EMBER

New Generation

Building a clean European electricity system by 2035

Summary for policymakers

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Contents

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Summary for policymakers

Ember modelling of power system pathways reveals that a clean power system by 2035 should be at the core of energy planning for a net-zero continent by mid-century.

This study explores least-cost pathways to a clean power system in Europe,[1] compatible with the Paris Agreement climate goals (1.5C). The outcomes reveal that a resilient, clean and expanded power system can be built at comparable cost to stated plans. The additional clean electrification can reduce fossil fuel consumption and unlock up to €1 trillion of savings by 2035, and likely more if high fossil fuel prices persist. Central to achieving this is rapidly scaling up wind and solar this decade, to become the backbone of the power supply.

The energy crisis, catalysed by the invasion of Ukraine, has brought into sharp focus the problem of Europe's dependence on imported fossil fuels. Urgently reducing fossil consumption is no longer just a climate necessity, but an economic and security priority. Wind and solar, combined with electrification, can make massive in-roads, but the power system must be transformed to maximise the contribution of these cheap energy sources. With enhanced grid flexibility, fossil power can be phased out without compromising security of supply.

This report summarises the results of three modelled pathways for the European power sector. The **Stated Policy** pathway is aligned with stated national policies[2] until 2035. The other two pathways – **Technology Driven** and **System Change** – are computed to minimise power system cost while remaining within a carbon budget compatible with the Paris Agreement climate goals. The latter two pathways are referred to as 'clean power pathways'; they both expand electrification, but differ in their assumptions about available technologies and the levels of energy savings resulting from societal change. Pathway storylines and key assumptions are elaborated in a methodology section at the end of this summary report.

[1] The term Europe is used to refer to the countries included in the modelling: EU27 + UK + Norway + Switzerland + the Western Balkan six (AL, BA, KX, ME, MK, RS). Turkey and Ukraine are not included.

[2] As of October 2021

Clean power 2035

95% clean power, **70–80%** wind and solar

Cleaning the power supply for Net Zero

Carbon intensity 90% lower than 2020

Less than 5% unabated gas generation remains

Electrifying Europe

Power supply increases by more than 50%

Europe's green hydrogen demand met

Building security and resilience

More flexible power system provides secure supply

Wind and solar boost domestic energy

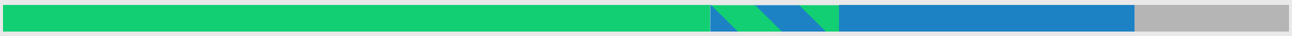
Boosting the green economy

€530–1010bn saved in avoided fossil fuel costs

€300–750bn additional investment in the economy

2030 – Highlights

>85% clean power, **55–65%** wind and solar



Projects in place to double interconnection by 2035

Coal phase-out (<1% in power generation)

Europe's total fossil fuel consumption halved

2025 – Highlights

66% clean power, **29%** wind and solar

150 GW new wind and solar every year after 2025

No new baseload gas after 2025

From today

Place a clean power system by 2035 at the centre of plans to transition Europe to a net-zero economy

= Wind and solar   = Other clean   = Fossil

Emergent themes

Main conclusions drawn from the modelled pathways

1) Clean power is cheaper than stated policies

An expanded and (~95%) clean power system in Europe can be achieved by 2035 at no extra cost above stated plans.

Larger upfront capital costs for wind and solar in the power system are offset by avoided carbon costs and avoided costs associated with new nuclear and fossil capacities.

The additional electricity (and green hydrogen) supply unlocks further electrification in the economy, leading to substantial cost savings of €530–1010 billion in total by 2035 as a result of avoided fossil fuel consumption.

This is likely an underestimate as the unprecedented increase in fossil fuel prices in 2021–2022 are not taken into account. The expanded power supply in clean power pathways allows direct electrification to reach 40–47% by 2035, compared to 30% under Stated Policy.

As a result of expanded supply and lower costs, the price of electricity in clean power pathways is lower than in Stated Policy.

By 2035 the average cost of electricity in clean power pathways is 23–30% lower than under stated policy.

Building a clean, wind and solar dominated power system by 2035 will require an additional upfront investment of between €300–750bn above existing plans.

While larger upfront investment is needed, mostly in wind and solar, these are strongly justified by the cost savings which are rapidly realised (as stated above), as well as benefits to climate, health, and energy security.

€2020 billion	Stated Policy	Technology Driven	System Change
Power systems costs* until 2035	315	305	300
Energy systems costs until 2035	8,150	7,620	7,140
Energy systems cost savings by 2035	–	530	1,010
Investment requirements** before 2035	1,330	1,630	2,080
Additional investments by 2035	–	300	750

*Both power system and energy system costs are given as a cumulative sum of annualised costs between 2020 and 2035. **Investment requirements are the sum of overnight investment in the power system between 2020 and 2035.

Table 1: Summary of pathway costs in the clean power pathways versus Stated Policy.

2) Fossil fuel consumption halves this decade

The EU27 is highly dependent on imports of all major fossil fuel types. This state of high exposure to price-volatile energy sources poses a clear risk to the EU27's energy sovereignty and economic stability. Pursuing an energy system based on domestic renewables presents a safer path with better outcomes for European consumers.

A combination of clean electrification and energy savings can reduce Europe's (and EU27) fossil fuel consumption by up to 50% by 2030, improving energy sovereignty.

The modelled clean power pathways would reduce total fossil fuel consumption in Europe (and the EU27) by an estimated 38–50%. This is compared to an estimated 25% reduction under stated policies. The Fit-for-55 plan, if implemented, would reduce EU27 consumption by 33%. The REPowerEU plan, which represents increased ambition above Fit-for-55, reduces consumption by 40%. REPowerEU is particularly focused on gas consumption which in 2030 is halved compared to the Fit-for-55 plan. However, this is at the expense of additional coal consumption in 2030, and little extra progress on oil reduction.

Electrification contributes to approximately 70% of fossil fuel reductions.

Electrification of end uses often delivers major efficiency improvements compared to conventional use of fossil fuels. This is most obvious in the case of space heating (heat pumps) and light-duty transport (electric vehicles), which represent the low-hanging fruit for decarbonisation through electrification. Direct and indirect electrification, combined with the efficiency savings from these technology switches, deliver approximately 70% of estimated fossil fuel reductions by 2030. The remainder are delivered through energy savings, primarily from building renovation and modal shift in transport, showing that societal change also has a role to play.

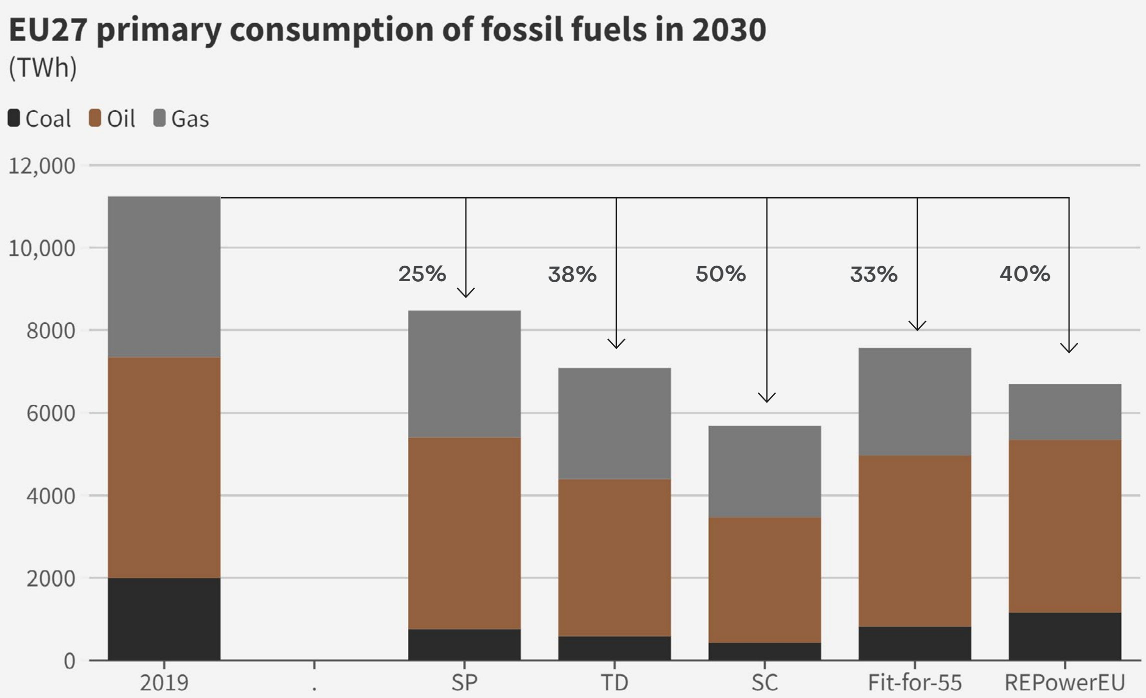


Figure 1: Estimated primary consumption of fossil fuels in modelled pathways (SP, TD, SC) in 2030 compared with estimates in Fit-for-55 and REPowerEU plans, and actual data from 2019 (source: Eurostat).

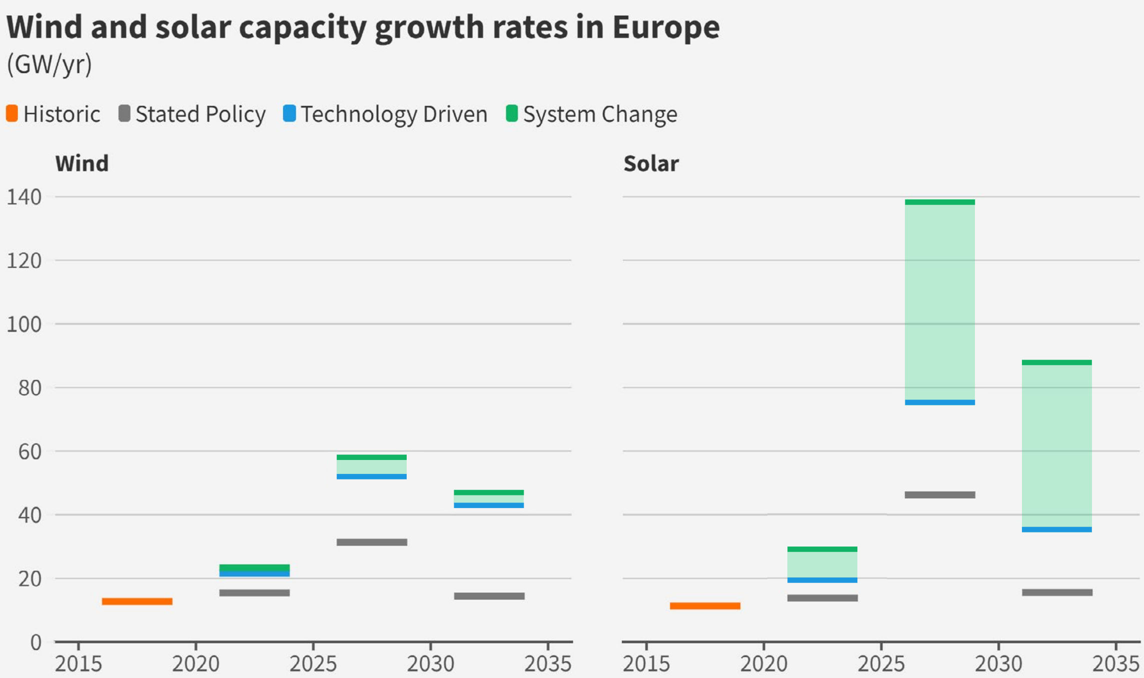


Figure 2: Deployment rate (GW per year net additions) of wind and solar in Europe over time in the three main modelled pathways compared with historic rates and Stated Policy.

3) Wind and solar deployment quadruples

Annual growth in wind and solar capacity must quadruple by 2025 compared to the last decade; this is the central challenge to deliver a clean power sector by 2035.

Over the period 2025–2035 the combined deployment rate should reach 100–165 GW per year, compared to an annual growth of 24 GW per year between 2010–2020. There are signs of acceleration, with additions hitting a record 36 GW in 2021, but a big deployment challenge lies ahead. Meeting the challenge requires permitting times to be slashed, and supply chains and manufacturing capacity to be secured. In least-cost pathways Europe's wind fleet quadruples to 800 GW by 2035, and solar expands 5–9 fold reaching 800–1400 GW.

Required solar deployment aligns with ambitious industry estimates, but wind deployment would need to exceed industry's best expectations.

The required growth rates in solar (55–115 GW per year), coincide with ambitious industry estimates[3] that EU27 expansion can reach 53–90GW/yr by 2025. In contrast, the required wind growth (47–52 GW per year) is significantly higher than best case industry estimates, which forecast just 18GW per year (EU27) by 2025.

Stated policies would deliver just 45–65% of the wind and solar capacity required by 2035. Ambitions for 2030 set out previously by the European Commission as part of the Fit-for-55 package would also fall short. However, the recently announced REpowerEU plan goes a long way to closing the gap between stated ambition and the modelled pathways to 2035 clean power. While this is encouraging, major challenges remain in translating this higher ambition into European and national policy, and deploying the infrastructure on the ground.

4) Wind and solar become the backbone

In the least-cost pathways, wind and solar provide 70–80% of the electricity supply by 2035.

Such high shares of wind and solar are robust to sensitivity analysis, demonstrating a clear cost benefit to maximising the contribution of wind and solar. Stated Policy puts these technologies on track for a 52% share by 2035. While the increased penetration of wind and solar does present challenges to system operation, there are some important (and sometimes overlooked) complementarities that benefit system operation.

Wind and solar outputs are complementary over a range of timescales.

Studies have shown that a degree of complementarity exists between wind and solar outputs over timescales of hours to months for many regions in Europe.[4] Key to exploiting these natural patterns is the development of flexibility solutions, and notably interconnection, to create a more dynamic system capable of balancing temporal and geographic imbalances.

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[3] Industry estimates for solar based on Solar Power Europe's *Raising Solar Ambition* report, specifically the '*High*' and '*Accelerated High*' scenarios. Industry estimates for wind based on WindEurope's 2022–2026 market outlook, specifically the *Realistic Expectations* scenario.

[4] For example, Jurasz et al. 2022 demonstrate complementarity using granular European generation data for 2020. Miglietta et al. 2017 find a correlation in hourly meteorological wind and solar data over three years in Europe (2012–14). Monforti et al. 2014 find favourable complementarity between wind and solar in Italy at high levels of spatial resolution.

Wind and solar deliver across a large fraction of the year.
While there are some periods in the year where wind and solar output are anomalously low (see main finding 6 for analysis of a *dunkelflaute* period), there are many hours of the year where wind and solar provide or exceed total demand at the system level. At such times, excess generation can be shared between regions, or converted into hydrogen through electrolysis, or stored for later use. Enabling these routes with the right infrastructure is vital to maximising the value of renewables output.

System operators must start planning and adapting now for very high instantaneous shares of wind and solar. There are lessons to be learned from countries that already regularly manage this.

A paradigm shift in power system operation is needed, as an increasing share of weather-dependent sources means the system must become more responsive to available supply rather than demand. Maintaining system stability will require new approaches, as unlike conventional generation, wind and solar are variable on short timescales and have a non-synchronous interface with the grid. Technical studies and real world experiences are accumulating, and evidence suggests that engineering and technical challenges can be overcome. Some parts of the European grid already regularly operate with close to 100% renewables – Portugal and Denmark have experienced periods of instantaneous wind and solar exceeding 100% of demand.

5) Increasing flexibility is crucial

Enabling demand flexibility and deploying key power technologies facilitates the cost-efficient integration of wind and solar, while avoiding unnecessary gas investments.

As the power supply transforms into one dominated by wind and solar, a parallel system transformation is required to provide for their distinct flexibility needs, and to efficiently integrate new types of power demand. Maximising system flexibility reduces dependence on thermal (gas) capacities for balancing.

Electrification provides challenges but also opportunities if demand-side flexibility (such as smart charging EVs and flexible heat pumps) and battery storage, including that carried by electric vehicles, can be activated. This is particularly important for the integration of solar power, as shifting demand by a few hours can boost alignment with daylight hours.

Three key technologies emerge as the cornerstones of flexibility in a clean power system, maintaining system balance over a range of temporal scales: electrolysers, interconnections, and clean dispatchable generation.

The electrolyser fleet grows to 200–400 GW by 2035 and supplies 14–27Mt of green hydrogen, enough to cover the majority of estimated European domestic demand while maximising the value of renewables output. The REPowerEU plan broadly puts the EU27 on track for this by 2030, aiming for more than 65 GW of electrolyser capacity and 10Mt of hydrogen production.

Total interconnections at least doubles by 2035 compared to 2020, enabling the cost-efficient expansion of wind and solar capacities by allowing their deployment in countries with the most favourable conditions.

New clean dispatchable power sources enter the system by 2035, but the complete replacement of declining fossil and nuclear capacities is not required. As such, the general trend is towards a smaller and cleaner fleet of dispatchable sources by 2035, despite increases in electricity demand (and peak demand).

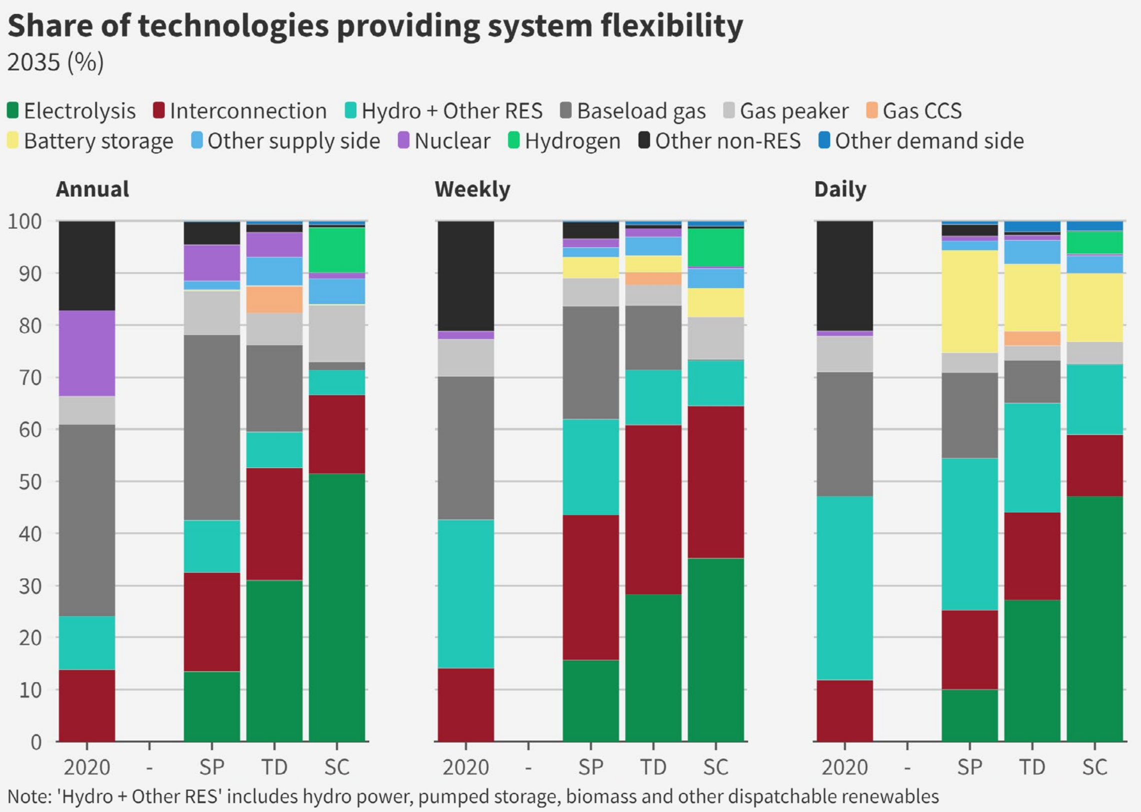

Figure 3: Technologies providing system flexibility at the three different temporal scales, by percentage contribution in 2020 and 2035 in the three modelled scenarios. Not reflected here is the absolute increase in the power system's flexibility needs between 2020 and 2035 which occurs in all three modelled pathways.

6) A clean system is reliable and resilient

A highly renewable power system is reliable and resilient even to extreme weather events.

Granular modelling reveals that Europe can operate a 95% clean power system by 2035 without compromising reliability and that the weather-dependent, variable nature of wind and solar does not pose a threat to the resilience of the grid. This remains the case with unfavourable climatic conditions – the 2035 clean power system is stress-tested using a year notable for both record low temperatures and severe heat waves (2010).

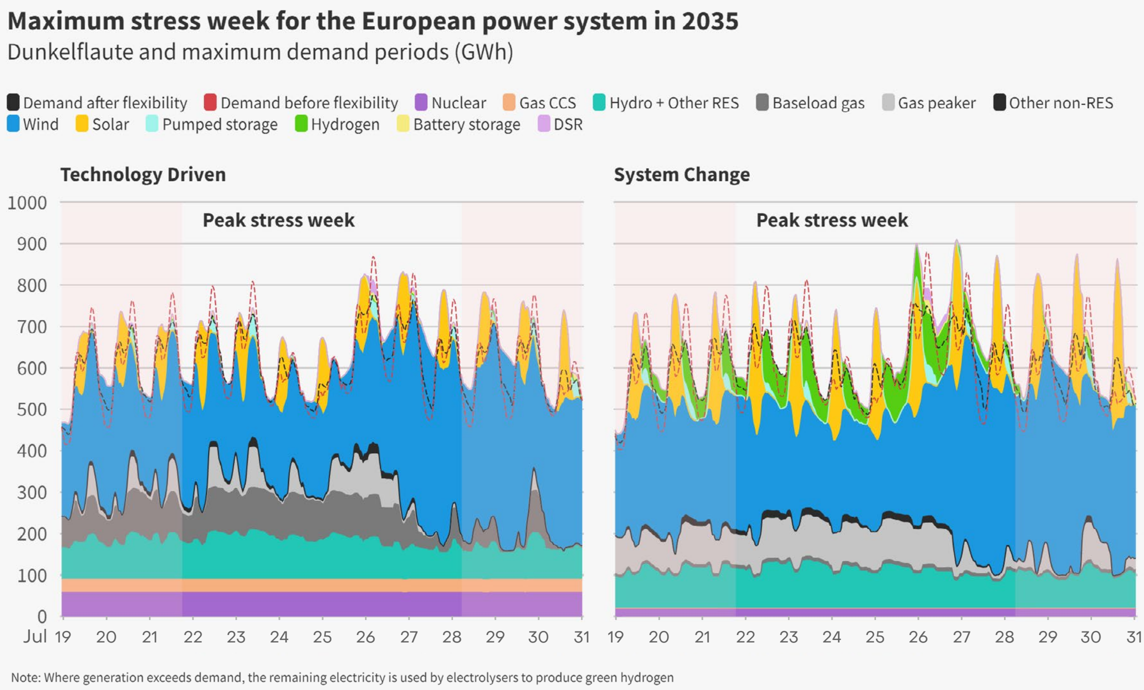

Figure 4: Hourly generation over a two-week period in 2035 in the modelled pathways. The middle 7-day period represents the a maximum stress week for the European grid, i.e., a simultaneous cold spell and prolonged lull in wind and solar output.

Resilient to a simultaneous cold spell and dunkelflaute.

The modelled ~95% clean power system delivers through a harsh cold spell – which drives up power demand – and a simultaneous prolonged reduction in wind and solar (dunkelflaute). Even during this period, there remains a sizeable contribution of wind and solar (~30%) at the system level, because it is exceedingly rare for meteorological events to affect the entirety of the European power system simultaneously.[5] The successional impact of unfavourable weather conditions moving over Europe highlights the importance of interconnections in alleviating regional or national supply tightness.

Resilient to the hottest summer days.

Large solar capacities on the system lead to extreme daily supply variations, and increased cooling demand is expected in a warming climate, meaning summer months can also present challenging conditions. This modelling shows that a greater alignment of hourly supply and demand can be created through a combination of demand shifting (especially electric vehicle charging), storage, and electrolysis, successfully managing solar output that would otherwise far exceed demand.

7) Limited room for new fossil fuel capacity

Coal must be phased out by 2030 and unabated gas reduced to <5% of generation by 2035 to make Europe's power system fit for the Paris Agreement.

This study agrees with multiple previous analyses that coal must be phased out by 2030. Any use beyond this – with the possible exception of a small reserve fleet – is neither cost-competitive nor compatible with climate goals. For similar reasons, unabated gas contributes only 4–6% of Europe's power supply by 2035. The outlook could be worse if gas supply pressures and price volatility persist.

No new baseload (unabated) gas plants need to be commissioned beyond those expected by 2025.

Planned investments in baseload (unabated) gas power stations are currently higher than what is needed for clean power by 2035.

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[5] Analysis of multi-decadal data has shown that while some large meteorological events are common across Europe, the resulting peak power events do not necessarily impact the whole region simultaneously [Bloomfield et al. 2020, *Meteorological Drivers of European Power System Stress*, Journal of Renewable Energy, vol. 2020].

While the conventional gas fleet maintains a role in balancing until 2035, stated plans deliver an estimated 60 GW of excess baseload gas assets. Instead, least-cost pathways see no expansion beyond what is expected by 2025.[6] After this, investment quickly pivots away from baseload to peaking capacities, at least until low or zero-carbon gas capacities become available in the 2030s.

Bringing forward investment in clean dispatchable technologies can remove the need for any new unabated gas investments after 2025, with minimal impact on costs.

If all deployment of unabated gas (peaking and baseload) stopped after 2025, the resulting shortfall in dispatchable capacity could be compensated by earlier investment in hydrogen turbines, gas with CCS and utility-scale batteries, at minimal extra cost.

8) A smaller and cleaner dispatchable fleet

Reductions in fossil capacity do not need to be fully compensated by growth in clean dispatchable capacities.

As a result, the total dispatchable fleet declines over time, which is perhaps unexpected given that electricity demand (and peak demand) increases over time. New clean dispatchable technologies – gas CCS and hydrogen turbines – enter the system by 2035 in sufficient quantities to compensate for the decline in nuclear, resulting in a similar sized but more flexible clean fleet.

The composition of the dispatchable fleet may take a variety of forms and still achieve clean power by 2035. The technology choices present different risk profiles, but estimated cost differences are minimal.

New nuclear is found not to be a cost-competitive option in clean power pathways. However, sensitivity analysis reveals that economic cost does not significantly distinguish between pathways using (or not) different clean dispatchable technology options. This includes a scenario in which new nuclear is developed in line with national plans, and a scenario in which CCS technology is not available. Instead of cost, decisions require balancing different risk profiles.

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[6] The ENTSO-E/ENTSOG TYNDP National Trends scenario (2020) is taken to represent the best estimate of system configuration in 2025, according to system operators. It shows a growth in baseload gas relative to 2020, which is interpreted here as the 'expected' deployment. Estimated additions by 2025 agree with the pipeline of projects according to Global Energy Monitor's Europe Gas Plant tracker (accessed June 2021). However, these expected developments may change as a result of the current energy crisis and REPowerEU plans to shift away from gas.

The wind and solar deployment challenge is largely unaffected by choices between dispatchable capacity options, which have greater implications for Europe's dependency on fossil gas.

None of the alternative pathways explored — from additional nuclear to an absence of CCS technology - significantly change the wind and solar deployment requirements by 2035. This confirms that deploying wind and solar, plus supporting power system infrastructure, is the central challenge for power sector decarbonisation. The composition of the dispatchable fleet has a more notable impact on the consumption of natural gas in the power sector. In 2035, alternative clean power pathways with i) no gas CCS or ii) new nuclear (in line with current plans) see reductions of 13% and 15% in gas consumption respectively.

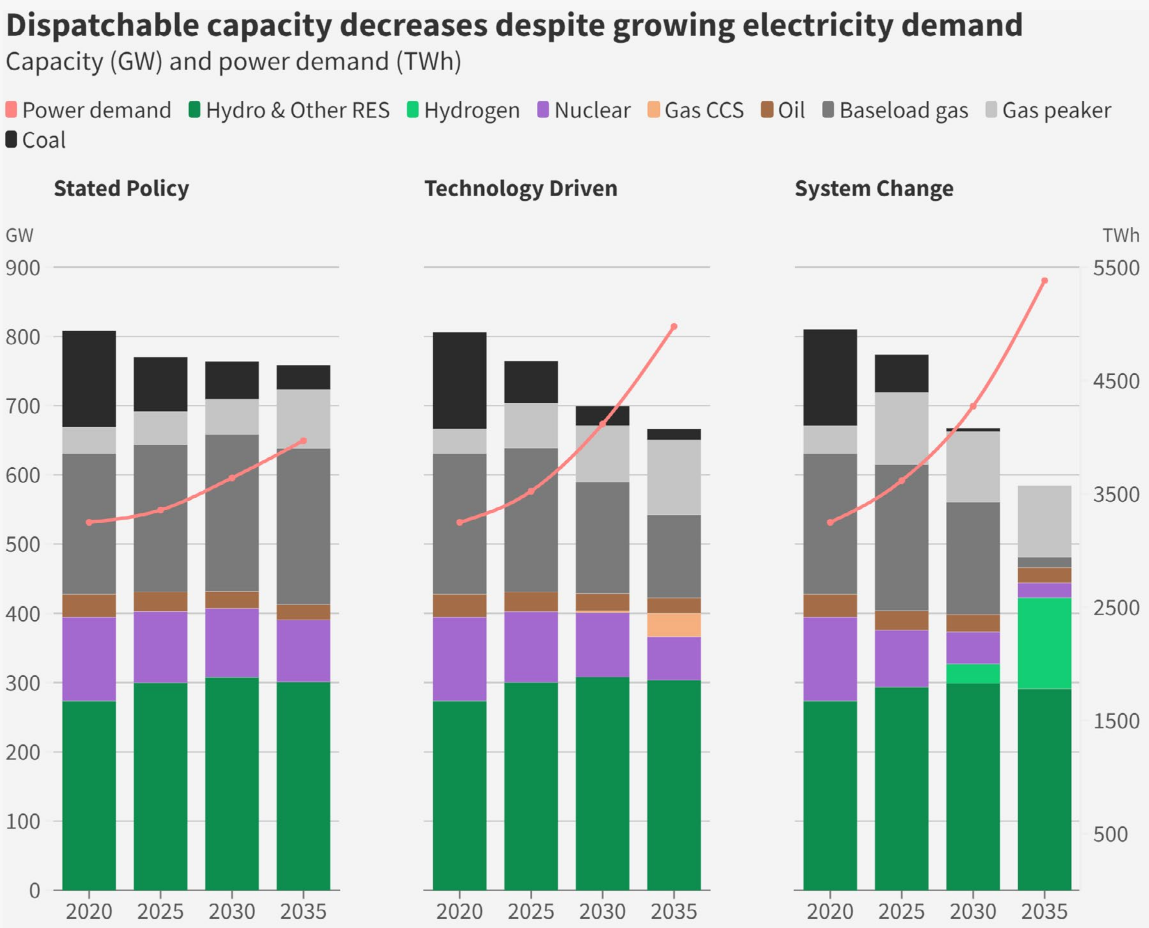

Figure 5: Evolution of the dispatchable fleet between 2020 and 2035.

Policy recommendations

Setting a path for clean power by 2035

Place a clean power system by 2035 (less than 5% fossil) at the centre of plans to transition Europe and the EU27 to a net-zero economy.

Faster action is needed immediately. The period 2025 to 2030 sees major transformation of the power system, reaching more than 85% clean power.

Recognise that rapidly scaling up wind and solar deployment is the central challenge to the energy sector transition.

Wind and solar

Urgently facilitate a massive scaling of wind and solar deployment by streamlining and shortening permitting procedures.

Increase Europe's domestic wind and solar manufacturing capabilities to contribute to supply chain security and sustainability.

Ensure long-term supply chain security for the materials required to build wind and solar infrastructure.

Fossil fuels

Focus policies that aim to reduce fossil fuel import dependency on measures that will permanently reduce demand. Prioritise direct electrification and building renovation. Policies promoting diversification of fossil fuel supply should only address immediate needs.

Phase-out subsidies that encourage development of new unabated baseload gas assets, such that deployment can end with the existing pipeline (i.e., by 2025), avoiding stranded assets.

Energy markets

Promote new markets for flexibility and low-carbon grid supporting technologies, essential to minimise costly gas infrastructure.

Create market conditions that support decreasing utilisation of the existing unabated gas fleet through 2035, maintaining its availability.

Incentivise smart consumption in policies which drive electrification, particularly those targeting transport and heating. Enable flexible consumption by increasing exposure to price signals and equipping consumers with the ability to respond.

Cooperation

Urgently facilitate a massive scaling of wind and solar deployment by streamlining and shortening permitting procedures.

Increase Europe's domestic wind and solar manufacturing capabilities to contribute to supply chain security and sustainability.

Ensure long-term supply chain security for the materials required to build wind and solar infrastructure.

Key technologies

Maintain and modernise existing hydropower infrastructure – an increasingly important flexibility provider.

Prioritise the readiness of zero or low-carbon dispatchable capacity options in order to avoid an overcapacity of conventional gas assets.

Where required, enact regulatory and legal changes to accommodate investment in new technologies.

Promote the use of V2G capabilities and incentivise smart vehicle charging, activating their significant load shifting potential.

Pathway assumptions

	Stated Policy		Technology Driven		System Change	
			Clean power (2035) pathways			
Storyline	Represents the power system as described by national plans until 2035 after which assumptions converge with Technology Driven pathway.		Least-cost optimised pathway compatible with the Paris Agreement climate goals (1.5C), and consistent with a net-zero energy system by 2050.		A pathway aligned with the assumptions of CAN Europe's Paris Agreement Compatible scenario. Consistent with a net-zero energy sector by 2040.	
Carbon emissions	Total unrestricted. Zero power sector emissions by 2050.		Total power sector emissions less than 9 $GtCO_2$ (2020–2050). Zero power sector emissions by 2050.		Total power sector emissions less than 8 $GtCO_2$ (2020–2050). Zero power sector emissions by 2040.	
Direct electricity demand / power generation (TWh)	2035	2050	2035	2050	2035	2050
	3540/4000	4520/6640	4050/5050	4520/6620	3830/5450	3840/5640
Direct electrification	2035	2050	2035	2050	2035	2050
	30%	62%	40%	62%	47%	66%
Demand assumptions						
Transport	Increased car activity by 2035. 100% of new cars are BEVs from 2040. Car fleet electrification: 15% by 2035, 100% by 2050. Road freight electrification: 4% by 2035, 33% by 2050.		Unchanged car activity by 2035. 100% of new cars are BEVs from 2035. Car fleet electrification: 30% by 2035, 100% by 2050. Road freight electrification: 21% by 2035, 33% by 2050.		Modal shift reduces car activity by 2035. Share of BEVs in new passenger vehicles reaches 100% in 2025. Passenger car fleet electrification: 45% by 2035, 100% by 2040. Road freight electrification: 33% by 2035, 57% by 2050.	
Buildings	Announced efficiency measures reduce heating and cooling demand by 9% by 2035. Electric heat pumps cover all space-heating requirements by 2050. Large heat pumps account for 40% of District Heating by 2050.		An average 2% renovation rate reduces heating and cooling demand by 20% by 2035. Electric heat pumps cover all space-heating requirements by 2050. Large heat pumps account for 40% of District Heating by 2050.		An average 3% renovation rate reduces heating and cooling demand by 45% by 2035 Electric heat pumps cover all space-heating requirements by 2040. Large heat pumps account for 40% of District Heating by 2040.	
Industry	Energy demand unchanged by 2035. Direct and indirect electrification: 36% and 8% by 2035		Energy demand reduced 9% by 2035. Direct and indirect electrification: 46% and 12% by 2035		Energy demand reduced 14% by 2035. Direct and indirect electrification: 51% and 14% by 2035	
Supply assumptions	All generation technologies		All generation technologies		No new nuclear or gas CCS	
Storage	Deployment of pumped storage (and hydropower) is not cost-optimised, but follows expected pathways. Deployment of utility scale batteries is determined by cost optimisation. Development of the hydrogen system is determined by cost optimisation (electrolysers and hydrogen-burning turbines).					
Interconnection	Growth restricted to planned projects, allowing maximum expansion by a factor of 1.5 by 2035. After 2035, as Technology Driven.		Expansion determined by cost optimisation, up to a maximum potential on each border, informed by the TYNDP candidate project list.		As Technology Driven	

The results discussed above are based primarily on three modelled pathways. The storylines describing these pathways, and the key assumptions underpinning their construction are summarised in the table below.

Power system modelling

The pathways are computed using the Artelys Crystal Super Grid power system modelling platform – a leading tool in European energy system planning. As input, assumptions about the energy sector (outlined above) are converted into hourly electricity demand profiles across entire years, taking into account increasing demand from a variety of new sources. Each type of new demand changes the profile of electricity demand in a unique way, across hours and seasons. While the study is focused on power system evolution (and decarbonisation) by 2035, all pathways were computed in 5-year time intervals between 2020–2050. This ensures investments before 2035 have foresight of possible energy system configurations beyond 2035.

Hourly power system modelling was carried out, by which investments in and operation of the power system is optimised, minimising cost, while ensuring security of supply over the year – in line with European system security standards. Three years of actual historic weather data was used to simulate every modelled year, of which an average is typically presented. This ensures that a variety of weather conditions and their impact on wind and solar output are accounted for. The impact of weather (temperature) on demand is also included, particularly important as heating is increasingly electrified and cooling demand grows.

Pathway outcomes

Key features of the modelled clean power system pathways are presented here. The results of power system modelling provide insights into what actions are necessary by when, in order to put Europe on a path to a (95%) clean power system by 2035, at least cost.

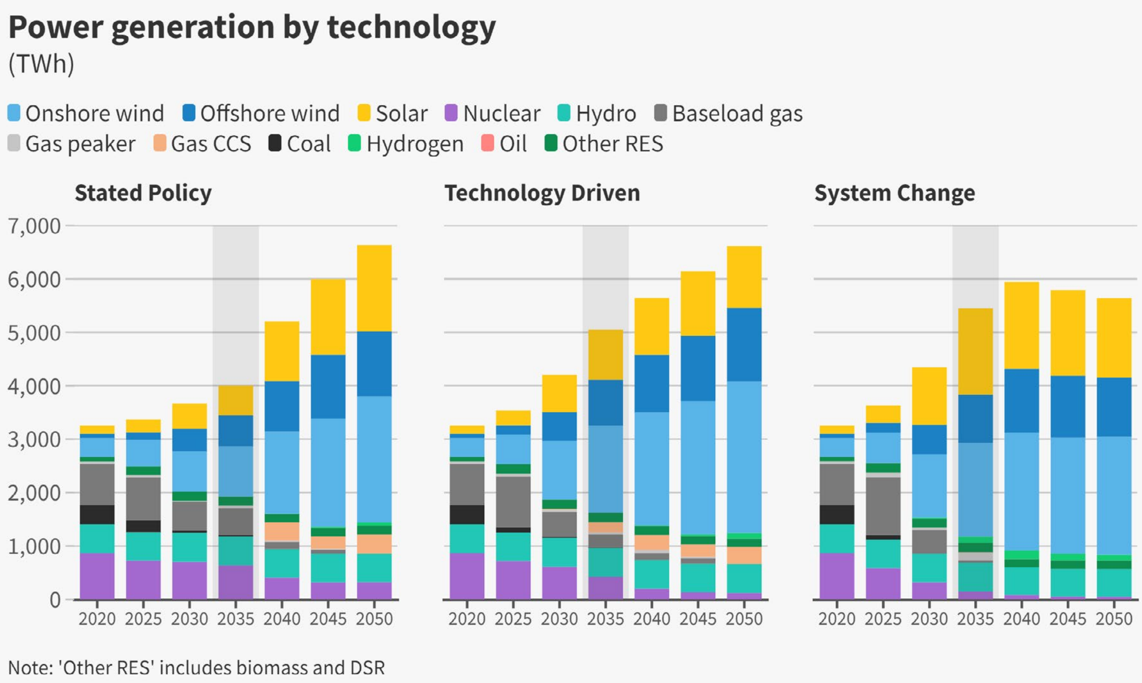

Figure 6: Electricity generation by technology between 2020–2050 in the three modelled pathways.

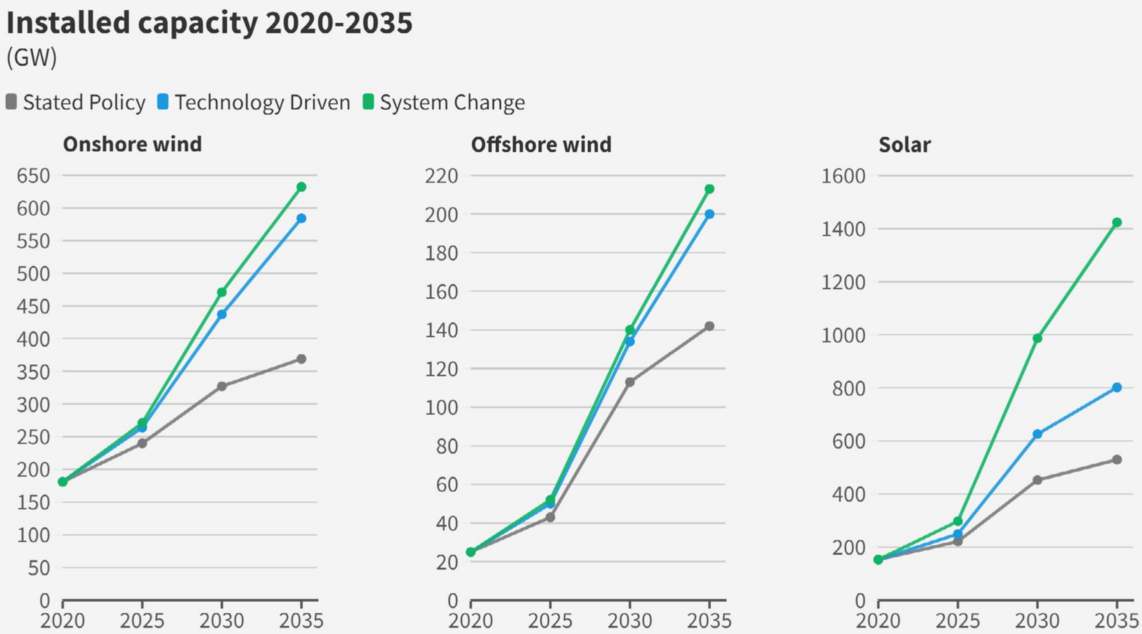

Figure 7: Installed capacity of the wind and solar fleet in the three modelled pathways between 2020 and 2035.

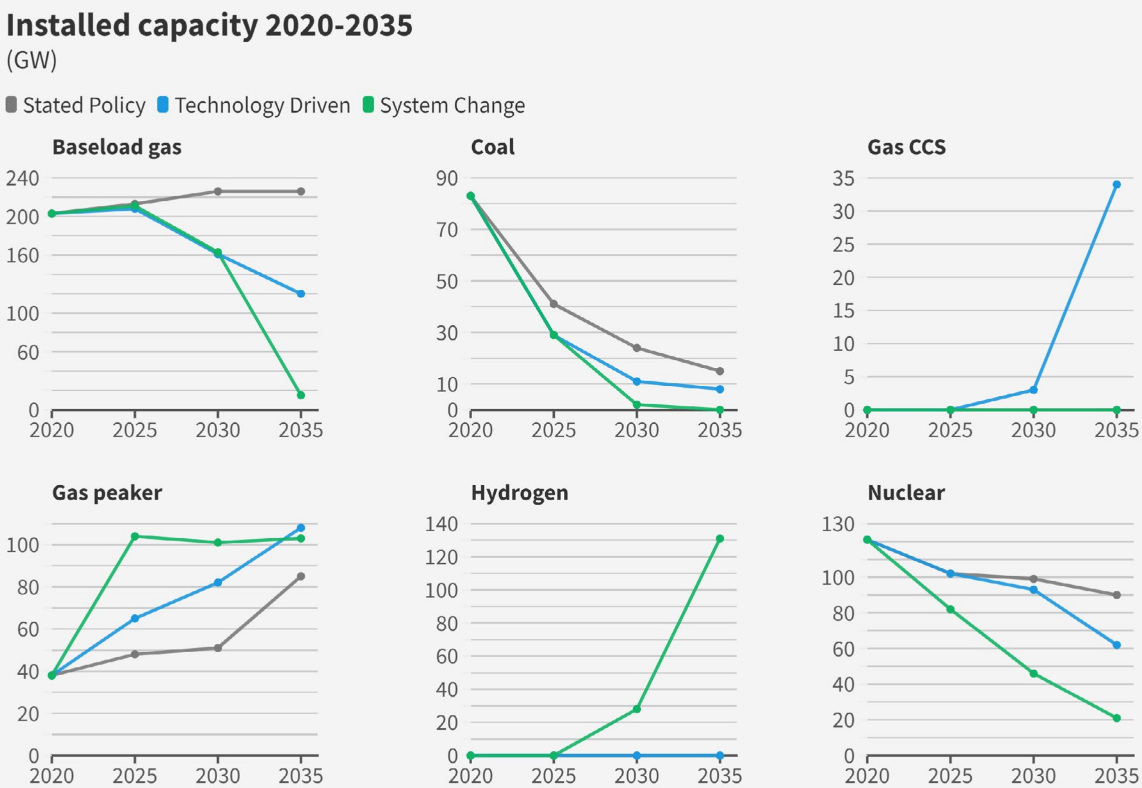

Figure 8: Installed capacity of the main dispatchable generation technologies in the three modelled pathways between 2020 and 2035. Hydropower (not shown) is the same in all pathways.

		Stated Policy	Technology Driven	System Change
Power generation	TWh	3,823	5,047	5,454
Generation mix	Clean %	86	94	96
	W&S %	52	68	78
	Fossil %	14	6	4
Onshore wind	GW	369	584	632
	TWh	940	1,640	1,760
	%	24	32	32
Offshore wind	GW	142	200	213
	TWh	580	855	905
	%	14	17	17
Solar	GW	530	802	1,424
	TWh	555	933	1,616
	%	14	18	30
Unabated gas	GW	310	228	118
	TWh	545	283	188
	%	14	6	4
Gas CCS	GW	–	34	–
	TWh	–	190	–
	%	–	4	–
Hydrogen	GW	–	–	131
	TWh	–	–	115
	%	–	–	2
Nuclear	GW	90	62	21
	TWh	635	425	150
	%	16	8	3
Hydro (and pumped storage)	GW	246	246	246
	TWh	540	540	540
	%	13	11	10
Electrolysers	GW	84	192	415
Green H2 production	TWh	109	480	920
Battery storage	GWh	148	246	842
Interconnectors	2020=1	1.5	2.1	2.4
Flexibility from clean sources	%	67	82	92
Total cost saved by 2035 vs. Stated Policy	€bn	–	529	975

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