Flexibility Solutions for High-Renewable Energy Systems

A BNEF study in partnership with Eaton and Statkraft

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EATON
Powering Business Worldwide

Statkraft

BloombergNEF

2017 flexibility study recap

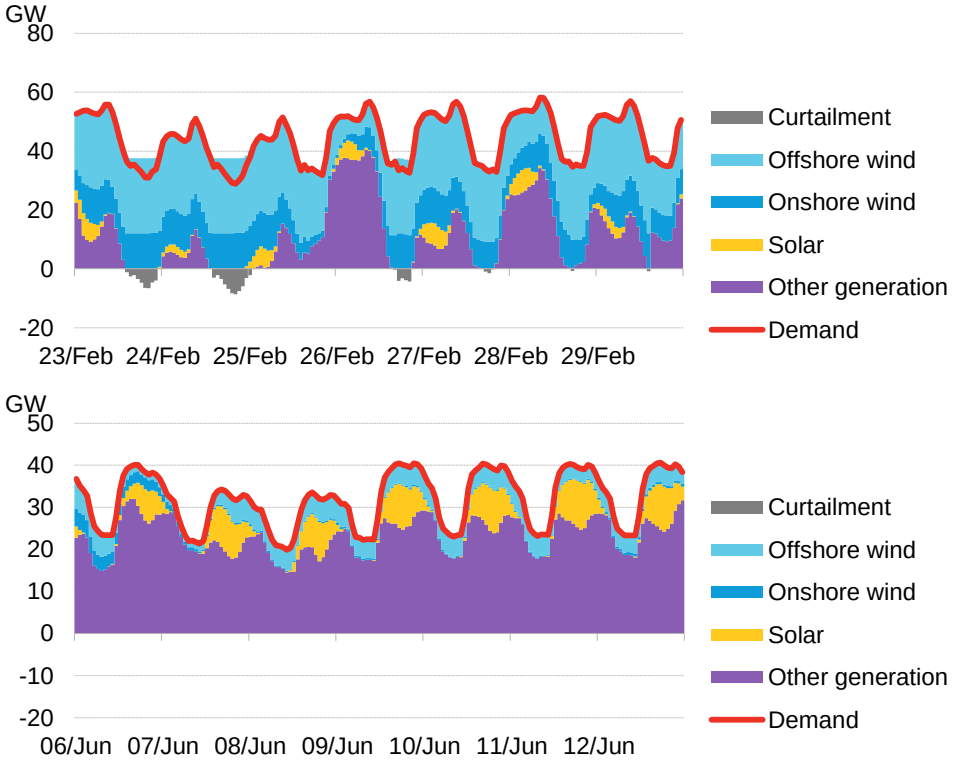
U.K. and Germany:

- Renewables dominate on economic basis
- Growing need for flexibility at all timescales
- Little room left for ‘baseload’ generation
- More days, weeks and months dominated by renewables…
- …but still days, weeks and months with little renewables too

Nordics:

- Hydro resource allows very high renewable penetration; might have surplus flexibility

High and low renewables weeks in the U.K., 2030



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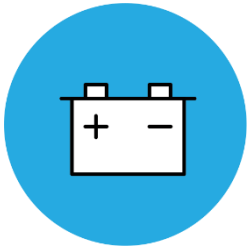
2018: solving the flexibility gap
U.K. and Germany

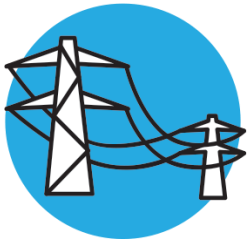
Flexible demand

Energy storage



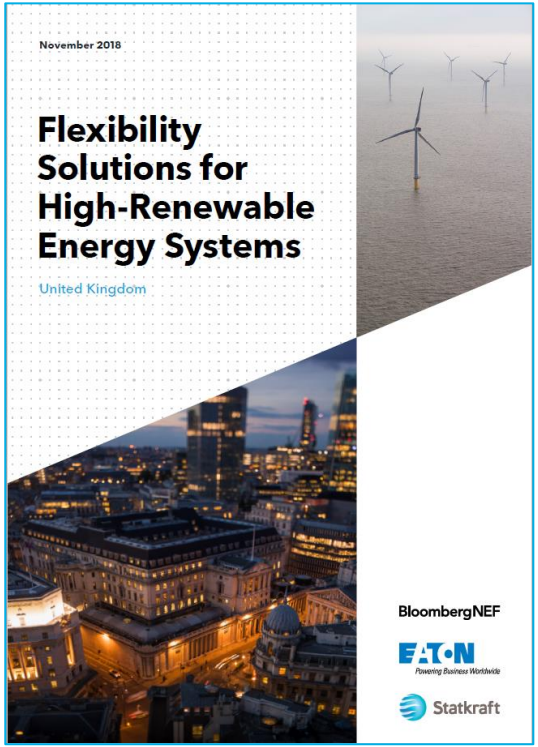
EVs with flexible charging

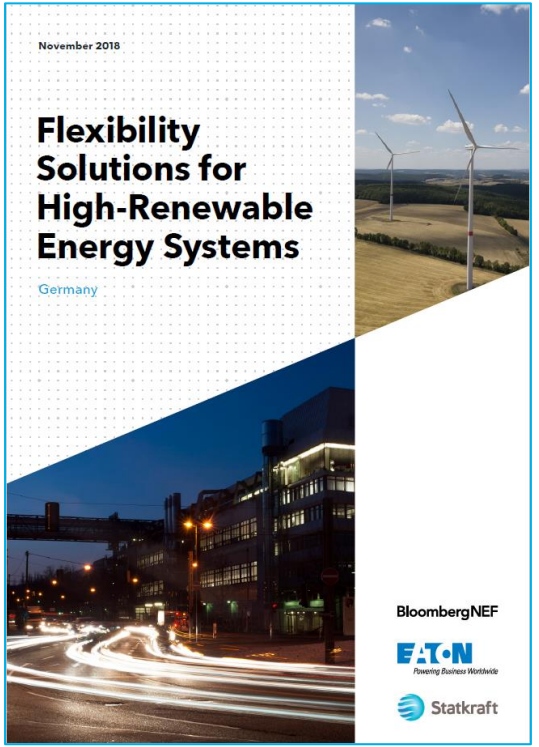
Interconnectors to Nordic hydro



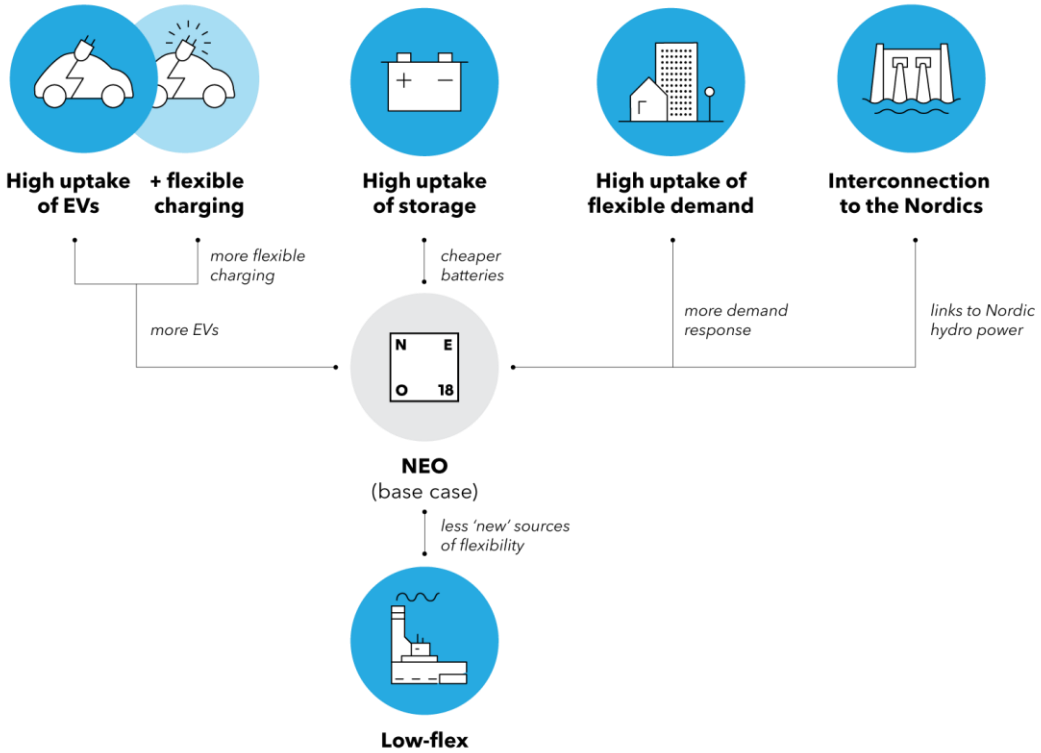
- To what extent can these technologies solve the flexibility challenge?
- How do they influence overall outcomes in the energy system? Are there trade-offs?

U.K. and Germany reports



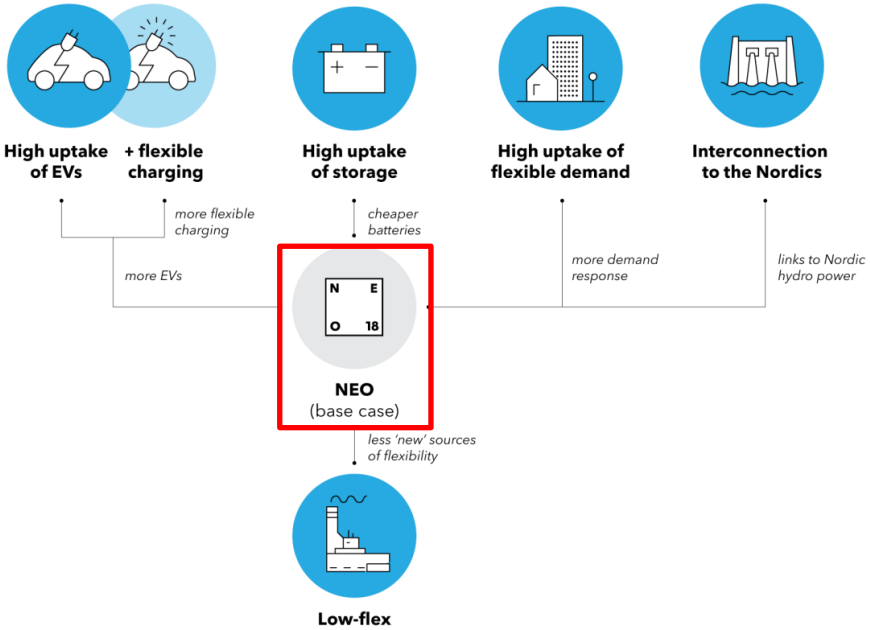


Our seven scenarios



- New Energy Outlook as the base case
- Technology scenarios that can be interpreted through a policy lens
- Each is a least-cost optimisation to 2040 (market design-agnostic)
- All scenarios successfully solve the flexibility challenge, but in different ways…
- …giving different outcomes in terms of cost, emissions, etc.

NEO (base case) scenario



A world with good amounts of 'new' flexibility

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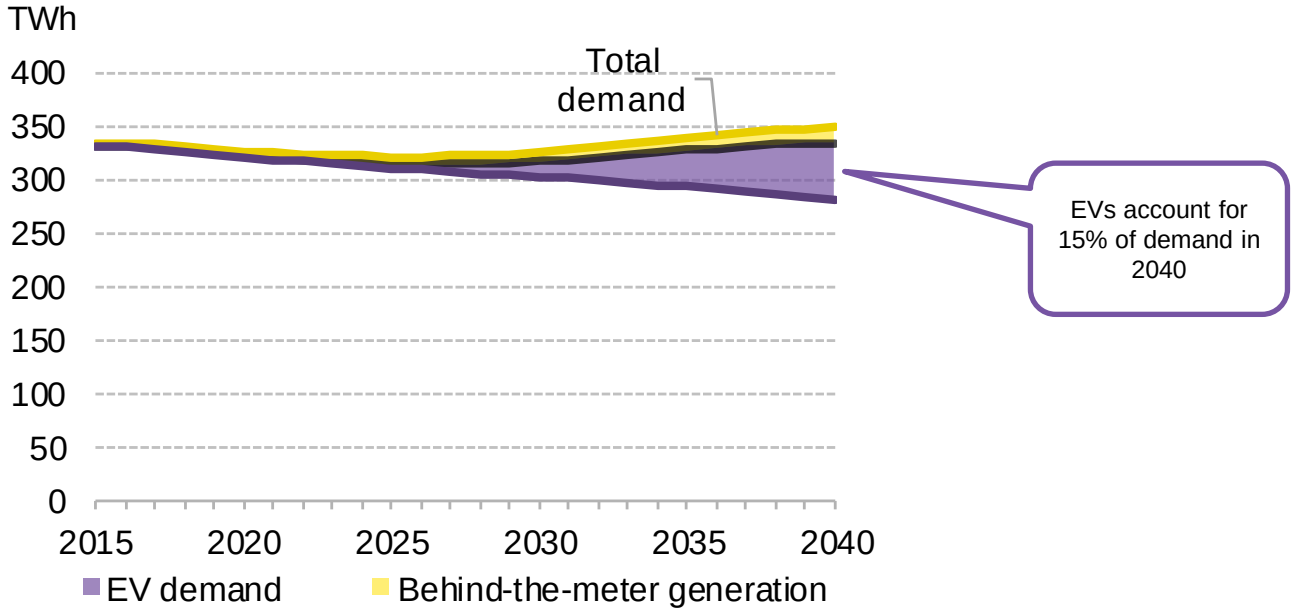
NEO base scenario: key flexibility assumptions

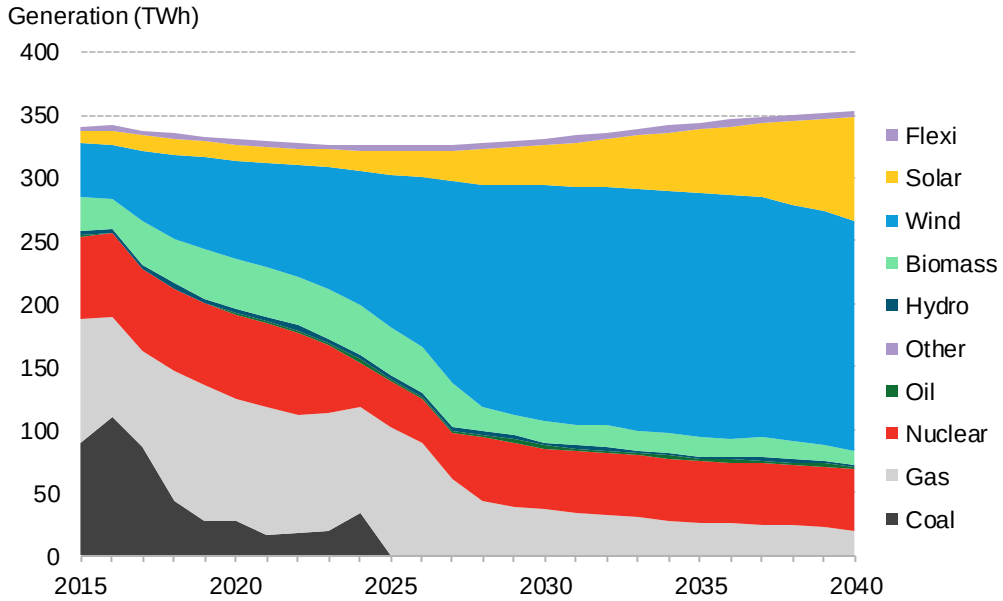
- Battery storage costs continue to fall quickly (based on BNEF experience curve)
- Electric vehicles grow to 13% of the fleet by 2030 and 48% by 2040
  - They charge inflexibly to begin with, but become smarter over time (50% smart by 2035)
- Demand response grows to 5.5% of peak load (2.7GW)
- Interconnectors not modelled

Electricity demand breakdown



Source: Bloomberg NEF

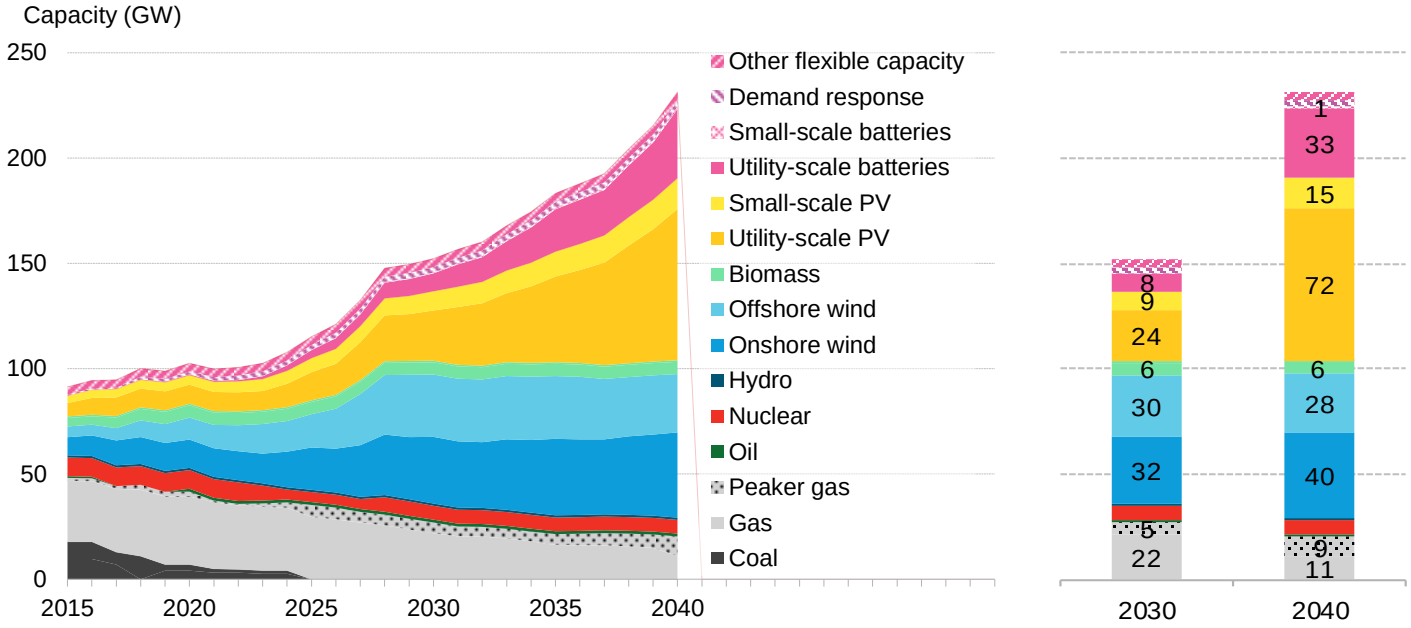
Evolution of U.K. generation mix



Renewable energy shares:
- 74% by 2030
- 80% by 2040

Source: BloombergNEF

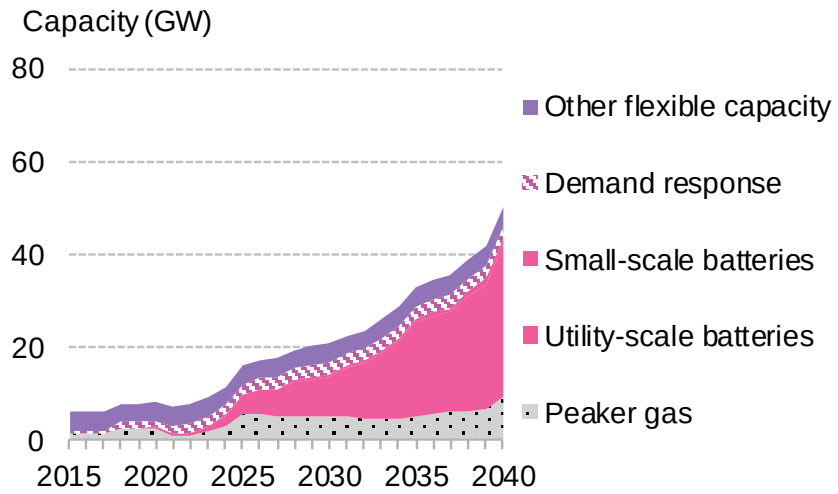
Evolution of U.K. generation capacity



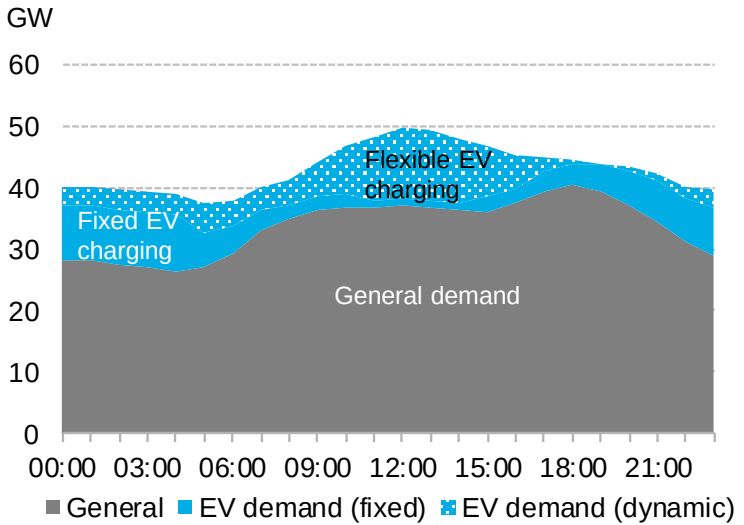
Source: BloombergNEF

Flexibility

Cumulative new flexible capacity



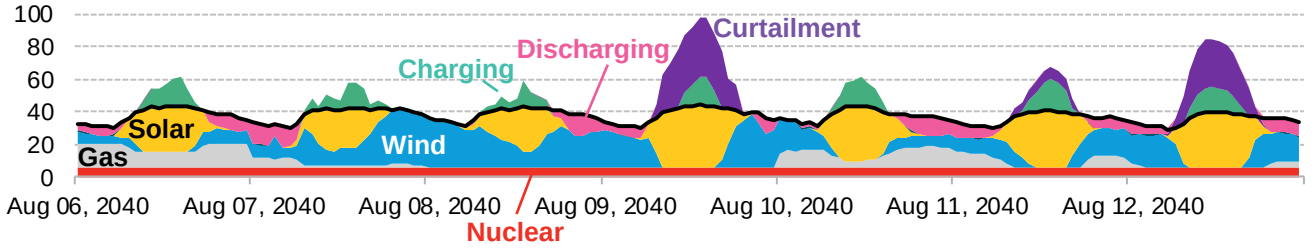
Typical demand profile, Q1 2040



Source: BloombergNEF. Note: Flexible EV demand not shown.

Solving for all types of weather, 2040

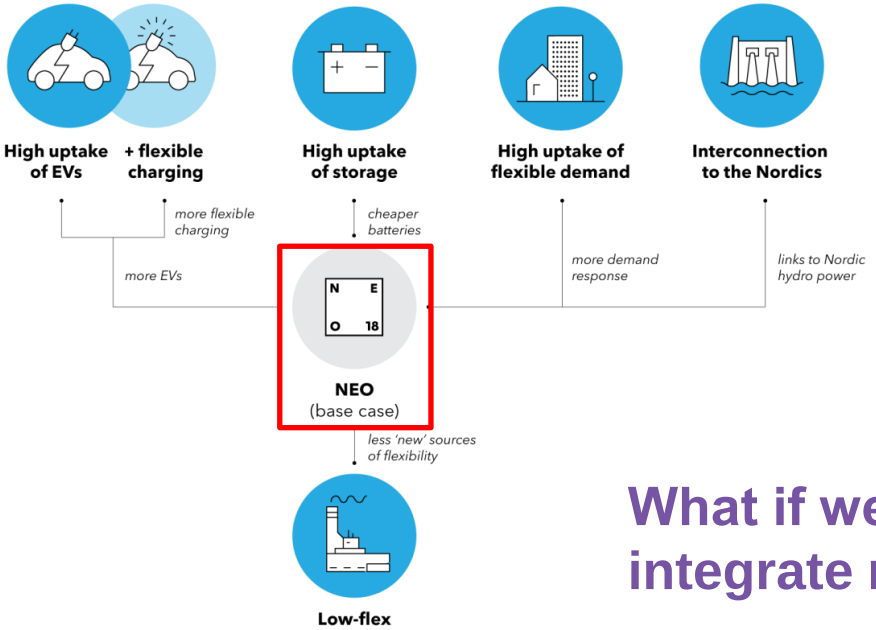
Week with median renewable output



Key metrics for NEO scenario

Metric	Units	2030	2040
System cost	GBPm/TWh	32.8	39.8
Emissions	MtCO2	16.8	11.6
Fossil capacity as share of peak demand	%	49%	34%
Renewable share of generation	%	74%	80%

Low-flex scenario



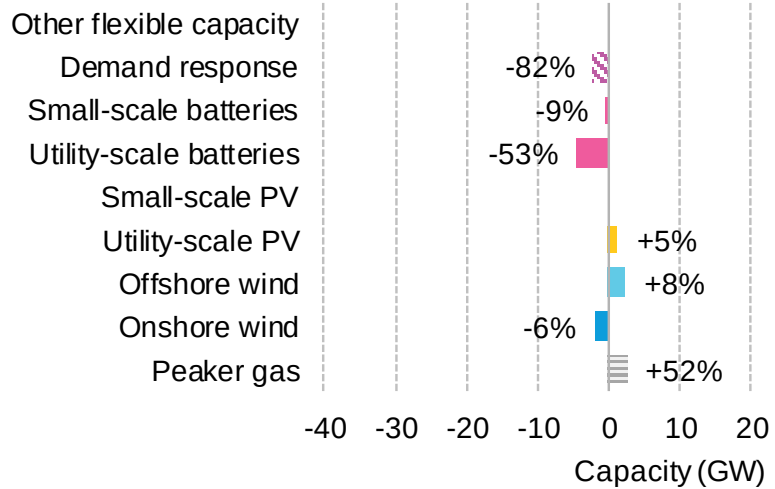
What if we don't manage to integrate new forms of flexibility?

Low-flex scenario: key flexibility assumptions

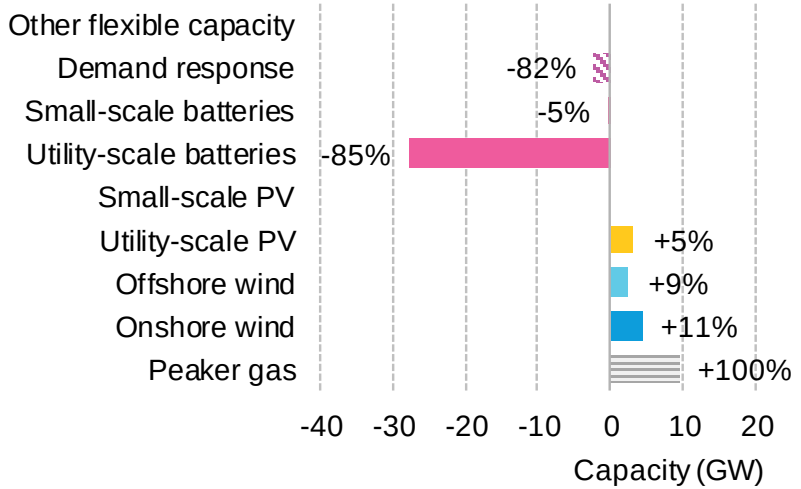
- Battery storage costs fall more slowly (top-end of BNEF expectation)
- Electric vehicles charge inflexibly
- Demand response doesn’t grow from today’s levels
- Interconnectors not modelled

Generation capacity changes for low-flex scenario, versus NEO base case

2030



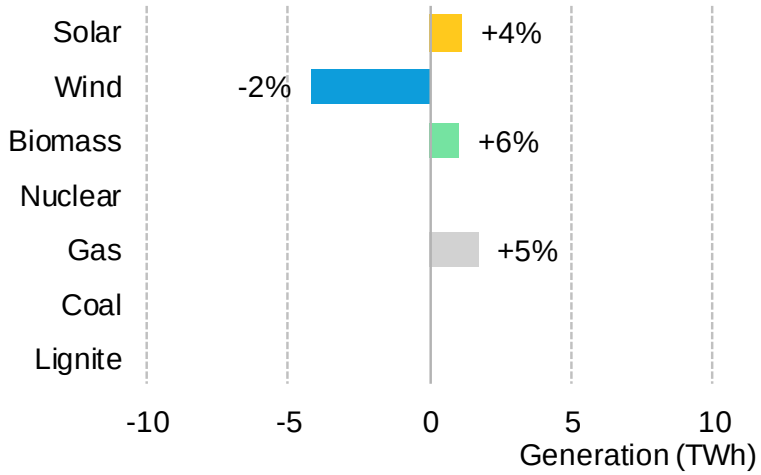
2040



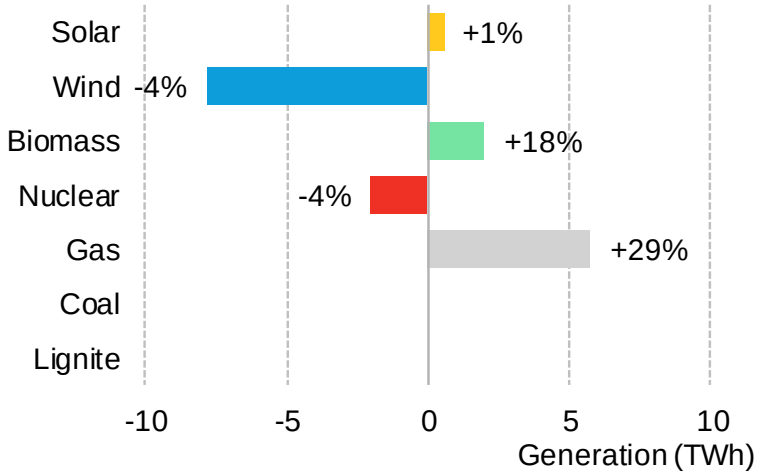
Source: BloombergNEF. Note: percentages show relative change against the NEO scenario

Power generation change for low-flex scenario, versus NEO base case

2030



2040



Source: BloombergNEF. Note: percentages show relative change against the NEO scenario

Key metrics for low-flex scenario, vs. NEO

Metric	Units	2030	2030
		Value	Δ vs NEO
System cost	GBPm/TWh	33.9	+3%
Emissions	MtCO2	18.4	+9%
Fossil capacity as share of peak demand	%	54%	+10%
Renewable share of generation	%	73%	-0.7%

Source: BloombergNEF

Key messages from base case and low-flex scenarios

- **None of the scenarios halt the transition to low-carbon**
  - In all cases renewable energy achieves roughly three-quarters of the energy mix by 2030, and four-fifths by 2040.

- **However, a lack of ‘new’ flexibility would have a real cost**
  - For both 2030 and 2040, the low-flex scenario is the least desirable across all metrics.
  - This means a greater reliance on gas peakers, leading to higher system costs (13% by 2040), higher emissions (36% by 2040) and a greater level of back-up capacity.

- **New sources of flexibility are needed relatively soon**
  - For example, in the U.K. by 2025, 4GW of storage capacity required in our base case NEO scenario. Interconnectors coming online in the early 2020s will also bring benefits (covered later).

Key messages on specific technology scenarios

- **A full switch to EVs won't overload the power generation system**
  - System costs are raised just 2% and 4% in 2030 and 2040 on a per-TWh basis
  - Fossil fuel capacity share is raised by just 3% in 2040 (and not at all in 2030).
  - Emission reductions in road fuel far outweigh rises in power sector (net 19% improvement in 2030 and 88% in 2040).
- **…especially if they are flexibly charged**
  - In our high-EV, high-flexibility scenario, the results are even better: net emissions down 30% and 96% in 2030 and 2040 respectively.
- **Energy storage accelerates the transition, but doesn't solve the seasonal gap**
  - High-storage scenario reduces fossil back-up further by 12% and emissions by 13% to 2030 vs. base case. But gains are gone by 2040.
- **Flexible demand is needed in the long run**
  - Greater demand flexibility allows the energy system to operate with 10% less fossil capacity, 42% less battery capacity and 5% lower system costs in 2040.
- **Interconnections with highly flexible markets can improve outcomes across decades**
  - The interconnector scenario delivers the best performance on emissions (excl. the high-EV scenarios) with 24% and 25% reductions in 2030 and 2040 respectively. The interconnectors displace 11% and 10% of fossil capacity in these years.

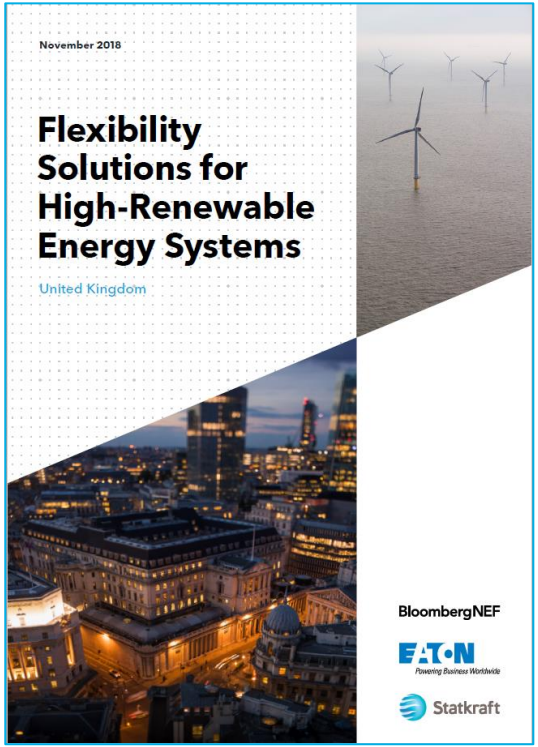
Surprising result for Germany

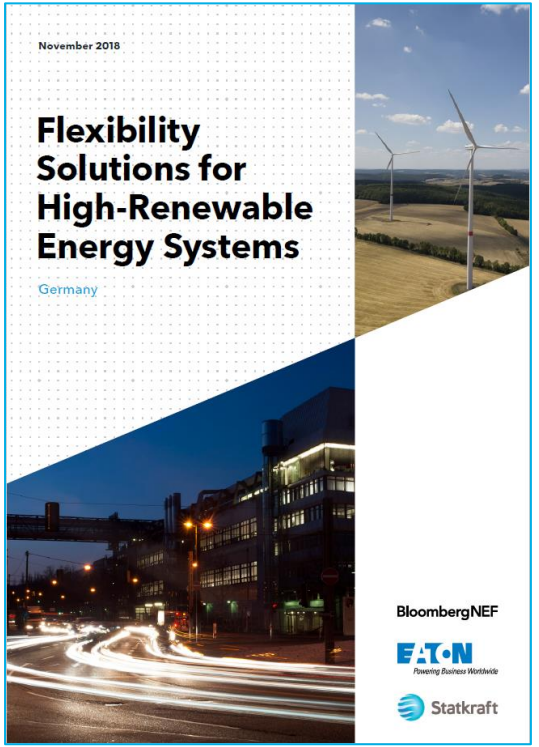
Low-flex scenario comparison vs. NEO base case, Germany

Metric	Units	2030	2030
		Value	Δ vs NEO
System cost	EURm/TWh	40.9	+0%
Emissions	MtCO2	139.5	-3%
Fossil capacity as share of peak demand	%	80%	-1%
Renewable share of generation	%	76%	+1%

Source: BloombergNEF

Download at about.bnef.com -> blog





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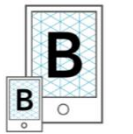

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