

Factbook Generation Capacity in Europe

June, 2007



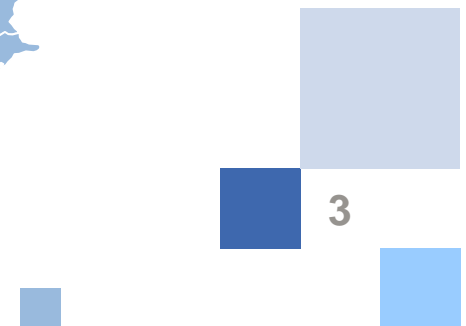
Generation capacity in Europe will stay tight

- Different sources e.g. Union for the Coordination of Transmission of Electricity (UCTE), Cambridge Energy Research Associates (CERA), IEA expect capacity bottlenecks
- Major drivers for capacity bottlenecks:
 - Ageing power plants
 - Volatile gas prices (driven by oil prices)
 - Supply constraints for power plant components, scarcity of consented sites
 - Lengthy approval procedures for interconnector extensions
 - Political risks threatening investment plans for power plants and networks
 - Special drivers:
 - Nuclear phase out in Germany
 - Large Combustion Plant Directive (LCPD) in UK
 - Increased peak-load demand in France
 - Volatile hydro reservoir levels in Spain, Scandinavia, Austria, Switzerland
 - Decommissioning of old nuclear reactors in new EU member states

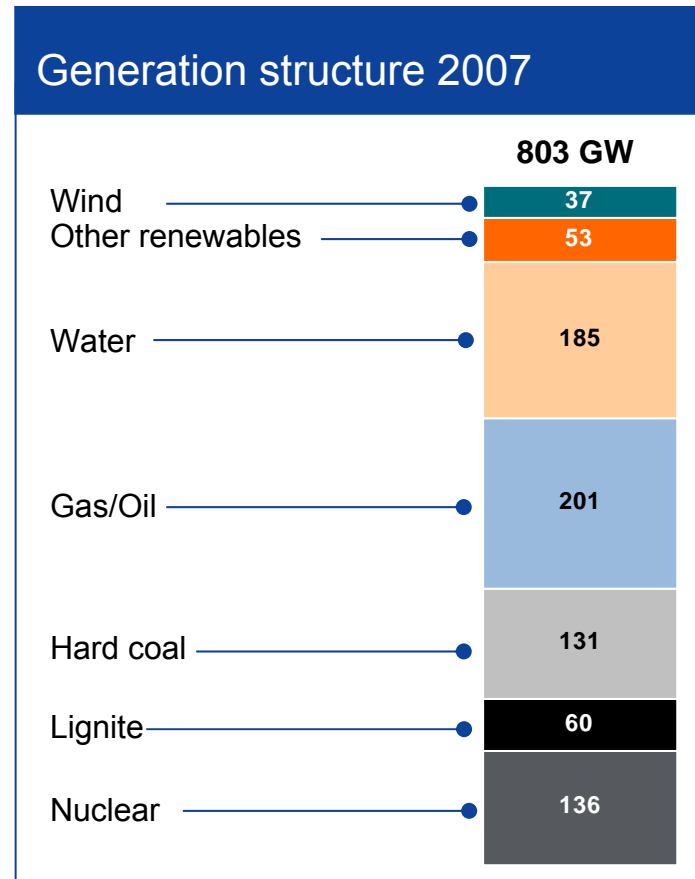
Europe



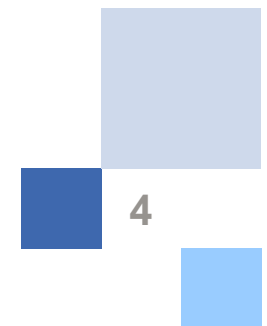
Factbook – Generation Capacity in Europe



Europe's total generation capacity: 800 GW



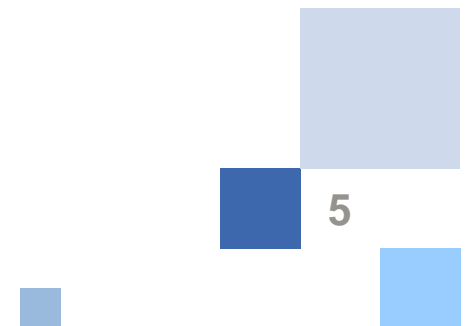
Sources: BCG, RWE



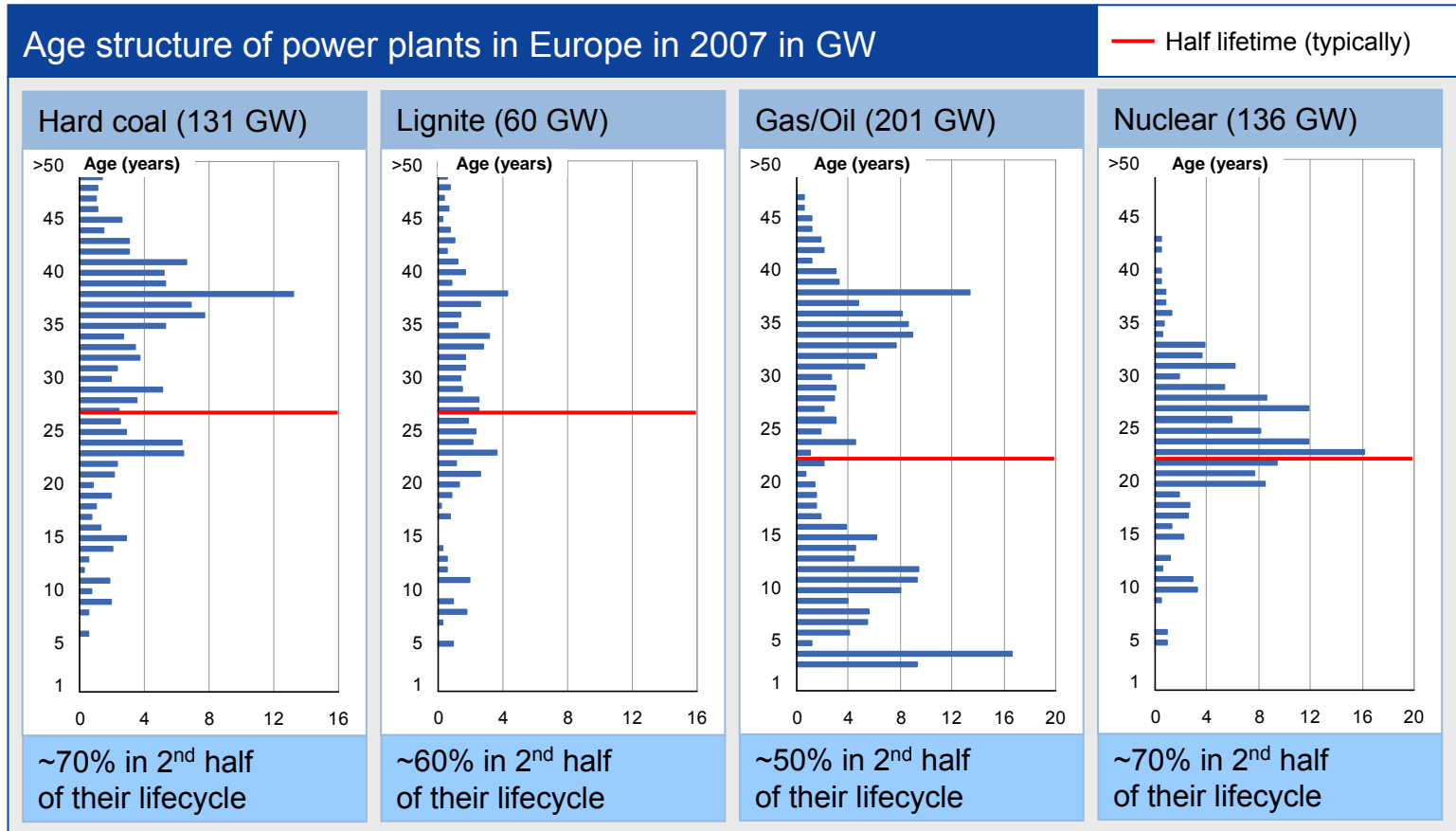
Europe has an “age problem”



- Last boom for the construction of conventional and nuclear power plants was in the 80s
 - Since then mainly gas fired power plants have been built
 - Ca. 40% of thermal and nuclear power plants older than 25 years
- Hard coal plants
 - Ca. 60% older than 25 years
 - Replacement of all these (old) plants needed by 2030

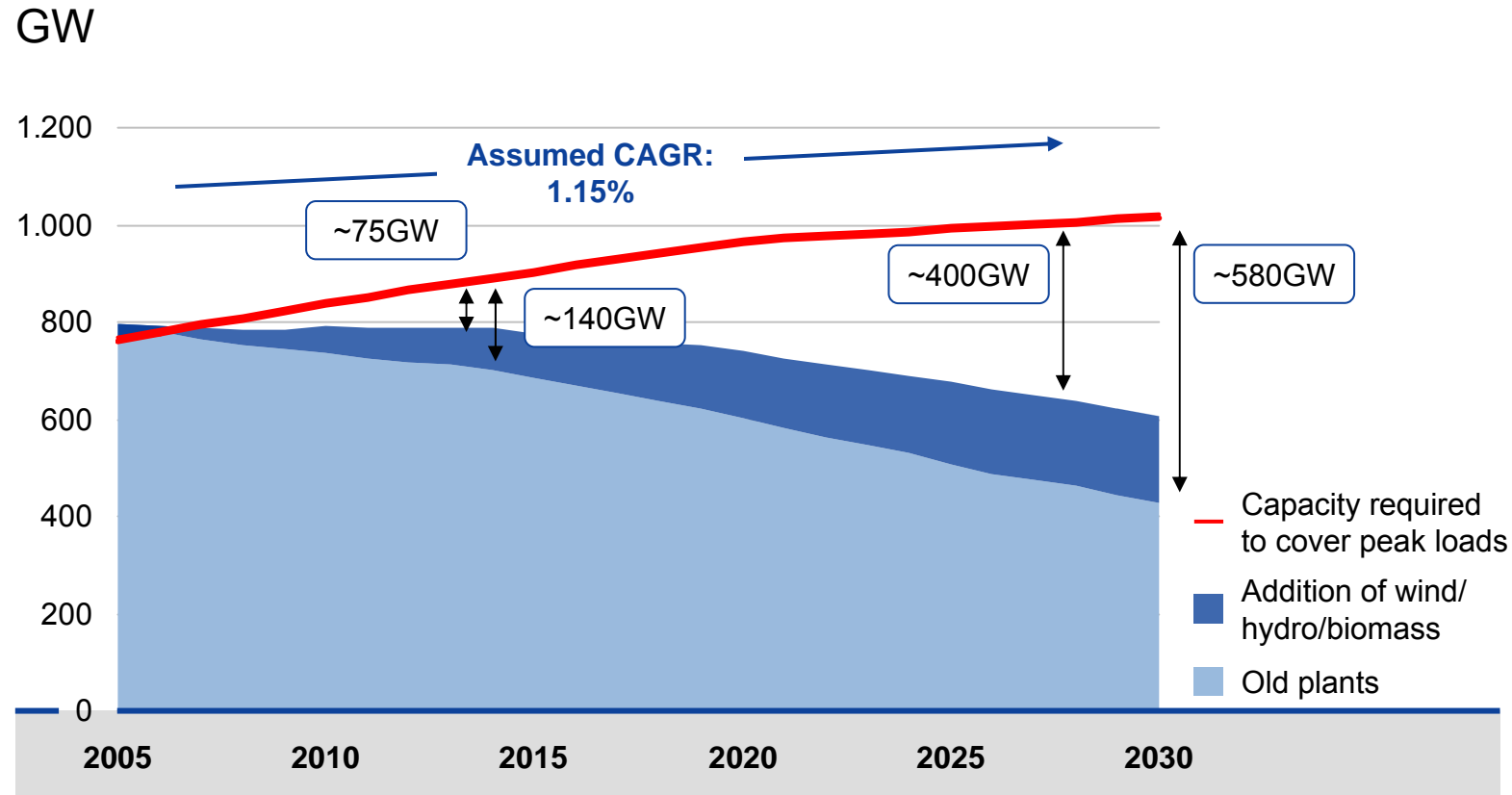


Ageing power plants throughout Europe ...

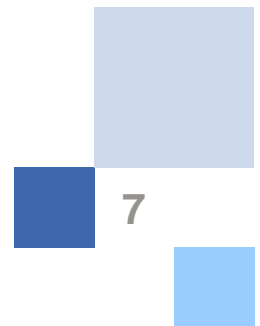


Sources: BCG, RWE

... resulting in a dramatic need for new thermal power plants by 2030



EU 27, Norway, Switzerland
Sources: BCG, EURPROG, UCTE, RWE, 2006



Need for capacity per country

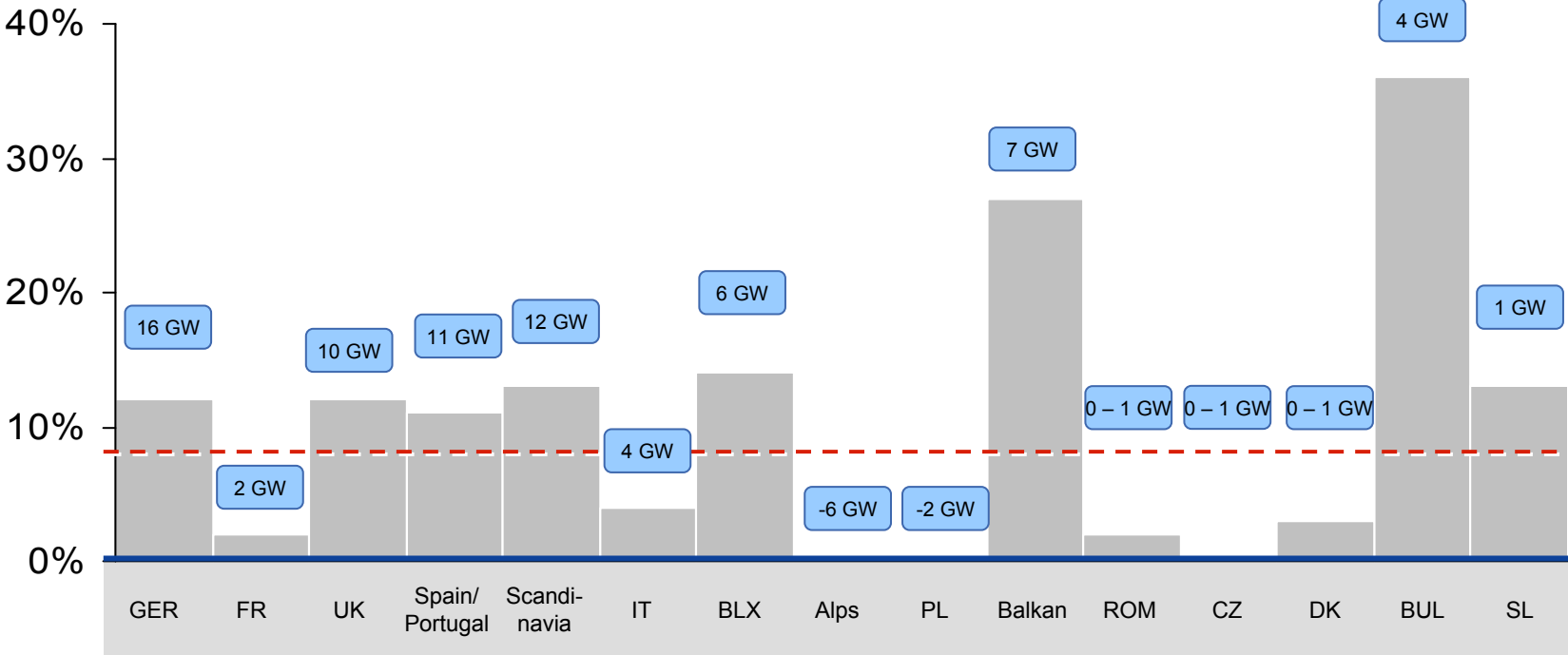


Expected new build by 2012 for thermal and nuclear power plants

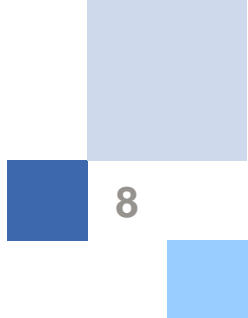
--- Average is 9% in Europe (72 GW)

■ New build in GW

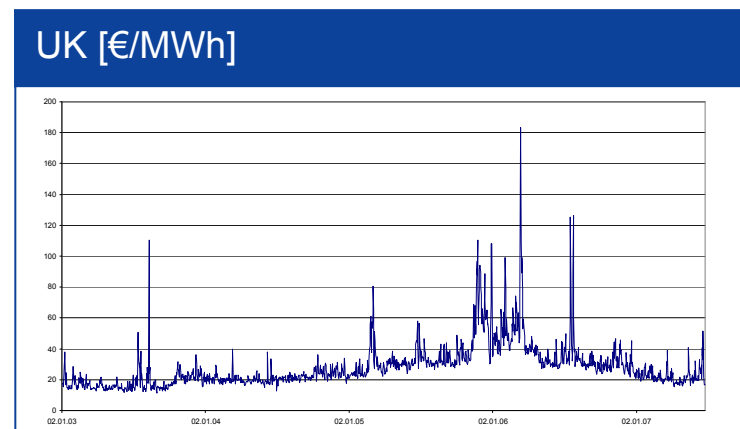
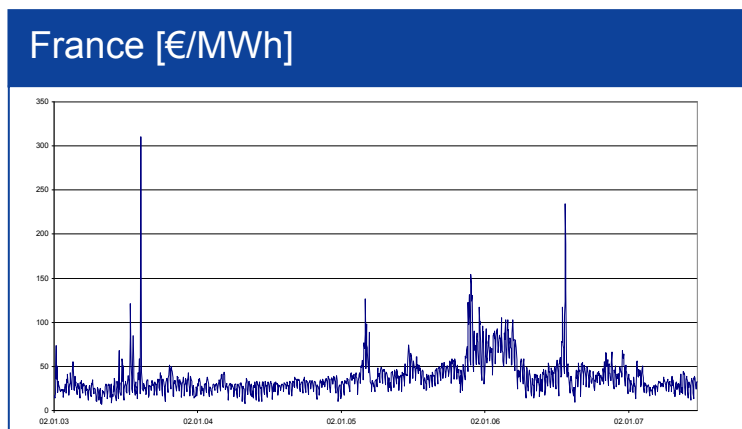
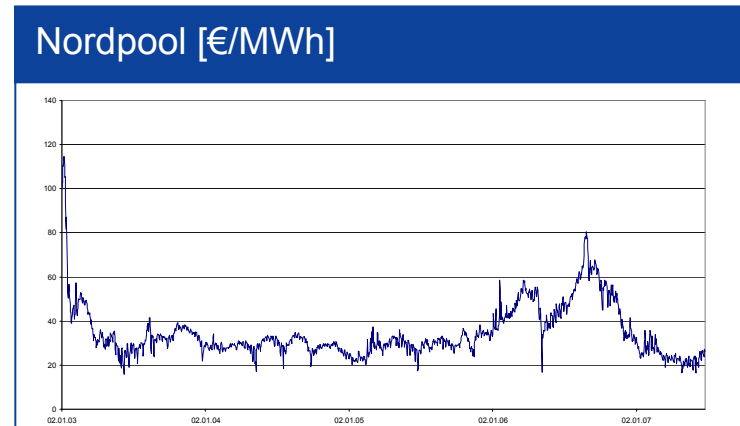
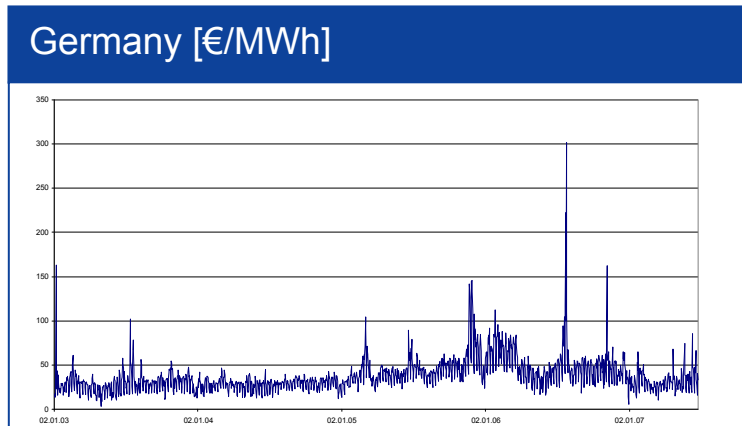
■ New build in % of needed capacity per country by 2012



Sources: BCG, RWE, 2006



Increased imbalance between supply and demand has resulted in very volatile spot prices in Europe

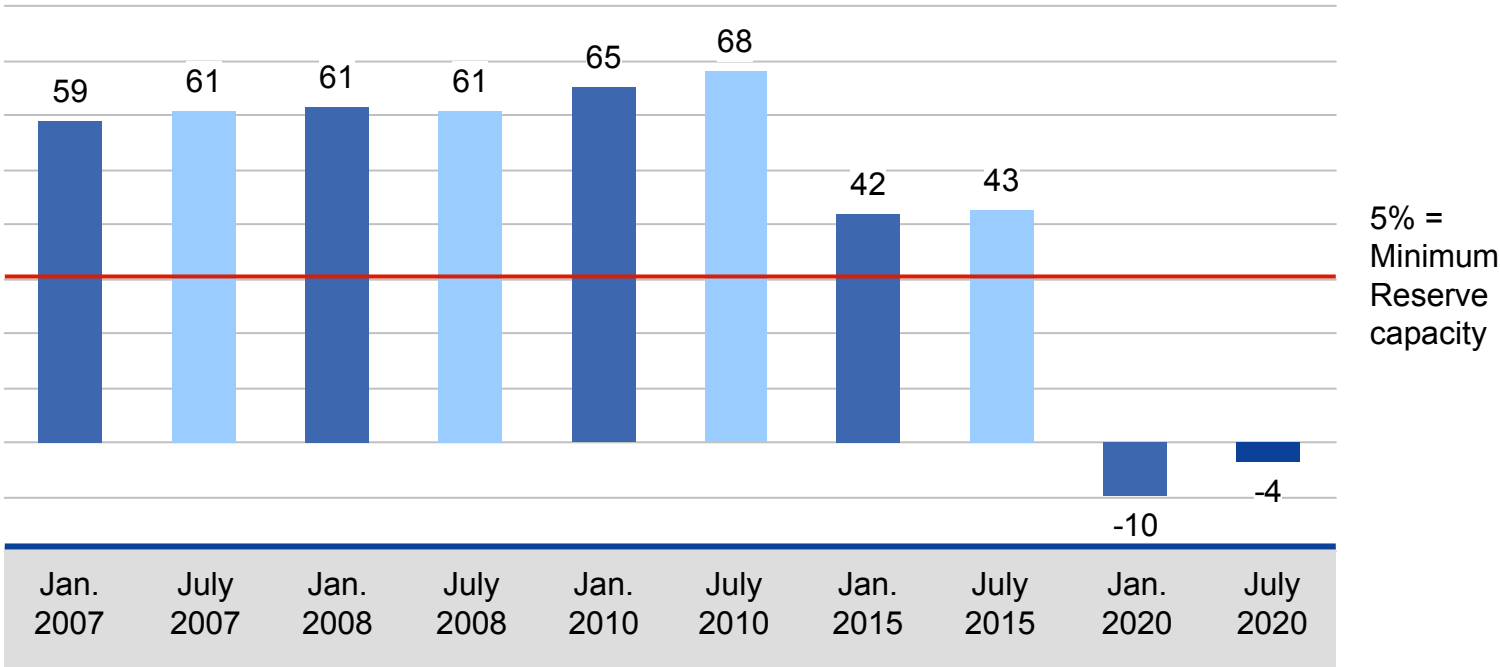


Source: Bloomberg
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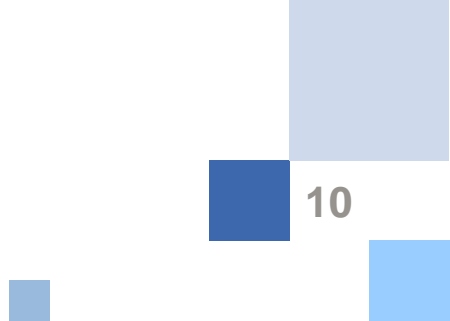
UCTE expects severe capacity shortage by 2020



Reserve Capacity in GW



Basis: third Wednesday 11 a.m.; 25 European countries
 Domestic generating plant capacity Europe: 623.2 GW (Jan. 2007);
 Estimated net generating plant capacity for 2007-2020 (UCTE), underlying consumption growth 1.8% p.a.
 Source: UCTE (Jan. 2007)



CERA expects capacity bottleneck in Europe as soon as 2009 (I)

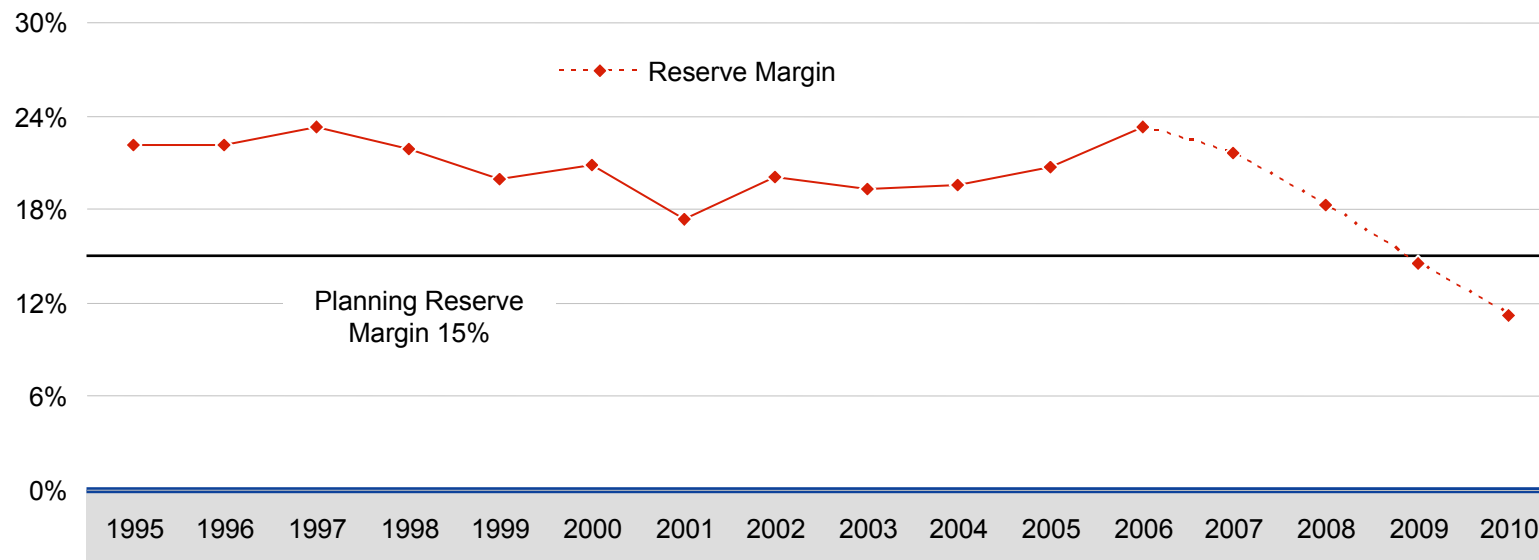
- “With solid demand growth and decommissioning plants underway, European electricity supply will be strained. The countries receiving investments won’t always be the markets where capacity will be needed, and some project pipelines seem inadequate in the face of impending retirements and projected increases in peak demand.”
- “For the EU 15 as a whole, CERA sees a declining reserve margin, even after accounting for new projects. If only those projects currently under construction are built, the electricity market would be short of around 26 gigawatts (GW) in 2010 and the EU 15 reserve margin would fall from 22 percent currently to around 10 percent in 2010.”

Source: CERA, 2006

CERA expects capacity bottleneck in Europe as soon as 2009 (II)



EU 15 reserve margin calculated by CERA



CERA definitions:

Reserve margin is the difference between dependable capacity and peak demand divided by peak demand.

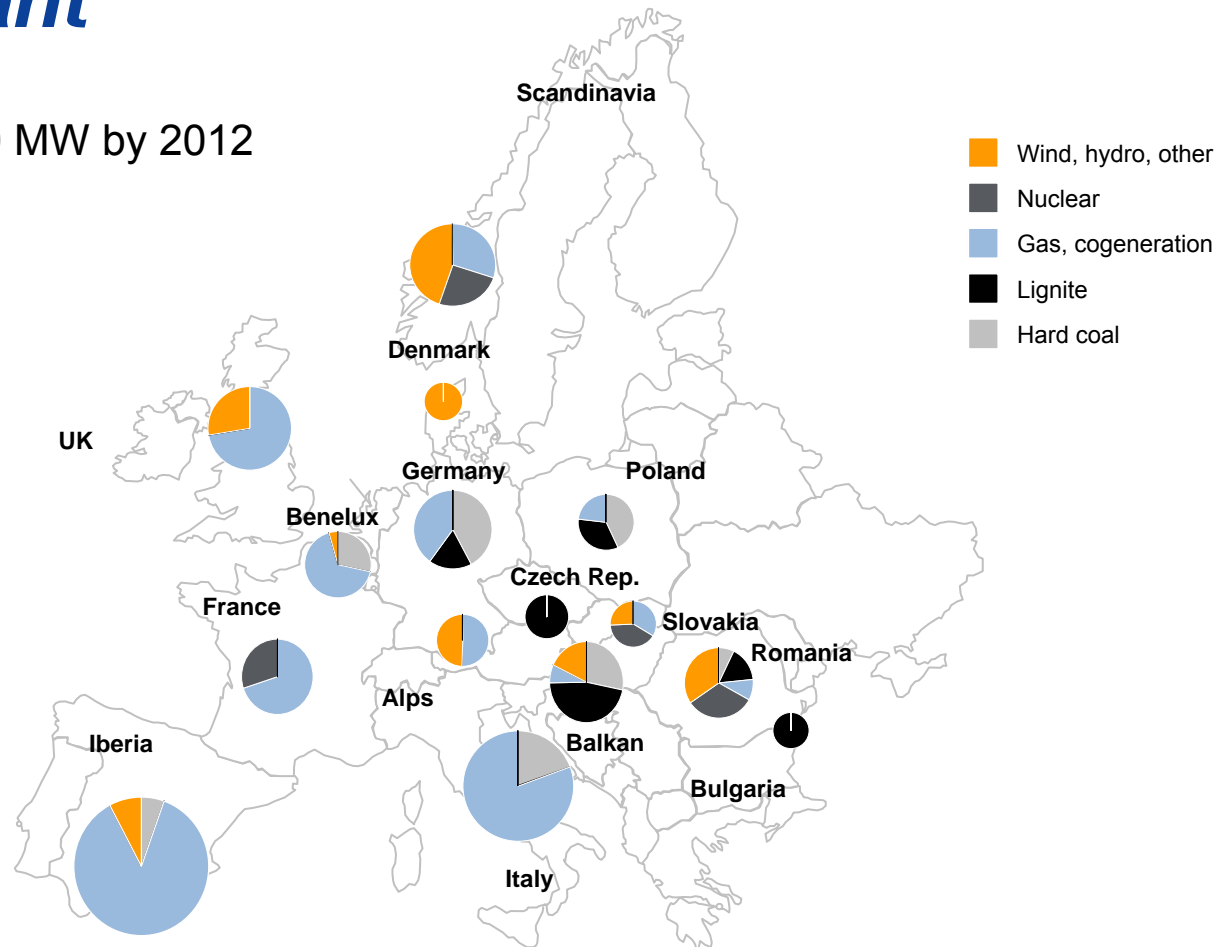
Dependable capacity is firm capacity at peak; CERA's forecast includes existing plants or plants under construction.

Source: CERA, 2006

Proposed new plants with different fuel mix in each country – Gas projects are dominant

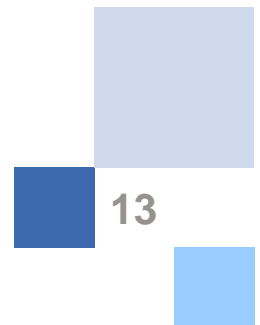


in GW
Projects > 300 MW by 2012



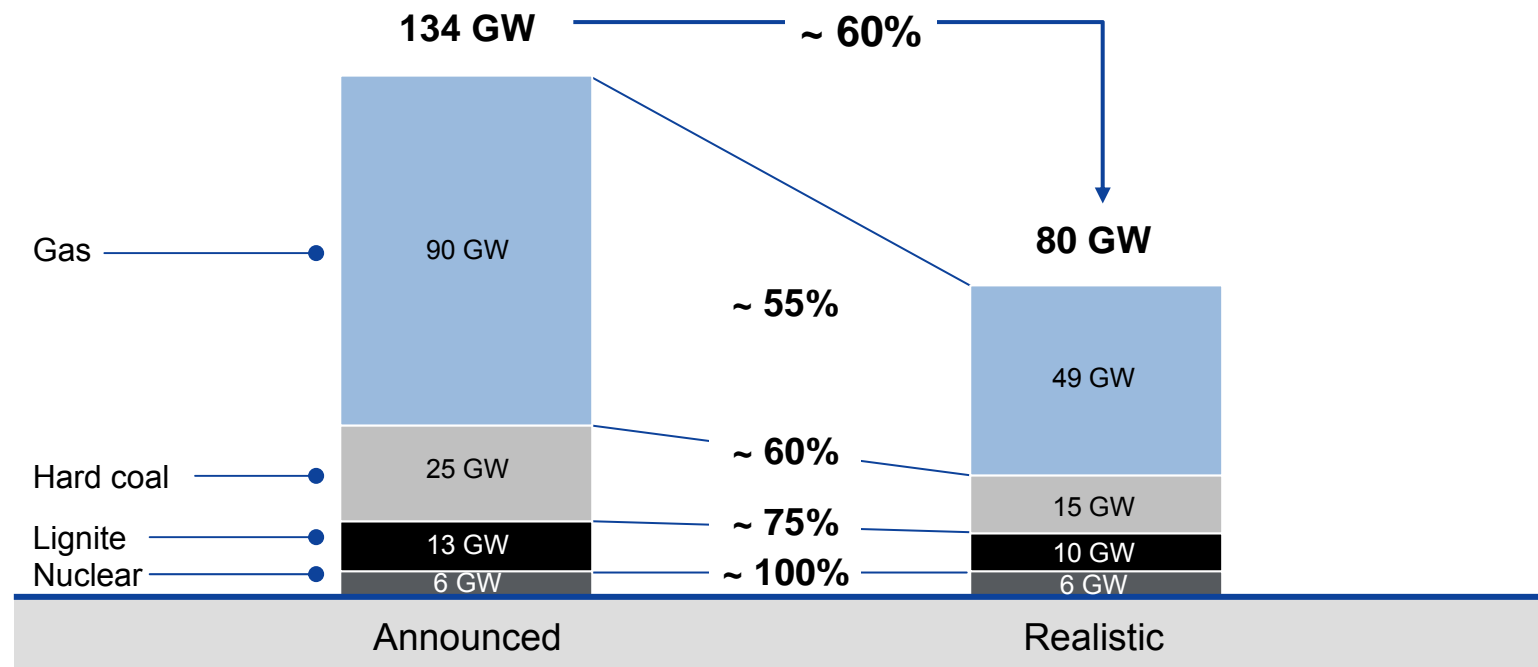
Sources: BCG, RWE, 2006

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But only 60% of the proposed gas power plant projects (by 2012) are realistic ...

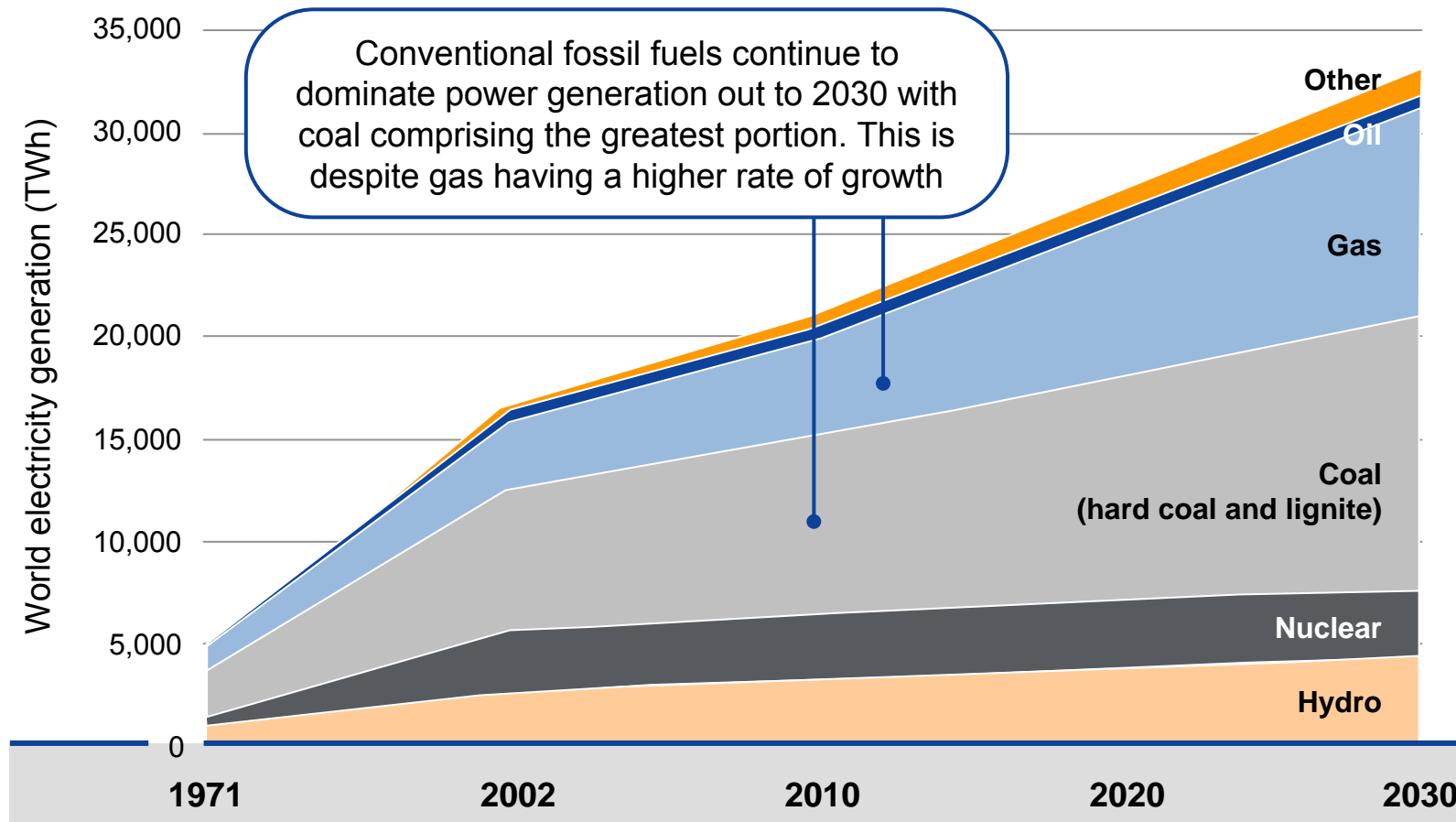
... due to volatile gas prices and problems to secure critical components e.g. gas turbines



Sources: BCG, RWE, 2006

Factbook – Generation Capacity in Europe

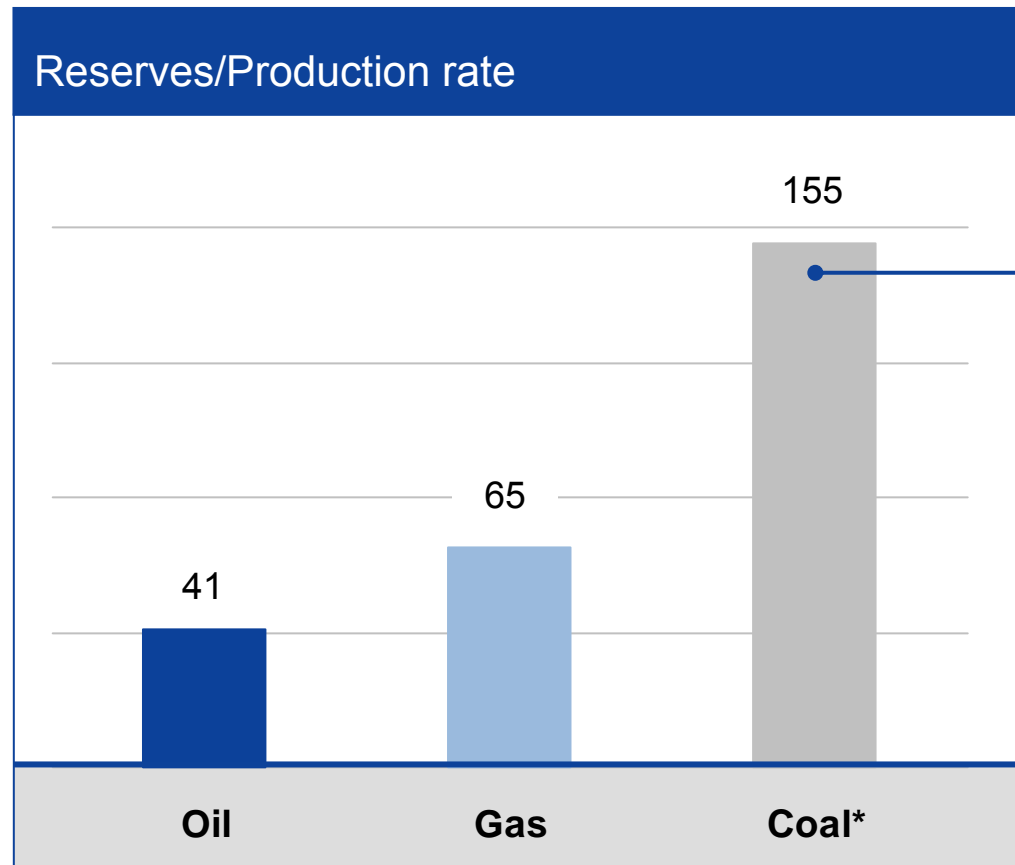
Coal will provide largest share of generation worldwide ...



Sources: IEA, Morgan Stanley Research 2007

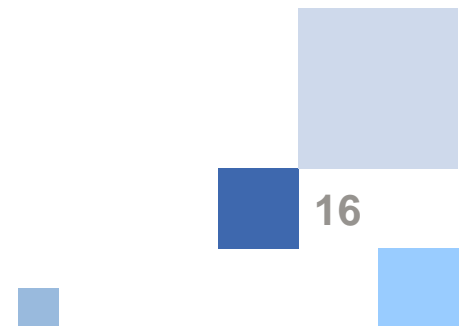
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... because coal is abundant relative to other fuels

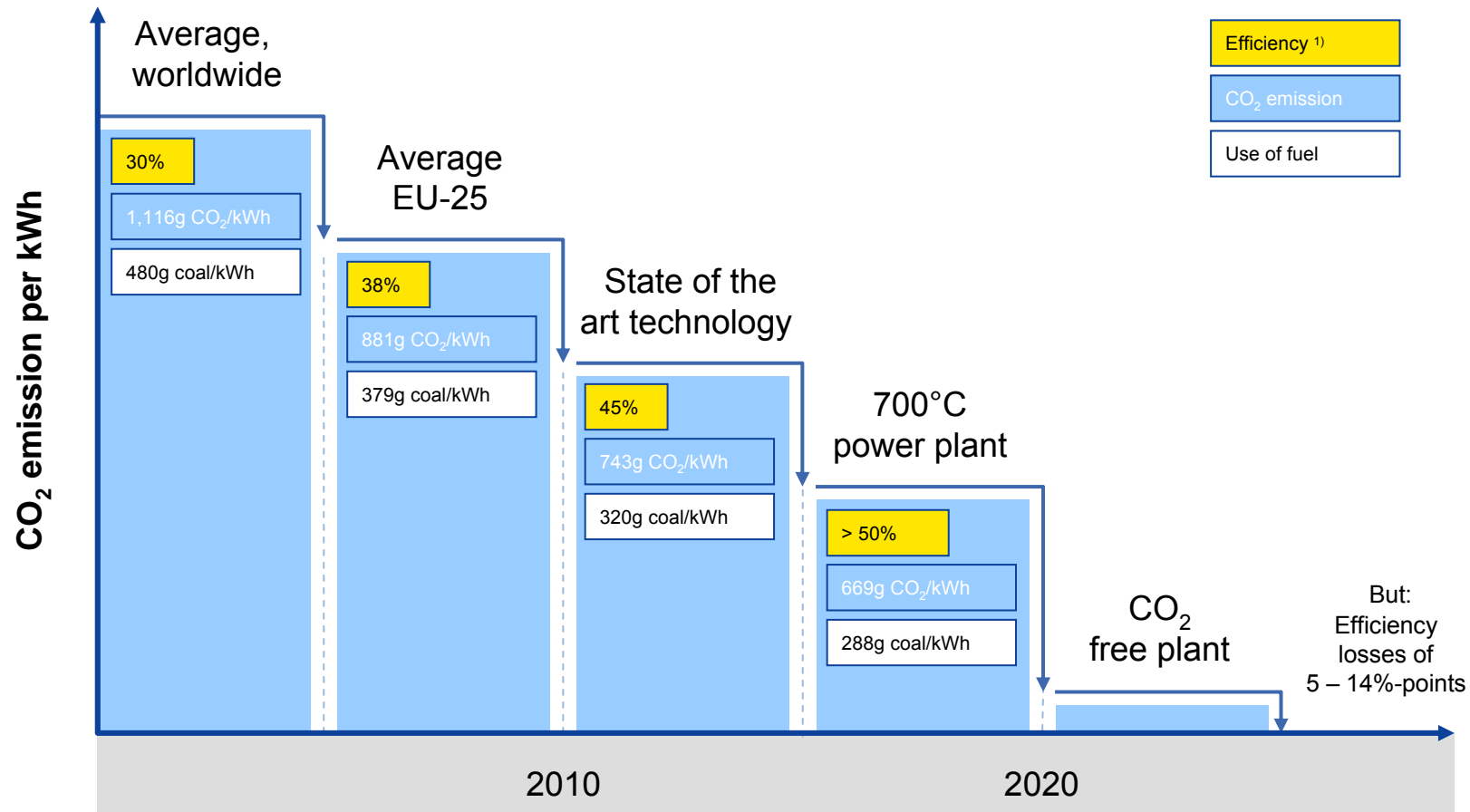


Implied number of years reserves would last if production continues at present levels

Source: BP 2006, Morgan Stanley Research 2007
*Coal = Hard coal and lignite



CO₂ -reduction through higher efficiency essential for hard coal plants

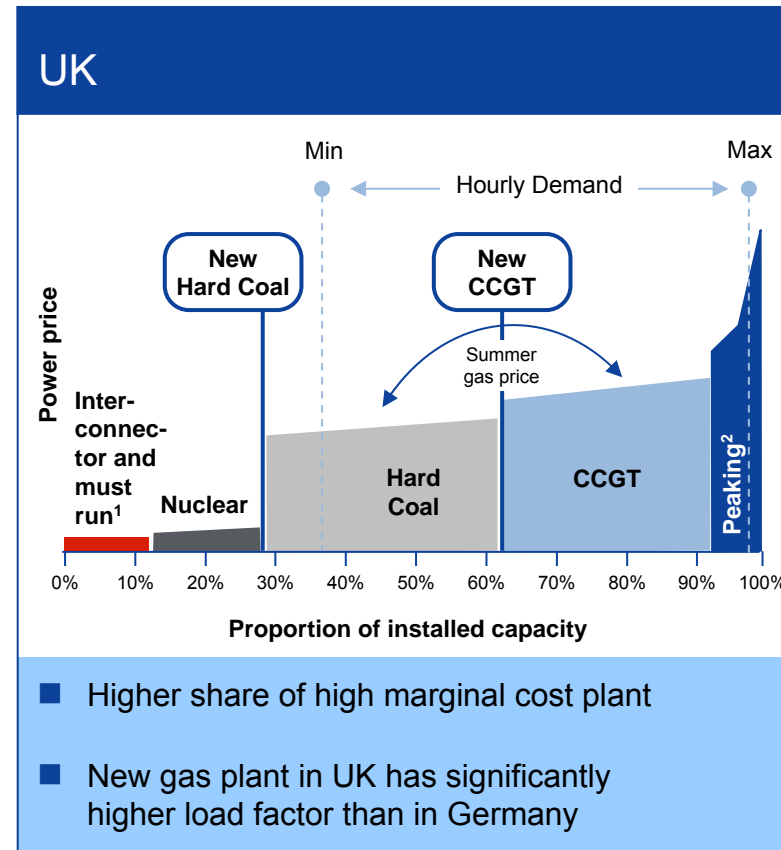
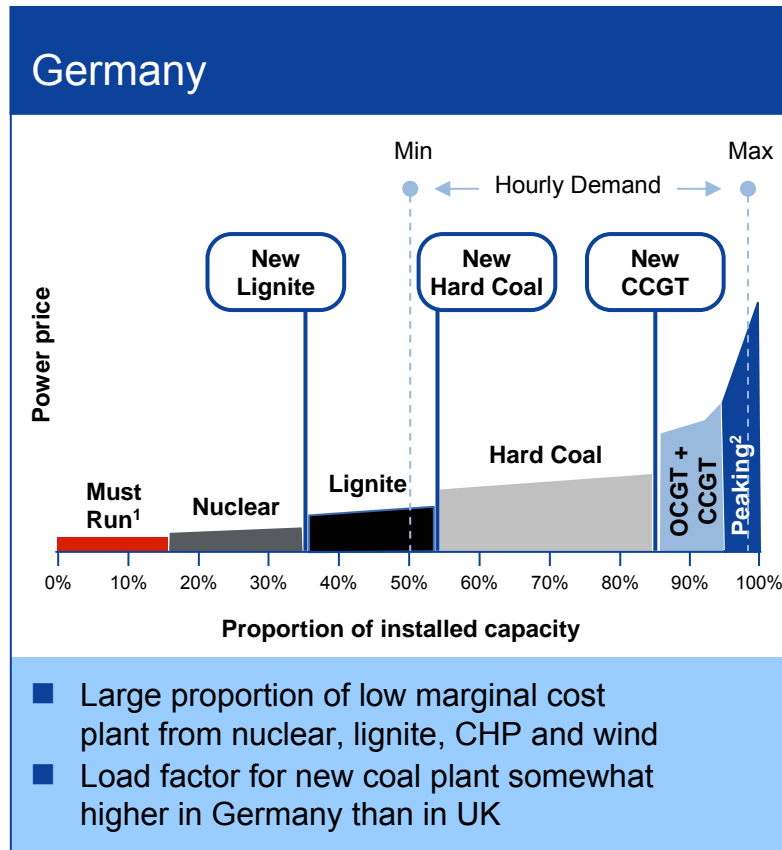


¹⁾ Average data for hard coal plants

Attractiveness of coal and gas differs in Germany and the UK



ILLUSTRATIVE



¹ Including renewables and CHP

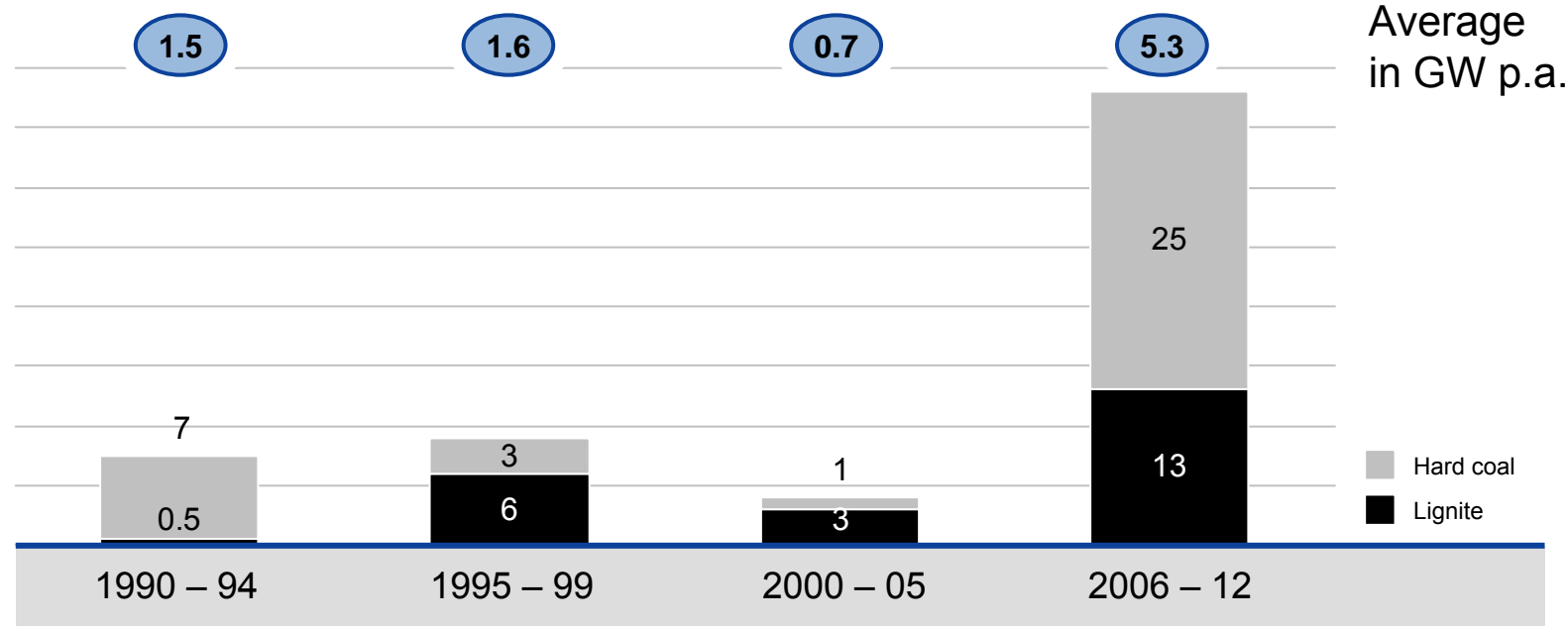
² Oil, OCGT, Hydro, etc.

Tight European engineering capacity

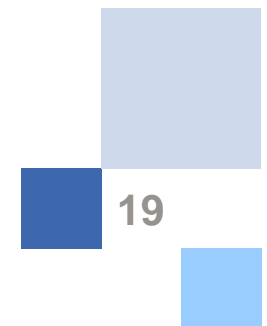


Construction programmes for new coal-fired power plants are a challenge for engineering companies' capacities.

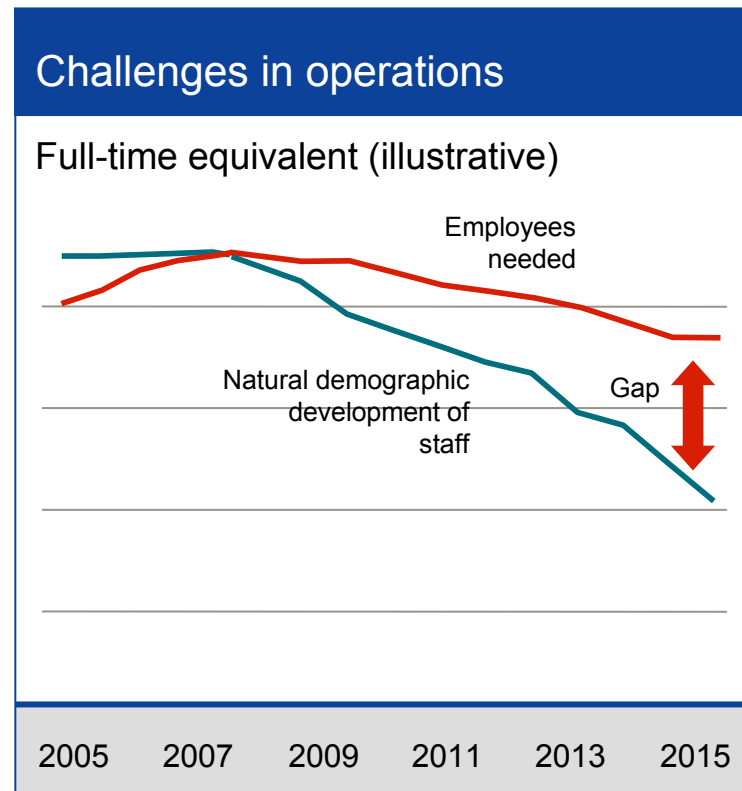
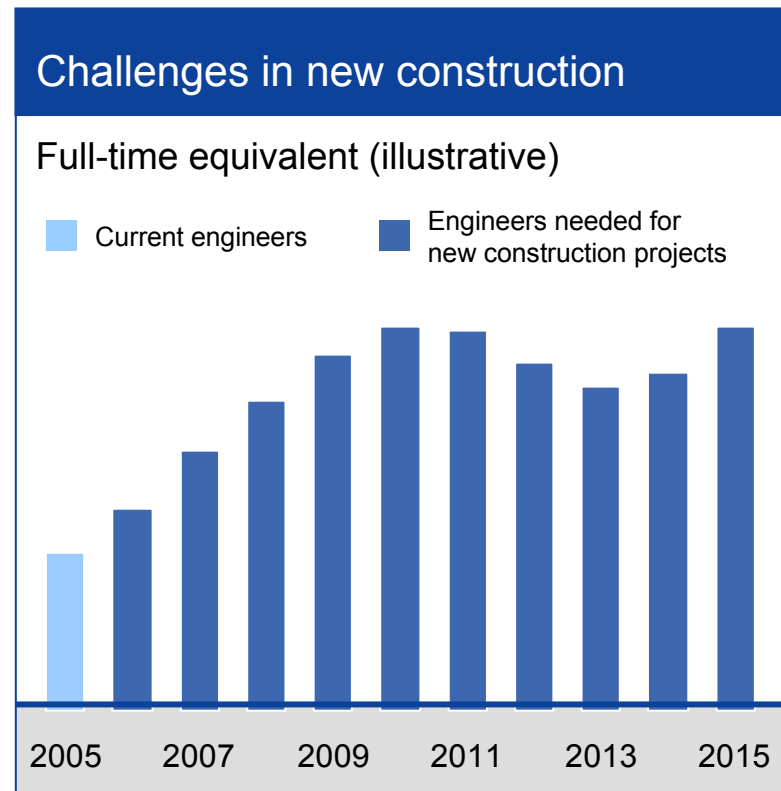
New construction of coal power plants over time (Europe)^{1, 2}



¹ 1990 – 2005: plants with a gross capacity over 150 MW
² 2006 – 12: new-construction projects with a capacity >300 MW
 Sources: UDI, Platts, RWE, BCG 2006

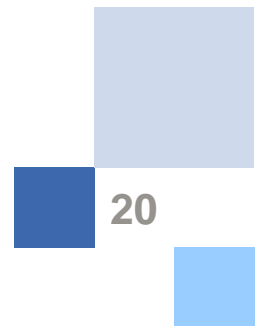


Construction companies are also short of personnel



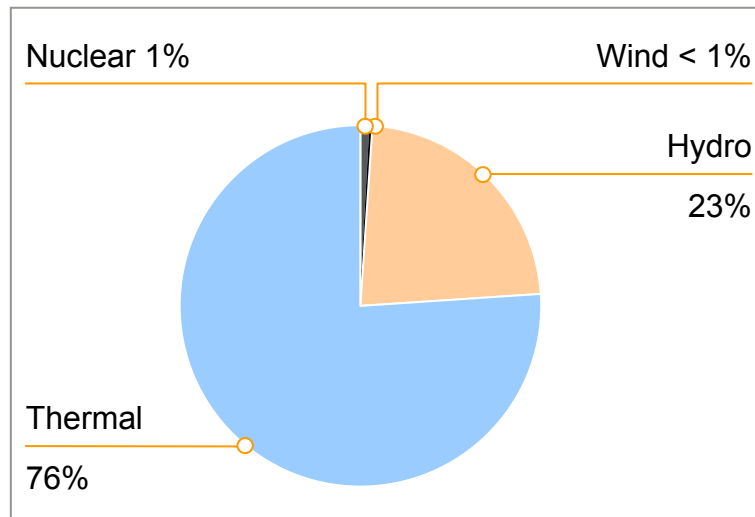
Sources: BCG, RWE, 2006

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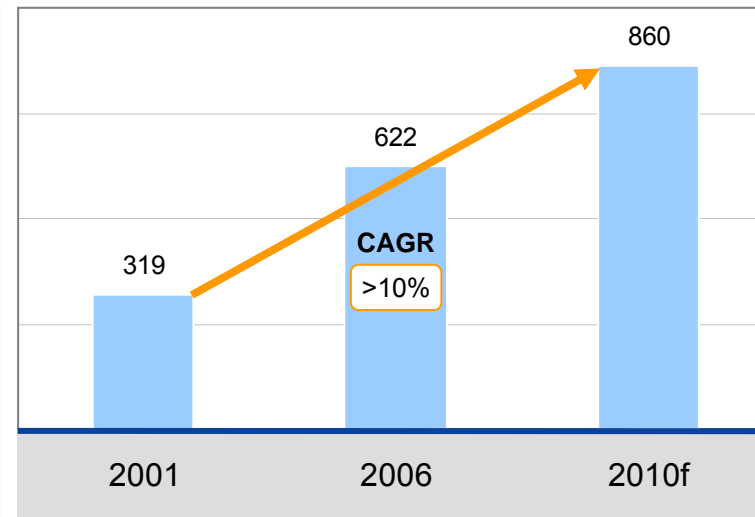


Construction companies are also constrained due to China's demand

Installed capacity by fuel type 2005



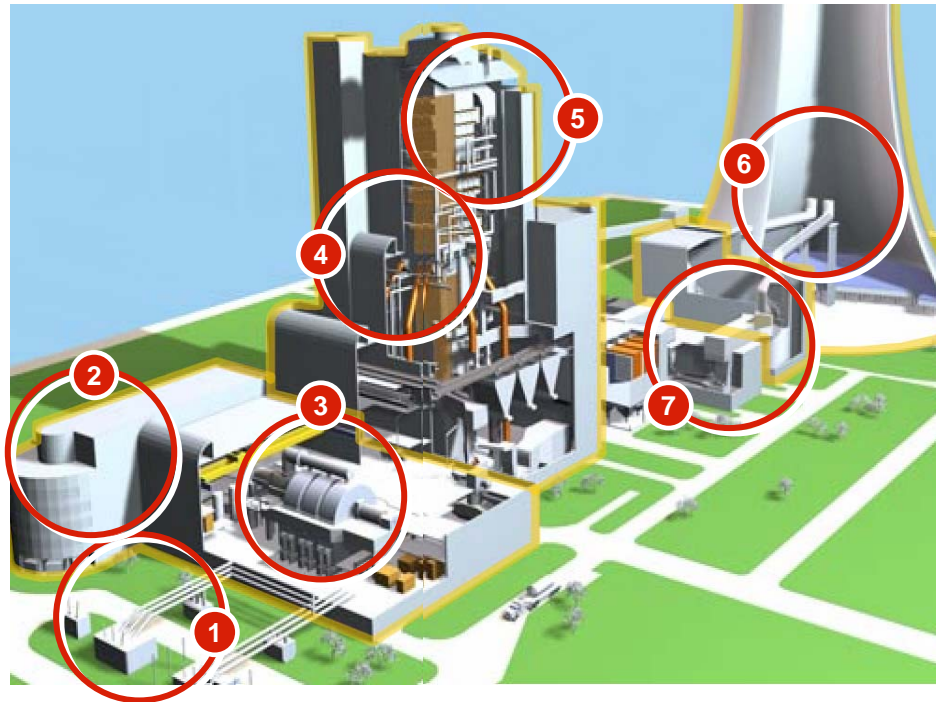
Total installed capacity in GW



- ▶ China has the 2nd largest installed base in the world and is growing fast
- ▶ Thermal (esp. Coal) will remain dominant in the foreseeable future

Source: Alstom, Power in China – Analyst day 12.03.2007

Due to limited producer capacity essential components are scarce



Key power plant components

- 1 Transformers
- 2 Control technology
- 3 Steam turbines
- 4 High pressure piping
- 5 Steam generators
- 6 Cooling technology
- 7 Flue gas desulphurization

Scarcity drives costs: New-build power station costs up 30%

- "The global boom in coal-fired generation equipment orders, rising material costs and margin improvement by suppliers have forced new-build power station costs up by as much as 30% since 2005", European power plant developers told Platts April 20."
- "The hikes have come in two waves. Power generation equipment prices fell over a four-year period to 2004 as orders were few and far between, and competition among the big suppliers – GE, Alstom and Siemens – was fierce."
- "Over the next 18 months to mid-2006 prices rose about 15% as suppliers sought to improve margins," said an independent developer with several CCGT projects in continental Europe. "And now we've seen another 10 – 15% increase on the back of rising material costs, especially steel, and rising sub-contractor costs."
- "Some suppliers are refusing to fix the price of contracts in full until an order is firm, the developer said. "We are seeing some quotes in the market where suppliers are taking key items like boilers out and saying 'it is what it is when you place your actual order'. So you can sign a contract not knowing what the full price impact will be six or nine months later." For a number of years, given low orders, capacity in specialist manufacturing centres (such as for boiler tubing) was steady. Now orders are ramping up, existing capacity is stretched."

Source: Platts 23.04.2007

Last but not least: Political risks impeding investment plans

Europe

- Emissions Trading: National Allocation Plans 2008 – 2012 with reduced number of free certificates for generators, further significant reduction expected post 2012
- Discussion of ownership unbundling of power networks

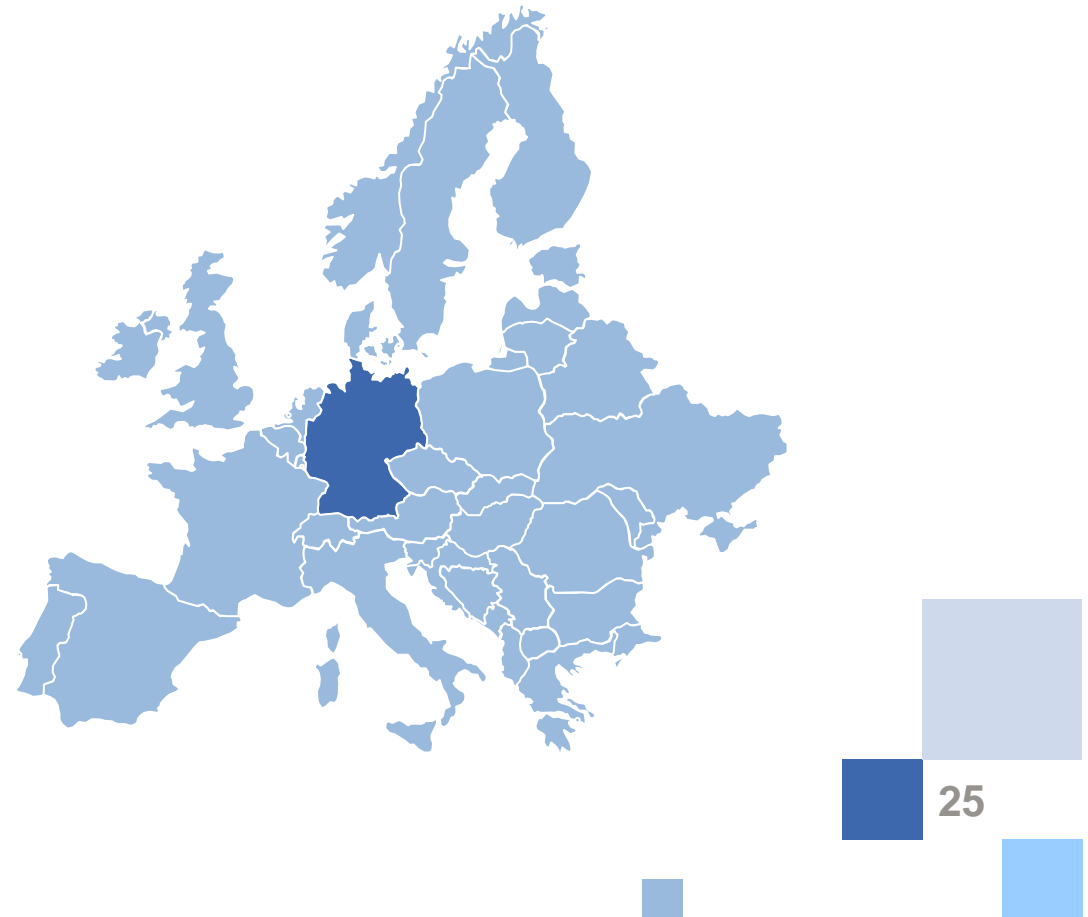
Germany

- Emissions Trading: No guarantee of grandfathering for replacement plants post 2012
- Tightening of anti-trust legislation
- Phasing out of nuclear plants

Eastern Europe

- Political uncertainty as regards liberalisation, privatisation and support for new entrants

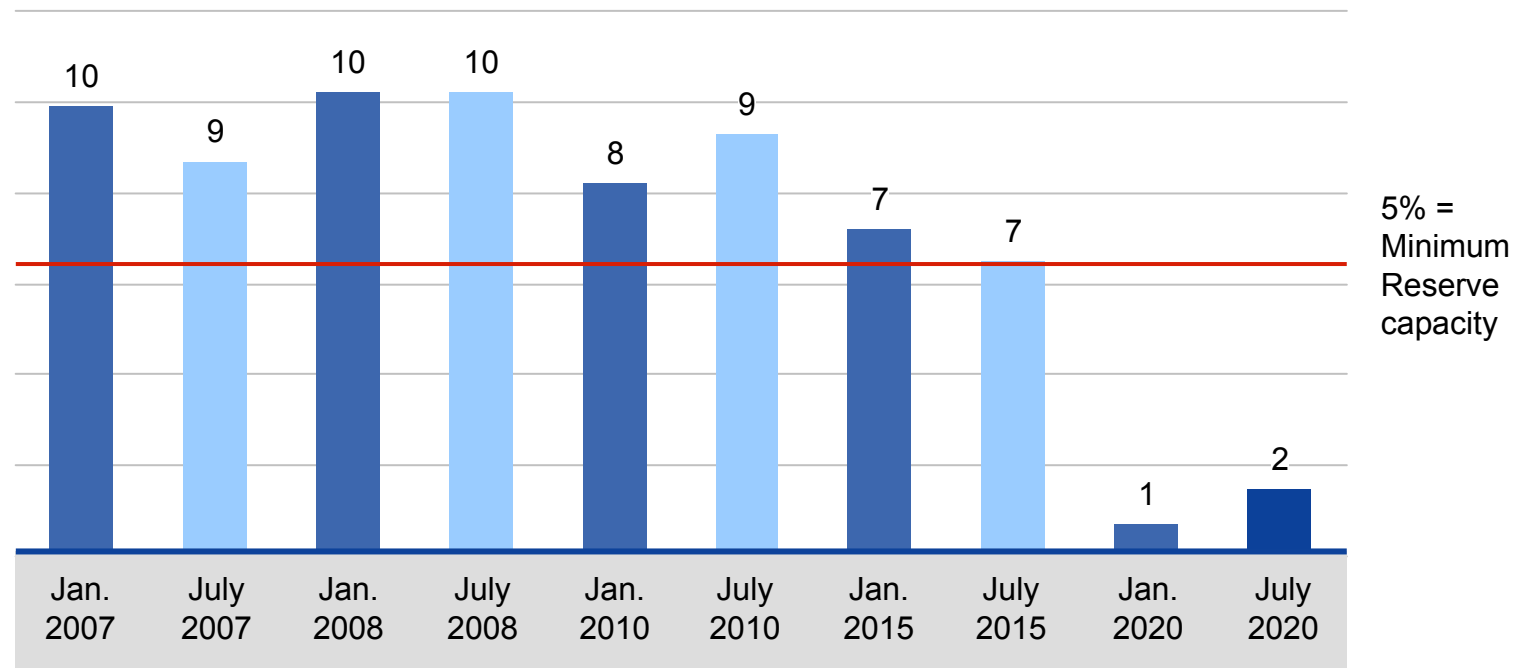
Germany



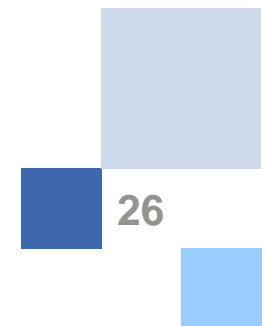
UCTE expects capacity bottleneck in Germany from 2015 onwards



Reserve Capacity in GW



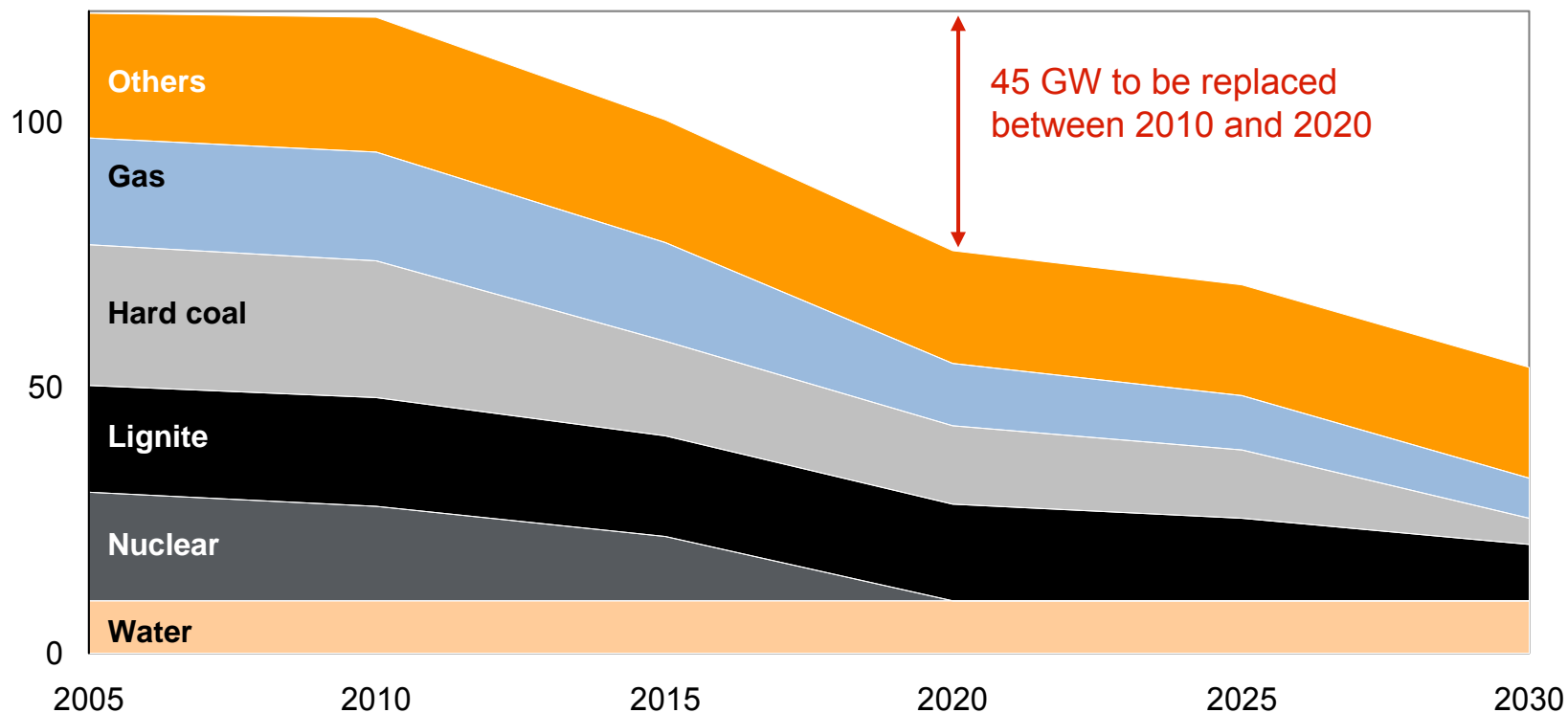
Basis: third Wednesday 11 a.m.
 Domestic generating plant capacity Germany: 122.3 GW (Jan. 2007);
 Estimated net generating plant capacity for 2007-2020 (UCTE)
 Source: UCTE (Jan. 2007)



Considerable replacement needed in Germany - including nuclear phase out



Age-related reduction in existing power plant capacities (in GW)

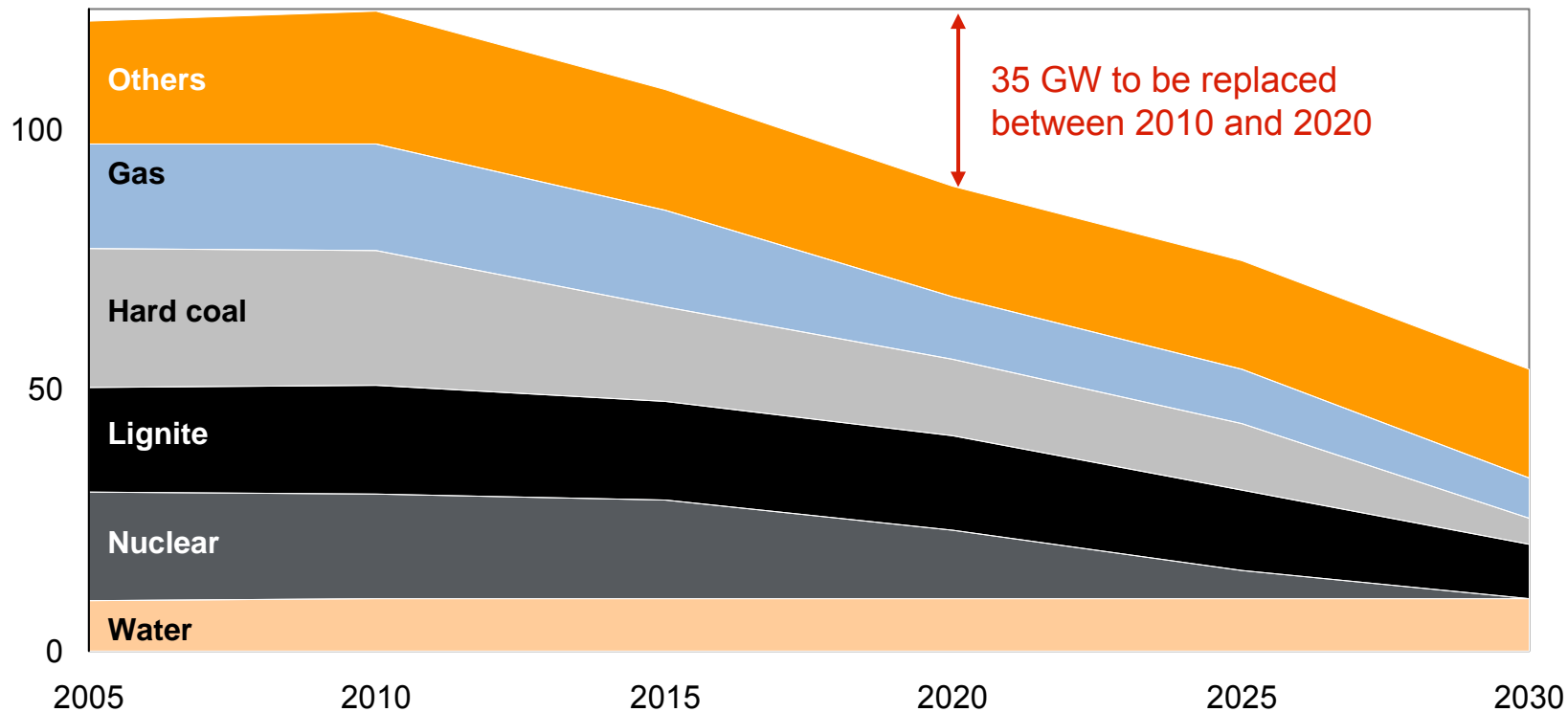


Note: Including plants currently under construction. General plant lifetime is 40 years. Decommissioning of nuclear power plants under the terms of the German government's nuclear phase-out program.

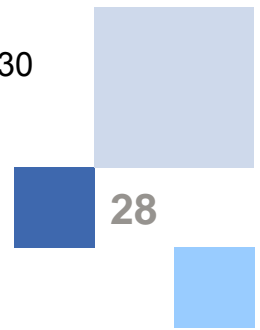
Considerable replacement needed in Germany - excluding nuclear phase out



Age-related reduction in existing power plant capacities (in GW)



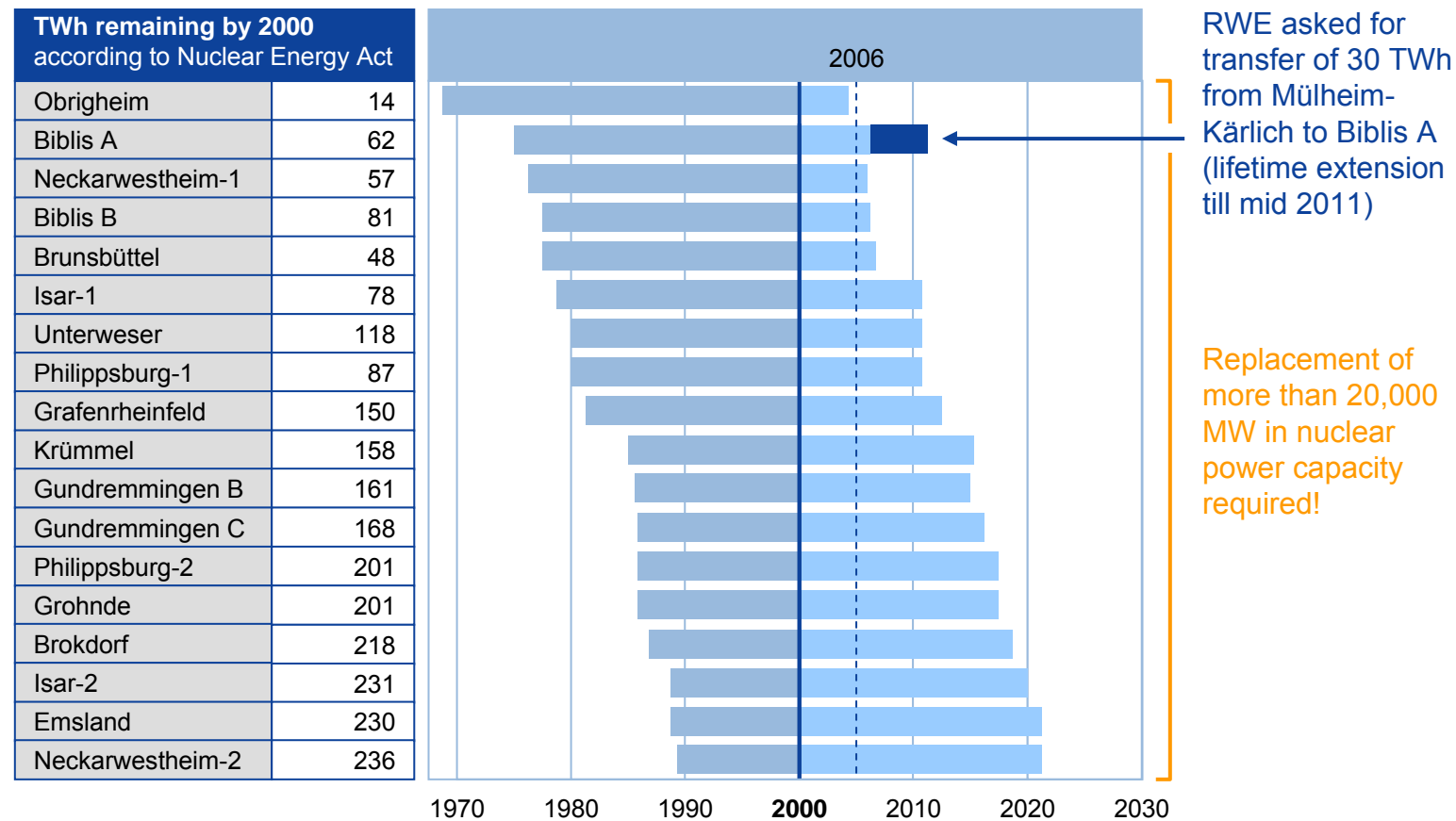
Note: Including plants currently under construction. Decommissioning in each case after 40 years. If the remaining periods of operation for nuclear power plants specified in the German government's nuclear phase-out program are stipulated, the replacement requirements up to 2020 will be higher.



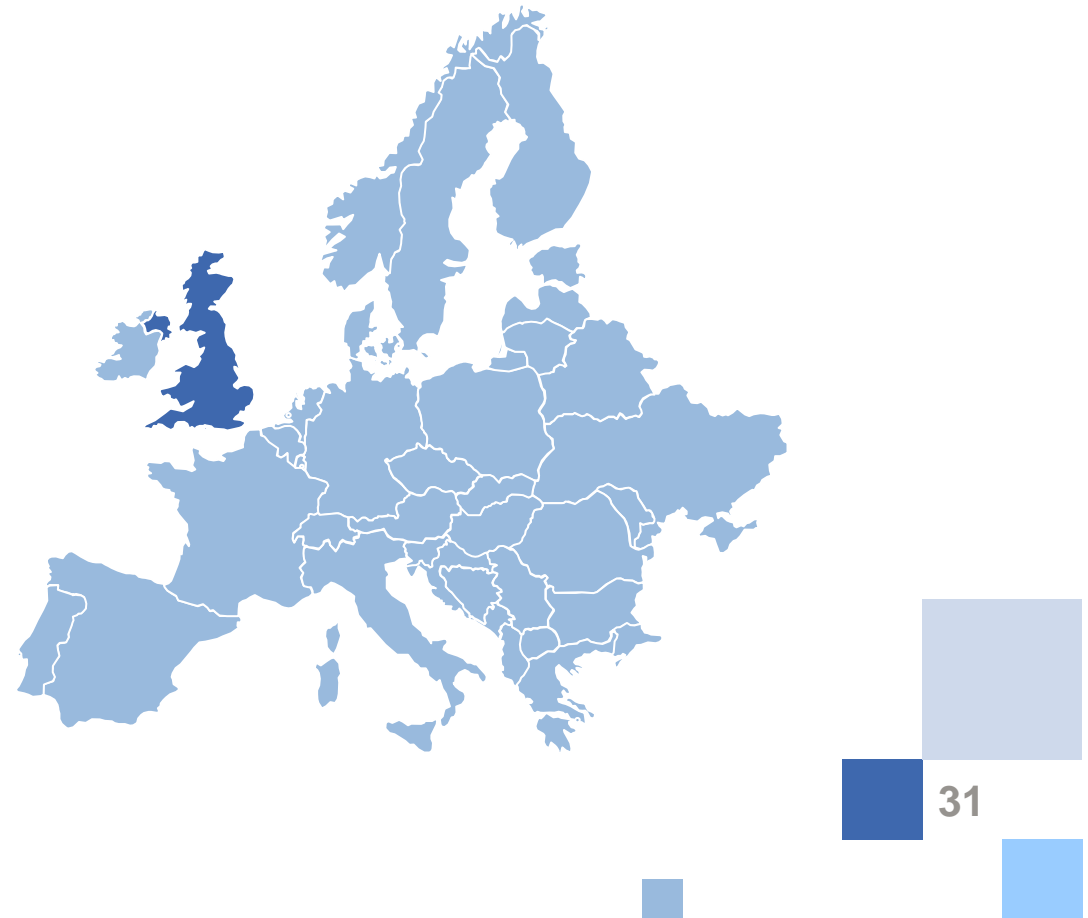
Phase out of nuclear power plants in Germany is another tightening factor



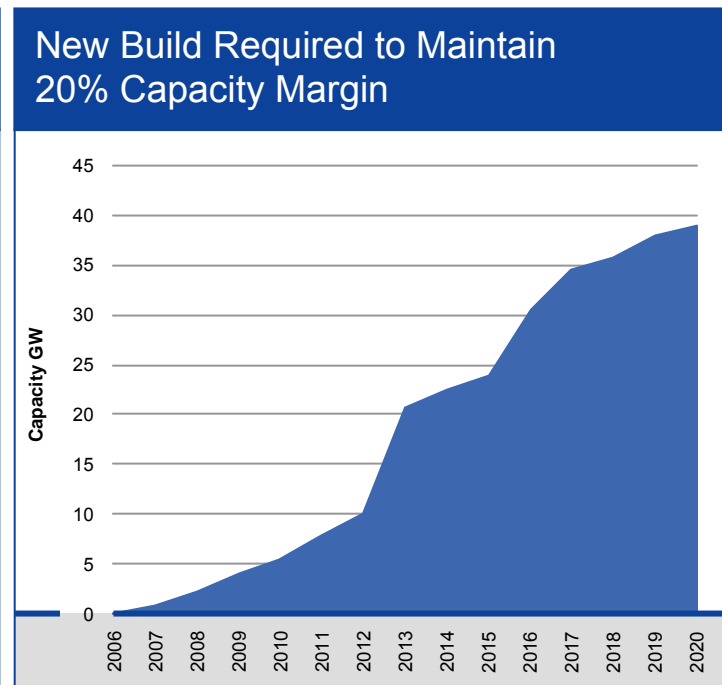
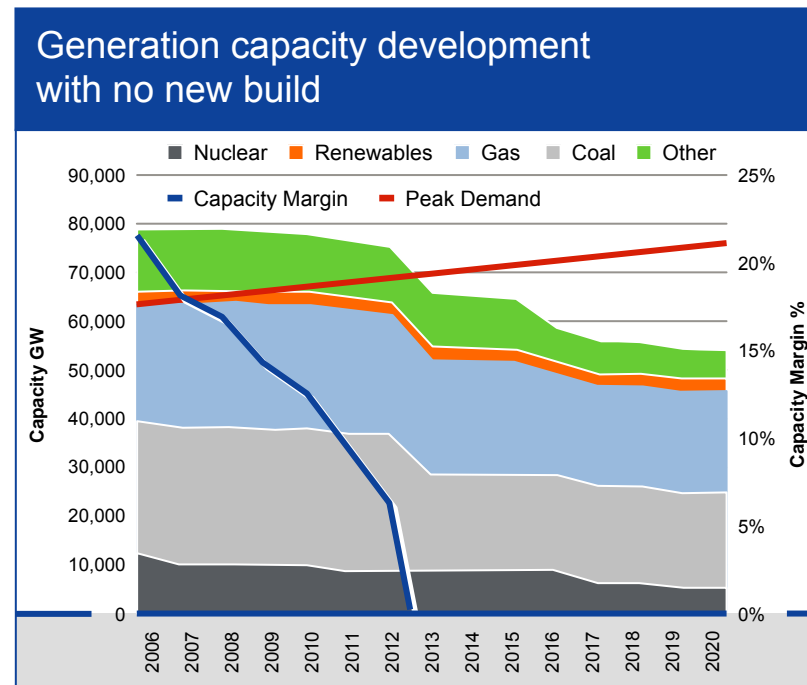
Plant lifetime based on residual electricity generation



UK



Substantial investment in capacity needed in the UK to replace shut downs and meet rising demand



- Approximately 20-40 GW of new capacity (= 25-50% of total capacity) will be required by 2020 to maintain margins
- Market fundamentals support a sustained return of value to the generation sector

Large combustion plant directive (LCPD): Shut down of 13 GW by 2015 (or earlier) in UK



| Installation | Operator | Fuel | Installed Capacity (MWe) | Number of boilers | Number of plant | Capacity Opted in ¹ (MW) | Capacity Opted out ² (MW) | FGD ³ status |
|----------------|----------------------------|----------|--------------------------|-------------------|-----------------|-------------------------------------|--------------------------------------|-------------------------|
| Drax | Drax Power | Coal | 3,960 | 6 | 1 | 3,960 | 0 | Fitted |
| Eggborough | British Energy | Coal | 2,000 | 4 | 1 | 2,000 | 0 | 2 units fitted |
| Cottam | EDF Energy | Coal | 2,000 | 4 | 1 | 2,000 | 0 | Fitted |
| Ferrybridge | Scottish & Southern Energy | Coal | 2,000 | 4 | 2 | 1,000 | 1,000 | Under construction |
| Fiddlers Ferry | Scottish & Southern Energy | Coal | 2,000 | 4 | 1 | 2,000 | 0 | Under construction |
| Didcot A | RWE npower | Coal | 2,000 | 4 | 1 | 0 | 2,000 | No FGD |
| Tilbury | RWE npower | Coal | 1,520 | 4 | 2 | 0 | 1,520 | No FGD |
| Kingsnorth | E.ON UK | Coal | 2,000 | 4 | 1 | 0 | 2,000 | No FGD |
| Ratcliffe | E.ON UK | Coal | 2,000 | 4 | 1 | 2,000 | 0 | Fitted |
| Ironbridge | E.ON UK | Coal | 1,000 | 2 | 1 | 0 | 1,000 | No FGD |
| Rugeley | International Power | Coal | 1,000 | 2 | 1 | 1,000 | 0 | Contracting |
| West Burton | EDF Energy | Coal | 2,000 | 4 | 2 | 2,000 | 0 | Fitted |
| Peterhead | Scottish & Southern Energy | CCGT | 1,320 | 2 | 1 | 1,320 | 0 | N/A |
| Longannet | Scottish Power | Coal | 2,304 | 4 | 1 | 2,304 | 0 | Contractor selected |
| Cockenzie | Scottish Power | Coal | 1,152 | 4 | 2 | 0 | 1,152 | No FGD |
| Aberthaw | RWE npower | Coal | 1,500 | 3 | 1 | 1,500 | 0 | Under construction |
| Kilroot | AES | Coal/Oil | 520 | 2 | 1 | 520 | 0 | Under construction |
| Uskmouth | Uskmouth Power | Coal | 393 | 3 | 1 | 393 | 0 | Fitted |
| Littlebrook | RWE npower | Oil | 2,000 | 3 | 1 | 0 | 2,000 | No FGD |
| Fawley | RWE npower | Oil | 1,000 | 2 | 1 | 0 | 1,000 | No FGD |
| Grain | E.ON UK | Oil | 1,300 | 2 | 1 | 0 | 1,300 | No FGD |
| Total | | | 34,969 | 71 | 25 | 21,997 | 12,972 | |

¹ Compliant with emission limits in LCPD

² Limitation of operating hours to 20,000 between 01.01.2008 and 31.12.2015. No requirement to fit FGD

³ FGD: Flue gas desulphurization

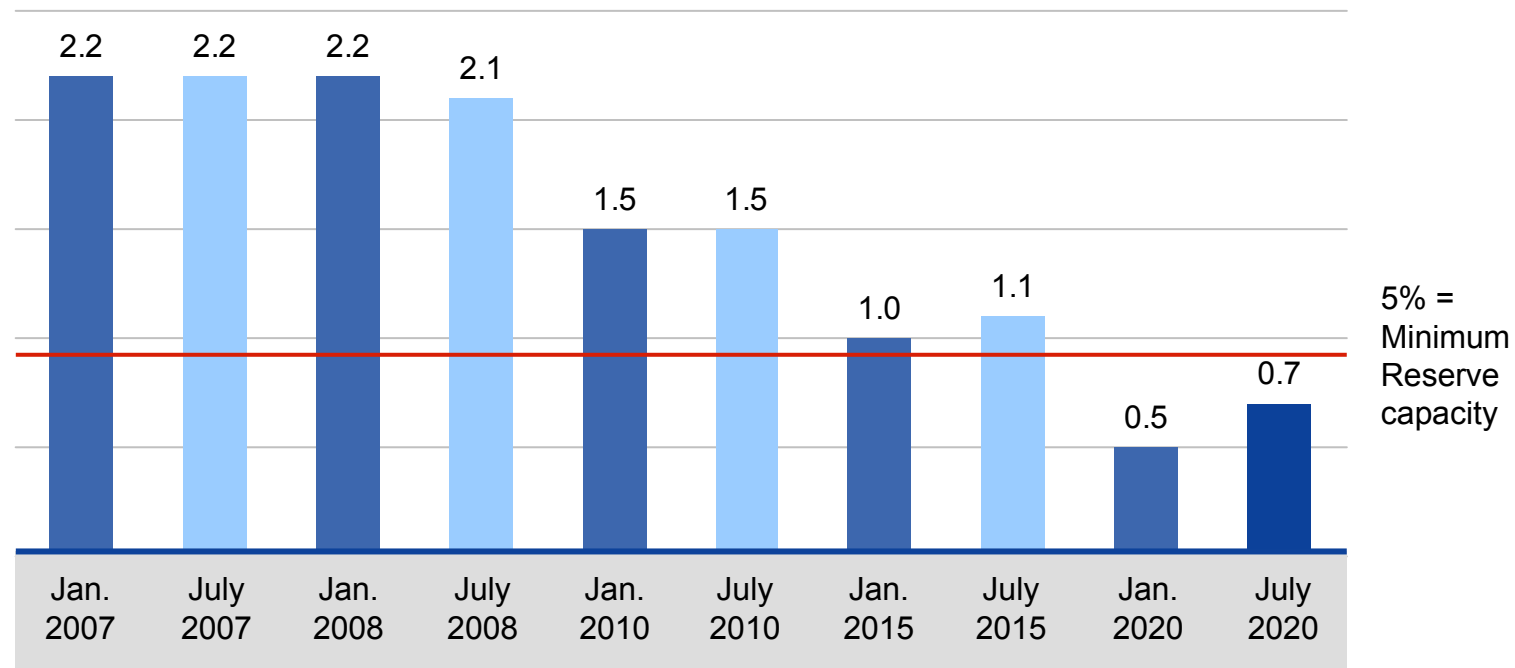
Central Eastern Europe



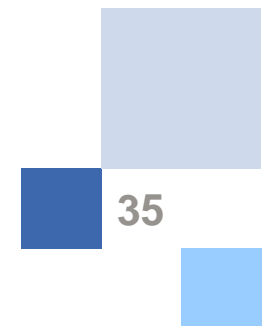
UCTE expects capacity bottlenecks in Czech Republic by 2020 ...



Reserve Capacity in GW

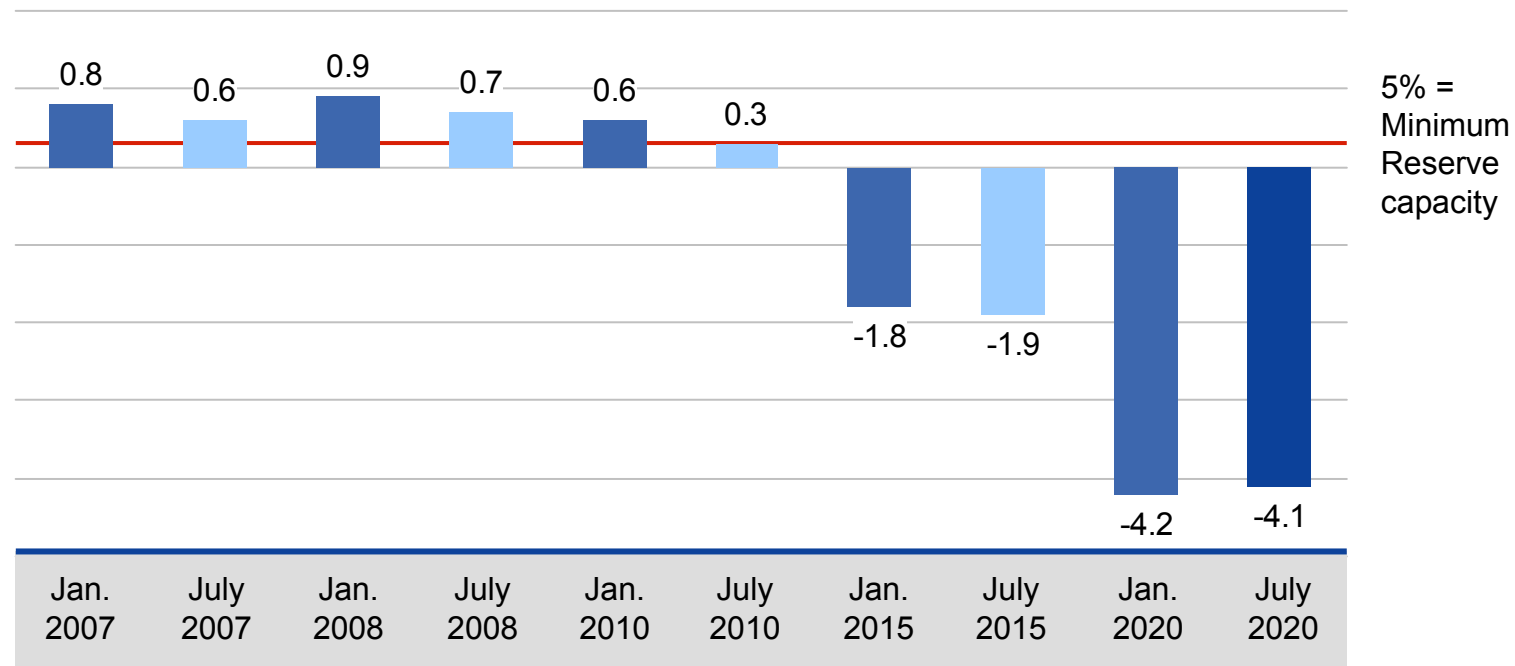


Basis: Third Wednesday 11 a.m.
 Domestic generating plant capacity Czech Republic: 16.3 GW (Jan. 2007);
 Estimated net generating plant capacity for 2007 – 2020 (UCTE)
 Source: UCTE (Jan. 2007)

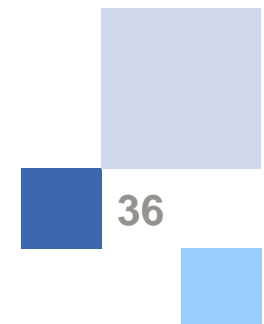


... a negative reserve margin in Hungary by 2015 ...

Reserve Capacity in GW

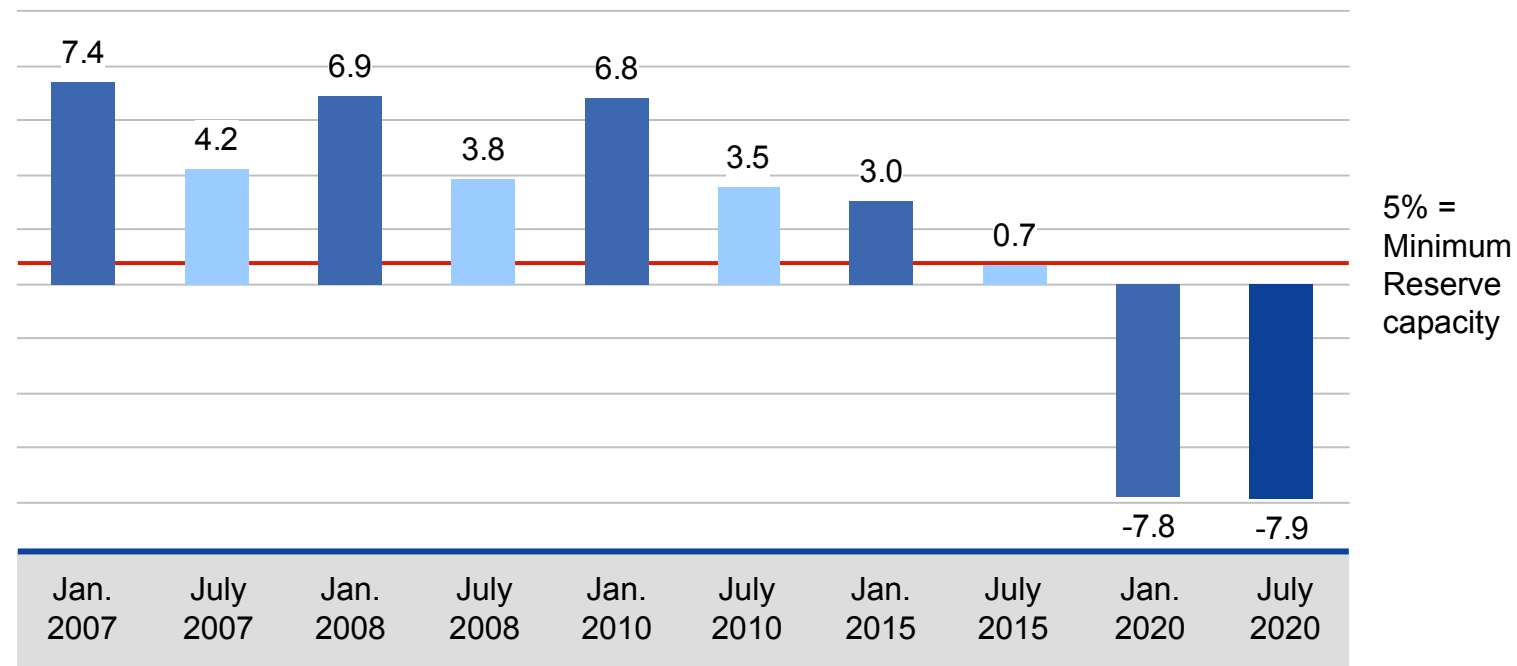


Basis: third Wednesday 11 a.m.
 Domestic generating plant capacity Hungary: 8.1 GW (Jan. 2007);
 Estimated net generating plant capacity for 2007 – 2020 (UCTE)
 Source: UCTE (Jan. 2007)



... and a negative reserve margin in Poland by 2020

Reserve Capacity in GW



Basis: third Wednesday 11 a.m.
 Domestic generating plant capacity Poland: 32.4 GW (Jan. 2007);
 Estimated net generating plant capacity for 2007 – 2020 (UCTE)
 Source: UCTE (Jan. 2007)

EU membership forces closure of nuclear power plants in CEE countries



Bulgaria

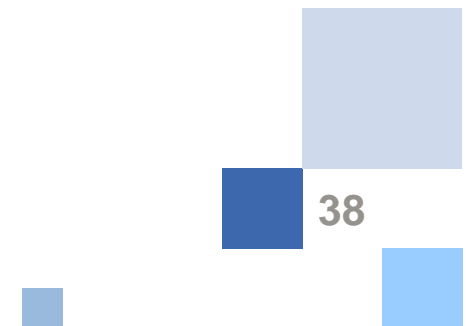
- Nuclear power plant Kozloduy
Closure of blocks 3 and 4 (440 MW each) by 01. Jan. 2007

Slovakia

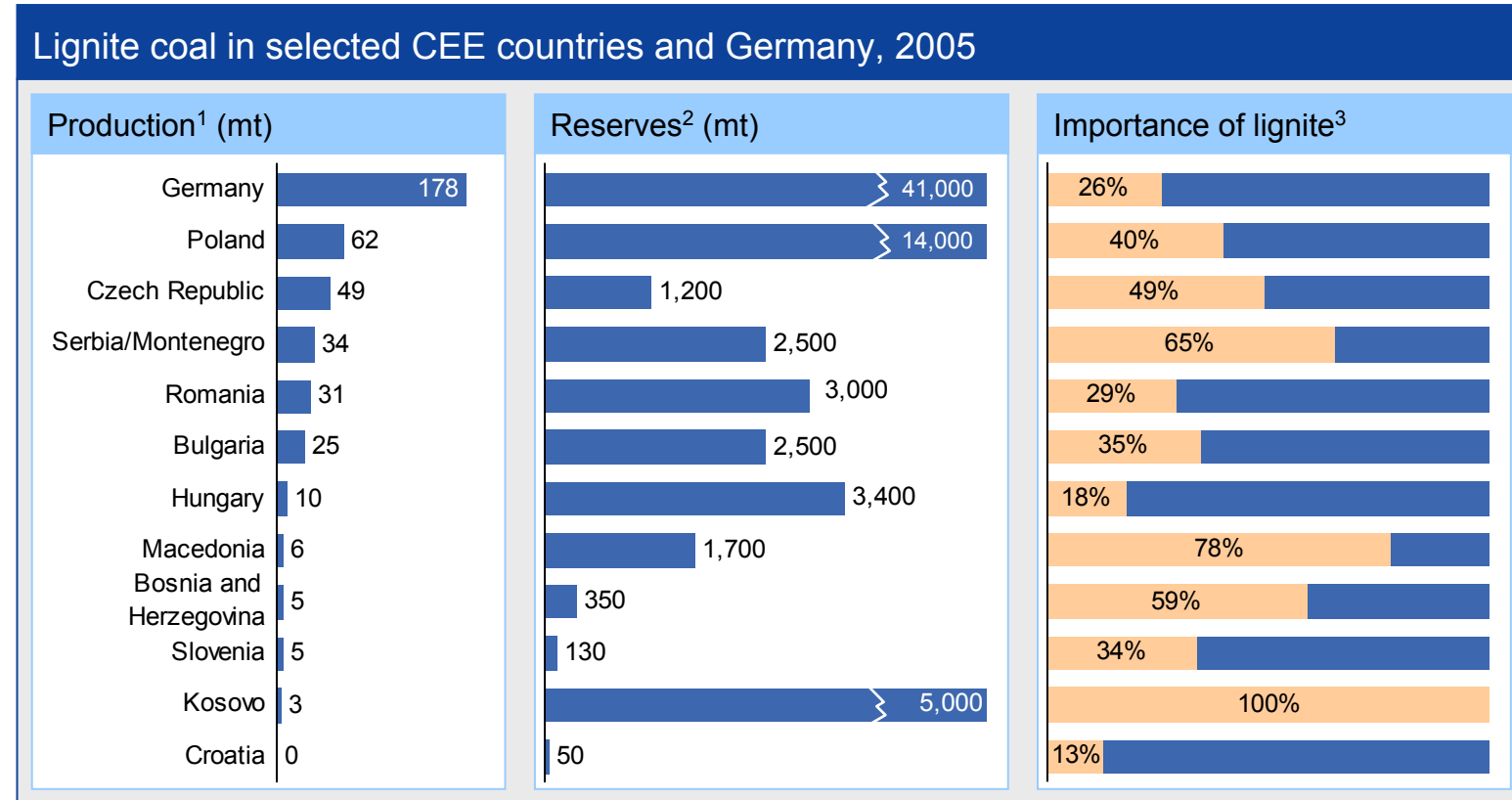
- Nuclear power plant Jaslovske Bohunice V1
Closure of block 1 (220 MW) by 31. Dec. 2006
Closure of block 2 (220 MW) by 31. Dec. 2008

Lithuania

- Nuclear power plant Ignalina
Closure of block 2 (1,360 MW) by 2009



Lignite is a key fuel in CEE markets to resolve the capacity issue



➤ RWE's lignite position and experience gives us a competitive advantage for upcoming privatization projects in CEE countries.

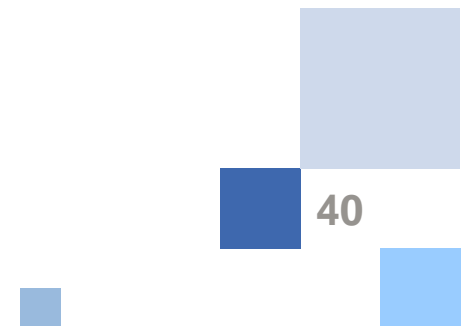
¹ Source: "Energy Statistics of OECD and Non-OECD Countries", Edition 2006; ² Source: "Euracoal"; RWE

³ Share of lignite in total power generation; Source: VDEW, RWE

Back up

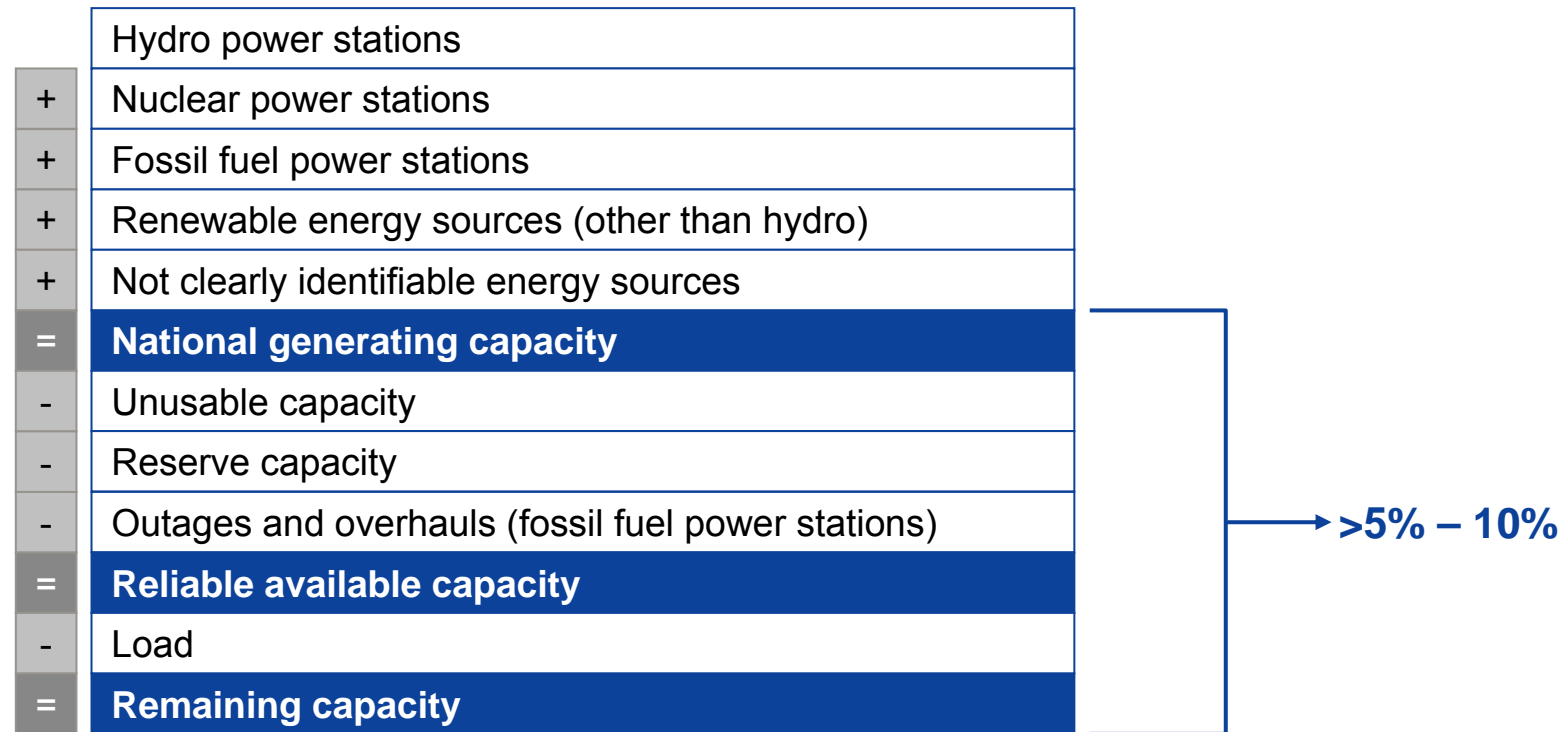


Factbook – Generation Capacity in Europe



UCTE System for evaluating the Remaining Generation Capacity in Europe

Minimum criteria: "For an individual country, remaining capacity should be at least 5% or 10% of the national generating capacity."



Source: UCTE
Factbook – Generation Capacity in Europe

Planned Power Plant Projects in Germany (1/3)



| Company | Planned location | Source of Energy | Net capacity in MW | Commercial operation presumably by |
|-------------------------------|-------------------|------------------------|--------------------|------------------------------------|
| Trianel Power | Hamm-Uentrop | Gas (CCGT) | 800 | 2007 |
| Statkraft | Hürth | Gas (CCGT) | 800 | 2007 |
| Mark-E/Statkraft | Herdecke | Gas (CCGT) | 400 | 2007 |
| Vattenfall | Hamburg-Tiefstack | Gas | 125 | 2007 |
| Subtotal 2007 | | | 2,125 | |
| Concord Power | Lubmin I | Gas (CCGT) | 1,200 | 2008 |
| E.ON/N-ERGIE/Mainova | Irsching 5 | Gas (CCGT) | 820 | 2008 |
| Braunschweiger Versorgungs AG | Braunschweig | Gas | 400 | 2008 |
| Subtotal 2008 | | | 2,420 | |
| RWE Power | Lingen | Gas (CCGT) | 850 | 2009 |
| Subtotal 2009 | | | 850 | |
| RWE Power | BoA Neurath | Lignite | 2,100 | 2010 |
| Iberdrola | Mecklar Marbach | Gas | 1,000 | 2010 |
| STEAG/EVN AG | Duisburg-Walsum10 | Hard coal | 700 | 2010 |
| Gazprom/Soteg | Eisenhüttenstadt | Gas | 800 | 2010 |
| Nuon | Frankfurt a.M. | Gas | 400 | 2010 |
| BKW Energie | Bocholt | Gas | 400 | 2010 |
| Subtotal 2010 | | | 5,400 | |
| EnBW | Niedersachsen | Compressed air storage | 150 – 600 | 2010/11 |
| Electrabel | Norddeutschland | Hard coal | 800 | 2011 |
| EWMR and others | Ruhrgebiet | Hard coal | 1,100 | 2011 |
| E.ON | Datteln 4 | Hard coal | 1,050 | 2011 |
| KMW | Mainz | Hard coal | 750 | 2011 |
| STEAG | Herne 5 | Hard coal | 690 | 2011 |
| Vattenfall | Boxberg | Lignite | 675 | 2011 |
| E.ON | Irsching 4 | Gas | 530 | 2011 |
| Vattenfall | Hamburg-Moorburg | Hard coal | 1,680 | 2011/12 |
| Subtotal 2011 | | | 7,875 | |

Source: VDEW, April 2007

Factbook – Generation Capacity in Europe

Planned Power Plant Projects in Germany (2/3)



| Company | Planned location | Source of Energy | Net capacity in MW | Commercial operation presumably by |
|------------------------|--|-------------------|-----------------------|---------------------------------------|
| Dong | Lubmin | Hard coal | 1,600 | 2012 |
| RWE Power | Hamm | Hard coal | 1,600 | 2012 |
| swb AG (Bremen) | Bremen-Mittelbüren | Hard coal | 800 | 2012 |
| Vattenfall | Berlin (definite location not announced) | Hard coal | 800 | 2012 |
| TrianelPower | Lünen | Hard coal | 750 | 2012 |
| Stadtwerke Bielefeld | Bielefeld | Hard coal | 100 | 2012 |
| Stadtwerke Düsseldorf | Düsseldorf | Hard coal | 400 | 2012 |
| STEAG | Lünen | Hard coal | 750 | 2012 |
| Südweststrom/Iberdrola | Brunsbüttel | Hard coal | 800 | 2012 |
| E.ON/Stw. Hannover | Staudinger 6 | Hard coal | 1,100 | 2012 |
| Subtotal 2012 | | | 8,700 | |
| Rheinenergie | Köln-Niehl | Hard coal | 800 | 2013/14 |
| RWE Power | IGCC-Kraftwerk (CO ₂ -free) (Location not announced) | Lignite/Hard coal | 450 | 2014 |
| Electrabel | Stade/Wilhelmshaven | Hard coal | 800 | 2014 |
| Internat. Investors | Dörpen | Hard coal | 800 | 2014 |
| E.ON/Stw. Kiel | Kiel | Hard coal | 800 | 2014 |
| Subtotal 2014 | | | 3,650 | |
| Vattenfall | GuD-Lichterfelde | Gas (CCGT) | 150 | 2016 |

Source: VDEW, April 2007

Planned Power Plant Projects in Germany (3/3)



| Company | Planned location | Source of Energy | Net capacity in MW | Commercial operation presumably by |
|--|--|------------------|-----------------------|---------------------------------------|
| Concord Power | Lubmin II | Gas | 1,200 | open |
| EnBW | Karlsruhe | Hard coal | 820 | open |
| MIBRAG | Profen | Lignite | 660 | open |
| EnBW | Karlsruhe | Gas | 410 | open |
| Electrabel | Südwestdeutschland/ Mitteldeutschland | Gas | 400 | open |
| Südweststrom | Norddeutschland | Hard coal | 800 | open |
| Südweststrom | Bayern (2 locations) | Gas | 800 | open |
| STEAG Saar Energie AG | Quierschied/Saarland | Hard coal | 690 | open |
| Gesellschaft f. Stromhandel | Ruhrgebiet | Gas | 400 | open |
| GKM | Mannheim | Hard coal | 800 | open |
| Stadtwerke Lippstadt/ Deutsche Essent | Lippstadt | Gas | 260 | open |
| Subtotal operation post 2014 | | | 7,240 | |
| Total | | | ~ 38,410 | |

Source: VDEW, April 2007

Planned Power Plant Projects in UK



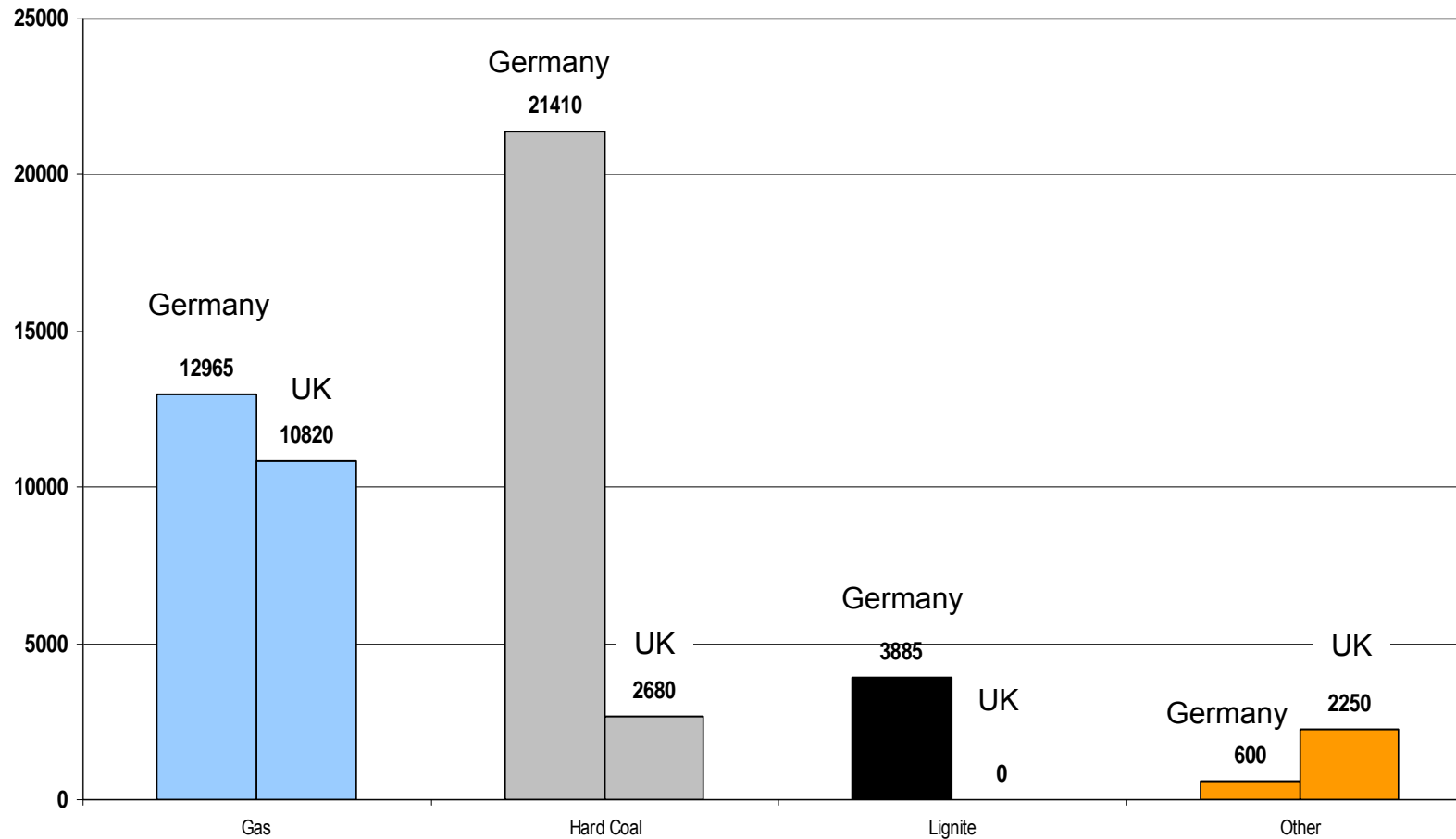
| Company | Planned location | Source of Energy | Net capacity in MW | Commercial operation presumably by |
|-------------------------------------|--|------------------|--------------------|------------------------------------|
| CDCE/TilfenLand | Greenwich, London | Gasfired CHP | 140 | 2007 |
| Subtotal 2007 | | | 140 | |
| London Array | Thames Estuary | Wind | 1,000 | 2007/2008 |
| Carron Energy | Uskmouth, Newport, SWales | Gas (CCGT) | 800 | 2008 |
| SSE | Glendoe, Loch Ness | Hydro | 100 | 2008 |
| Centrica | Langage Energy Centre, Plymouth, Devon | Gas (CCGT) | 1,010 | 2008 |
| ESB International | Marchwood, Hampshire | Gas (CCGT) | 800 | 2008 |
| Conoco | Immingham, Humberside | Gas (CCGT) cogen | 470 | 2008 |
| Subtotal 2008 | | | 4,180 | |
| British Energy/Amec | Isle of Lewis, Scotland | Wind | 700 | 2008/2009 |
| EON UK | Drakelow | Gas (CCGT) | 1,200 | 2009 |
| BP/Conoco Phillips/Shell/SSE | Peterhead, Scotland | Hydrogen | 350 | 2009 |
| Subtotal 2009 | | | 2,250 | |
| RWE npower | Staythorpe, Nottinghamshire | Gas (CCGT) | 1,600 | 2010 |
| EON UK | Grain, Kent | Gas (CCGT) | 1,200 | 2010 |
| Milford Power (Petroplus) | Waterston, Wales | Gas (CCGT) | 1,600 | 2010 |
| Progressive Energy | River Tees, Tees Valley | IGCC | 800 | 2010 |
| Subtotal 2010 | | | 5,200 | |
| RWE npower | Pembroke, south Wales | Gas (CCGT) | 2,000 | 2011 |
| Subtotal 2011 | | | 2,000 | |
| EON UK | Killingholme, Lincolnshire | Coal with CCS | 450 | 2012 |
| Subtotal 2012 | | | 450 | |
| RWE npower | Tilbury, Thames Estuary | Coal with CCS | 1,000 | 2016 |
| Subtotal 2016 | | | 1,000 | |
| Norfolk Offshore Wind (EDF Energy) | North Norfolk, off Cromer | Wind | 100 | open |
| Coal Power | Hatfield Colliery | IGCC | 430 | open |
| Subtotal operation post 2016 | | | 530 | |
| Total | | | 15,750 | |

Source: Platts, April 2006
Factbook – Generation Capacity in Europe

Planned Power Plant Projects in Germany/UK by fuel type



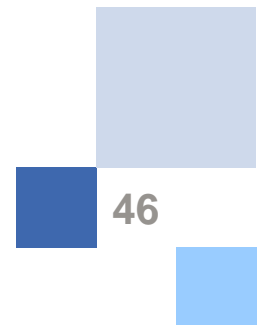
Net capacity in MW*



*450 MW included in Germany's Hard coal and Lignite capacity (not yet decided)

Sources: VDEW, Platts

Factbook – Generation Capacity in Europe



External sources



| | | |
|--|------------------------|--|
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| ■ Energy Industry Intelligence from Platts | UDI | www.platts.com |
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