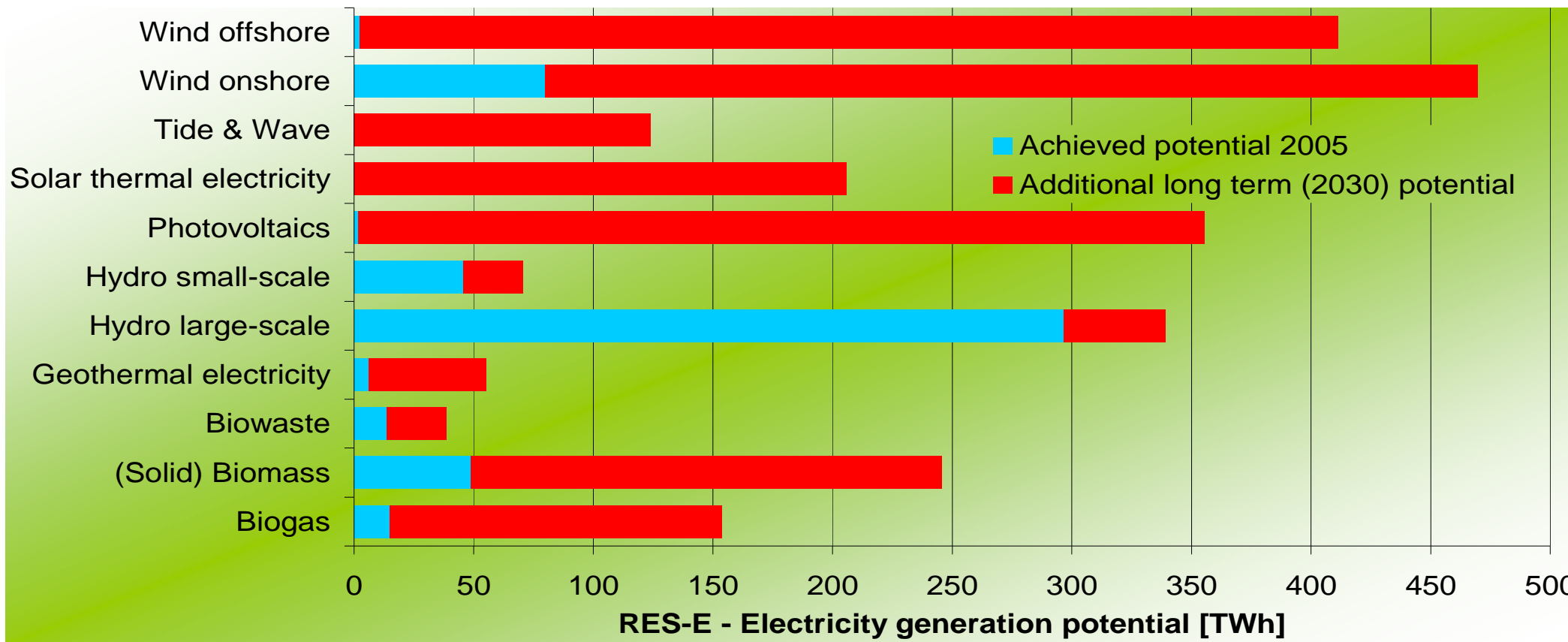
CO₂ mitigation > 90% by 2050

RES share up to 74% in 2050

[Source: ADAM project

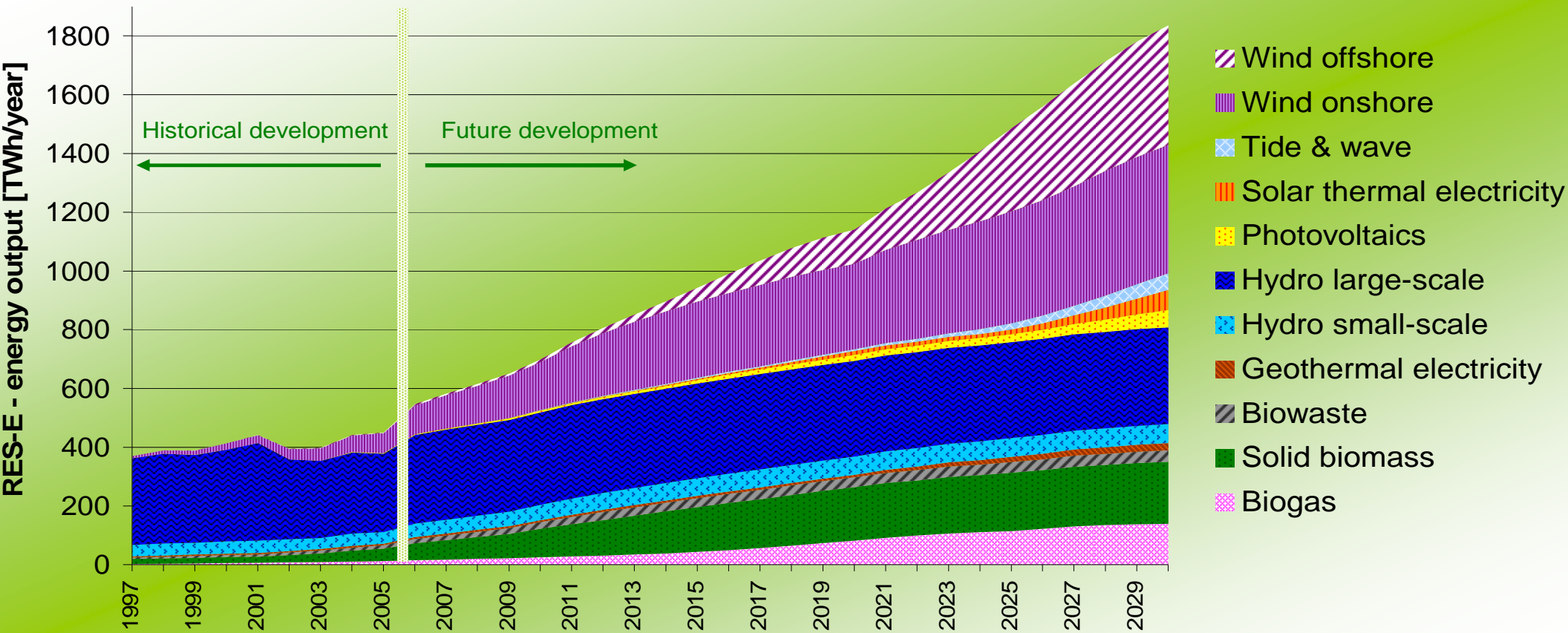
Reiter U., Held A. (2009)]

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

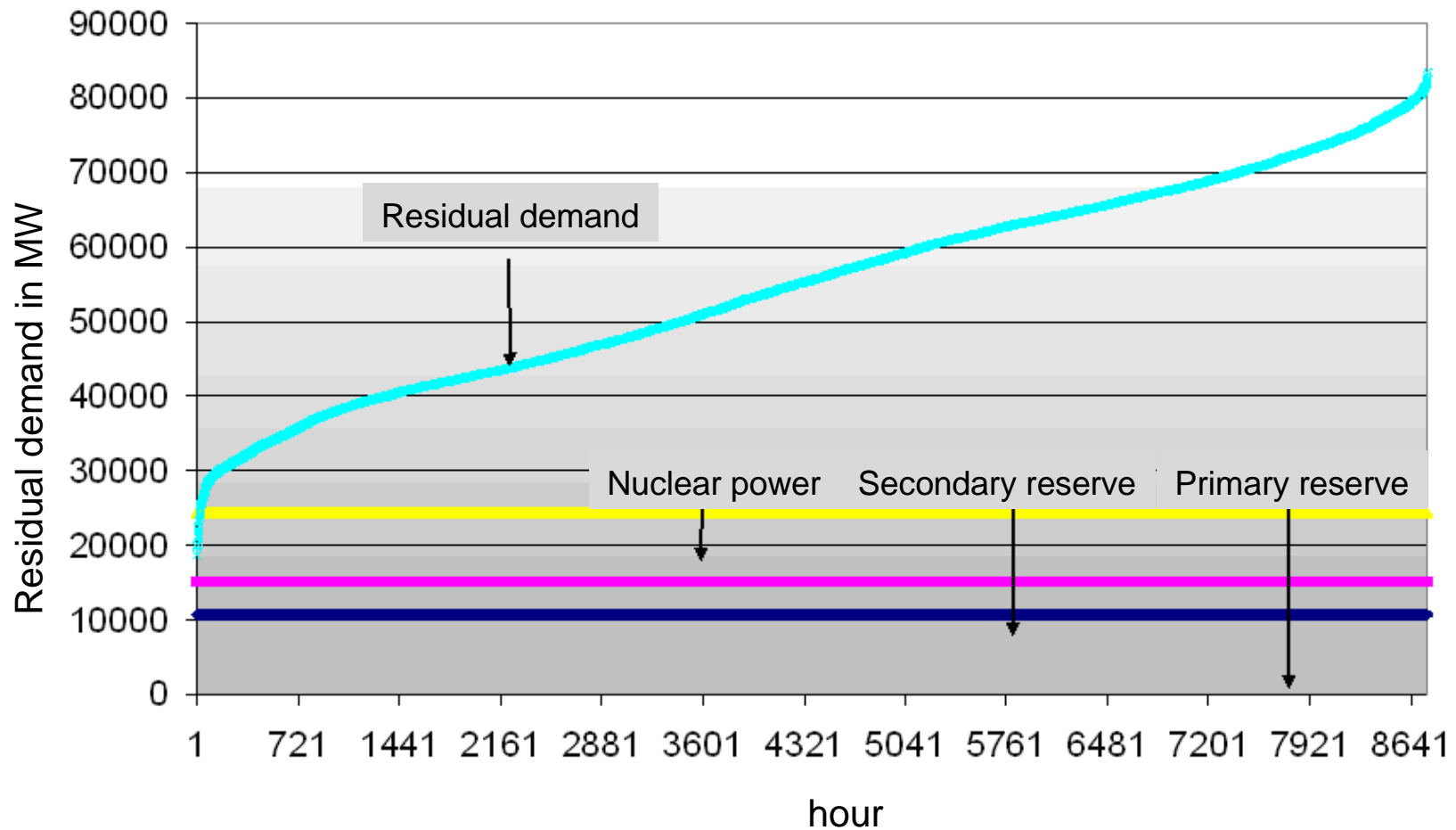
Germany

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

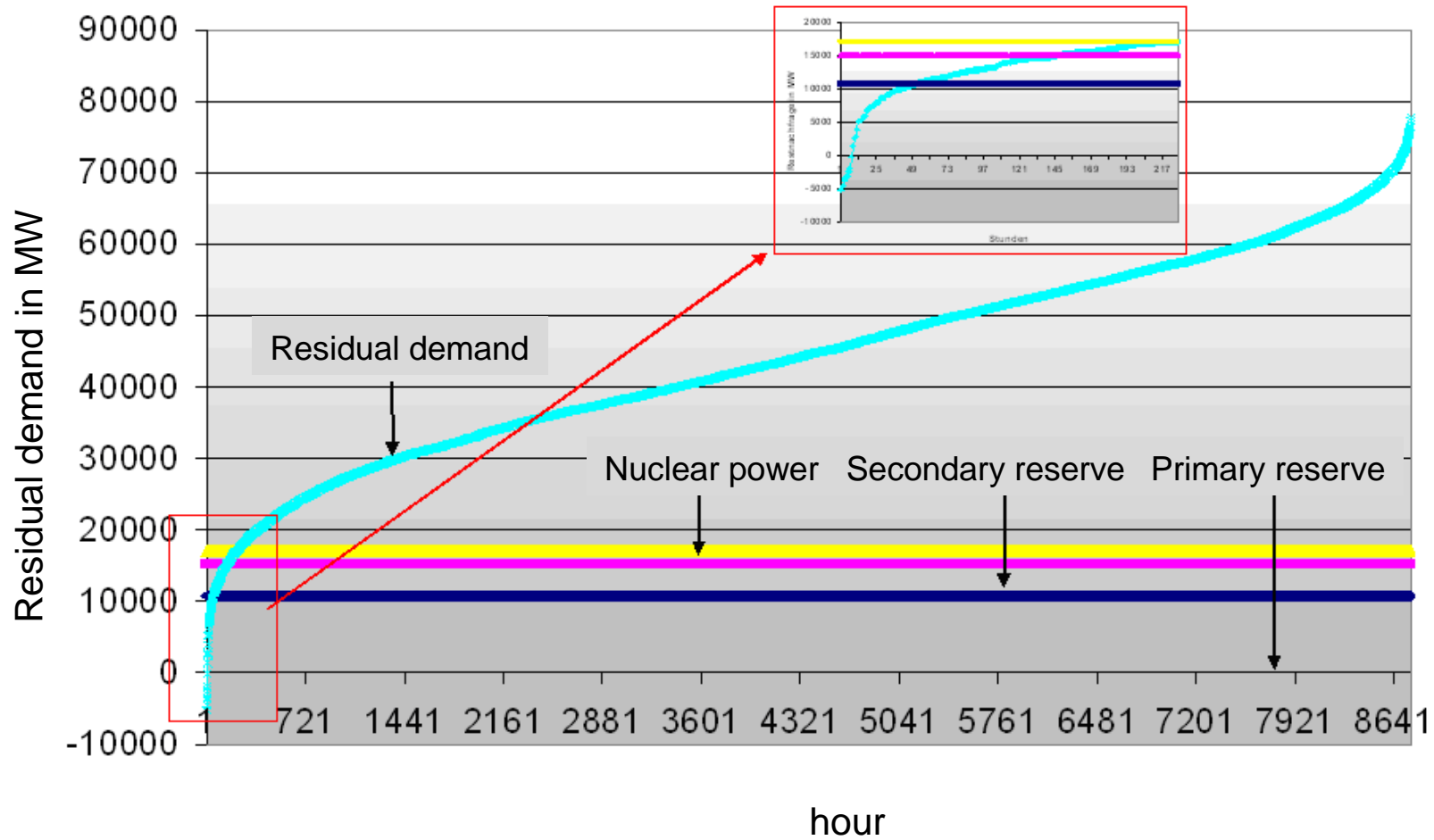
Technologie	2006	2020	2050
	Leistung	Leistung	Leistung
	MW	MW	MW
Wind Onshore	20.600	35.000	48.000
Wind Offshore	0	12.000	50.000
PV	2.800	15.000	52.000
Wasserkraft	4.722	4.722	4.722
Biomasse	1.200	2.000	3.500
Biogas	1.100	2.000	3.920
Geothermie	0	0	3.000

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

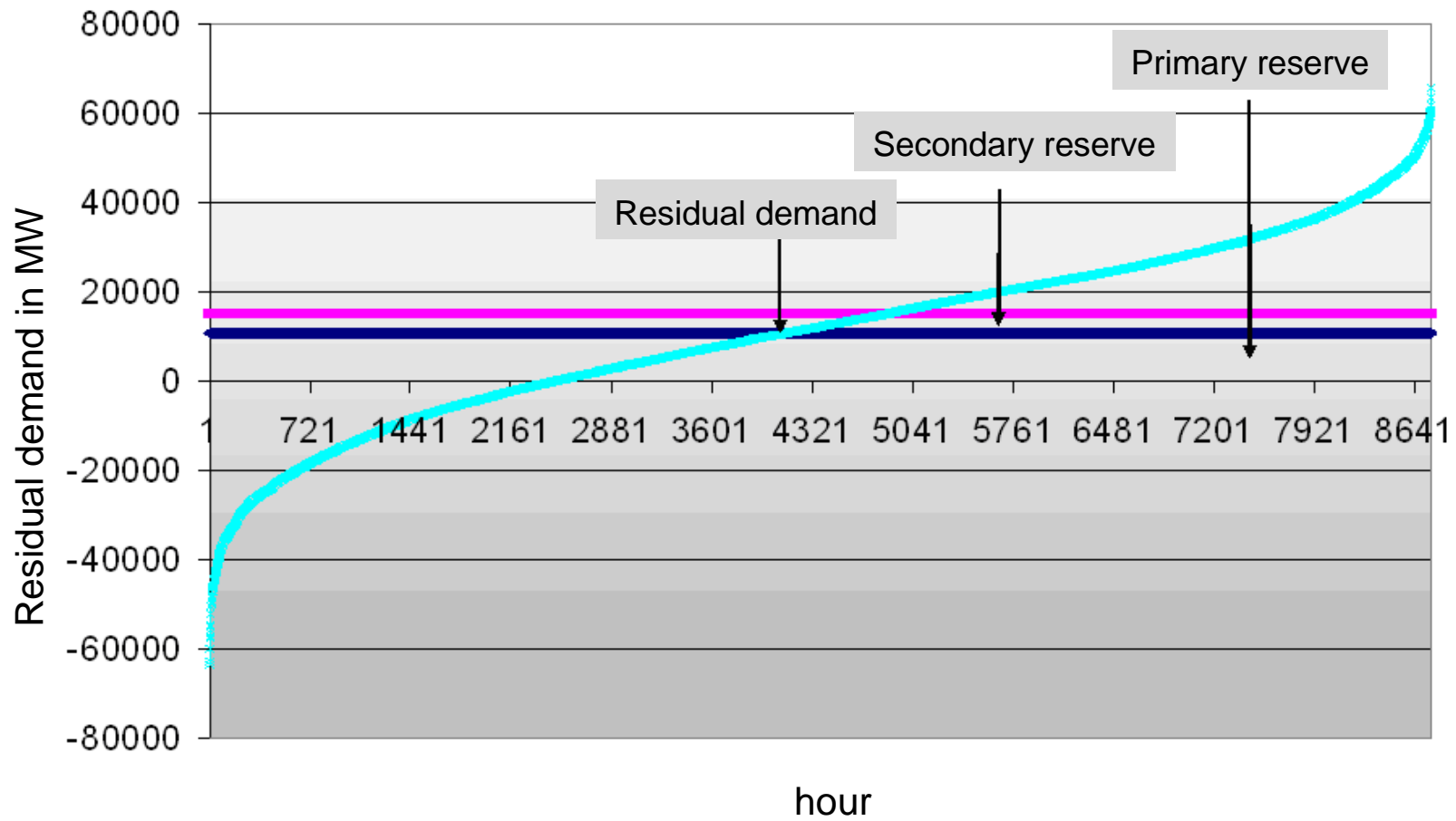
Analysis of residual demand in 2006



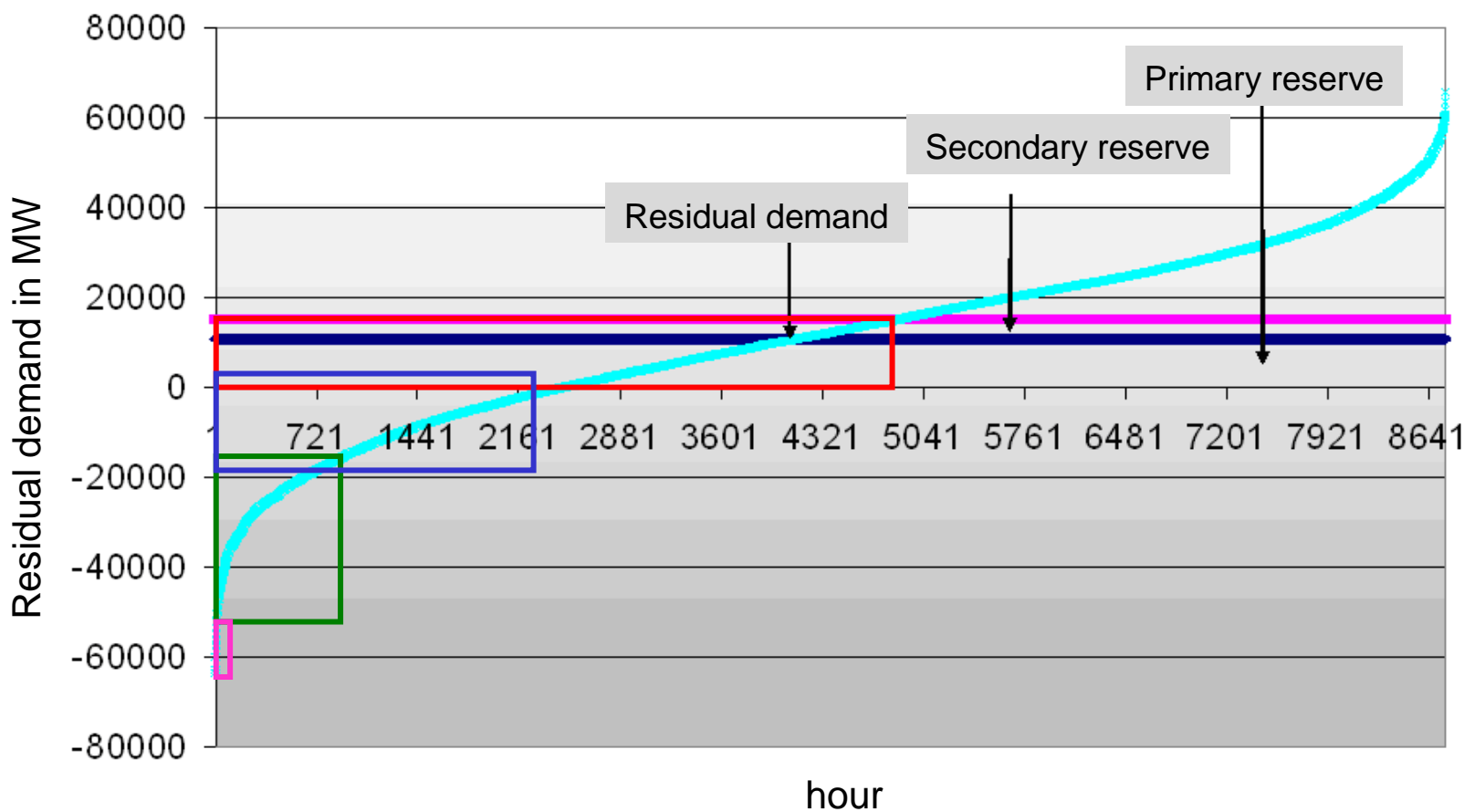
Analysis of residual demand in 2020



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

- 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

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Thank you!