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The rise of Power in European Economies

The rise of power in European economies: While our previous research has focused on the 2050 net zero end game, here we explore a more immediate, more tangible topic; one that is poised to revolutionize European economies and our everyday lives: the ***urgency of electrification.*** Late last year, the Fit for 55 plan (F55) and its German translation gave us a glimpse of how the immediate future might look – and that is, ***much more electric.*** In fact, as stated in F55, the most effective way for Europe to reach a 55% reduction in emissions by 2030 is through a major electrification process, a process that is about to start.

Major shift in power demand: On our estimates, electrification could lead to a c.50% increase in power demand to 2030, reversing a near 15-year negative trend. This should be driven by incremental demand from new sources such as passenger cars, heat pumps, industrial motors, and electrolysers. By 2030, electricity could account for c.50% of primary energy consumption, vs. c.20% today.

The urgency to accelerate green energy investment: We estimate that electrification could require Europe to mobilise €3.7 tn of capital over the coming nine years, most of which in green energy infrastructure (more than half).

Power prices to show more near-term resilience: Given the consistent closure of legacy power plants, and the execution risks associated with smoothly accelerating wind/solar additions, the supply/demand balance of European power markets could tighten, supporting higher power prices to 2025E (e.g. Germany).

Solid returns, double-digit growth, meaningful upside to intrinsic value: We believe this backdrop will have three main consequences for the Green Energy Majors (GEMS): (1) much higher returns than expected (2) double-digit earnings growth to 2027E, twice the level of the market; and (3) significant intrinsic value creation, even assuming a 50 bp in-crease in nominal WACC.

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Executive Summary

While our previous research has focused on the 2050 net zero end game, here we explore a more immediate, more tangible topic, one that is poised to revolutionize European economies and our everyday lives: ***the urgency of electrification***. Late last year, the Fit for 55 plan (F55) and its German translation gave us a glimpse of how the immediate future might look – and that is, ***much more electric***.

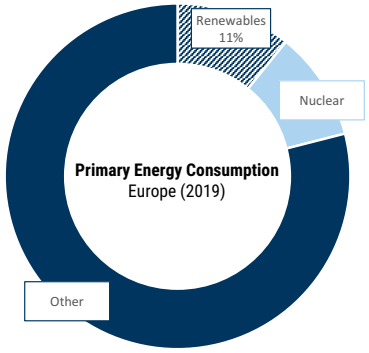
In fact, as stated in F55, the most effective way for Europe to reach a 55% reduction in emissions by 2030 is through a major electrification process, a process that is about to start. We believe that this will have three main outcomes for the sector:

- **Power demand will begin to grow**, strongly, inverting a near-15-year negative trend. We estimate a 50% increase in power consumption to 2030. By then, electricity could represent c.50% of total European primary energy consumption, vs c.20% today.
- **Europe will need to mobilise €3.7 tn of capital**, most into green energy infrastructure, to develop renewables, upgrade power grids, refurbish buildings and to support the switch to electricity for mobility, real estate and manufacturing.
- **Power prices to be temporarily supported**, as certain power markets (e.g., Germany) are likely to tighten over the coming 3-5 years, owing to the extremely rapid phaseout of thermal plants (which is unlikely to be fully offset by the gradual acceleration in RES additions, until later in the decade).

The rise of power in European economies

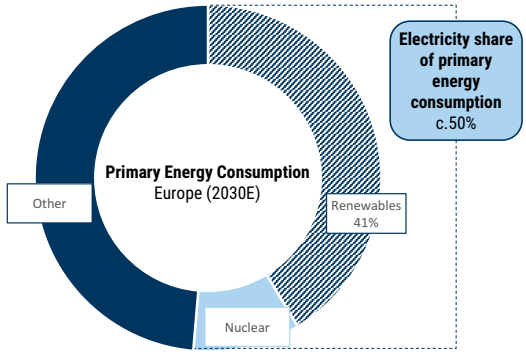
Late last year, the Fit for 55 plan (F55) and its German translation gave us a glimpse of how the immediate future might look. In fact, as stated in F55, the most effective way for Europe to reach a 55% reduction in emissions by 2030 is through a major electrification process (automotive, real estate, manufacturing, green hydrogen), a process that is about to start. As a result, the share of power in the primary energy mix in Europe could increase to c.50%, vs. c.20% today.

Exhibit 1: In 2019, renewables and nuclear accounted for c.20% of primary energy in Europe
Primary energy consumption mix Europe, 2019



Source: OurWorldInData, BP

Exhibit 2: By 2030, electricity's share (nuclear and renewables) of primary energy could increase to c.50%, driven by electrification
Primary energy consumption, Europe 2030E



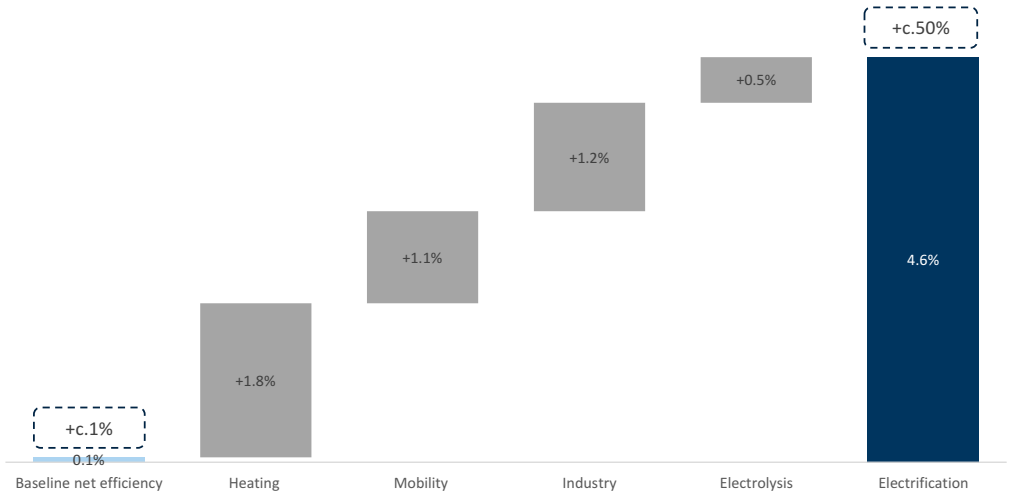
We assume growth is offset by energy efficiency measures, i.e. that total primary energy in 2030E = primary energy in 2019

Source: OurWorldInData, BP, Goldman Sachs Global Investment Research

Major shift in power demand: 50% increase by 2030E

Currently, European power consumption is c.5% below the 2008 level. On our estimates, the electrification process could lead to a c.50% cumulative increase in power demand by 2030, reversing a near-15-year negative trend. This would be driven by incremental power demand from new sources, such as passenger cars, heat pumps, electric motors, and electrolyzers.

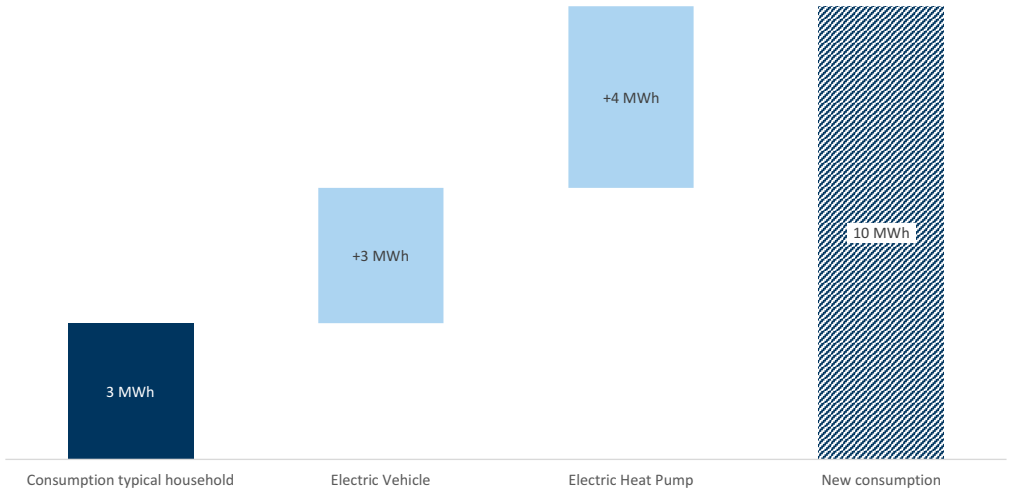
Exhibit 3: Electrification could result in a 50% cumulative surge in power demand to 2030E
European power demand - baseline net energy efficiency vs. electrification (% CAGR to 2030E)



Source: Goldman Sachs Global Investment Research

As a simple demonstration, and to underpin our estimate, we note that the purchase of an electric vehicle and a heat pump would more than triple the power consumption of a typical European household. In other words, full electrification of mobility and heating would broadly be equivalent to tripling Europe's population.

Exhibit 4: For a typical household, acquiring an EV and installing a heat pump would lead to a three-fold increase in electricity consumption
Household electricity consumption (MWh)



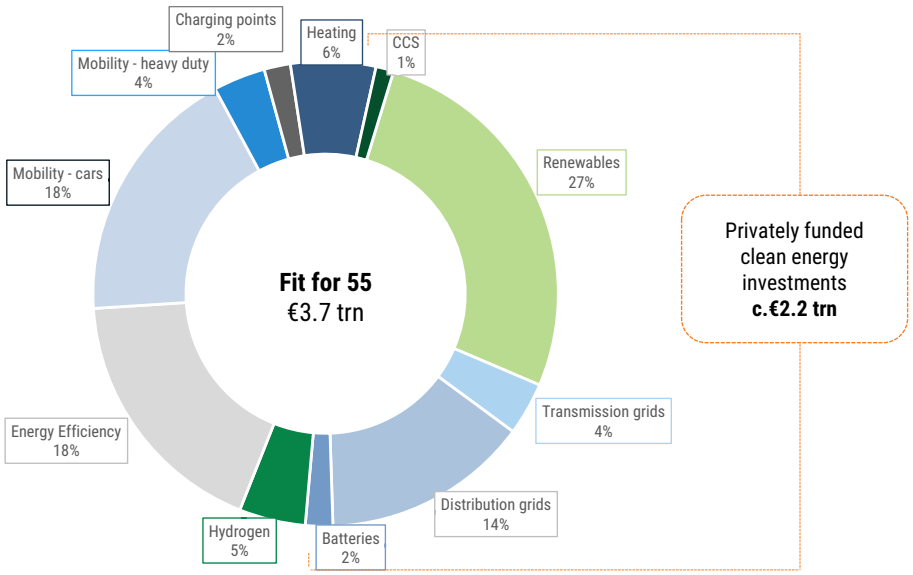
Source: Goldman Sachs Global Investment Research

The urgency to accelerate green energy investment

Meeting the Fit for 55 goals would require the mobilisation of €3.7 tn, we estimate. Of this, we estimate more than half (c.€2.2 tn) could be privately funded investment, carried out for the most part by green energy companies. This alone would imply a c.100%-200% incremental EBITDA increase for our coverage to 2030E vs. 2021 (based on our returns assumptions - see later).

Exhibit 5: Fit for 55 plan implies c.€3.7 tn of capital mobilisation by 2030E, more than half in clean energy investments

Fit for 55 mobilized investments breakdown (percentage)

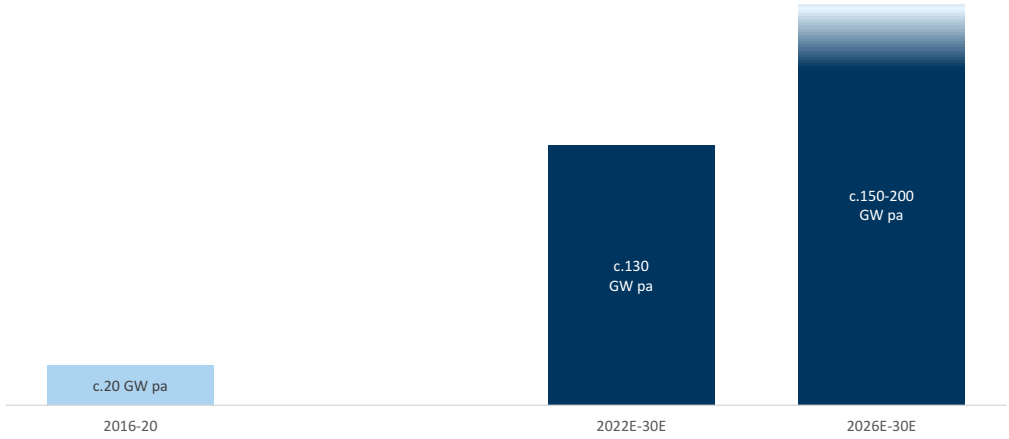


Source: Goldman Sachs Global Investment Research

Unprecedented acceleration in wind/solar annual capacity additions (Europe)

Currently, about 40% of European power production comes from renewable sources (hydro, wind, solar, biomass etc.); by 2030, this share could reach 70%, according to the Fit for 55 plan. To comply with the F55 plan and the resulting increase in power demand, we estimate that Europe might experience a quadrupling of its installed wind and solar base, and a major acceleration in annual installations (which could peak at 150-200 GW pa in the second half of the decade, vs. an average of c.20 GW pa in 2016-20).

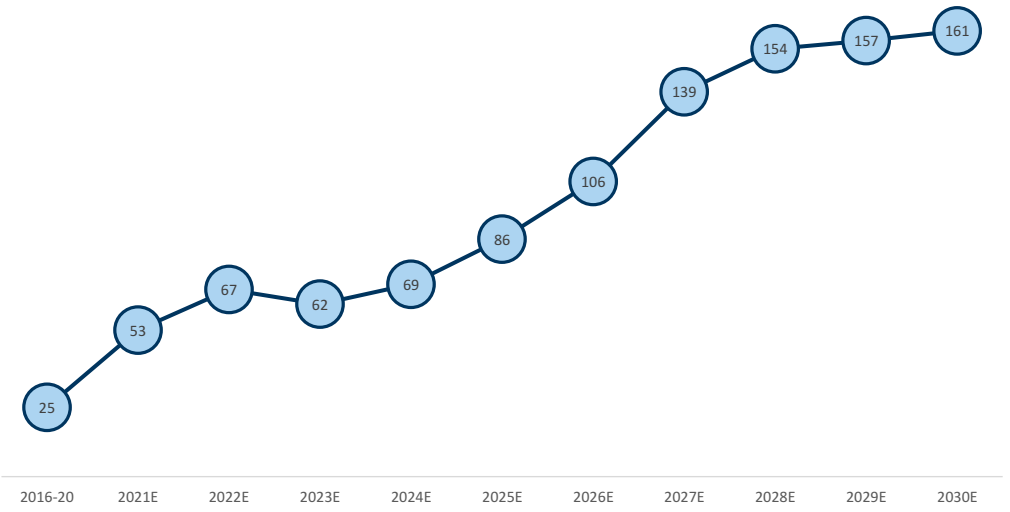
Exhibit 6: By the second half of the decade, we estimate that Europe could reach peak additions of 150-200 GW pa
EU capacity additions (GW)



Source: Goldman Sachs Global Investment Research, ENTSO-E Statistical Factsheet

As explained in our previous research, the process of scaling up renewables investments does not happen overnight. The time needed to raise the number of public employees necessary to support the approval of permits, to develop larger pipelines, and to convert them into actual assets, implies a lag between the announcement of new policies and the achievement of peak capacity growth. It is for these reasons that we believe the step up in RES investments will be gradual, and that growth will continue accelerating until the end of the decade. The following exhibit shows our estimates of the annual capex in wind/solar (€ bn) necessary for Europe to comply with its Fit for 55 plan. Investments (at c.€25 bn per year, in 2016-20, on average) could reach a peak of €160 bn pa by the end of the decade.

Exhibit 7: Annual investments in wind/solar could rise from c.€25 bn pa in 2016-20, to c.€160 bn by 2030E
Annual capex in RES, Europe (€ bn)

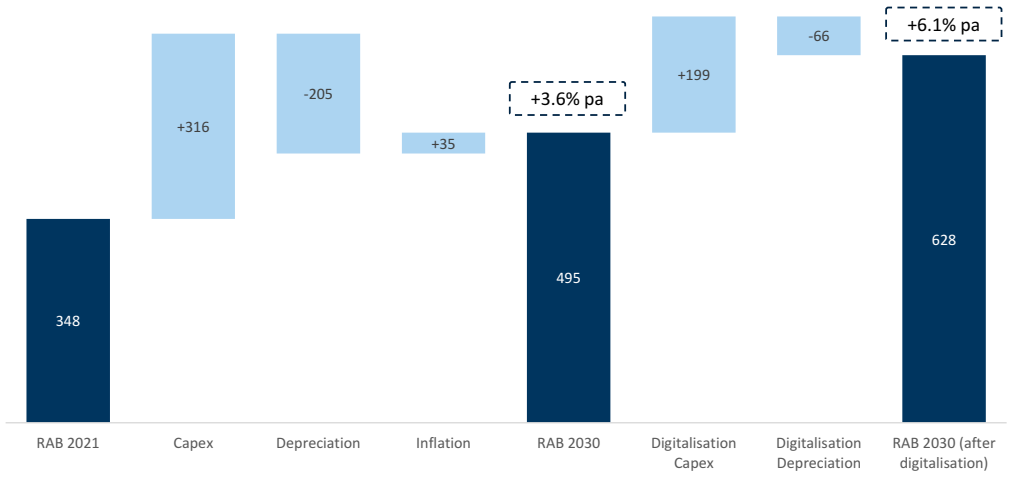


Source: Goldman Sachs Global Investment Research

Power grids need a complete overhaul

By 2030, the EU is targeting a 50% reduction in emissions from road transport, and a 50% share of renewables buildings (i.e., buildings heated by clean rces, such as heat pumps). These trends, coupled with the rising share of RES in the system, would require greater investment in the resilience of power networks, leading to a major digitalisation push in power networks. For power distribution in particular, this could lead to the roll out of smart meters, wall boxes, sensors, upgrades to substations, more advanced telecommunication systems, and new software to handle the much larger number of datapoints generated by such a complex power system. This could push power distribution investment up by c.60% vs. current level.

Exhibit 8: When including digitalisation investments, we estimate European power distribution RAB could grow by c.6.1% pa to 2030
European RAB (€ bn)

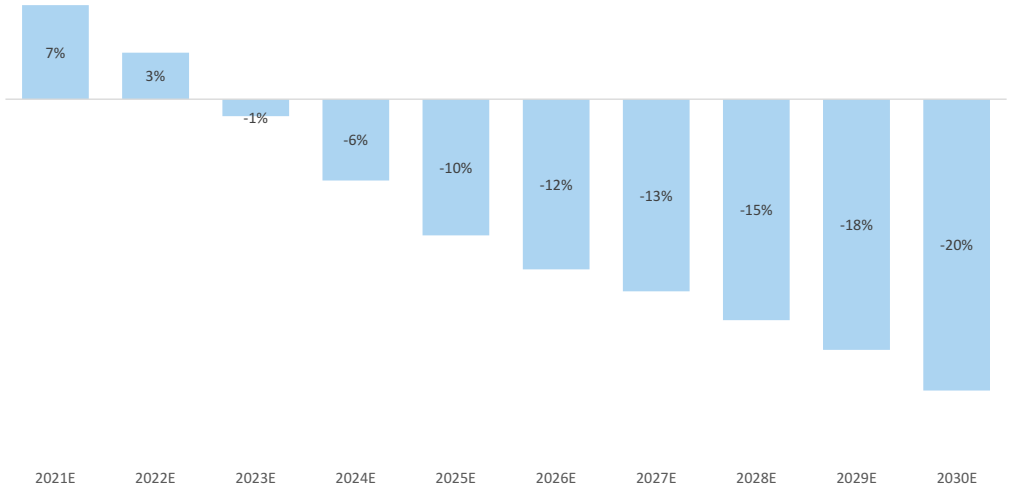


Source: Goldman Sachs Global Investment Research

Power prices to be temporarily supported by thermal closures

Given the consistent closure of legacy power plants (we estimate that by 2025 c.40% of the EU coal/lignite fleet will be decommissioned) and the execution risk associated with smoothly accelerating wind/solar additions (supply chain constraints, permitting delays), the supply-demand balance of European power markets could tighten significantly, as demonstrated by the significant contraction in the EU reserve margin (the excess of 'available capacity' over peak demand) in the following exhibit. Such S-D tightness could support power prices (and thermal spreads) until 2025E.

Exhibit 9: We expect to see a reduction in the European reseve margin
Europe reserve margin (%)



Source: Goldman Sachs Global Investment Research

Why isn't the space performing yet?

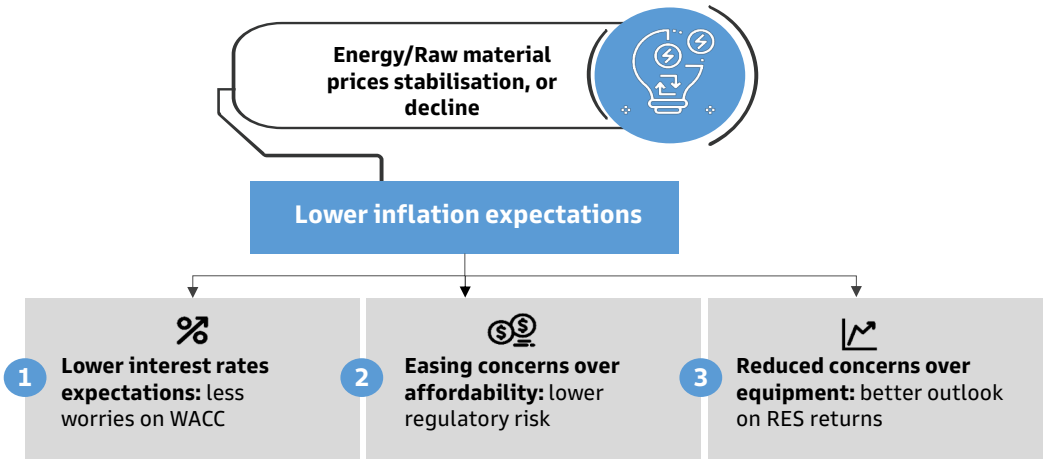
Following the publication of our 2022 Outlook and conversations with investors, we would characterize the main concerns over the Utilities and Green Energy space as follows:

- **Inflation/rates:** the majority of concerns relate to the expectation of higher-for-longer inflation, and (as a result) the chances of further increases in interest rates. This should favour industries with pricing power, or those positively correlated with rates, such as Banks or Energy or Metals & Mining, for instance. Additionally, rising rates should imply a higher discount rate, which is seen as a meaningful negative for capital-intensive, long-duration activities such as renewables or networks. Specific to the industry, equipment cost inflation has (unjustly, as several data points can prove, as discussed in previous reports) given birth to worries regarding a potential compression in RES IRRs.
- **Regulatory risk**: as explained in previous reports, the c.60%-80%increase in energy bills over the past year has increased the chances of regulatory intervention against Utilities we believe, as recently seen for EDF, or as reported by the Italian press with regard to Enel.

In our view, the above-mentioned threats are connected: higher energy prices have been a key driver of higher inflation rates, which in turn has increased expectations for higher rates. If we were to see a stabilization in commodity prices, and if as a result inflation rates started to normalize (GS Economists' central case), we could see a meaningful rotation back into Utilities.

Indeed, the chain reaction (lower commodity prices, to lower inflation, to lower rates) would simultaneously imply less risk of regulatory intervention and less concern over the cost of capital.

Exhibit 10: Our 2022E sector framework summarised



The main factors to monitor... which may turn into bottlenecks

We identify several factors that should allow for a smooth execution of the European climate plans, or that – if not properly executed upon – could negatively hit the whole narrative: (i) stable regulation is imperative to attract trillions of investments from the private sector: a prolonged energy crisis (and a subsequent affordability debate) could lead to unpredictable regulatory changes, which might delay green investment plans; (ii) an improvement in administrative processes that would allow for a smoother approval of projects: permitting has so far been a key bottleneck; (iii) most of the supply chain bottlenecks relate to shortages in the workforce: hiring more employees (manufacturing and logistics) and scaling-up their businesses, would allow them to cope with rising investment opportunities; and (iv) a deep economic crisis – at some stage over the coming nine years – could lower the impetus of these climate policies, and slow-down the decarbonisation path of Europe.

Source: Goldman Sachs Global Investment Research

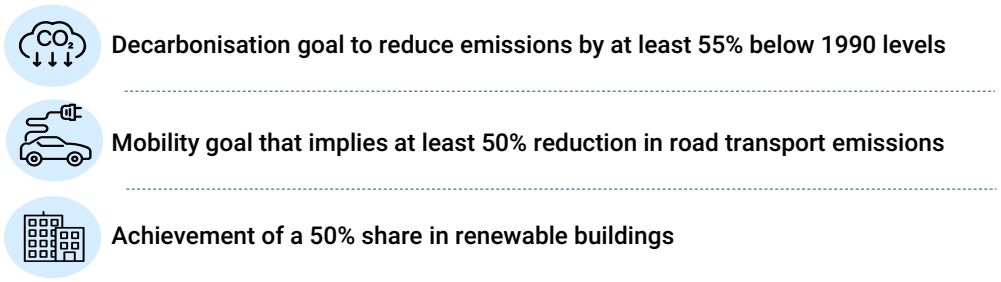
A major and imminent electrification push

While our previous research has largely focused on the 2050 net zero end game and the related addressable market, we now explore a more immediate and tangible topic, one that is poised to revolutionize European economies and our everyday life: *the urgency of electrification*. Indeed, late last year the Fit for 55 plan (F55) and its German translation, gave us a glimpse of the immediate future and how it will look – and that is, *much more electric*. As stated in F55, the most effective way for Europe to reach a 55% reduction in emissions by 2030 is a major electrification process, one which is about to start. This should impact other industries, such as automotive, real estate, manufacturing, and green hydrogen.

The European Fit for 55 plan: Three main pillars

The Fit for 55 plan, disclosed in mid-July last year, is a comprehensive decarbonisation plan for the European Union. Goals are expressed for 2030, and include: (1) a wider decarbonisation goal than before, with emissions to fall to at least 55% below 1990 levels; (2) an ambitious mobility goal which implies at least a 50% reduction in road transport emissions; and (3) the achievement of a 50% share for 'renewables buildings'.

Exhibit 11: The Fit for 55 goals imply a major electrification push through the following goals...

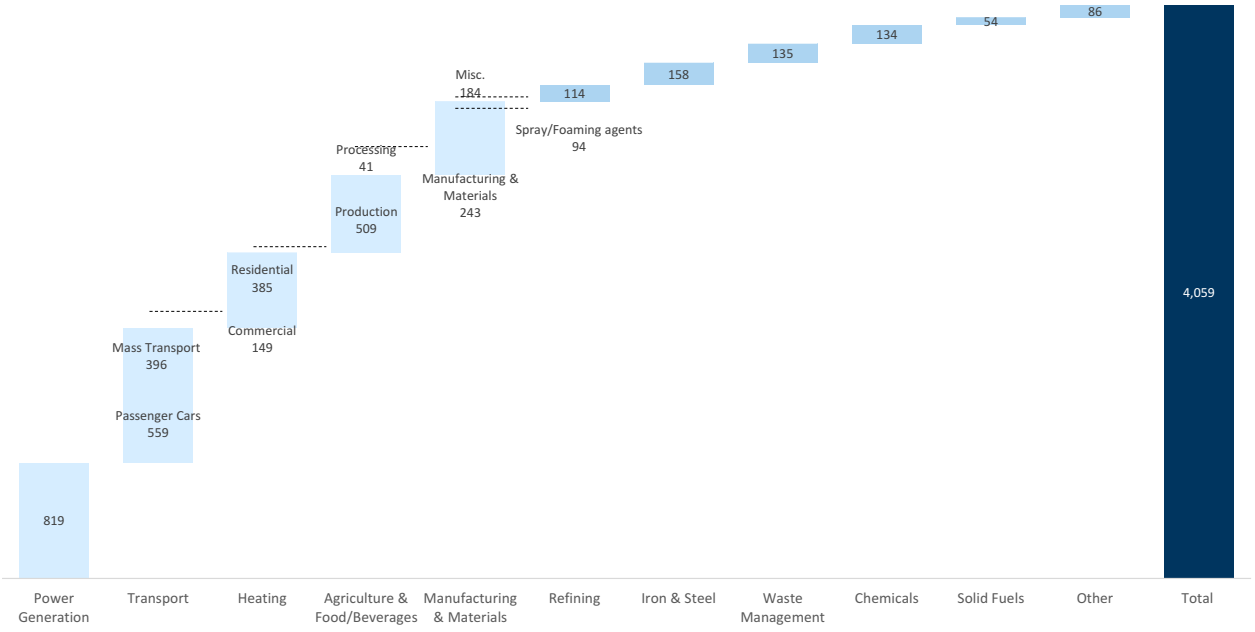


Source: Goldman Sachs Global Investment Research

At least a 55% reduction in emissions

European greenhouse gas emissions (c.4 giga tonnes in 2019) can easily be classified into a few key segments (Exhibit 12) , with c.70% of EU emissions stemming from: (1) the way we produce electricity (power generation); (2) the way we move people and goods around (transport); (3) the way we produce goods (manufacturing); and (4) real estate (heating space).

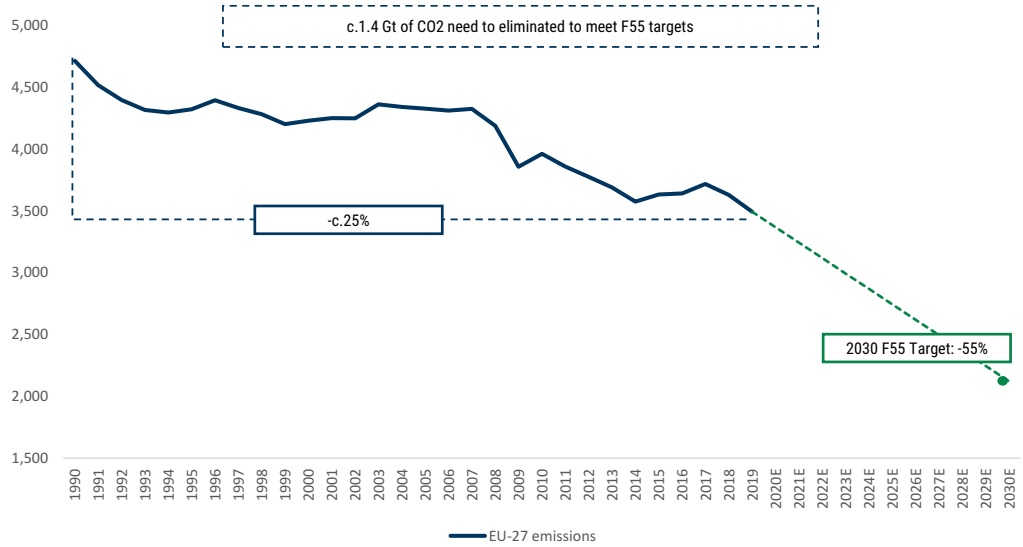
Exhibit 12: Power generation, transport, heating and manufacturing jointly account for c.70% of European emissions
EU-28 greenhouse gas emissions (mn tonnes of CO2, 2019)



Source: Eurostat, Goldman Sachs Global Investment Research

The F55 plan is targeting an 'at least 55%' reduction in emissions by 2030, vs. 1990. Since the reference year, emissions have already fallen by c.25%, as seen in Exhibit 13; this is equivalent to a c.1.2 Gt reduction in absolute terms since 1990. To reach the end-of-the-decade goals an incremental c.1.4 Gt of CO_2 emissions would have to be removed.

Exhibit 13: To reach 2030 goals, c.1.4 Gt of emissions would have to be removed EU-27 GHG emission evolution (mtCO2e)

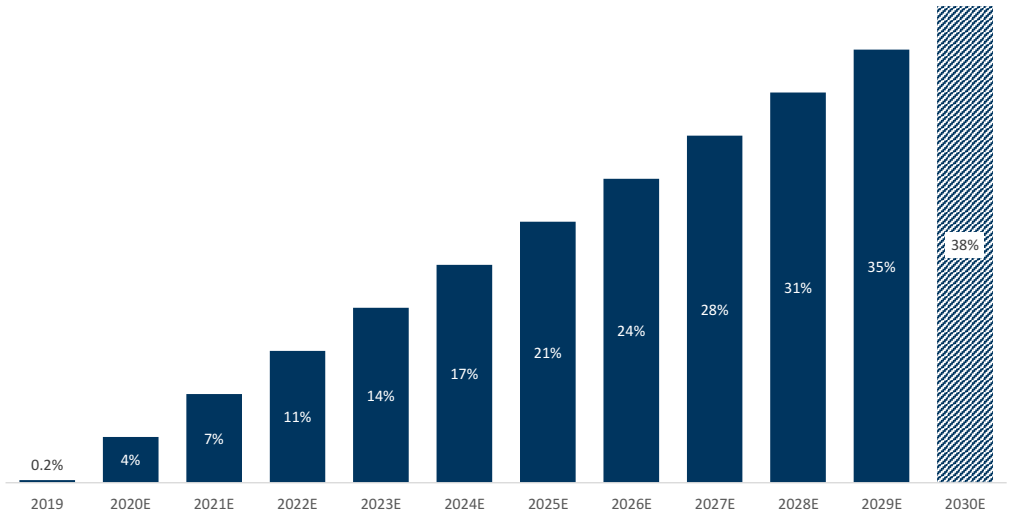


Source: European Environmental Agency, Goldman Sachs Global Investment Research

No more polluting combustion car sales by 2035

The F55 plan targets a c.50% reduction in emissions from road transport, implying a reduction of about c.0.5 Giga tons of emissions. Based on data from the United States Environmental Protection Agency (US EPA) that suggests that an average combustion vehicle emits c.250 grams of CO_2 per km, we estimate that F55 targets would require c.100 mn electric cars by 2030. In terms of penetration, this would result in a c.40% EV penetration by the end of the decade as shown in Exhibit 14, substantially up from <1% today.

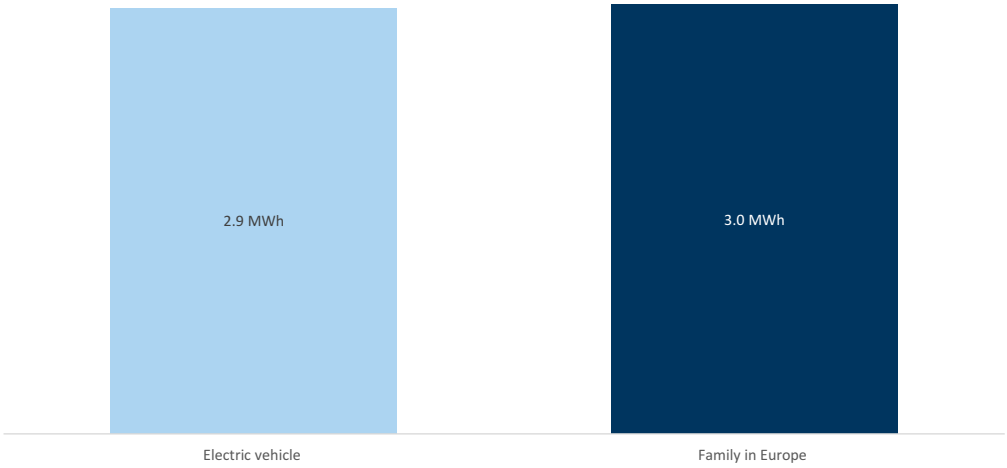
Exhibit 14: F55 targets imply a c.40% EV penetration in Europe
EV penetration in Europe under the F55 plan



Source: Goldman Sachs Global Investment Research

An average electric vehicle consumes nearly 3 MWh of electricity per year, which is equivalent to the annual power consumption of a typical household, as shown in Exhibit 15. We base our 3 MWh/year estimate for an average EV on: (1) power consumption of c.0.18 KWh per km; and (2) distance traveled of 17k km per year.

Exhibit 15: Every EV consumes power equivalent to a household in Europe
Annual power consumption per unit

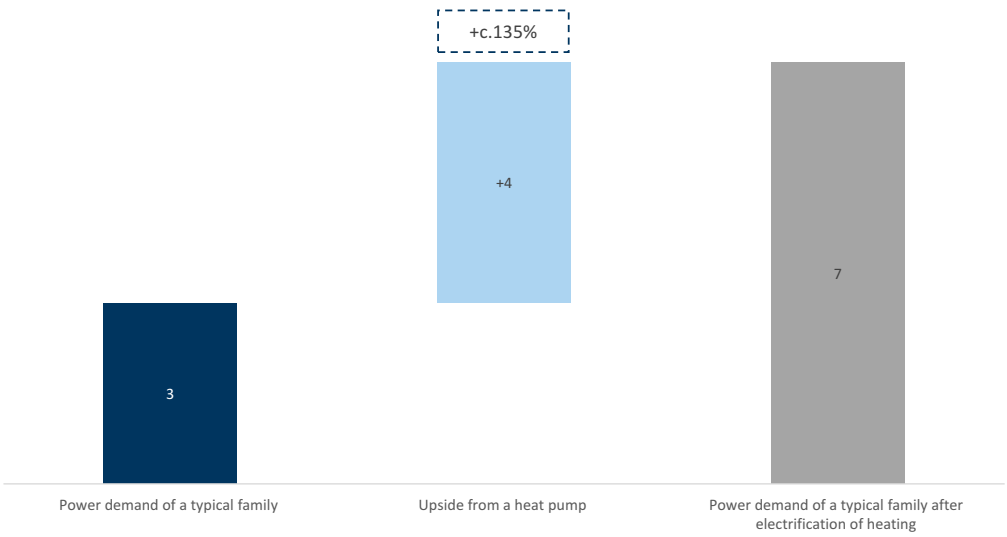


Source: Goldman Sachs Global Investment Research

About half of renewable buildings by 2030

Over the course of the last 10 years, heating has contributed c.15% of the total emissions in the EU-28. The electrification of space heating is one of the largest sources of upside for power demand. For instance, an average heat pump needs 4 MWh of power annually, more than twice the power consumption needs of a typical European household. Electrification of residential households and service buildings has the potential to increase power demand by c.15% vs. current levels, we estimate. An average heat pump consumes 4 MWh of electricity annually, which is nearly 135% more than the average power consumption of a typical household in Europe. This 4 MWh is estimated from average heat consumption needs of 12 MWh/year and a heat pump's electricity-heat conversion rate of 1:3.

Exhibit 16: A heat pump increases the annual power consumption of a typical European household from 3 MWh to 7 MWh
Power demand (TWh)

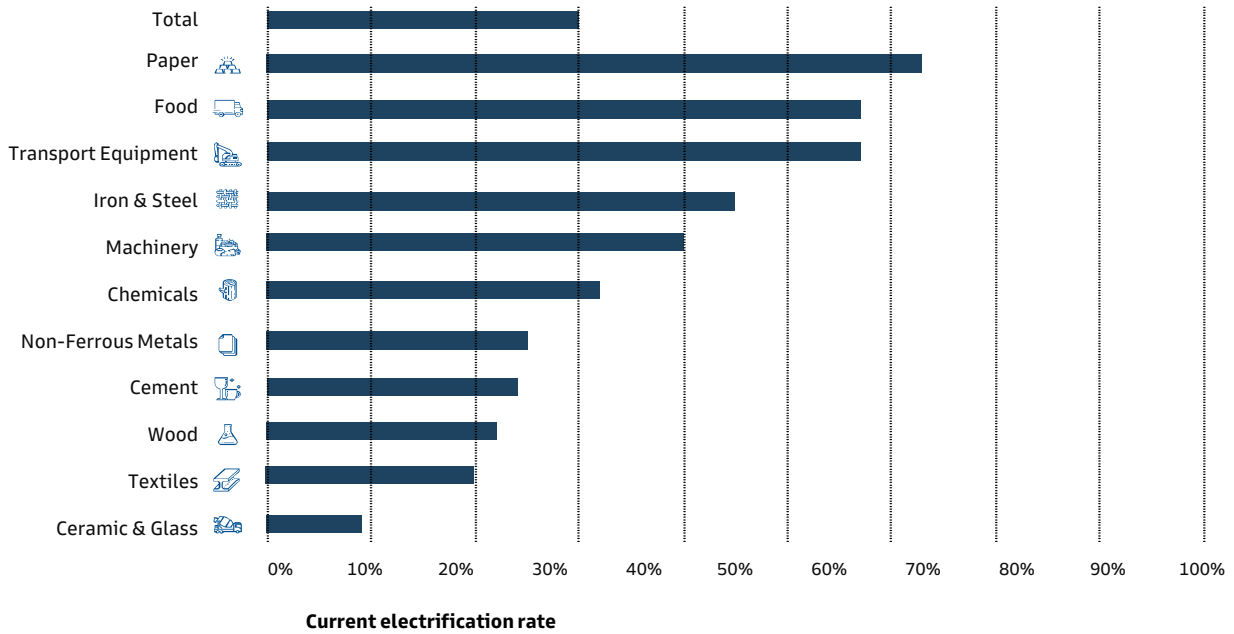


Source: Goldman Sachs Global Investment Research

The electrification of manufacturing

Over the past decade, the manufacturing sector has emitted a little over a quarter of the total EU-28's emissions. Based on our division of sectors (Exhibit 17), the manufacturing sector comprises Manufacturing/Materials, Refining, Iron & Steel, Waste Management, Chemicals and Solid Fuels. Currently, c.30% of this sector is electrified; reaching a c.40% electrification rate by the end of the decade would imply c.15% upside to 2021's total power consumption.

Exhibit 17: The current rate of electrification in the industrial sector stands at only 30%
Current rate of electrification



Source: Goldman Sachs Global Investment Research, Wind Europe

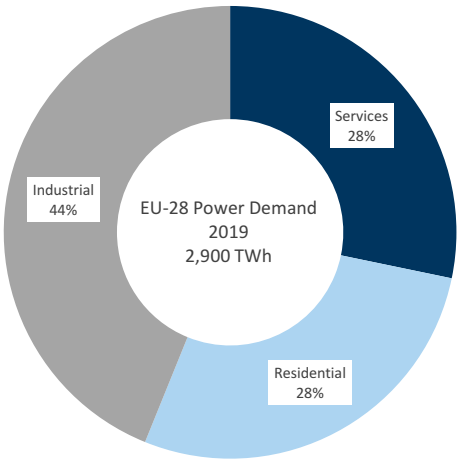
Power consumption to inflect: +50% to 2030

On our estimates, the electrification process that is soon to be kicked off by the F55 plan could lead to a c.50% cumulative increase in power demand to 2030, reversing a near 15-year negative trend. This should be possible thanks to incremental power demand from new sources, such as passenger cars, heat pumps, electric motors, and electrolyzers. As a result, electricity could become c.50% of the total primary energy consumption by then, vs. c.20% today.

Electricity: From 20% to 50% of European primary energy in less than a decade

Currently (2019), about 45% of European power demand comes from industrial clients, while the rest is broadly evenly split (c.30% each) between residential and services. Power consumption mostly comes from manufacturing processes, cooling, lighting and electrical appliances.

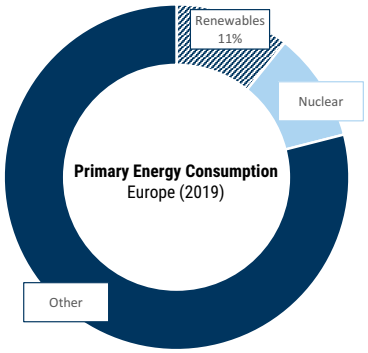
Exhibit 18: c.45% of power demand in Europe in 2019 came from industry while c.30% came from residential and services clients
EU-28 power demand split (2019)



Source: Goldman Sachs Global Investment Research, Eurostat

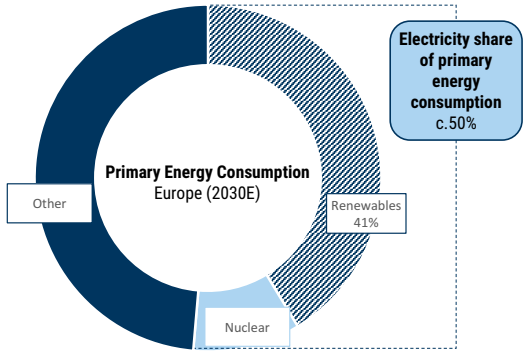
Data from BP shows that, currently (2019), electricity accounts for about 20% of primary energy – this treats as 'electric' only those sources that do not rely on fossil fuel, e.g., nuclear, hydro, wind and solar (excluding other renewables). On our estimates, to achieve the Fit for 55 plan by 2030, electricity would have to become c.50% of primary energy.

Exhibit 19: In 2019, renewables and nuclear accounted for c.20% of primary energy in Europe
Primary energy consumption mix Europe, 2019



Source: OurWorldInData, BP

Exhibit 20: By 2030, the electricity share (nuclear and renewables) of primary energy could increase to c.50%, driven by electrification
Primary Energy Consumption Europe 2030E



We assume growth is offset by energy efficiency measures, i.e. that total primary energy in 2030E = primary energy in 2019

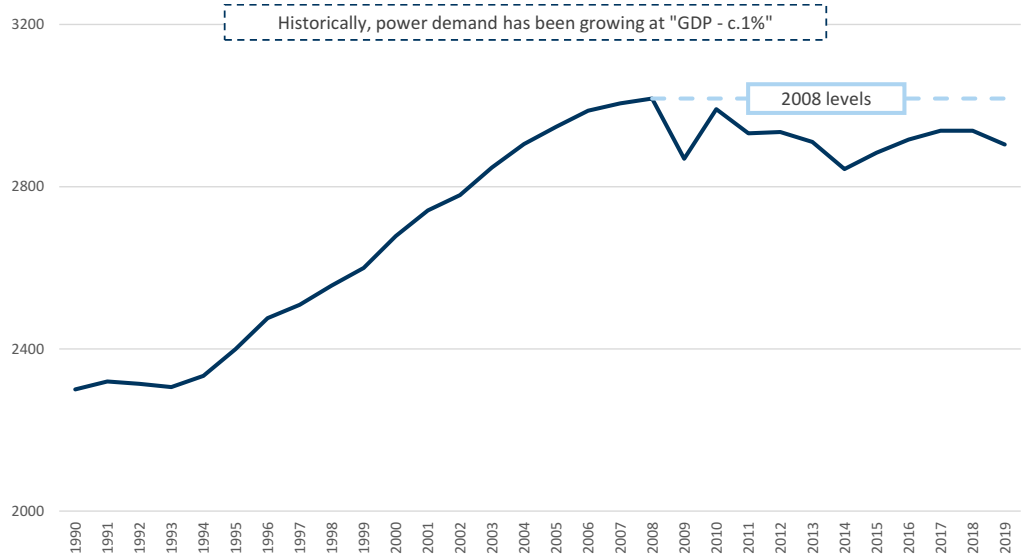
Source: OurWorldInData, BP, Goldman Sachs Global Investment Research

To reach the above conclusion, we have had to estimate the evolution of power demand, under a Fit for 55 scenario, which we describe in the rest of this chapter.

Power consumption: Status quo growth at "GDP - 1%"

Power demand between 1990 and 2008 increased by less than 1% pa, and peaked in 2008. On a cumulative basis, power demand between 2008 and 2019 fell by c.5%. In other words, currently, power demand across Europe is below its 2008 peak of >3,000 TWh.

Exhibit 21: The recent power demand trend has been unexciting
EU-28 power consumption (TWh)

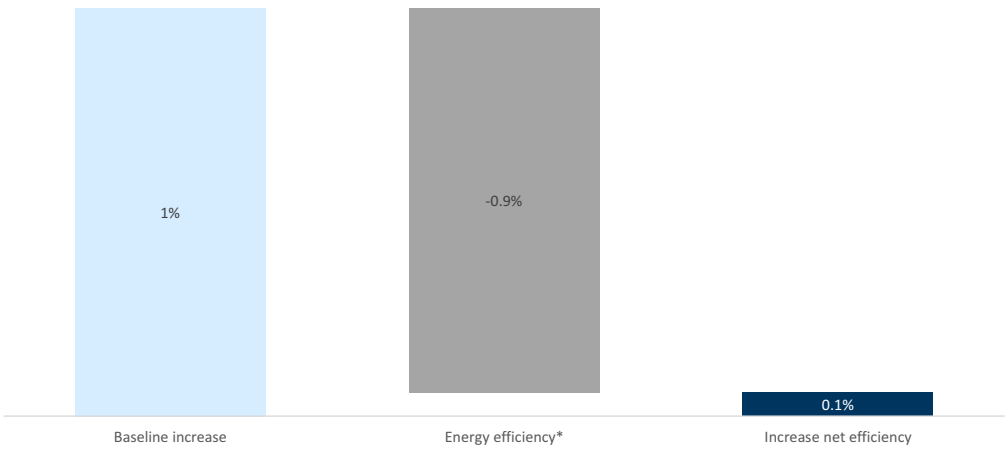


Source: Goldman Sachs Global Investment Research, Eurostat

As observed over the past 30 years, the ongoing reduction in energy intensity could lead to a rate of power demand growth equivalent to GDP - 1%, in a business as usual

scenario. Adopting a working assumption of a 2% pa increase in GDP, would imply a meagre 1% annual increase in power demand, in a business as usual scenario. If we then account for a step up in energy efficiency (most homes/buildings and factories can achieve a c.30% reduction in consumption once thoroughly refurbished, per a study by the UK government), power demand would remain roughly flat through to the end of the decade.

Exhibit 22: Power demand net of energy efficiency would remain roughly flat until the end of the decade
European power demand - no action base case, vs. energy efficiency (% CAGR to 2030E)



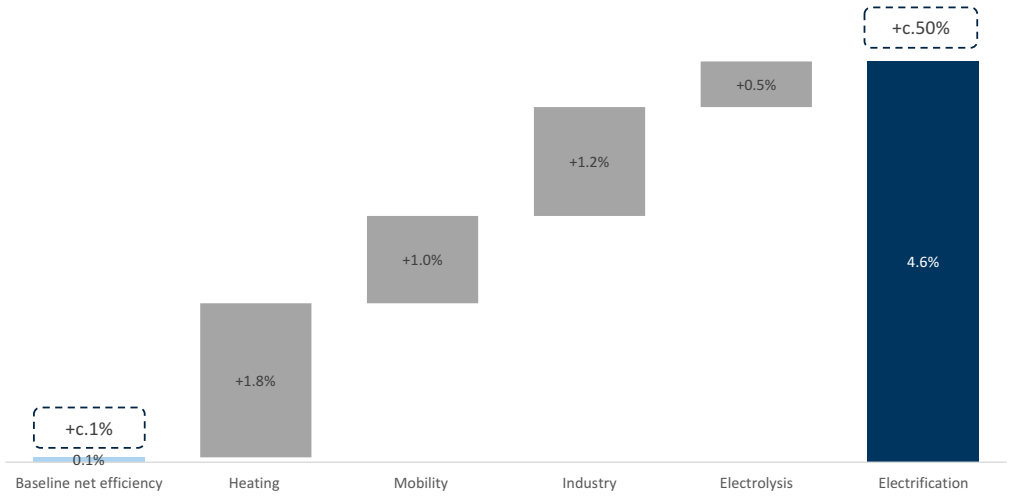
*We assume 20% for residential refurbishments, 35% for services refurbishments and 25% for industrial refurbishments. We also assume c.30% savings in consumption, consistent with the analysis by the UK government in 2018.

Source: Goldman Sachs Global Investment Research

Electrification to drive significant upside to power consumption: +50% to 2030

The recently unveiled 2030 decarbonisation goals of the EU – at least a 55% reduction in emissions vs. 1990 – imply an urgent need to kick off a major electrification push, which should support a strong acceleration in power consumption. We estimate that the gradual electrification of heating, mobility, and factories, coupled with the goal of developing 40 GW electrolysers, could potentially support c.4.5% annual demand growth, on a compound basis. This implies c.50% growth on a cumulative basis over the 2021-30 period.

Exhibit 23: Electrification could result in a +50% cumulative surge in power demand to 2030E
European power demand - baseline net energy efficiency vs. electrification (% CAGR to 2030E)



Source: Goldman Sachs Global Investment Research

We detail our assumptions supporting the c.50% power demand upside scenario to 2030 below. We stress that, out of prudence, our assumptions imply a lower level of electrification in heating and manufacturing than those implied by the targets detailed by the EU:

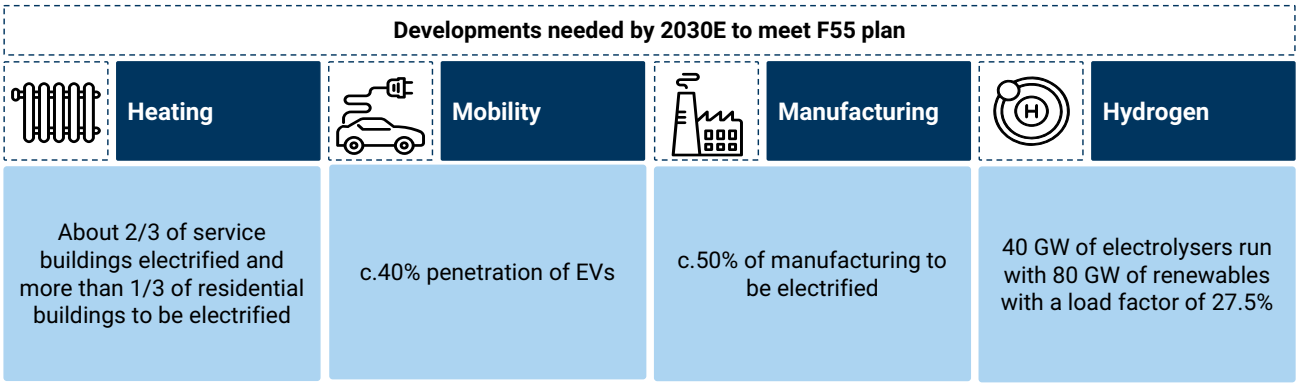
Heating. Our estimate for heating implies c.15% power demand upside (a CAGR of c.1.8%) vs. 2021E power consumption levels. We base this upside on an assumption that c.25% of residential households and two-thirds of service buildings, are electrified by 2030 (vs. c.10% and c.50% respectively today). Our assumptions imply that c.40% of total European real estate is electrified by 2030.

Mobility. A c.40% penetration level for electric vehicles to meet the F55 target of halving road transport emissions would imply c.100 mn electric vehicles by 2030, and based on an electric vehicle's annual consumption of c.3 MWh/year, we estimate potential power consumption upside of c.335 TWh annually. This additional power consumption would result in c.10% upside (a CAGR of 1%) vs. 2021E. Additionally, we base our 3 MWh/year estimate for an average EV on: (1) power consumption of c.0.18 KWh per km; and (2) distance traveled of 17k km per year.

Manufacturing. We assume that the electrification rate for industries increases from the current 30% to 40% by 2030, implying power demand upside of c.15% vs. 2021E.

Hydrogen. We assume power demand upside of c.7% (a CAGR of 0.5%) vs. current power consumption levels, based on a standard load factor of 27.5%, applied to 80 GW of renewables capacity (the capacity that would be needed to run the targeted 40 GW of electrolysers).

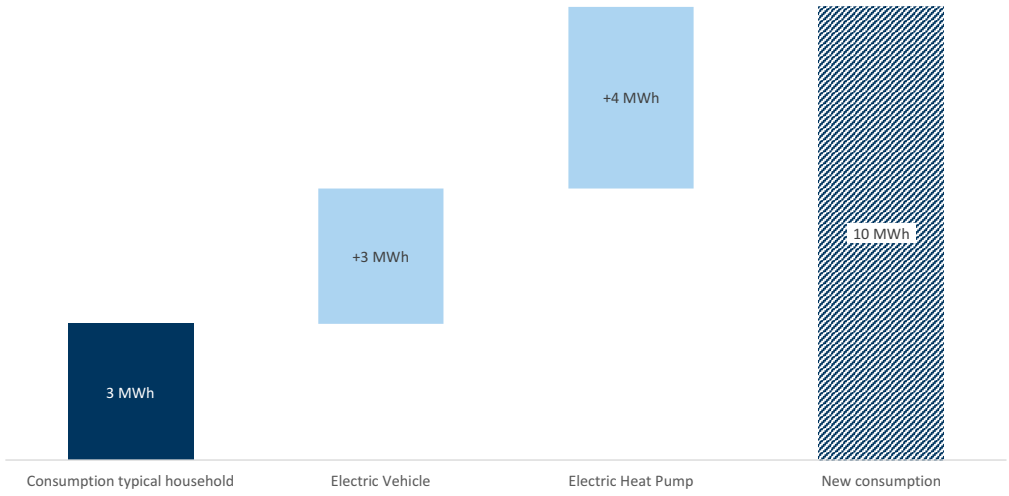
Exhibit 24: Developments needed by 2030E to meet F55 plan



Source: Goldman Sachs Global Investment Research

As a simple demonstration, and to underpin our estimate, we note that the purchase of an electric vehicle and a heat pump would more than triple the power consumption of a typical European household. In other words, full electrification of mobility and heating would broadly be equivalent to tripling Europe's population.

Exhibit 25: For a typical household, acquiring an EV and installing a heat pump would lead to a three-fold increase in electricity consumption
Household electricity consumption (MWh)



Source: Goldman Sachs Global Investment Research

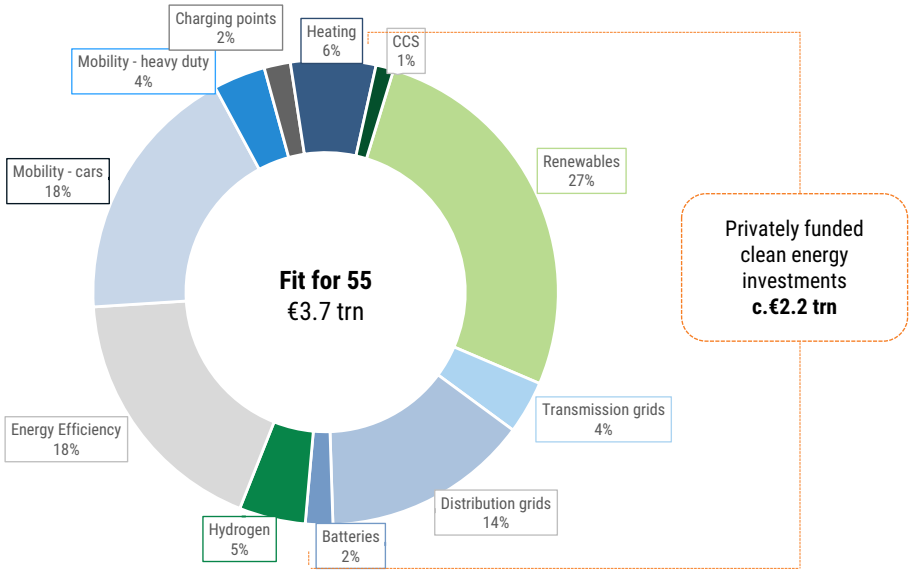
Capital mobilisation of €3.7 tn by 2030E

Meeting the Fit for 55 goals would require the mobilisation of €3.7 tn, we estimate. Of this, about 55% (c.€2.2 tn) should be privately funded investment carried out, for the most part, by energy companies (Utilities and Oils) - see later. This driver alone could imply a c.100%-200% EBITDA increase for our coverage to 2030E, vs. 2021 (based on current EBITDA/capex ratios).

About c.€3.7 tn of capital to be mobilised to 2030E

On our estimates, meeting the Fit for 55 goals would require the mobilisation of €3.7 tn of capital to 2030. This would imply an average c.€410 bn per year of capital being mobilised through this decade. The following exhibit shows the potential breakdown of Fit for 55 investments.

Exhibit 26: The Fit for 55 plan could require a c.€3.7 tn capital mobilisation by 2030, more than half of which could be in clean energy investments
Fit for 55 mobilized investments breakdown (percentage)



Source: Goldman Sachs Global Investment Research

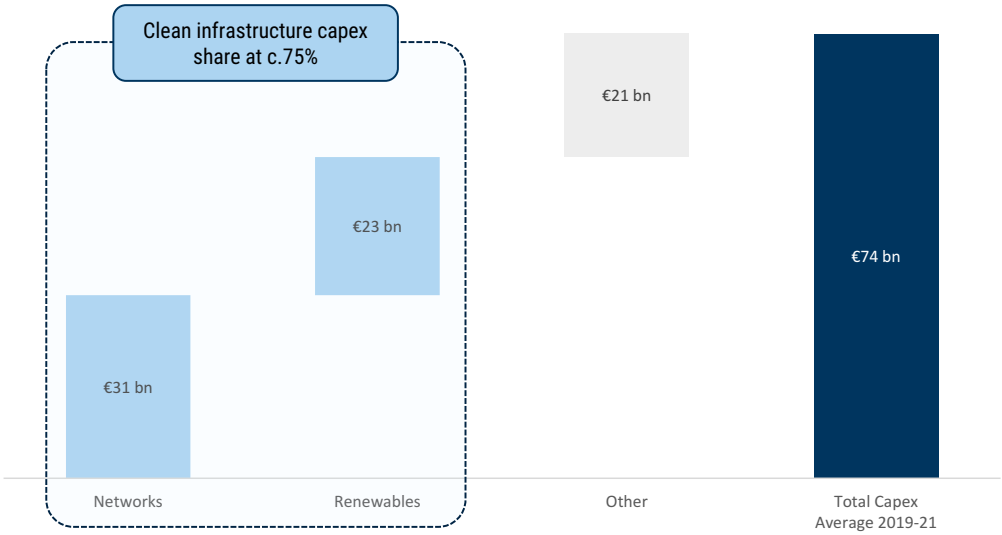
Our €3.7 tn estimate for the Fit for 55 goals builds on the analysis we have previously carried out when looking at the Green Deal and potential investments to 2050. We use the same analytical approach, amending only the time frame to 2030. Our estimate reflects a combination of assumptions:

- **Privately funded clean energy investments (c.55%)** mostly in renewables and power grids to support the rising electrification needs of the European economy.
- **Energy efficiency spending (c.25%)** to limit the consumption of energy in homes, buildings and factories – we estimate achievable energy savings of c.30%.
- **Grants (c.20%)** to switch to electric mobility (e.g. subsidies to purchase a BEV) and electric heating (e.g. incentives to install a heat pump).

Considerable upside to sector capex, just from Europe

We estimate that through 2019-21, the Utilities in our coverage invested a total of €74 bn pa. Of this, we estimate that investments in clean infrastructure (i.e., networks, renewables) accounted for nearly 75%.

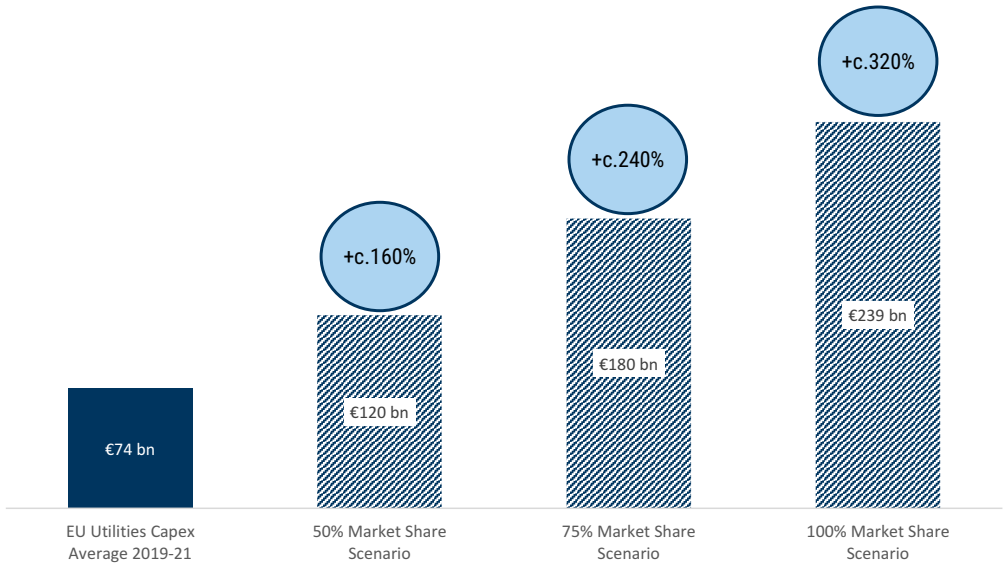
Exhibit 27: Over the last three years, we estimate that the Utilities in our coverage have invested c.€74 bn pa; clean infrastructure investments accounted for c.75% of the total
European Utilities in our coverage; average annual capex breakdown, 2019-21 (€ bn, percentage)



Source: Company data, Goldman Sachs Global Investment Research

We estimate that c.€2.2 tn of Fit for 55 mobilized investments in Europe to 2030 (cumulative) will be privately funded, equivalent to c.€200 bn per year. Depending on their market shares, Utilities could potentially see c.150%-300% upside to their annual capex.

Exhibit 28: Fit for 55 mobilized investments could lead to c.160%-320% capex upside for the Utilities in our coverage, vs. current levels
EU Utilities; annual capex implied by Fit for 55 in different scenarios (€ bn pa)



Source: Goldman Sachs Global Investment Research

Our methodology to reach our €3.7 tn estimate

- **Renewables:** we assume 700 GW of cumulative additions over 2022-30, to deliver nearly 70% of output from RES by the end of the decade, as per the EU F55 plan.
- **T&D:** we assume a c.50% acceleration in power networks investments, to digitalise the grid and improve resilience.
- **Mobility:** we assume nearly €5k average subsidies per car, as an incentive to transition to an EV, and assume that the price gap between combustion and electric/hydrogen buses will also be subsidised. Our estimate on charging points is consistent with the IEA's expectations.
- **Hydrogen**: we assume 40 GW of eletrolysers are developed by 2030, consistent with EU targets.
- **Batteries**: we assume that batteries will represent c.15% of 2030 RES capacity. This is similar to targets seen in California and Spain.
- **Energy efficiency:** we estimate insulation costs, assuming around one-third of buildings will be undergoing insulation by 2030.
- **Heating**: we assume that the cost to install a heat pump and upgrade the heating system (c.€5 k) will be subsidised.

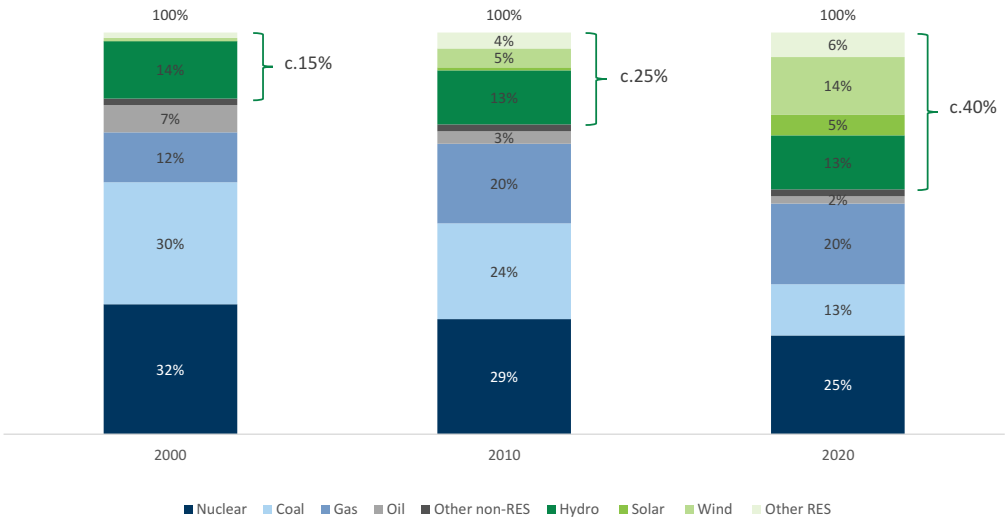
Imminent, strong acceleration in wind/solar additions

Currently, about 40% of European power production comes from renewable sources (hydro, wind, solar, biomass, other); by 2030, this share could reach 70%, according to the Fit for 55 plan. As we expect power demand to grow by nearly 50% to then, this implies a quadrupling of the wind and solar installed base, and a major acceleration in annual installations (which could peak at 150-200 GW pa in the second half of the decade, vs c.20 GW pa today).

Quadrupling capacity by 2030 implies a ten-fold acceleration in additions vs. 2016-20 annual levels

In 2000, only c.15% of power production came from RES, mostly hydro. Since then, a combination of supportive policies and a major improvement in economics has led to a steady rise in the share of RES. Presently (2021E), about 40% of European power production is from renewable sources.

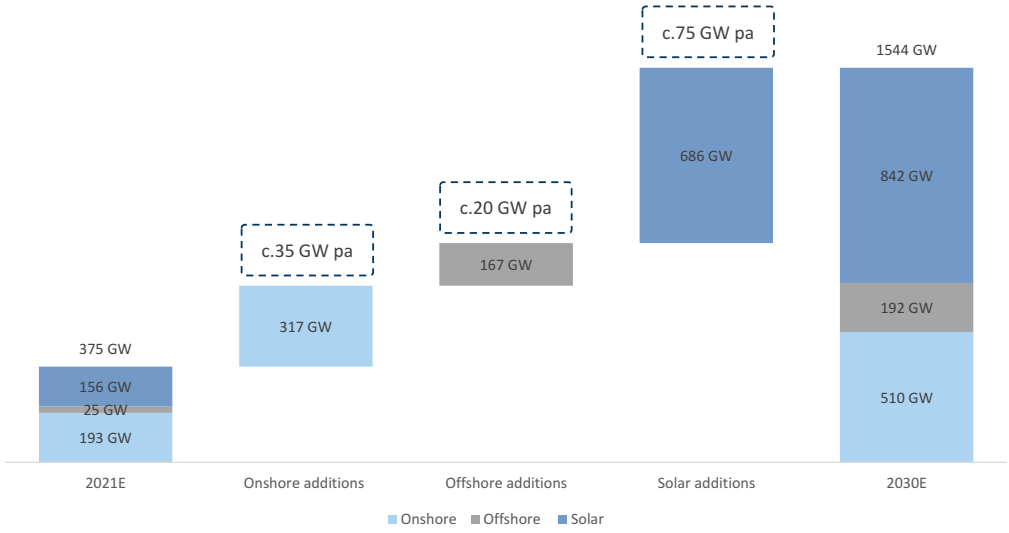
Exhibit 29: The EU has witnessed a steady rise in RES power production
EU-27 generation mix



Source: Eurostat, Goldman Sachs Global Investment Research

By 2030, we believe the share of RES in the power mix could potentially reach 70% in Europe, if the Fit for 55 plan were to be fully delivered. This would be the result of wind/solar additions (Exhibit 30) to meet a c.40% increase in power demand, and the ongoing closure of thermal plants.

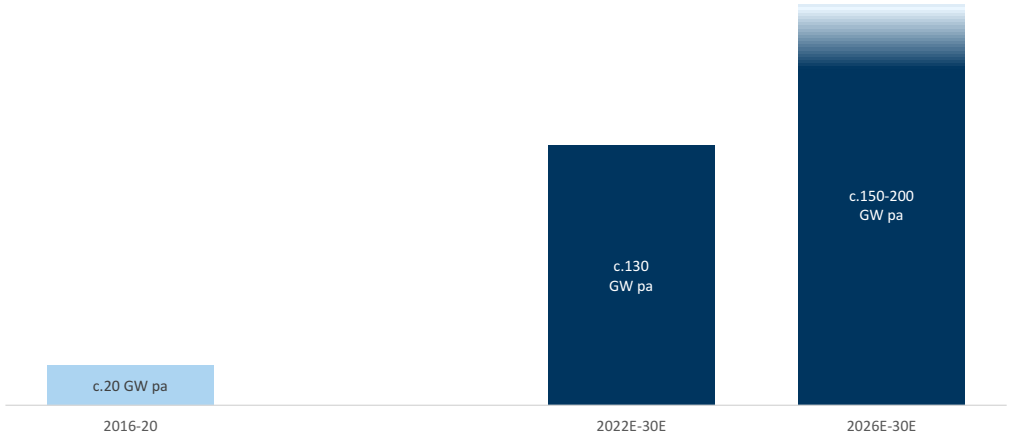
Exhibit 30: RES capacity additions needed over the next decade to meet Fit for 55 goals (70% production from RES)
RES capacity additions



Source: Goldman Sachs Global Investment Research

When compared to 2016-20 average annual additions of c.20 GW pa, we estimate that this plan would require c.130 GW of wind/solar additions pa. Critically, we do not believe that Europe will begin adding more than 100 GW in the immediate future, as prior to upgrading with RES additions, companies would have to: (1) scout for and lease new land; (2) complete the permitting phase; (3) win capacity auctions or sign PPA agreements; (4) contract equipment and reach agreements with other providers (shipping, civil works, etc.), (5) construct the assets; and (6) scale up of their workforces to cope with higher volumes of capacity additions. This is why we anticipate a steady acceleration in capacity additions, which could peak in the second half of the decade at 150-200 GW pa.

Exhibit 31: By the second half of the decade, we estimate that Europe could reach peak additions of 150-200 GW pa
EU capacity additions (GW)



Source: Goldman Sachs Global Investment Research, ENTSO-E Statistical Factsheet

RES capex acceleration may peak at more than €150 bn per year

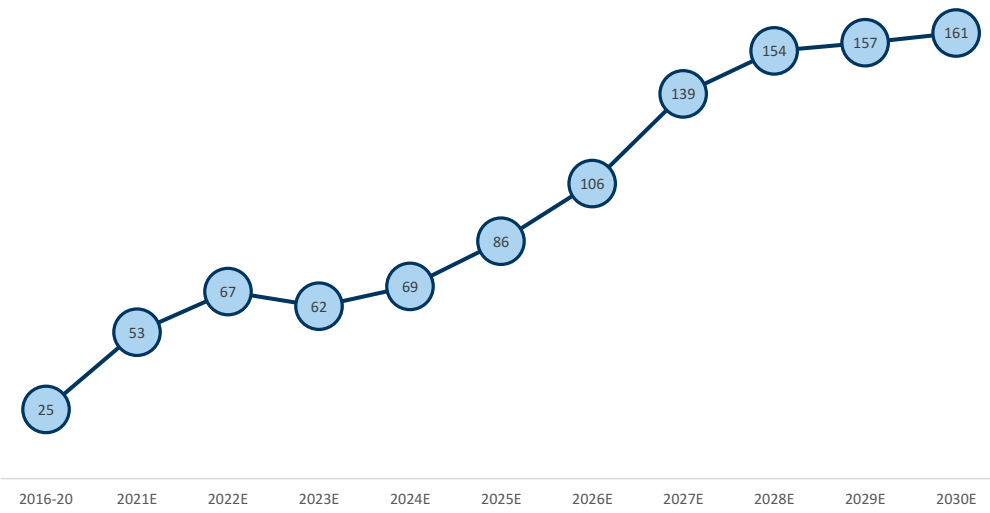
As explained in our previous research the process of scaling up renewables investments does not take place overnight. Here, we describe the steps needed (from a regulatory perspective and from a company's point of view) to accelerate the development of RES.

- **Top-down**. Any region seeking to accelerate the development of renewables requires: (1) a stable and predictable regulatory backdrop, to attract more private capital and support the credit market's propensity to lend money to these projects; (2) an increase in civil servants and the simplification of the permitting phase, to allow central/local administrations to deal with the greater number of requests.
- **Bottom-up**. Besides financial headroom (or the ability to raise equity), to scale up RES activities companies need proper processes in place. For instance, Iberdrola is currently developing at c.55 different construction sites around the world. Corporates would require additional skilled workers (or the ability to train unskilled ones) in business development, to scale up the size of the project pipeline – anecdotal evidence in onshore wind and solar suggests up to five years to meaningfully do so organically (secure land leases, carry out feasibility studies, obtain permits). Additionally, companies would have to win more auctions, and contract more workers to oversee and carry out the construction/installation phase (though this is mostly outsourced).

It is for these reasons that we believe the step up in RES investments will be gradual, and will continue accelerating until the end of the decade. The following exhibit shows our estimate of the annual capex in wind/solar (€ bn) needed for Europe to comply with its Fit for 55 plan. Investments (at c.€25 bn pa on average in 2016-20) could peak at €160

bn pa, by the end of the decade.

Exhibit 32: Annual investments in wind/solar could move from c.€25 bn pa in 2016-20, to c.€160 bn by 2030
Annual capex in RES, Europe (€bn)

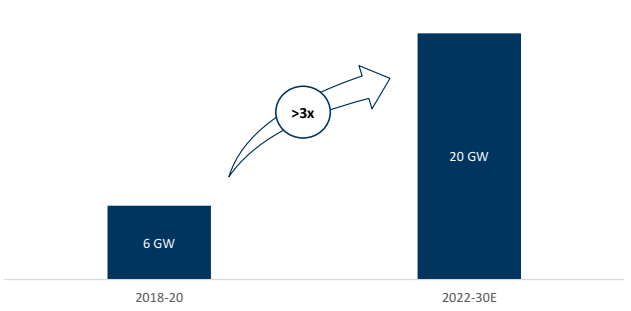


Source: Goldman Sachs Global Investment Research

Evidence showing that the process is already in motion: Germany and Italy

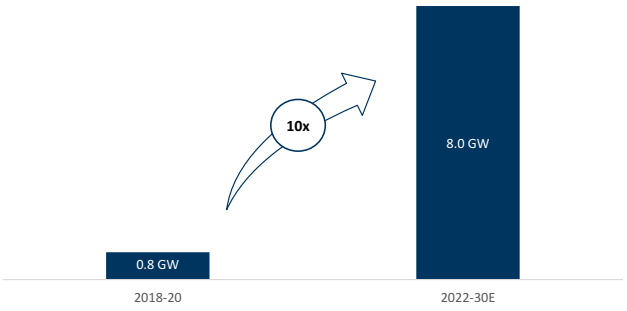
The climate plan presented late last year by Germany suggests annual RES additions of c.20 GW pa, on average, between 2022 and 2030. This compares with recent annual additions of 6 GW pa. In Italy, annual RES additions are targeted at 8 GW pa, which compares with the average 0.8 GW pa in recent history.

Exhibit 33: The German coalition agreement implies a >3x acceleration in renewable additions in 2022-30E (vs. 2018-20)
Renewable additions in Germany (GW)



Source: IRENA, SPD, Goldman Sachs Global Investment Research

Exhibit 34: Italy's renewable targets imply a 10-fold increase in average additions in 2022-30E (vs. 2018-20)
Renewable additions in Italy (GW)

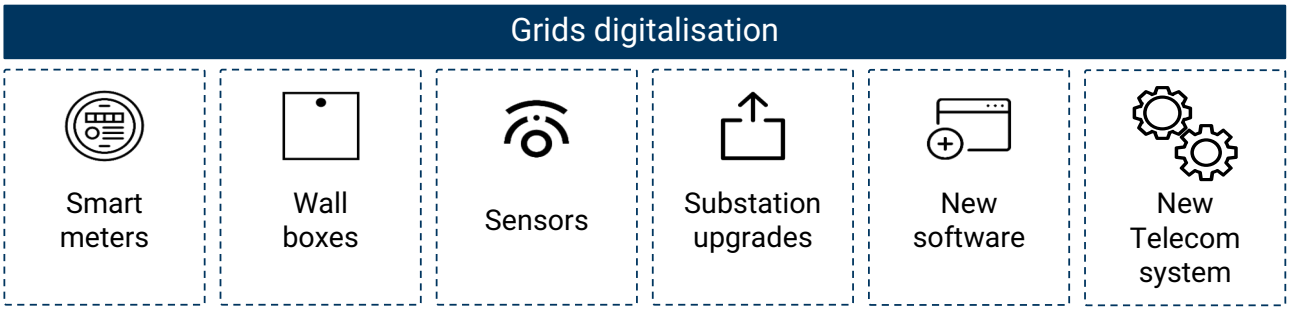


Source: Irena, Goldman Sachs Global Investment Research

Power grids need a complete overhaul: +6% RAB growth pa

The electrification process targeted by the European Union would transform mobility, heating and (in smaller part) manufacturing. By 2030, the EU is targeting a 50% reduction in emissions from road transport and a 50% share of renewables buildings. These trends, coupled with the rising share of RES in the system would require greater investment in the resilience of power networks, and could lead to a major digitalisation push in these power networks. Regarding power distribution in particular, this could lead to a >60% acceleration in capex through the roll out of smart meters, wall boxes, sensors, upgrades to substations, more advanced telecommunication systems, and new software to handle the much larger number of datapoints generated by such a complex power system.

Exhibit 35: A digitilisation push would need...

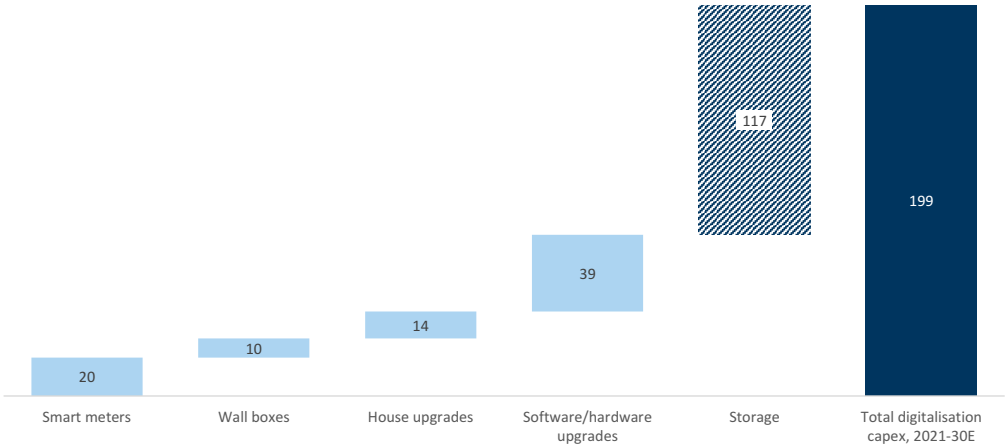


Source: Goldman Sachs Global Investment Research

Digitalising power distribution could cost nearly €200 bn

Current investments in power distribution amount to c.€30 bn pa, which we estimate will accelerate to c.€40 bn pa by 2030, based on an annual acceleration of 1.75%-2% in a business as usual scenario. We estimate c.€200 bn of total investments would be needed to digitalise the power distribution grid, as shown below. We base our estimates on costs of €100 per smart meter, €280 per house upgrade, €200 per software upgrade and €500 per wallbox (consistent with industry estimates). Additionally, to estimate storage, we assume unitary costs of €990/kW, again consistent with industry estimates.

Exhibit 36: Total capex upgrade from digitalisation: c.€200 bn Europe distribution digitilisation capex, 2022-30E (€ bn)

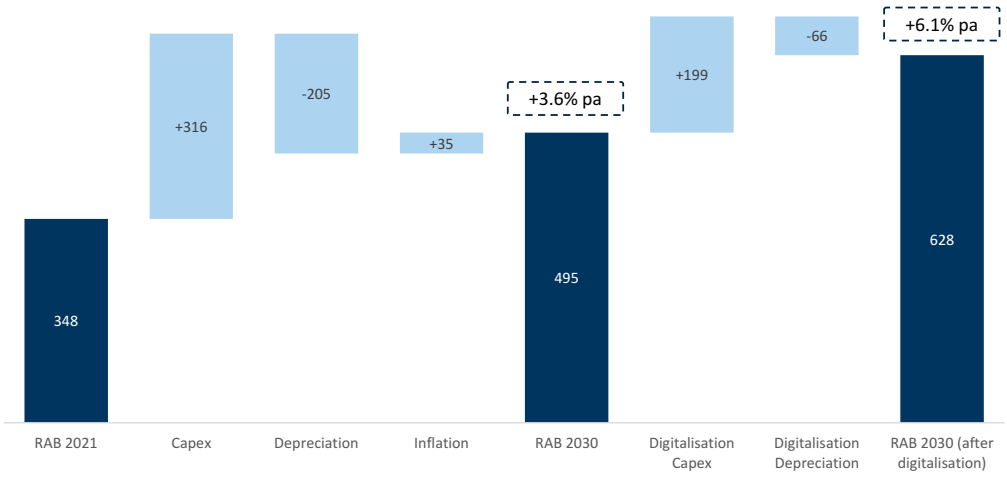


Source: Goldman Sachs Global Investment Research

Distribution RAB could grow by c.6% pa to 2030

Currently, European power distribution RAB is c.€350 bn, we estimate. Based on the above-described investments, and assuming that half of regimes are structured on a real basis (i.e., RAB and depreciation are both inflated annually) while half are nominal, we estimate that European power distribution RAB could grow by c.6% pa to 2030. We assume 100% implementation of the digitalisation investments discussed above in this analysis. Additionally, we depreciate digitalisation capex over 15 years while the remaining capex is depreciated over 40 years.

Exhibit 37: Including digitalisation investments, we estimate European power distribution RAB could grow by c.6.1% pa to 2030
European RAB (€ bn)



Source: Goldman Sachs Global Investment Research

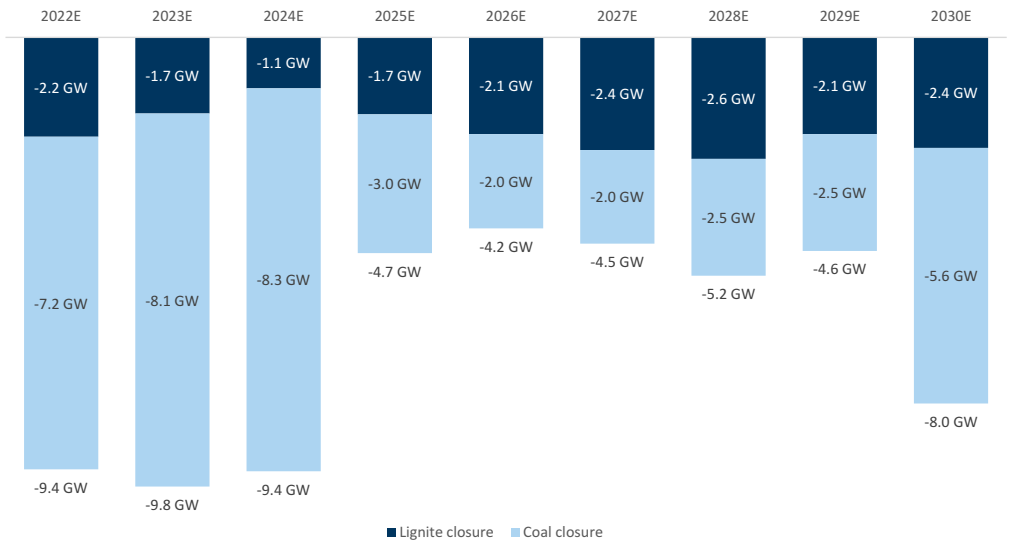
Power prices temporarily supported by thermal closures

Given the consistent closure of legacy power plants (we estimate that by 2025 c.40% of the EU coal/lignite fleet will be decommissioned) and the execution risk associated with smoothly accelerating wind/solar additions (supply chain constraints, permitting delays), the supply-demand balance of European power markets could tighten significantly. This could support power prices to 2025E, and temporarily delay a supply-led decline (a rising share of cheap renewables), which we have described in our previous research.

About 40% of coal and lignite plants should be decommissioned by 2025

As seen in the following exhibit, by 2030 we believe that Europe could decommission c.60 GW of coal and lignite power plants. We expect the closure of these plants to be front-loaded: by 2025, about 40% of the European coal/lignite fleet will be shut, we estimate.

Exhibit 38: Between 2022 and 2030, we forecast c.60 GW of thermal plant closures
Thermal closure in EU

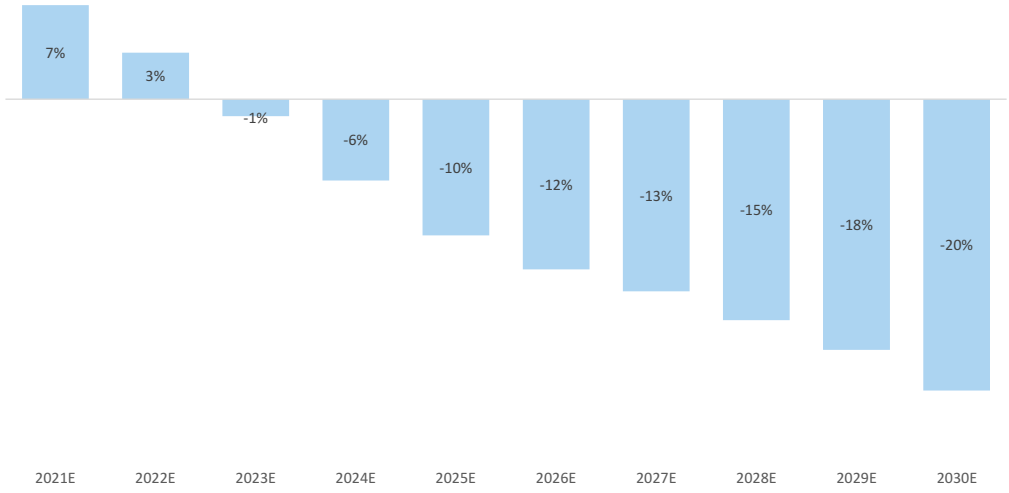


Source: Goldman Sachs Global Investment Research

Reserve margins to turn negative as early as next year: a need to build much more

If we also account for the closure of nuclear plants (nearly 20 GW by 2025E), and for the availability gap between thermal plants and renewables, we would expect to see a major reduction in the European reserve margin, which measures the spread between availability-adjusted capacity and peak power demand.

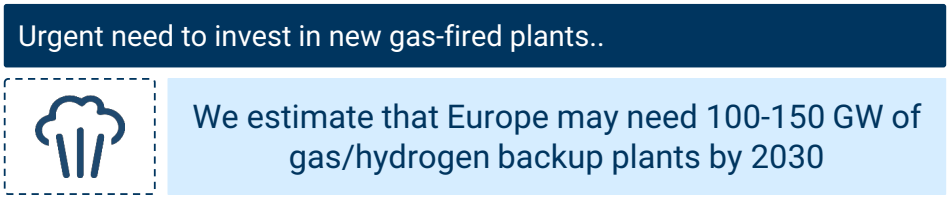
Exhibit 39: We expect to see a reduction in the European reseve margin Europe reserve margin (%)



Source: Goldman Sachs Global Investment Research

This suggests an urgent need to invest in storage, and in new, gas-fired (or hydrogen-ready) turbine plants. We estimate that Europe may need 100-150 GW of gas/hydrogen backup plants by 2030.

Exhibit 40: There is an urgent need to invest in new, gas-fired turbine plants



Source: Goldman Sachs Global Investment Research

Spark spreads could expand further

Spark spreads measure the unitary gross margin of a gas plant; although this is a poor proxy for the profitability of these plants, their evolution is an important driver of the evolution of power prices. The following exhibit shows the evolution of spark spreads in Germany since 2011, which have been close to zero. However, in times of tightness (power markets have been in oversupply since 2009) spreads begin to expand, and can settle at €10-20/MWh, as was seen in the Italian market in the early 2000s.

Exhibit 41: Spark spreads in Germany could go from zero in recent history to €10-20/MWh consistently
Germany 1-year forward spark sprad (€/MWh)

Source: Goldman Sachs Global Investment Research, Bloomberg

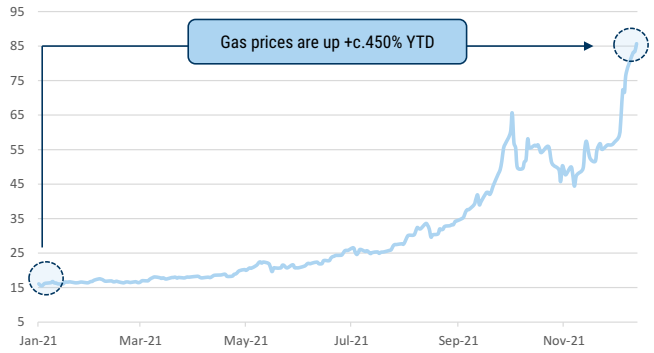
Appendix: Affordability – moving incentives downstream

During 2021, the increase in gas and CO_2 prices led to an unprecedented increase in power prices, and in turn to a c.60%-80% increase in electricity and gas bills in Europe. The impact that this will have on families (a c.€900 pa increase in energy bills) has led to an intense focus on affordability. We draw three key conclusions: (1) the increase in gas prices appears unsustainable: current 1-year forward curves are about six times higher than the average gas price of the past 15 years; (2) as noted earlier, attractive RES economics suggest that, over the longer run, a rising share of wind/solar will place steady deflationary pressure on power prices and therefore electricity bills; and (3) through 2000-2015, Europe has encouraged the development of renewables with incentives. We believe that incentives will now move from upstream (wind, solar) to downstream (families), to stimulate switching to electric cars, and/or to heat pumps. We mostly focus on this last aspect of affordability, and show that the payback period on these new incentives could be very rapid (3.5 years) and highly beneficial to families, potentially allowing savings of c.50% on energy bills (gas, power) and fuel costs (petrol/diesel).

The recent surge in power prices has sparked a major debate over affordability

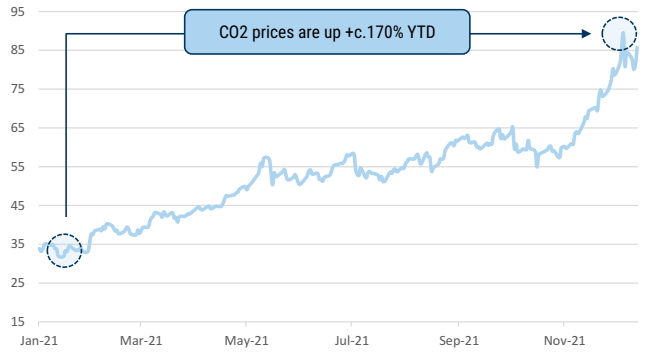
During 2021, gas prices rose more than five-fold, on the back of a pick-up in demand and consistent with the gas price's correlation with oil prices. Similarly, carbon prices nearly tripled, on the back of a tighter supply/demand balance, induced by the market stability reserve and by the expectation of further market reforms, as detailed in our recent report.

Exhibit 42: Gas prices have risen c.450% since the beginning of 2021
TTF 1-year forward evolution, YTD (€/MWh, percentage)



Source: Bloomberg, Goldman Sachs Global Investment Research

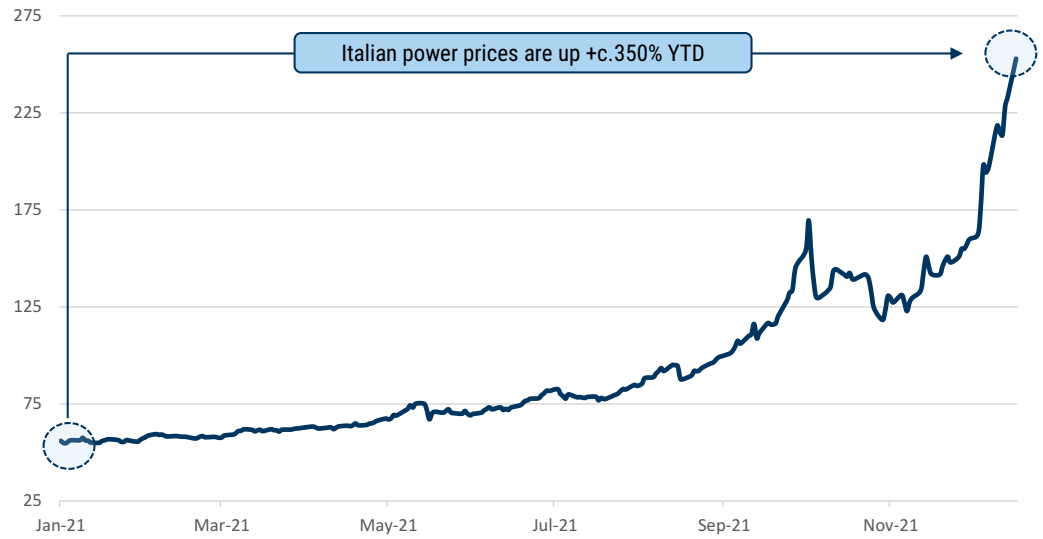
Exhibit 43: Carbon prices have risen c.170% since the beginning of 2021
Carbon ETS evolution YTD (€/tonne, percentage)



Source: Bloomberg, Goldman Sachs Global Investment Research

This unprecedented increase in commodity prices led to a significant increase in power prices in almost every European market. The following exhibit shows that Italian power prices are up by c.350% from the start of 2021.

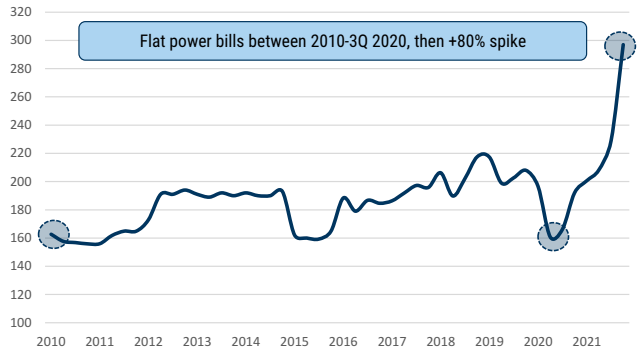
Exhibit 44: Italian power prices are up c.350% year-to-date, due to the rise in commodity prices Italian 1-year forward power price evolution, YTD (€/MWh, percentage)



Source: Bloomberg, Goldman Sachs Global Investment Research

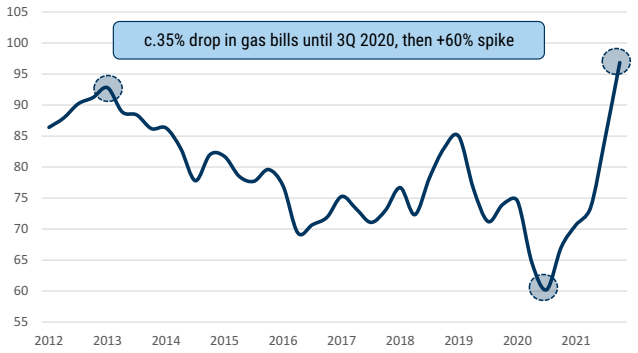
Using Italy as a case study, we can see that, until recently, energy bills for households had remained broadly flat since 2010-12. However, while electricity bills in 2020 were broadly similar to levels paid by consumers in 2010-11, since the 3Q trough, electricity bills have spiked by 80%. As for gas bills (which had been steadily declining since early 2013), in just over a year, they have spiked by c.60%.

Exhibit 45: Power bills were broadly flat from 2010, then saw an 80% spike from 3Q 2020
Italy electricity household bill evolution (€/MWh)



Source: Goldman Sachs Global Investment Research, Arera

Exhibit 46: Gas bills fell by c.35% between 2012-13 and 3Q 2020, and then spiked by c.60%
Italy households gas bills evolution (€/m3)



Source: Goldman Sachs Global Investment Research, Arera

We estimate that the recent c.60%-80% increase in power and gas bills, for average households (consuming c.3 MWh of electricity and c.1,400 cubic meters of gas per year), could lead to a c.€900 increase in annual bills, or >€100/month in winter.

Exhibit 47: Energy bills could increase by c.€900 for households and by >€100/month during winter time
Energy bills increase breakdown (€ per month and per year)

	Annualized cost	Monthly, in winter
Power: 3Q 2020	498	52
Power: Winter 2021	891	93
Power bills increase	**393**	**41**
Gas: 3Q 2020	843	112
Gas: Winter 2021	1,356	181
Gas bills increase	**513**	**68**
Energy (power + gas): 3Q 2020	1,341	164
Energy (gas + power): Winter 2021	2,247	274
Energy bills increase	**905**	**109**

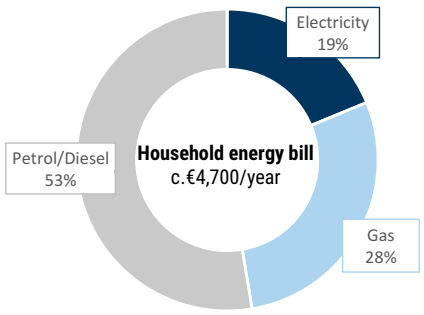
Source: Goldman Sachs Global Investment Research, Arera

Electrification could save more than €2,000 per year, per household

For 2021, we estimate that a typical household (we base our calculations on a typical Italian family, using official tariffs disclosed by the regulator, Arera) would incur energy bills of nearly €4,700, or c.€390/month, to reflect three main cost items.

- **Electricity.** Electricity costs represent about 20% of the annual energy costs (c.€890/year), and mostly reflect the costs of lighting and appliances in a typical household consuming 3 MWh per year.
- **Gas.** Gas bills in Italy represent about 30% of total energy costs (c.€1,400/year), and are the result of the heavy utilisation of gas for heating residential homes during winter.
- **Petrol/diesel.** Fuel for passenger cars (a typical household owns 1.5 cars) represents c.50% of annual energy costs for a standard household, or c.€2,700/year at the current level of petrol.

Exhibit 47: We estimate that households spend nearly €4,700 per year on energy bills, with the bulk of it coming from petrol/diesel
Typical household energy bill breakdown by source, 2021 (percentage)



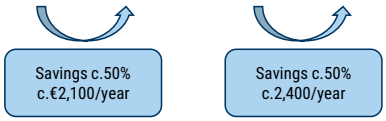
Source: Goldman Sachs Global Investment Research

We believe that in an Electrification scenario (one with carbon-free power generation,

the electrification of heating, and switching to electric vehicles) consumers could save nearly c.€2,100 pa by 2030, vs. current bills, and c.€2,400 pa vs. a business as usual 2050 forecast. Put another way, this process could lead to a c.50% reduction in energy bills for European families, mostly owing to savings in heating and petrol expenditure. Lower power prices, owing to the rising share of renewables and the normalisation in commodity prices, complete the picture.

Exhibit 48: The Electrification process could lead to c.50% annual savings in energy costs for a typical household, more than c.€2,000 per year
Typical household energy bill evolution in different scenarios (€ year)

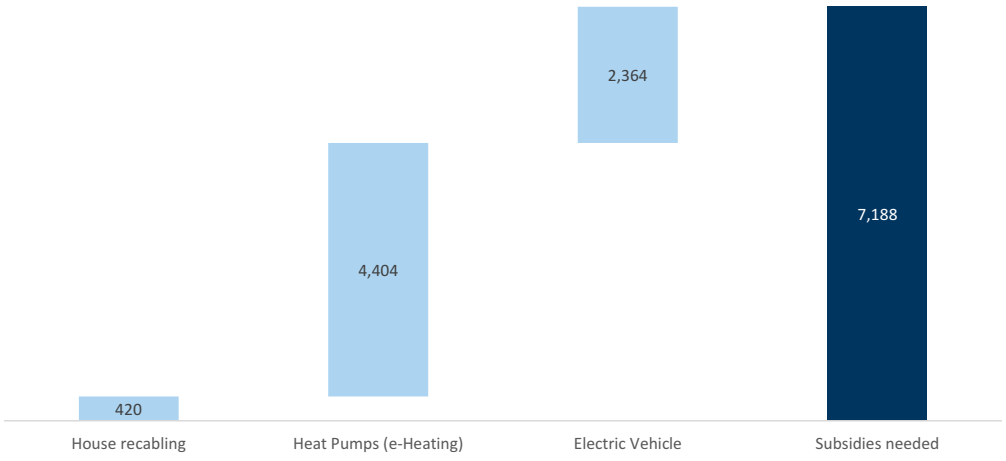
	2021E		2030E		2050E	
Energy Bills (€/year)	No Net Zero	Net Zero	No Net Zero	Net Zero	No Net Zero	Net Zero
Electricity	€ 891	€ 891	€ 665	€ 677	€ 788	€ 1,052
Gas/ Heat Pump	€ 1,356	€ 1,356	€ 1,054	€ 602	€ 1,419	€ 637
Petrol/Diesel/ EVs	€ 2,498	€ 2,498	€ 2,259	€ 596	€ 2,757	€ 815
Total	**€ 4,745**	**€ 4,745**	**€ 3,977**	**€ 1,875**	**€ 4,963**	**€ 2,503**



Source: Goldman Sachs Global Investment Research

However, to achieve these savings, we estimate that households would have to spend c.€7,000 in up-front capital costs. Capital costs would mostly fund house recabling (as households intensify their electricity consumption owing to electrification, house electricity cables will need an increase in voltage capacity from c.3 kW to c.9 kW), the purchase of an electric vehicle, and the installation of a new heating system relying on heat pumps.

Exhibit 49: The up-front investments in house recabling, HPs and BEVs might total c.€7,000 for a household, we estimate
Upfront costs for electrification per household, breakdown by source (€)



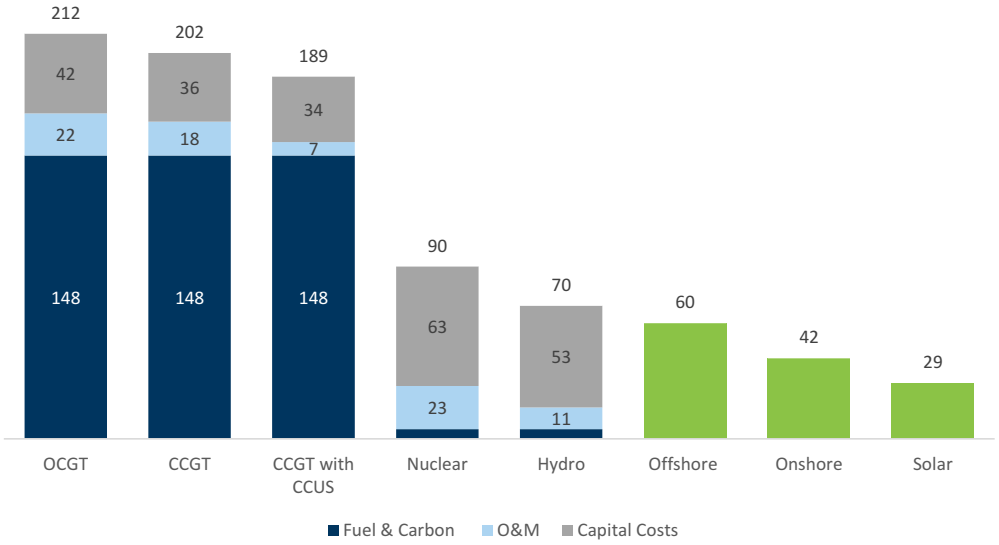
Source: Goldman Sachs Global Investment Research

Time for incentives to move from upstream to downstream

Between 2000 and 2015, Europe built a renewables industry based on incentives. However, the electricity produced from RES was expensive at that time, and became a burden for consumers. Germany is the most extreme case, as RES subsidies currently account for c.20%-25% of end-user bills.

However, following a material cost reduction in renewables costs – wind and solar costs have dropped by 60% and 80% respectively over the past 10 years – a rising share of RES in the supply curve should prove a deflationary force for power markets, as incentives become less and less necessary. The following exhibit shows that the LCOEs of wind and solar are now well below the cash costs of thermal plants, and are even lower than the replacement costs of legacy generation assets.

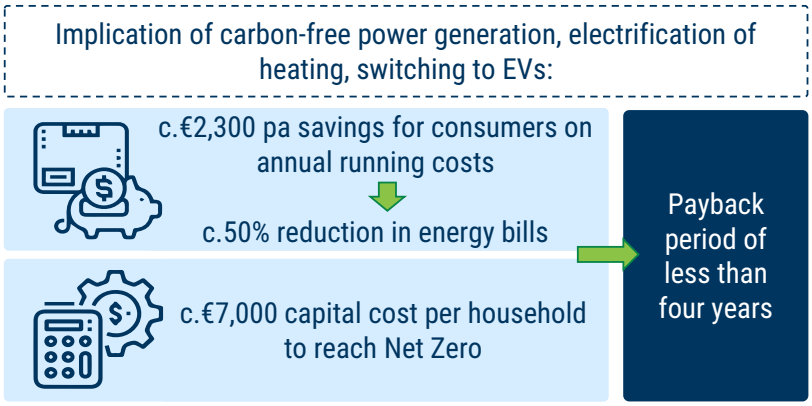
Exhibit 50: Renewable technologies are now significantly cheaper than thermal plants and cheaper than the replacement costs of legacy generation assets
LCOEs of different technologies (2022E, €/MWh)



Source: Goldman Sachs Global Investment Research

With the power system upstream relying less on incentives, this could free up funds for subsidies in the downstream, to incentivize a change in consumer behaviors. As stated above, we estimate up-front costs for the electrification process for households at c.€7,000, a significant amount for the majority of families. If these costs were to be covered by state-incentives (nearly €1.6 tn to 2050, or about €50 bn per year for Europe would be required), the savings in energy bills would "repay" up-front costs in less than four years. We believe this policy would allow Europe to take a significant step in achieving its decarbonisation goals.

Exhibit 51: Payback period for grants for a typical household would be less than four years

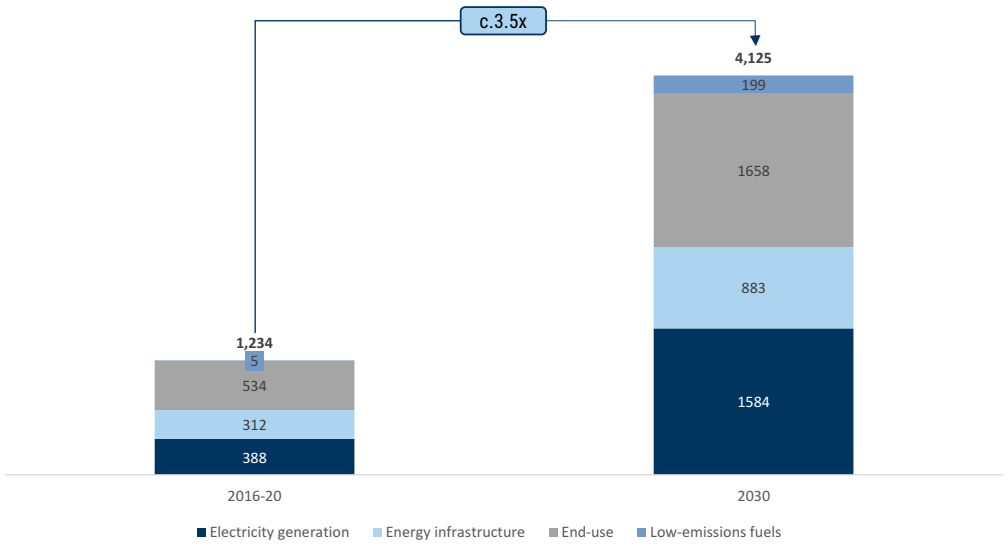


Source: Goldman Sachs Global Investment Research

Appendix: A glance at the global RES market

As discussed in previous research, data from the IEA suggests that, to reach net zero, global clean energy investments (at c.US$1,230 bn in 2020) would have to accelerate to more than US$4 tn pa by 2030.

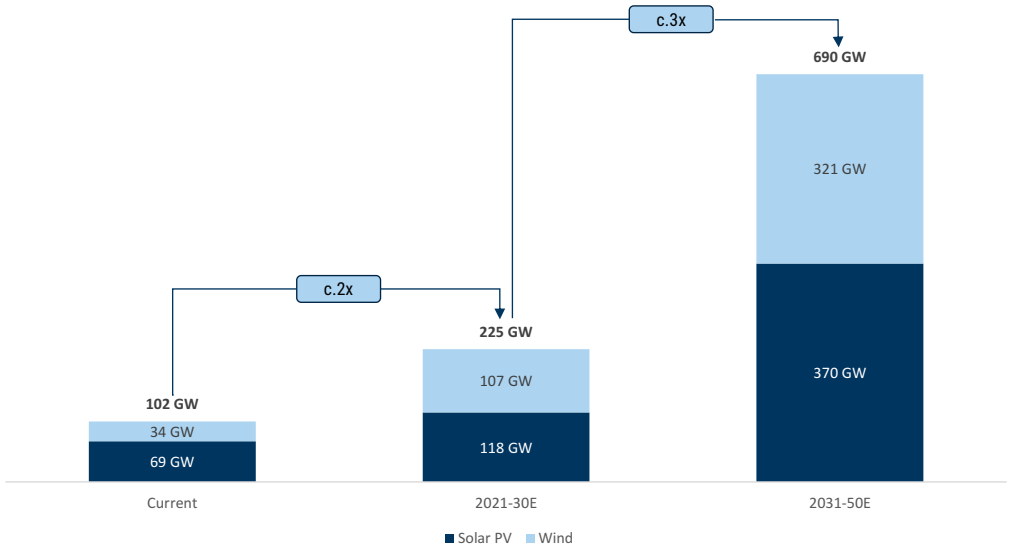
Exhibit 52: To reach net zero, clean energy investments would have to surge to more than US$4 tn (vs. c.US$1 tn today), per IEA estimates
Global clean energy investments (US$ bn), net zero scenario



Source: IEA, Goldman Sachs Global Investment Research

We estimate that wind and solar additions (Global ex-China) could accelerate to c.700 GW pa (c.7x the current rate) through 2031-50, which compares with c.100 GW pa currently, and potentially 225 GW pa throughout this decade.

Exhibit 53: We expect c.700 GW wind/solar additions annually in 2031-50E
Global (ex-China) capacity additions (GW)

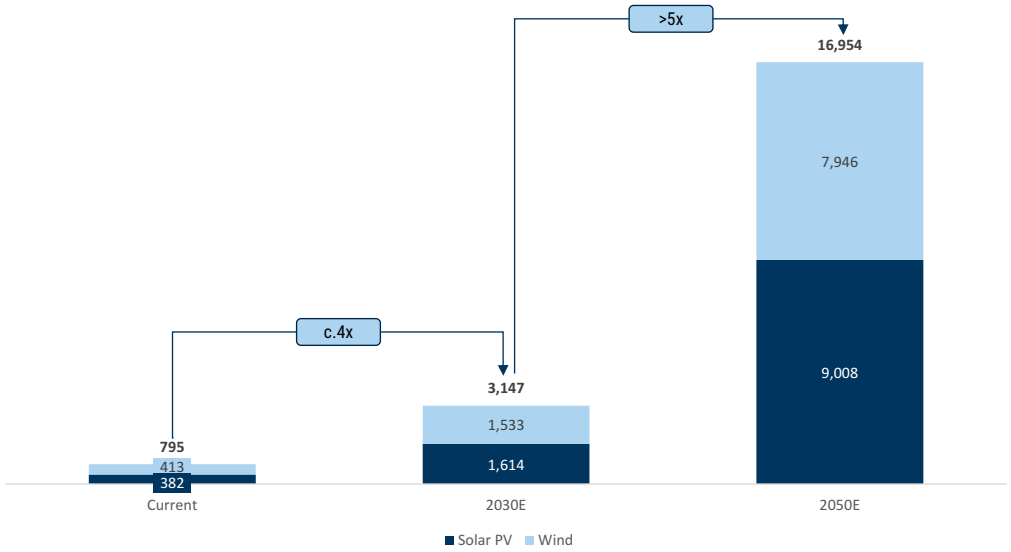


Current: 2019

Source: IEA, Goldman Sachs Global Investment Research

This would bring the total renewable capacity to nearly 17,000 GW by 2050, vs. only c.800 GW today.

Exhibit 54: We expect a c.4x increase in the renewable base by 2030E, and a c.20x increase by 2050E
Global (ex-China) installed wind/solar capacity (GW)



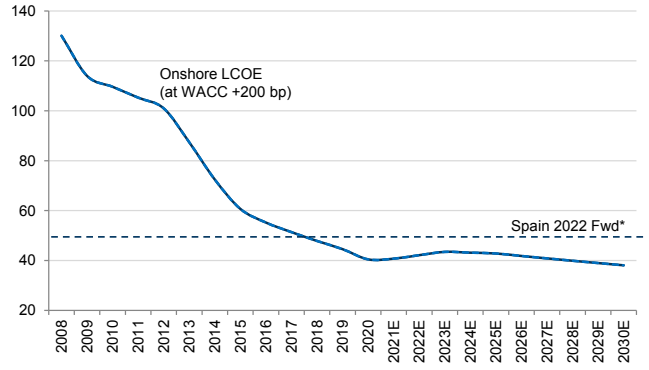
Current: 2019

Source: IEA, Goldman Sachs Global Investment Research

Appendix: The LT deflationary trend in RES activities

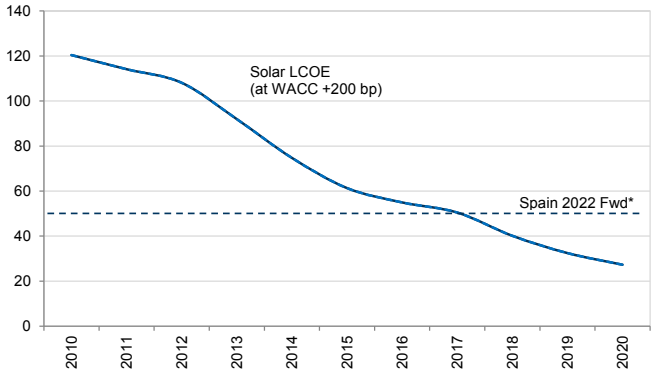
Since 2010, the levelised cost of producing electricity (LCOE) from onshore wind and solar has fallen, respectively, by 60% and 80%, as seen in the following exhibits. The cost of offshore wind also fell by c.80% over the same time frame. This pronounced improvement in the economics of wind and solar was a key factor in the acceleration of global installations.

Exhibit 55: There has been a pronounced improvement in the economics of wind...
Onshore LCOE (€/MWh)



Source: Goldman Sachs Global Investment Research

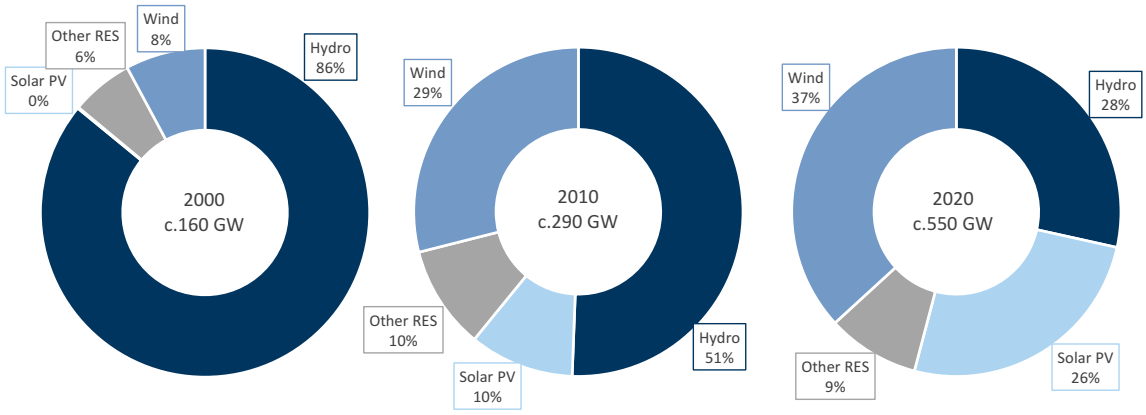
Exhibit 56: ...and solar, and this promotes the acceleration of global installations
Solar LCOE (€/MWh)



Source: Goldman Sachs Global Investment Research

Attractive economics also explain why solar PV gained market share within the European RES mix. The following exhibit shows the rising share of solar (expressed as a percentage of the total RES installed base) since 2000.

Exhibit 57: Over the last two decades, solar's share of the total installed RES base has increased
EU RES installed capacity

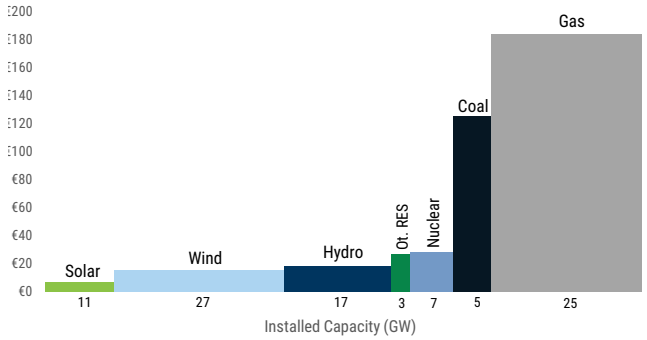


Source: Goldman Sachs Global Investment Research, IEA

As seen above, the LCOE of wind and solar is well below the prevailing power forward curves across Europe. Thus, adding renewables would 'flatten' the supply curve, increase the share of cheaper power generation sources and, as a result, put downward pressure on power prices.

Exhibit 58: Currently, RES accounts for c.50% of Spain's installed capacity

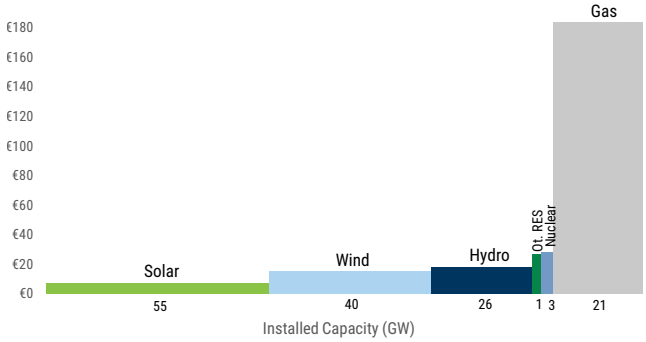
Spain power capacity supply curve, 2020 (€/MWh)



Source: Goldman Sachs Global Investment Research

Exhibit 59: This RES share in Spain's installed capacity could grow to c.80% by 2030E

Spain power capacity supply curve, 2030E (€/MWh)



Source: Goldman Sachs Global Investment Research

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