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The unsubsidised solar revolution

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- **Unsubsidised solar era begins – utilities' customers turn into competitors**

Solar has turned from a heavily-subsidised marginal technology into a mainstream source of power generation. Thanks to significant cost reductions and rising retail tariffs, households and commercial users are set to install solar systems to reduce electricity bills – without any subsidies. The economics looks set to work best in Germany, Italy and, with a time-lag, Spain. We estimate up to 18% of electricity demand could be replaced by self-produced solar power in these markets.

- **Grid-supplied power demand to shrink by another 6-10% by 2020E**

Assuming gradual penetration, we estimate 43GW of unsubsidised solar in those markets by 2020, reducing demand for grid-supplied power by 6-9%. This comes on top of shrinking demand due to energy efficiency and subsidised renewables. The rise in power tariffs should accelerate, as grid fees and subsidies would have to be divided by less consumption. This could lead to a change in the pricing model.

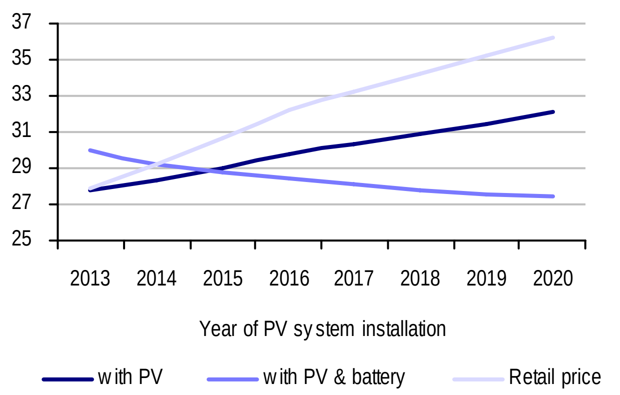
- **Negative for generators; battery solutions to also shave the evening peak**

The unsubsidised solar growth should drive wholesale power prices and load factors of conventional plants further down – we forecast the EBITDA pool to shrink c50% by 2020. Batteries will increasingly shave the evening peak, which further eliminates production hours of thermal plants that used to be attractive.

- **Central and southern European utilities affected, RWE key Sell idea**

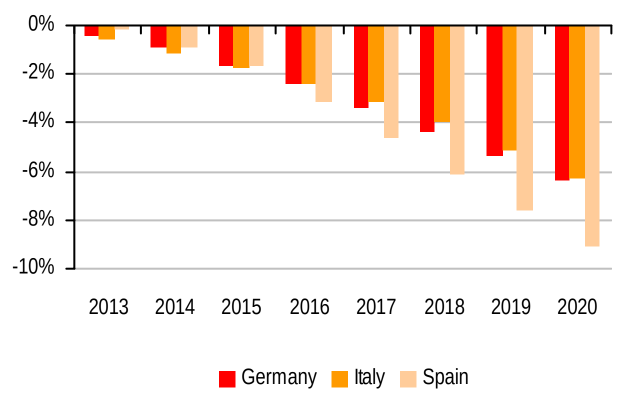
We reiterate our Sell ratings on RWE (key idea), E.ON and CEZ due to their high share of EBITDA from central European power generation. We also see additional earnings risk for Verbund and, in the long term, the southern European players.

Chart 1: Unsubsidised solar already cheaper than grid electricity (example: southern Germany, €¢/kWh)



Source: UBS estimates (for a rooftop system on a family home)

Chart 2: Up to 9% additional decline in power demand from utilities by 2020E due to unsubsidised solar



Source: UBS estimates

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We would like to thank Alexander Bernhart for his contribution to this report.

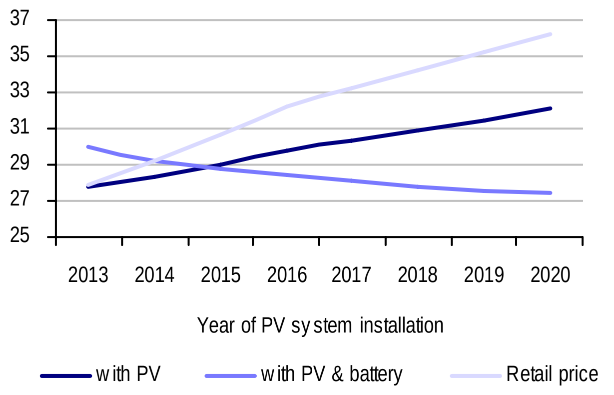
Executive summary

Unsubsidised solar – a revolution

Utilities customers expected to turn into competitors

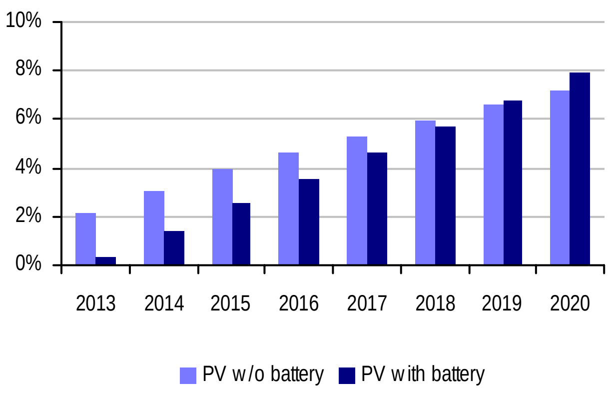
We are at the beginning of a new era in power markets. Sharply decreasing costs for solar panels and batteries, combined with rising electricity tariffs, make solar viable without any subsidies in several key European markets, such as Germany, Spain and Italy. In those countries, the installation of solar panels is expected to reduce the owners' electricity bills by more than what the solar system costs. The economics work in both the private household and commercial segment. Hence, there is a vast opportunity for unsubsidised solar, even though certain financial and technical limitations will leave some potential untapped. Battery solutions, which are at the beginning of a steep learning curve, can increase returns further and accelerate the demand destruction for utilities.

Chart 3: Southern Germany – solar now cheaper than grid electricity (€/MWh)



Source: UBS estimates (for a 4kWp rooftop system on a family home)

Chart 4: IRRs of unsubsidised solar systems in southern Germany



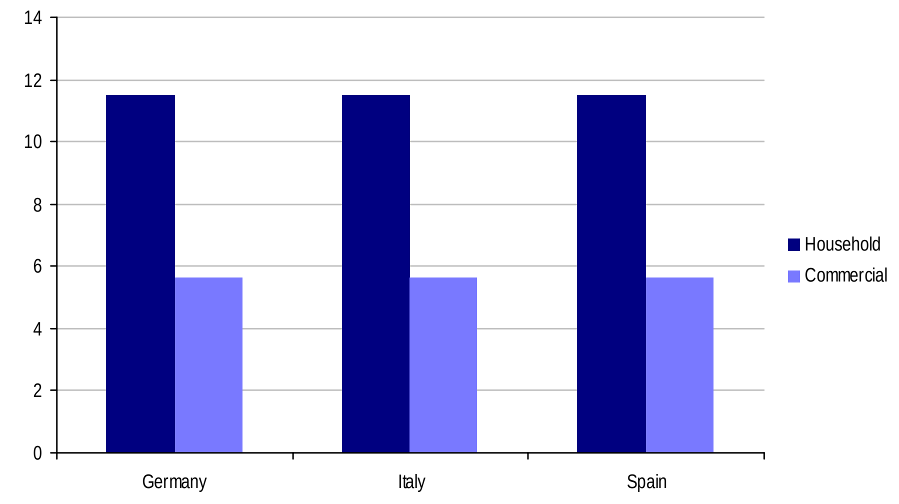
Source: UBS estimates

Investment in solar becomes a no-brainer

Solar can reduce electricity bills by 20-30% by 2020E, ex subsidies

Purely based on economics, we believe almost every family home and every commercial rooftop in Germany, Italy and Spain should be equipped with a solar system by the end of this decade. On our estimates for 2020, electricity bills could be reduced by 20-30%, and the payback time would be 5-6 years for commercial solar systems and 10-11 years for residential systems. These numbers are based on a no-subsidy scenario. However, one should not expect straight-line growth. We think installations will accelerate in the second half of the decade as economics continue to improve. Also, we see certain near-term financial restrictions in southern Europe, in particular in the Spanish residential segment (high unemployment, limited access to credit).

Chart 5: Payback time of unsubsidised solar systems based on 2020E cost (years)



Source: UBS estimates

Up to 14-18% demand destruction for utilities by self-generated solar power

43GW of unsubsidised solar in Germany, Spain and Italy by 2020E

We expect unsubsidised solar to replace conventional generation by utilities. We calculate that up to 14-18% of electricity demand in Germany, Spain and Italy could be met by self-produced solar electricity. We estimate 6-9% of demand could be replaced on these markets by 2020 already. This negative trend for conventional generators comes on top of the already shrinking electricity demand due to energy efficiency and the ongoing growth in subsidised renewables (wind on- and offshore, biomass). In other large European markets, the potential of unsubsidised solar is smaller for the time being, either due to low retail tariffs (France) or worse weather (northern Europe).

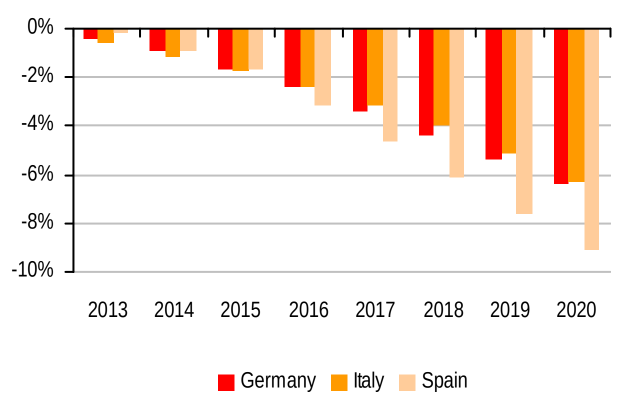
Table 1: Economical solar self-production in % of total demand (2020E)

	Industry	Transport	Households	Commercial	Total
Germany	4%	0%	29%	18%	14%
France	0%	0%	5%	3%	3%
Italy	5%	0%	25%	28%	17%
Spain	5%	0%	21%	26%	18%

Source: UBS estimates

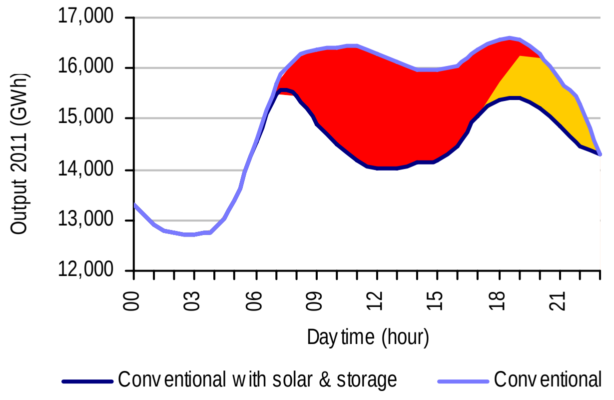
As another negative for conventional generators, solar systems with batteries attached will have a negative impact on the evening peak (while softening the midday peak). Households will be able to use the electricity stored in batteries during the evening, which means pressure on spot prices during the evening hours. So far, solar has only been shaving the midday peak. Even worse, batteries installed in family homes or commercial buildings could also reduce the morning peak as they could be charged with low-cost electricity from the grid during night hours.

Chart 6: Additional 6-9% demand destruction from unsubsidised solar by 2020E



Source: UBS estimates

Chart 7: Solar battery solutions shaving the evening peak

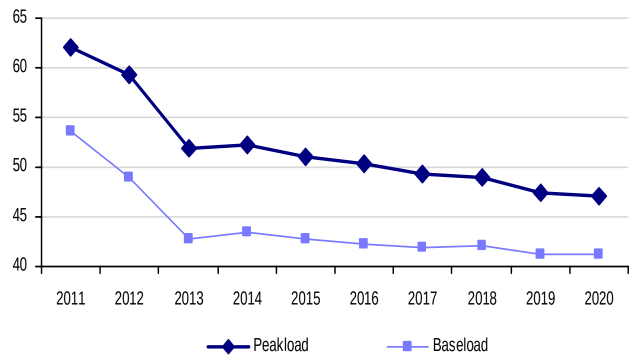


Source: UBS estimates

In our proprietary power market model for central Europe, we raise our 2020 forecast for installed solar capacity by 17% to 102GW. This suggests a base-load power price of €41/MWh in 2010, some 10% below the current already depressed level *(ceteris paribus)*. The load factor of lignite plants drops from 72% to 59%, and the load factor of hard coal plants from 47% to 31% by 2020. Over the period, the EBITDA profit pool of the conventional generators shrinks by around 50%, on our numbers.

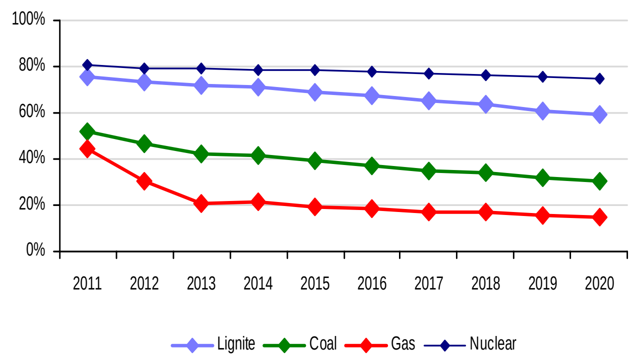
Further pressure on power prices and load factors of thermal plants, profits to fall by half by 2020

Chart 8: German power price to decline another 10% (€/MWh)



Source: EEX, UBS estimates

Chart 9: Load factors of thermal plants to shrink



Source: UBS estimates

Negative for generators in central Europe, Spain, Italy

The expected boom in unsubsidised solar installations adds to our already negative view on central European power generators, which we formulated in several previous sector notes. We do not change our near-term estimates as the growth in unsubsidised solar installations is set to accelerate in the second half of this decade only.

We consider RWE, E.ON, CEZ and Verbund the most exposed players in the region. However, the unsubsidised solar boom is likely to have a negative impact on Enel and Iberdrola in the longer term.

Table 2: Utilities affected by the unsubsidised solar boom

Company	Rating	PT	PE (UBS estimates)			EPS UBSe vs consensus			Net debt/EBITDA	Comment
		LC	2013E	2014E	2015E	2013E	2014E	2015E	2013E	
RWE	Sell	26.0	7.9x	8.8x	9.6x	-3%	-15%	-17%	3.6x	37% of EBITDA in CE power generation; high gearing implies further EPS dilution risk
E.ON	Sell	13.5	11.4x	10.0x	9.5x	-13%	-7%	-7%	3.4x	23% of EBITDA in CE and southern European power generation
CEZ	Sell	600.0	8.9x	10.0x	11.0x	-4%	-14%	-20%	2.1x	63% of EBITDA in CE generation
Verbund	Neutral	18.0	16.9x	16.7x	16.5x	-1%	-7%	1%	3.2x	91% of EBITDA in CE generation
Enel	Neutral	2.9	8.3x	8.6x	8.6x	6%	-5%	-11%	2.6x	23% of EBITDA in southern Europe generation
Iberdrola	Neutral	3.9	9.9x	9.6x	9.9x	2%	-2%	-13%	3.7x	16% of EBITDA in southern Europe generation

Source: UBS estimates

Key Sell idea: RWE (Sell, €26 PT) – earnings squeeze and stretched balance sheet ahead

Our key Sell idea on the theme is RWE, as it is largely exposed to the solar impact (price and load factor) and has a highly geared balance sheet on top of this. Our 2015E EPS estimate of €3.22 (after planned asset disposals), which is based on an achieved base-load power price of €45.5/MWh (in line with current forwards but c20% below consensus), has further downside risk in an accelerated solar penetration scenario. At €41/MWh, as predicted by our model for 2020E (at unchanged commodities), earnings would be as low as €2.7 per share. Based on the company's 50-60% payout policy, the bear-case EPS implies c30% downside risk to dividends.

Table 3: Further downside risk to our 2015E EPS – gearing could prove too high

	Main case (€45.5/MWh base load)	Bear case (€41/MWh base load)
EPS (€)	3.22	2.73
PE	9.2x	10.8x
Economic net debt/EBITDA	3.6x	4.2x

Source: UBS estimates

With economic net debt/EBITDA at 3.6x in 2015E (after planned asset disposals), we see further earnings dilution risk, in particular in a scenario of accelerated power price decline. In such a scenario, net debt/EBITDA could even exceed 4x, which would most likely trigger EPS-dilutive measures. We think RWE's business model should operate at a gearing no higher than 2.5x net debt/EBITDA over the cycle.

E.ON (Sell, €13.5 PT) – investor day could drive shares further down

E.ON is also likely to suffer from an ongoing decline in power generation earnings, even though its exposure is smaller than RWE's and its gearing is lower. After the November 2012 profit warning, expectations for 2013 EPS have come down c25%. Based on our €1.25 EPS (11.2x PE) and €0.70 DPS (5.0% DY) forecasts for 2013, the stock's valuation still looks slightly rich (c10% premium to the sector). The upcoming investor update on 30 January could lead to further disappointment, as expectations for medium-term earnings growth have to come down by another 10-20% (current 2015E consensus EPS is €1.6). Due to the negative trend in power generation earnings, we see little headroom for earnings growth, even including all of the €1.5bn cost-saving impact. In the absence of earnings growth, the valuation multiples might contract further.

CEZ (Sell, Kc600 PT) – power price drives EPS down

With 63% of EBITDA from power generation in central Europe, CEZ is highly exposed to the solar theme. We expect EPS to shrink to Kc60 in 2015E, some 20% below consensus, and we see further downside risk in an accelerated solar build-out scenario. On 10.8x PE 2015E, the stock's valuation looks expensive. On top, CEZ faces near-term challenges (Albania exit, lignite contract renegotiations and plant disposal(s), Czech nuclear plans), which could weigh on sentiment.

Verbund (Neutral, €18 PT) – price pressure versus restructuring

Verbund has the highest exposure to the CE power market – a 10% change in the price implies a change in EPS by €0.29 (25% based on 2013E), *ceteris paribus*. Thus, we have a cautious bias on the stock. However, Verbund has managed to restructure its portfolio of participations (Turkey, several Austrian local stakes, French supply) and we see potential for additional cost cutting. Verbund could also cut its €2.2bn capex budget (up to 2017) by c30%, thereby improving FCF. Should management push the right buttons, we would see the shares close to their fair value.

Iberdrola (Neutral, €3.90 PT)

We believe the surge in solar penetration in Spain could be limited over the next 3-5 years, owing to high unemployment and the high indebtedness of Spanish households and SMEs. Still, as we highlight throughout the note, by 2020, we believe solar panels may have a payback period of five years for commercial users and around 10 years for households. This would increase solar penetration in the long term. This could imply an increase in solar supplies of c15TWh by 2020, equivalent to a similar drop in demand (-9%). This would put further pressure on thermal spreads and power prices. Although we retain a positive bias – in view of deleverage, a sensible strategy and a superior asset quality – we rate the stock Neutral, given its solid performance and higher regulatory risk, which may drag into 2013.

Enel (Neutral, €2.90 PT)

We believe solar could also have a large penetration rate in Italy, thanks to a sharp decline in solar PV (photovoltaic) system costs. By 2020, we estimate a payback period of around 11 years for households and close to five years for commercial users. By 2020, solar supplies could increase by c11TWh (equivalent to a 6% drop in demand). For Enel specifically, we believe the ongoing solar additions will continue to hurt prices and volumes, as has already happened during the past few years. We remain Neutral on the stock in view of medium-term downside to consensus earnings and a dividend yield below peers.

Top picks: GDF Suez, PGE, UK and regulated names

Our top picks in European utilities have little or no exposure to the negative structural trend in the central and southern European power generation markets. Also, they show stable or structurally growing earnings, a solid balance sheet and attractive (stable) dividend yields.

- **GDF Suez (Buy, €16 price target):** Structural growth in international power generation and global LNG business, credible cost-cutting programme, 10% dividend yield, solid balance sheet.

- **PGE (Buy, PLN22 price target):** Medium-term tightening in Polish power market (not well interconnected with central Europe) a key earnings driver, shareholder return story due to net cash position (nuclear capex plans likely to get shelved).

- **Centrica (Buy, 340p price target):** Solid earnings growth trend (8.5% EPS CAGR 2012-16E), share buyback programme likely to be announced in H1 13, potential for EPS-enhancing acquisitions.

- **Enagas (Buy, €20 price target):** Strongest balance sheet among regulated utilities, c20% pre-growth FCF yield, attractive and rising dividend yield (8.6% in 2015E), moderate regulatory risk. Please see our note on Enagas also published today (*The 100% value dislocation – BUY*), in which we raise our rating to Buy from Neutral and our price target to €20 from €15.

Solar viable without subsidies

Thanks to large cost reductions in solar panel and battery manufacturing, the competitiveness of solar has increased dramatically. At the same time, retail tariffs for electricity have increased in the double-digits, due to rising fees for the grid and renewables subsidies. In combination, we see this as a game-changer for the competitiveness of solar systems. Private households and commercial users will be able to save on their electricity bills if they install a solar system – without any benefits from subsidies. Unsubsidised solar systems are now at break-even but, on our estimates, the payback time of unsubsidised solar systems will shrink to some five years for commercial installations and some 10 years for residential rooftops by 2020. The economics work in Germany, Italy and Spain.

Table 4: Solar to have a payback time of 5-10 years without subsidies (2020E scenario)

	Household (excl battery)			Commercial (excl battery)		
	S. Germany	Spain	Italy	S. Germany	Spain	Italy
Solar system capacity (kW)	5.6	3.6	3.9	131.0	84.0	91.0
Capex(€/kW)	1,381	1,381	1,381	979	979	979
Total capex (€)	7,733	4,971	5,385	128,195	82,201	89,052
Annual depreciation (20 years)	387	249	269	6,410	4,110	4,453
Annual cash opex	112	72	78	2,620	1,680	1,820
(1) Total annual cost of solar system	499	321	347	9,030	5,790	6,273
Load factor	12.0%	16.0%	14.8%	12.0%	16.0%	14.8%
Solar electricity generation (kWh)	5,887	5,046	5,056	137,707	117,734	117,980
Self consumption ratio	33%	38%	37%	75%	75%	75%
Total electricity demand	4,500	4,500	4,500	200,000	200,000	200,000
In-house solar electricity consumption	1,943	1,917	1,871	103,280	88,301	88,485
Grid electricity tariff (€ct/kWh)	36.3	25.9	27.0	24.0	22.0	18.6
(2) Saved annual cost for grid electricity	705	496	505	24,787	19,426	16,458
Net benefit (solar cost less saved cost for grid electricity)	207	175	158	15,758	13,636	10,186
(3) Sale of excess electricity at spot (€20/MWh)	79	63	64	689	589	590
(1)+(2)+(3) Total annual savings (including depreciation)	285	238	222	16,446	14,225	10,775
Total annual savings as % of electricity bill	17.5%	20.4%	18.2%	34.3%	32.3%	29.0%
(2)+(3) Total annual cash savings	672	486	491	22,856	18,335	15,228
Payback time on investment (years)	11.5	10.2	11.0	5.6	4.5	5.8

Source: UBS estimates

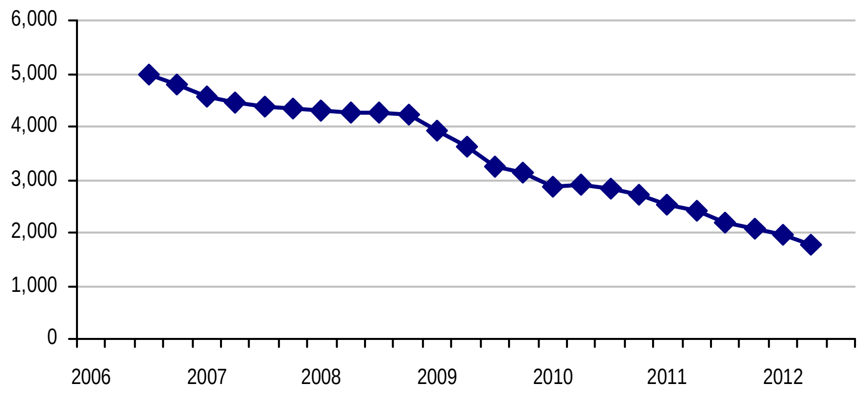
Note: Above calculation is based on expected solar cost and electricity tariffs in 2020.

Solar costs have declined >50% in five years

Solar subsidies might disappear soon, but solar growth is unstoppable

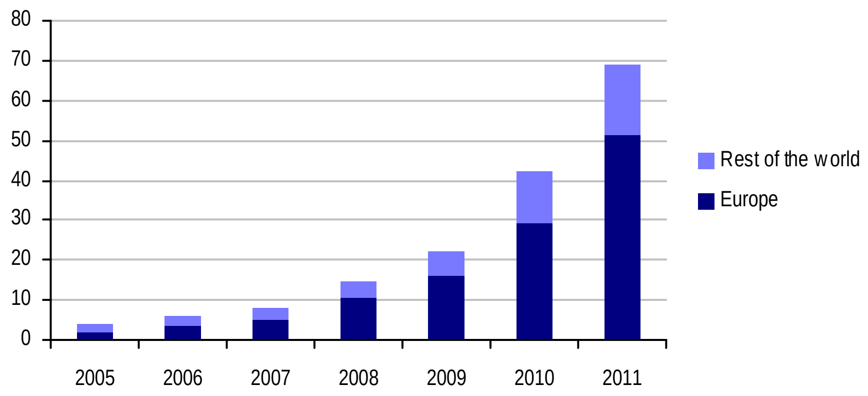
In the recent past, we have witnessed a remarkable increase in solar capacity, especially during the past five years. Regulators have regularly cut feed-in tariffs or amended their incentive schemes, but new installations have continued a high pace and much faster than envisaged by national action plans. This led some countries to put a limit on solar capacity after which subsidies or price guarantees run out – eg, the 52GW cap in Germany or the €6.7bn per year cost cap for renewable subsidies in Italy. The main reason for the ongoing boom is the sharp decline in PV system costs globally, which have decreased by more than 50% in the past five years. We expect this trend to continue on the back of further increasing manufacturing efficiency, innovation in manufacturing processes and ongoing overcapacities in the PV panel manufacturing sector. But even if solar subsidies disappear (like in Spain, for example), there is now a business case for solar systems.

Chart 10: Average end-customer cost of small-scale rooftop systems (€/kW)



Source: BSW 2012

Chart 11: Development of cumulative installed solar capacity (GW)



Source: UBS global solar market model

The table below shows the cost of a family-home rooftop solar system at today's prices. If amortised over 20 years, the annual cost is about €450.

Table 5: Current cost of a family home PV system (4kWp)

Cost factor	Cost incl VAT (€)
Solar panels	4,300
Inverter	1,200
Balance of system cost (including installation)	1,900
Total investment cost	7,400
Depreciation per year (assumed 20-year life)	370
Cash O&M cost per year	80
Total annual cost	450

Source: UBS estimates

Solar is now at break-even to power from the grid on retail level

Without subsidies, a solar system's profitability depends almost entirely on the amount of solar power directly consumed by its owner. This reduces the electricity bill since less energy needs to be bought from a utility. The savings potential is thus dependent on how much of the electricity consumption effectively takes place at the time the PV system is producing energy.

Table 6: Electricity bill of a 4,500kWh household in southern Germany

	Without PV system	With PV system
Purchase from utility (kWh)	4,500	3,150
Consumption of PV power	-	1,350
Retail electricity price 2013E (€¢/kWh)	28	28
Electricity bill 2013E (€)	1,260	882
Sale of excess electricity (€)	-	(80)
Annual cost PV system (€)*	-	450
Total cost (€)	1,260	1,252

Source: UBS
* Investment cost subject to linear depreciation over a lifetime of 20 years.

For example, a 4,500kWh household with a 4kW PV system should be able to reduce its electricity purchases from a utility by 30% without significantly changing its consumption habits. In southern Germany, such a household would save around €380 on its electricity bill, which would otherwise amount to some €1,260. Another €80 of income results from the sale of excess electricity if a price of 25 €/MWh is assumed. In the example above, it would already be worth installing a PV system, as the combined cost would be slightly smaller.

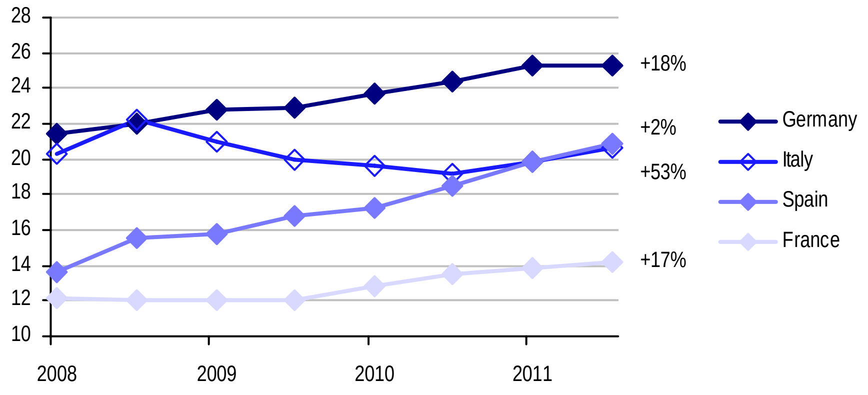
Over time, we expect PV systems to become more attractive as (1) retail tariffs will be rising (on higher grid and renewables levies, eg, for offshore wind) while (2) solar costs continue to come down.

Solar economics continue to improve

Retail tariffs on the rise, improving solar economics

The increase in subsidised renewables capacity and rising grid fees has led to significantly higher retail electricity prices. Even once incentive schemes for solar run out, the renewable surcharges may continue to increase on the back of other renewable capacity additions, most importantly on- and offshore wind. In Germany, for example, we expect an average increase in retail tariffs by 15% in 2013, in spite of declining wholesale prices.

Chart 12: Retail electricity prices incl taxes – households (€¢/kWh)



Source: Eurostat 2012

Fewer and fewer consumers will pay for the grid and renewables subsidies

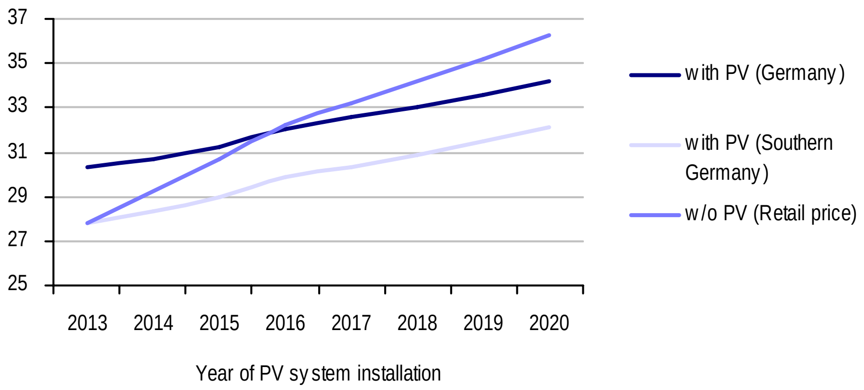
Also, an increase in unsubsidised PV capacity will ultimately lead to higher electricity prices, in our opinion: The demand reduction that results from higher energy efficiency and an increase in unsubsidised PV capacity makes it necessary to spread the grid investments and cost of the renewable subsidies over a smaller base. This leads to higher grid fees and renewable surcharges on a per-kWh basis, thereby increasing the incentives for households/firms to install a PV system. Those who already own PV systems are likely to respond by increasing their self-consumption rate, eg, by adding a battery storage system. Again, this leads to further demand reductions, which in turn further increase retail electricity prices, and so forth. This upward spiral in prices increases the savings potential from higher self-consumption.

At some point, we think this will trigger a political debate about how the grid fees and renewables subsidies should be paid for. It could lead to a flat-fee pricing model, but we think this debate is early stage.

Solar system could reduce electricity bill by 10% in 5 years from now

As seen in the chart below, solar in southern Germany is now at break-even to grid-supplied electricity. In the coming years, we estimate the cost advantage will increase further, to about 10% by 2017E.

Chart 13: Cost of electricity in €¢/kWh (4,500kWh household with a 4kW PV system)



Source: UBS estimates
Note: Electricity cost with PV refers to the cost in the first year of installation of the PV system; investment costs (PV system) subject to linear depreciation over 20 years.

Under the current subsidy schemes, the owner of a PV system does not have any incentive to consume its self-produced solar power – some countries even discourage or preclude self-consumption: In Spain, for instance, PV systems connected to the grid are required by law to feed the entire solar power into the grid. Even without such rules, it has been financially more attractive to feed the entire solar power into the grid at guaranteed tariffs, which exceeded the retail electricity price.

Self-consumption of solar can be increased by optimising demand

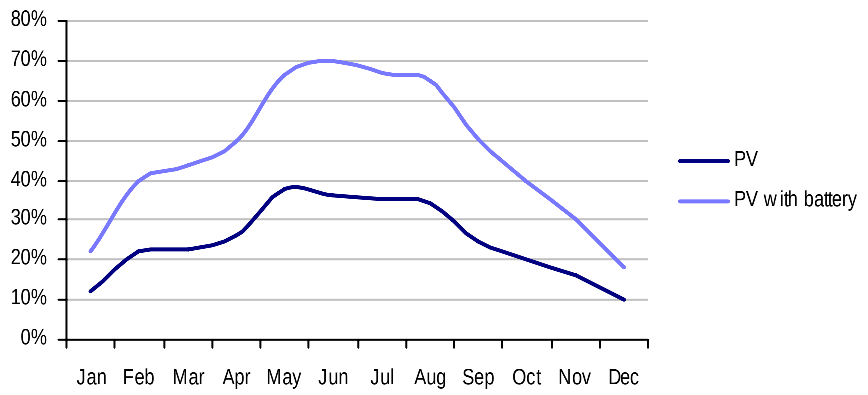
The situation is different for unsubsidised solar power: Once a PV system has been installed, households have a strong incentive to shift their consumption to times during which the PV system produces energy. This cannot be extended to all energy-consuming activities, but a household may, for example, turn on the dish washer, washing machine or dryer when PV power is available. Every kWh shifted from morning and evening hours to sunny hours becomes cost-free due to the fact that the initial investment in the PV system constitutes a sunk cost. The solar industry is also starting to offer devices to households that co-ordinate the timing of energy-intensive processes, aiming at increasing the self-consumption rate of a PV system.

Battery solutions are another game-changer

Combined, solar and battery systems could reduce power consumption from the grid by 50-60% (family home)

Storage technologies allow the owner of a PV system to further cut electricity purchases from utilities: PV power not immediately consumed charges a battery, which is later used as electricity source at times when the sun is not shining. According to different field tests, a battery with a capacity of 3kWh allows a 4,500kWh household with a 4kW PV system to lower its electricity consumed from the grid by 50-60%.

Chart 14: Power not purchased due to own PV production (4,500kWh household)



Source: IÖW (Institute for Ecological Economy Research)

Lithium-ion batteries to prevail

As of today, traditional battery technologies from the vehicle sector, such as lead-acid batteries, have mainly been used as back-up solution for blackouts. Even though lead acid batteries come at a seemingly low cost (50-800 €/kWh), their lifetime is limited to 2-6 years, given a maximum of up to 2,000 cycles. This has a negative impact on practicability and economics. Other technologies, such as lithium-ion batteries, are more promising, given deep-cycle resistance, a long lifetime, and higher cost-reduction potential in the near future.

Table 7: Characteristics of different battery technologies

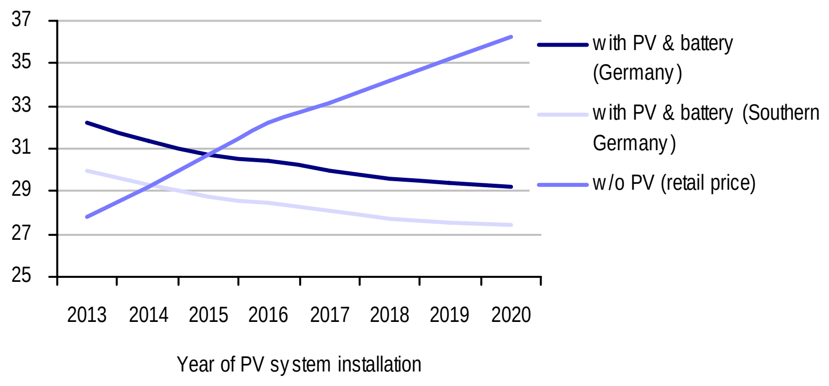
	Lead-acid	Lithium-ion
Efficiency factor	65-90%	90-95%
Depth of discharge	20-60%	up to 100%
Maximum cycles	up to 2,000	up to 15,000
Expected lifetime (years)	2-6	up to 20
Cost (€/kWh)	50-800	1,500-2,500

Source: IÖW, UBS estimates

Note: Above specifics show that lithium-ion batteries are outperforming lead-acid products on every single technical metric; however, the specs are conflicting with each other. For example, high depth of discharge comes with a lower number of maximum charging cycles.

Various companies have started to manufacture lithium-ion battery products designed for the storage of solar power. However, at the moment, it is a niche market and the batteries are still expensive. The products already available come at an end-customer cost of €1,500-2,500 per kWh of usable storage capacity – about three times the cost of a lithium-ion battery in the automotive sector. In addition, a battery management system is needed, which adds another 500-1,000 €/kWh to the costs for small-scale PV systems. However, we note that these products are the first of their kind and are not yet produced at large scale. In addition, the mentioned costs contain high margins for sales agents (up to 30%), given that PV storage solutions are not yet widely applied and hence still consulting-intensive.

Chart 15: Cost of electricity in €¢/kWh
(4,500kWh household with a 5,000kWh PV system and a 3kWh battery)

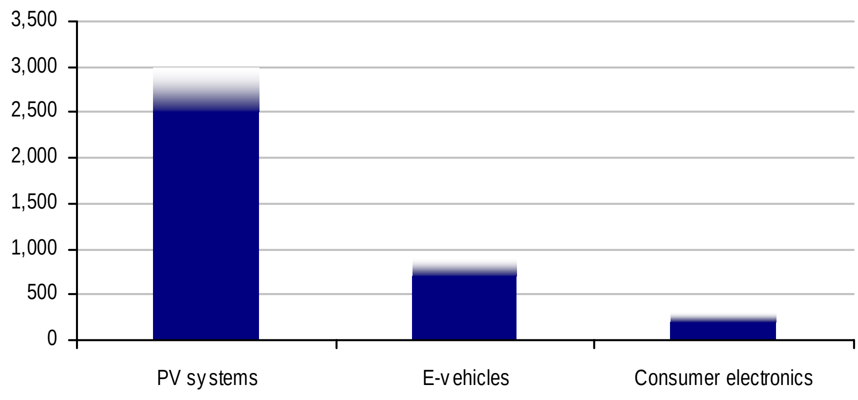


Source: UBS estimates
Note: Electricity cost with PV refers to the cost in the first year of installation of the PV system; investment costs (PV system) subject to linear depreciation over 20 years.

Cost could come down by 2/3 just on economics of scale

We expect the end-customer cost of lithium-ion technology applied in the PV sector to decline significantly over the next few years. We do not attribute this to any technological leaps, but rather to the start of industrial manufacturing, which should lead to lower unit costs; higher production volumes should improve components purchase conditions, and a more widespread application should decrease margins for sales agents. In addition, the characteristics required by batteries used to store solar power are quite similar to those for batteries used in e-vehicles. It can thus be expected that any progress in the production of batteries for e-vehicles should directly benefit solutions in the field of solar power storage.

Chart 16: Cost of lithium-ion battery packs in different application fields (€/kWh)



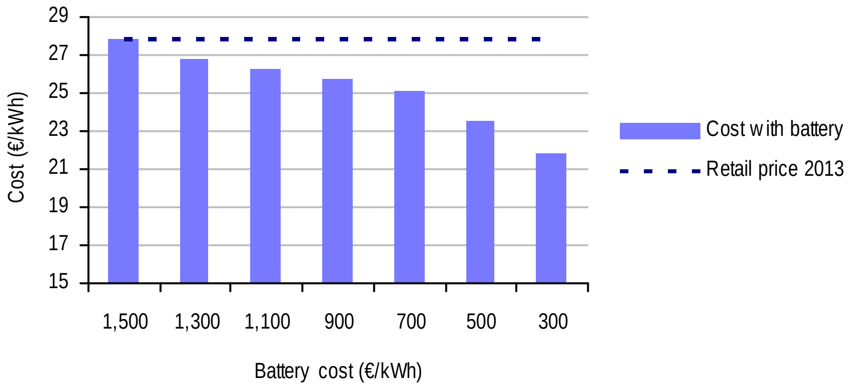
Source: UBS estimates

We assume a 10% annual price decline for batteries – no technology leaps are needed, just a 'normal' learning curve

We also highlight that the current cost of an e-vehicle battery pack based on the lithium-ion technology and manufactured at low volumes ranges from 800 to 900 €/kWh, while in the area of consumer electronics, the battery cost ranges from 200 to 300 €/kWh. In our analysis, we assume that a complete battery solution for storing PV power currently comes at a total cost of 2,500-3,000 €/kWh and will decline by 10% per year.

We note that even if batteries were cheaper right now, most countries' PV subsidy schemes would discourage investments in storage technologies because it is economically more convenient to feed PV power into the grid at guaranteed tariffs, ie, the opportunity costs are just too high. Once subsidy schemes run out – which is already foreseeable in several countries – we expect PV storage solutions to be applied at a larger scale.

Chart 17: Household electricity cost at different battery costs



Source: UBS estimates
Note: Electricity cost calculated at constant 2013E PV costs.

Chart 18: Germany – IRR (4,500kWh household)

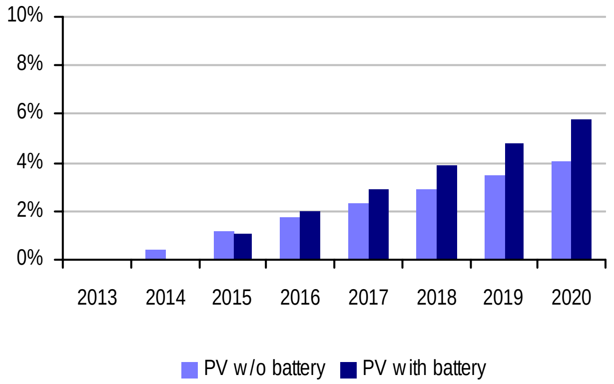
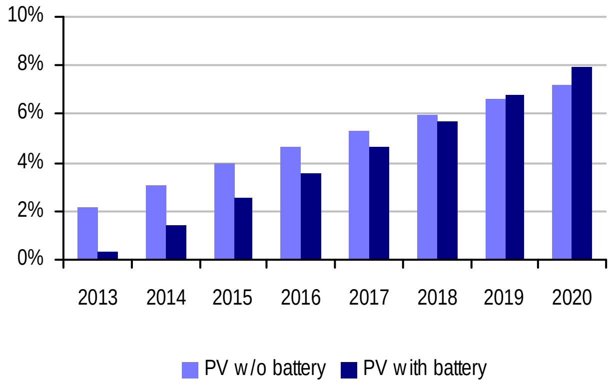


Chart 19: Southern Germany – IRR (4,500kWh household)



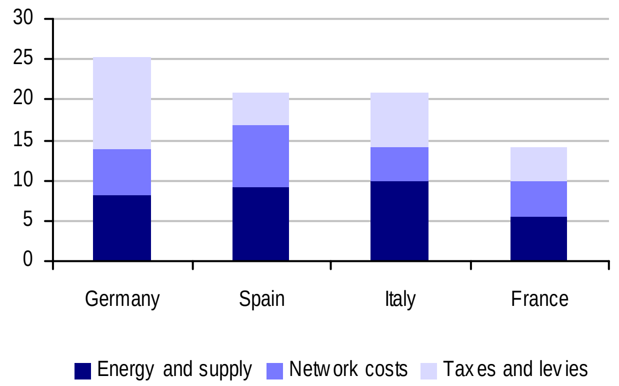
Source: UBS estimates
Note: Investment costs (PV system and battery) subject to linear depreciation over 20 years.

Germany is among the most attractive solar markets, thanks to high retail tariffs

Retail tariffs and solar irradiation are key drivers of solar economics

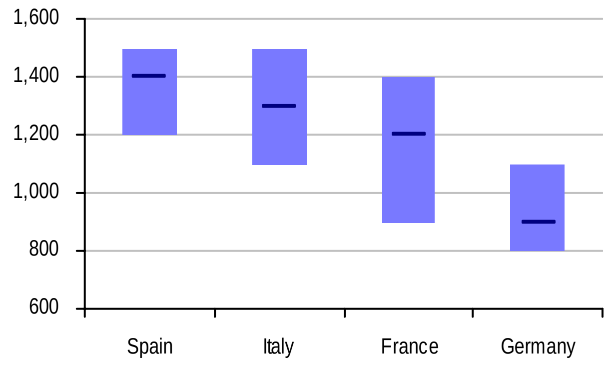
Since retail tariffs vary significantly from country to country, the expected profitability of an unsubsidised PV system varies accordingly. The savings potential increases in countries with a steeper development in retail electricity prices.

Chart 20: Retail electricity prices for households in 2011 (€¢/kWh)



Source: Eurostat

Chart 21: Solar radiation by country (kWh/kWp p.a.)

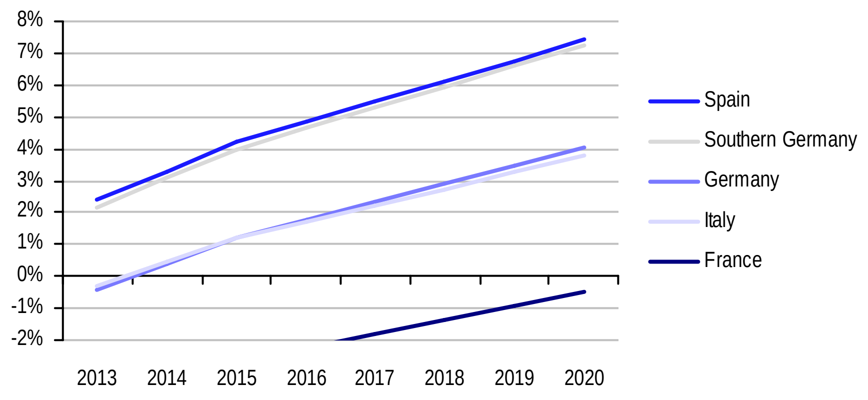


Source: UBS

Smaller systems (=less capex) needed in Mediterranean countries

Another important driver is the solar radiation/load factor of a PV system: The initial investment is lower in countries with high load factors, as less PV panels are required to produce the same amount of electricity: A Spanish 3.5kWp PV system produces as much energy on average as a 5.5kWp PV system located in Germany. This means that unsubsidised PV systems in countries with higher load factors, such as Spain, should break even earlier than in Germany even though retail electricity prices are not as high as in Germany.

Chart 22: IRR of a PV system (4,500kWh household) – no battery storage

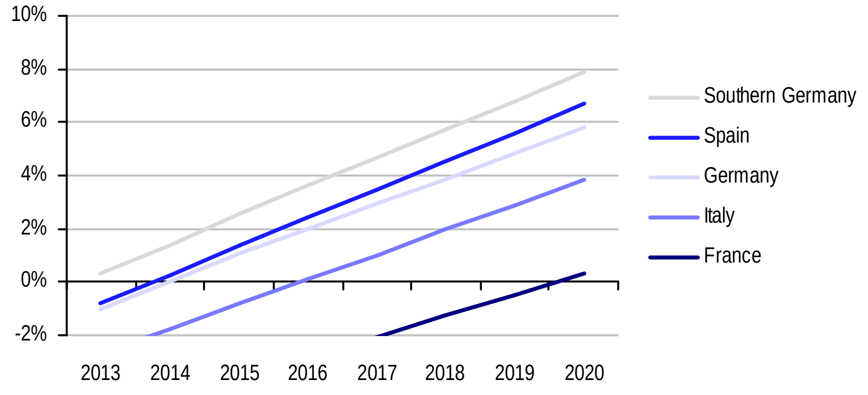


Source: UBS estimates

Note: Investment costs (PV system) subject to linear depreciation over 20 years.

As outlined above, battery storage solutions increase the energy autarky of a household. Storage technologies should first be installed in countries with high electricity prices as the savings potential is larger there. For example, battery-backed PV systems will break even earlier in Germany than in Italy. This means that high retail electricity prices may compensate for lower load factors.

Chart 23: IRR of a PV system with 3kWh battery (4,500kWh household)



Source: UBS estimates
Note: Investment costs (PV system and battery) subject to linear depreciation over 20 years.

Once PV incentives disappear and unsubsidised PV becomes financially viable, installations will likely start in the south of the respective countries, given the higher load factors there. The development in Germany will likely be led by the states of Baden-Württemberg and Bavaria with a solar radiation of up to 1,100kWh/kWp, compared with the German average of 900kWh/kWp.

Chart 24: IRR of a PV system (4,500kWh household)

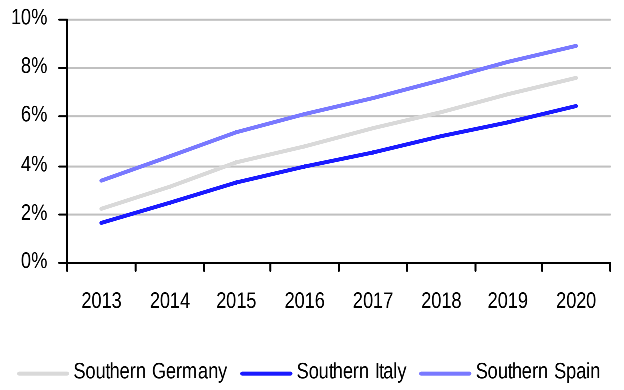
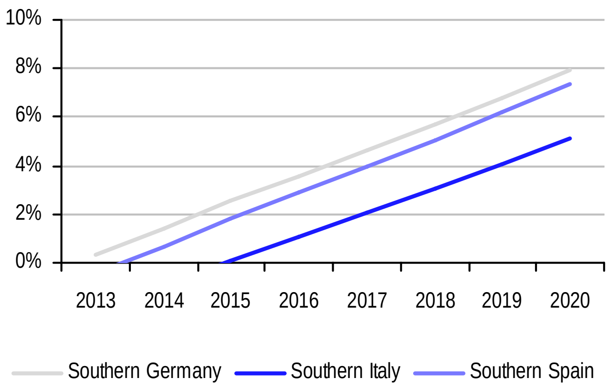


Chart 25: IRR of a PV system with 3kWh battery (4,500kWh household)

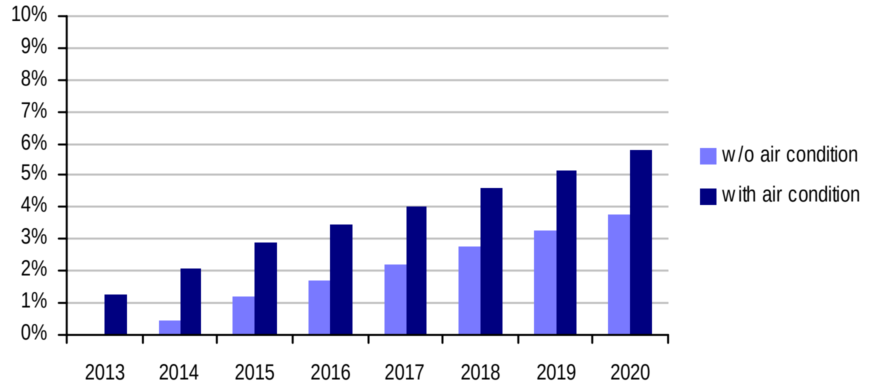


Source: UBS estimates
Note: Investment costs (PV system and battery) subject to linear depreciation over 20 years.

Higher self-consumption of PV in southern Europe due to A/C

The expansion of unsubsidised PV capacity should also be very pronounced in the south of Italy and Spain where solar radiation reaches 1,500kWh/kWp. This compares with a country-wide average of 1,300-1,400kWh/kWp. In fact, a large part of the energy required by an air-conditioning system is used in the summer months during hours when the sun is shining. The required electricity can thus be directly retrieved from the PV system, thereby increasing the own-consumption rate and savings potential. In countries like Italy, air conditioning can make up 10-20% of the whole electricity bill. A PV system can lead to further significant electricity bill reductions for such households.

Chart 26: Italy – IRR of household PV system with air conditioning



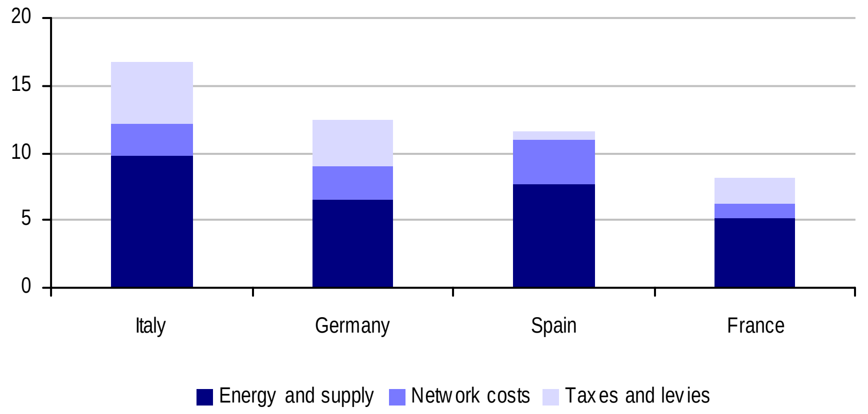
Source: UBS estimates
Note: Investment costs (PV system) subject to linear depreciation over 20 years.

Solar also works in the commercial sector

Significant cost-saving potential...

The cost of energy is generally lower for commercial customers than for private customers, the reasons being that: (1) companies eventually do not pay VAT; (2) their electricity purchase volumes are higher; and (3) certain countries apply less taxes and levies on energy sold to commercial customers.

Chart 27: Electricity prices for commercial customers in 2011 (€¢/kWh)



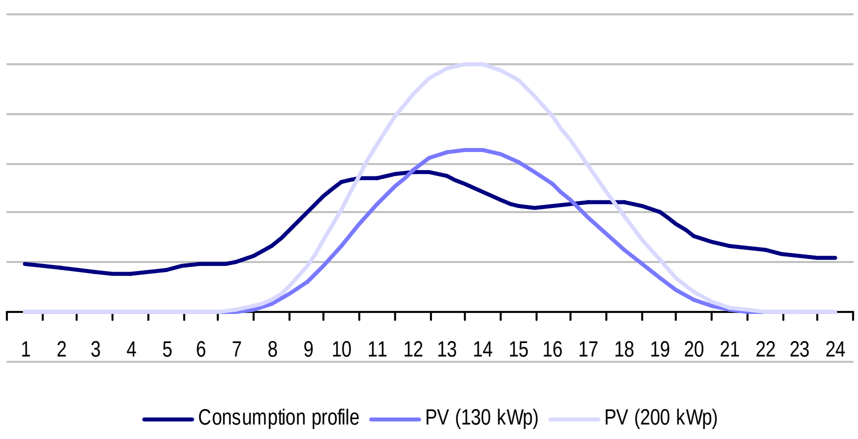
Source: Eurostat 2012

...thanks to high achievable self-consumption rates...

Electricity production from solar can mostly be used in-house

In contrast to households, commercial users can achieve 100% self-consumption of PV electricity. The rate of self-consumption of PV power that a commercial or a manufacturing enterprise can achieve depends on its electricity load profile, ie, the energy need and timing of the company's production processes, as well as the roof or surface space available for a solar PV system. While the power load profile is very much company-specific, for many sectors it holds true that a significant part of electricity consumption happens during sunny hours. This applies especially to stores, supermarkets and offices, but also to most manufacturing enterprises that operate also during daytime. These enterprises can achieve high self-consumption rates of PV power since most of the electricity produced by an appropriately dimensioned PV system is immediately consumed, rather than being fed into the grid or being lost.

Chart 28: Average load profile of 200MWh p.a. commercial enterprise with PV system



Source: UBS estimates

Sector-specific load profiles can be used to estimate the maximum achievable PV self-consumption rate. Depending on the size of the PV system, companies may achieve rates of up to 90%. For example, a German manufacturing company with an electricity consumption of 200MWh per year and a 130kWp PV system should be able to achieve a self-consumption rate of around 70%; the remaining 30% is fed into the grid or lost. If the PV system produces 120MWh per year, the company can cut its electricity purchase from a utility by around 84MWh, thus saving a gross amount of around 42% on its overall electricity bill. As can be seen from the chart above, increasing the capacity of the PV system to 200kWp yields only relatively small additional savings as the extra produced solar power cannot be consumed immediately.

...and cheaper PV system costs

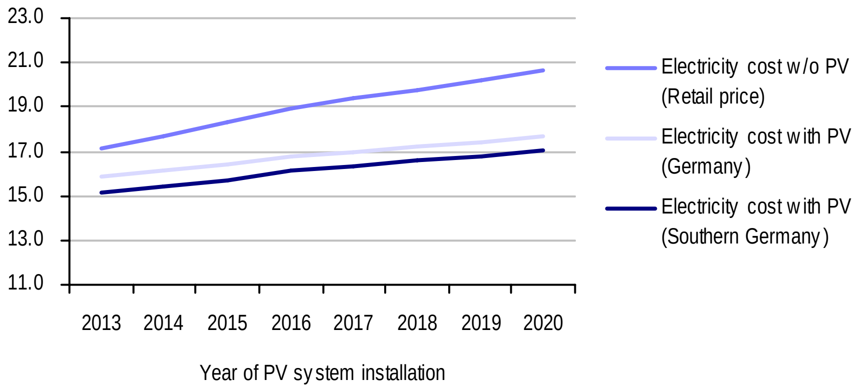
Larger-scale solar comes at >20% lower cost than household systems

The cost of a PV system is much lower for companies than for households as they can opt for VAT compensation, while households are the ultimate bearers of VAT on PV system costs. This amounts to a cost advantage of around 20% in most countries. In addition, as enterprises install larger-scale PV systems, they may benefit from lower unit costs as well as lower O&M costs. Finally, many companies, especially farms and firms located in rural areas, can opt for ground-mounted PV systems instead of installing them on rooftops and façades. This lowers the overall system cost and increases the load factor as the orientation of ground-mounted systems can more easily be optimised.

Solar power can already lower power bills in southern Germany...

Already at the current PV system costs, German companies operating in certain sectors can lower their overall energy costs. Given a firm's specific power load curve, choosing the proper dimension of the PV system is a crucial profitability factor. While increasing the size of a PV system yields a higher electricity production, it lowers the self-consumption rate after a certain limit. Given that a company mainly profits from the self-consumed solar power in the form of savings on electricity purchases, increasing the dimension of the PV system after a certain threshold decreases the relative returns on the investment. This puts a factual cap on the solar capacity potential that any firm can exploit at a reasonable cost. The cap is dynamic in time as it does not solely depend on a firm's own electricity needs and power load curve, but also on electricity prices and PV system costs. Firms that have installed an unsubsidised PV system may gradually increase their solar capacity in subsequent years as system costs are decreasing and electricity prises rising.

Chart 29: Cost of electricity in €¢/kWh
(200MWh manufacturing enterprise in Germany with a 130kW PV system)

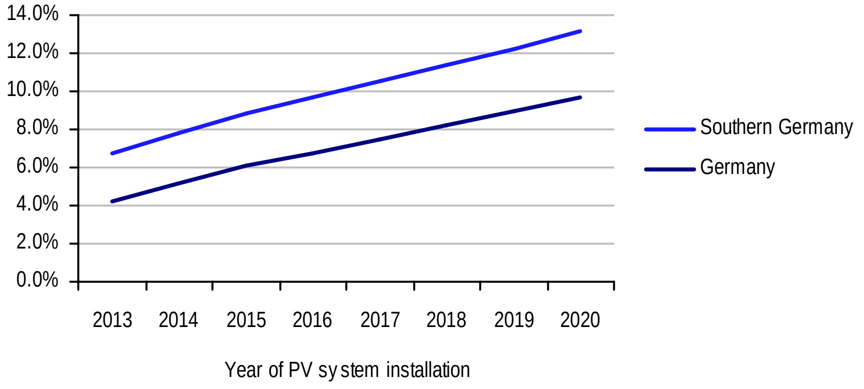


Source: UBS estimates
Note: Investment costs (PV system) subject to linear depreciation over 20 years.

Solar system as a 20-year hedge against opex inflation

From a managerial point of view, the installation of an unsubsidised PV system is nothing but a one-time investment that leads to a sustainable cost reduction and constitutes a partial hedge against increasing energy prices or general cost inflation over a 20-year period. However, an enterprise will only make the investment decision if the expected cost savings exceed the company's internal required rate of return – ie, the PV installation competes with other investment projects. In this regard, we note that any cost savings that exceed the depreciable investment costs are treated as taxable earnings.

Chart 30: IRR of 120MWh PV system (200MWh commercial enterprise in Germany)



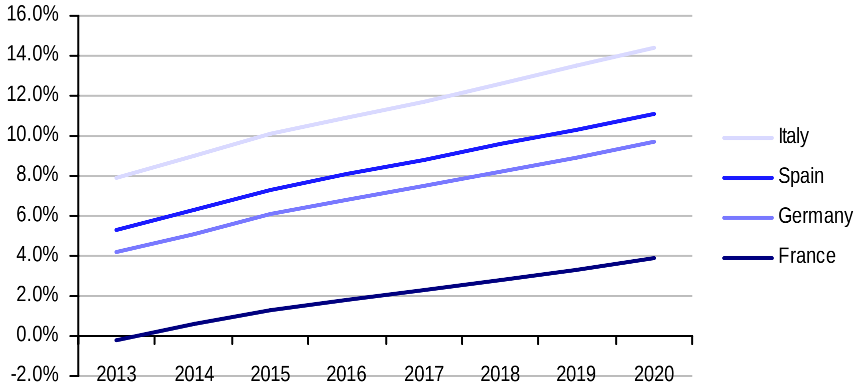
Source: UBS estimates

...and shows very attractive profitability in southern Europe

By 2020, a solar system could save an estimated 30% on electricity bills for commercial users

At this point, Italian firms can benefit most from the installation of a PV system. This results from a combination of high solar load factors and high electricity prices for commercial and industrial customers. Spain and Germany have slightly lower IRRs. Assuming a hurdle IRR of 8%, Spain will have a positive IRR-WACC spread from 2016. Germany should have a lower hurdle rate: assuming 6%, solar projects are 'in the money' starting in 2015. By 2020, we estimate electricity bill savings of about 30% in all three countries, and a payback time of investment of only 5-6 years.

Chart 31: IRR of 120MWh PV system (200MWh commercial enterprise)



Source: UBS estimates
Note: Investment costs (PV system) subject to linear depreciation over 20 years.

PV storage has medium-term potential also in the commercial sector

Higher self-consumption of solar power implies lower needs for batteries...

Looking at the standard load profiles for different companies, the need for storage technologies is limited to certain sectors. The more incongruent the production and immediate consumption of PV power are, the higher the technical potential for storage technologies. The potential is most pronounced for sectors with a power load curve showing morning or evening peaks.

Most companies will likely dimension their PV system in a way that it does not produce much excess electricity, given that this yields the highest IRR. This would mean there is not much electricity that could effectively be stored. Also, many commercial enterprises do not operate on weekends when electricity consumption is low so that batteries cycle only five days per week rather than seven, as is the case for households. This has a negative impact on the profitability of the battery investment.

…but, medium term, batteries could help optimise electricity consumption from the grid – a threat to the morning peak for utilities

However, with decreasing cost of battery solutions, storage could become more attractive, also in order to benefit from low-price (off-peak) purchases of electricity from the grid. Hence, a battery may not only serve to optimise solar economics but also to reduce the average cost for electricity purchased from the power grid. From a utility's perspective, the overnight charging of batteries would be a threat for the attractive peak hours during the morning.

Up to 18% demand destruction

Some 6-9% demand destruction in Germany, Italy and Spain by 2020E

The solar boom in Spain, Italy and Germany in recent years was mainly driven by attractive feed-in tariffs. However, as our analysis suggests, even if subsidies were to be cut to zero, there would still be a vast growth opportunity for solar. We calculate that up to 14-18% of electricity demand in Germany, Spain and Italy could be met by self-produced solar electricity. By 2020, we estimate 6-9% of demand could already be replaced in these markets.

In other large European markets, the potential of unsubsidised solar is smaller for the time being, either due to low retail tariffs (France) or less sunny weather (northern Europe). The likely rapid growth in German could even slow the development of solar in neighbouring countries, such as Switzerland, Austria and Benelux. As these countries do not pay significant subsidies for renewables, end-customer tariffs might even decrease, owing to the downwards pressure on wholesale prices due to German renewables. One could say that the German electricity consumers pay for lower tariffs of their neighbours.

The assessment of the solar market potential by 2020 is based on a two-stage process:

(1) What is the amount of TWh consumption that can theoretically be replaced with unsubsidised solar at a positive IRR?

(2) What is a *realistic* penetration rate by 2020, given restrictions (financial, technical, time-lag)?

What is the theoretical solar potential?

Up to 14-18% of demand could be replaced by self-generated solar

The table below shows a detailed assessment of the solar opportunity in Germany. We calculate that 76TWh of self-produced solar power is possible, equivalent to 14% of the country-wide electricity demand. Our estimates take into account the assumed availability of suitable rooftop space and the economic viability of solar systems. For example, energy-intensive industrial consumers pay much lower electricity tariffs, ie, the break-even point for solar will not be reached in the foreseeable future.

Table 8: 14% of German demand could be met by self-produced solar

Germany	Demand (TWh)	% of which can be replaced by solar (UBSe)	Potential of solar (TWh)
Residential	140	29%	41.0
Family homes	68	55%	37.4
Apartments	72	5%	3.6
Commercial	133	18%	24.4
Construction	3	5%	0.2
Office buildings	31	20%	6.2
Producing companies	4	5%	0.2
Retail	26	30%	7.8
Public buildings	14	20%	2.8
Hotels, restaurants, etc	16	5%	0.8
Agricultural	5	60%	3.0
Other	34	10%	3.4
Industrial	251	4%	10.7
Chemicals	37	0%	0.0
Food/beverages	18	10%	1.8
Paper	21	0%	0.0
Plastics	13	5%	0.6
Metals	26	0%	0.0
Automotive	16	8%	1.3
Mechanical engineering	25	9%	2.2
Other	96	5%	4.8
Transport	17	0%	0.0
Total	541	14%	76.0

Source: ARGE, UBS estimates

Adjusted for already installed (subsidised) solar systems on rooftops, we calculate another 80GW of solar panels could be installed, compared with 33GW as of end-2012.

Table 9: 80GW unsubsidised solar could be installed in Germany

Grid electricity demand potentially replaced by solar (TWh)	76
Solar capacity equivalent (GW, at 10.4% load factor, 20% excess solar production)	100
Solar capacity already installed on rooftops (GW, UBSe)	20
Solar growth opportunity (GW)	80

Source: UBS estimates

Some 14-18% of demand could be replaced by unsubsidised solar

The table below summarises the demand at risk in the key European markets due to self-generated solar power. The analysis behind this is similar to the German case study above.

Table 10: Economical PV self-production in % of total demand (2020E)

	Industry	Transport	Households	Commercial	Total
Germany	4%	0%	29%	18%	14%
France	0%	0%	5%	3%	3%
Italy	5%	0%	25%	28%	17%
Spain	5%	0%	21%	26%	18%

Source: UBS estimates

Case study: BMW Group

For the individual subsectors, we have made a rough estimate of energy consumption and available (roof) space for solar. As an example, the table below shows the solar potential for BMW Group. Electricity consumption and size of property are reported by BMW (source: Sustainability Report 2011). The report also states that 18.8% of the land is developed. We estimate that 10% of the size of the total property can be used for solar generation. Assuming a 13% average global load factor for solar, BMW could produce 490MWh of solar electricity per year or 29% of the group-wide electricity demand. This is much higher than the 10% we have used for the automotive sector in Germany, ie, we think our estimates are conservative.

Table 11: BMW could in theory generate up to 29% of electricity needs from own solar

Size of property (km^2)	28.7
% of property which can be used for solar (UBSe)	10%
Size of property usable for solar (km^2)	2.9
Solar capacity in watt per m^2	150
Solar capacity on usable BMW property (MW)	430
Annual solar production at 13% average load factor (MWh)	490
Group-wide electricity consumption (MWh)	1,702
Theoretical solar production as % of total demand (including sale of excess solar production at peak hours)	29%

Source: BMW Sustainability Report 2011, UBS estimates

What is a realistic penetration rate?

Commercial users might act quicker than retail customers; awareness and financing look better in Germany

Due to various constraints (financial, technical, educational), it is difficult to assess the speed of solar capacity penetration. We think growth could be fairly moderate in the early years, but accelerate rapidly the more compelling the economics become and the more familiar people become with the concept of solar self-consumption. We think that in the commercial/industrial sector, penetration rates will be relatively high as solar self-consumption is an effective means to save costs. The residential segment might develop more slowly, in particular in Spain where financial constraints and high unemployment could hamper investment decisions. Also, we think the awareness of ‘green’ investments is higher in markets like Germany.

Table 12: Out of the total *economical* PV potential, what is the penetration rate in 2020?

	Industry	Transport	Households	Commercial
Germany	50%	0%	50%	50%
France	0%	0%	20%	20%
Italy	50%	0%	30%	50%
Spain	40%	0%	15%	40%

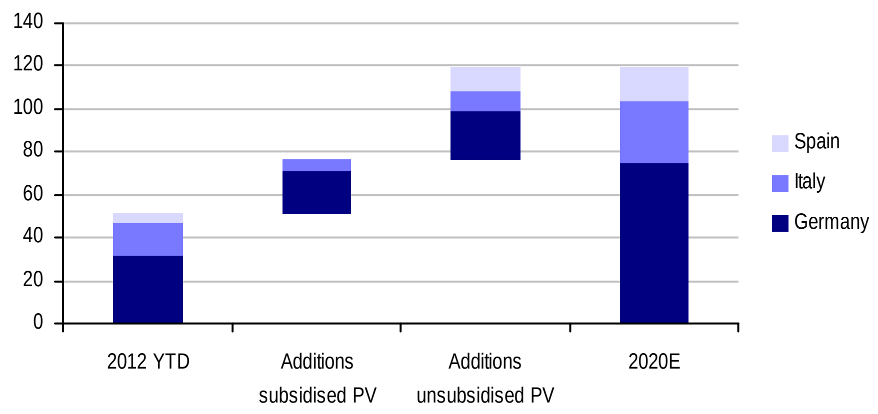
Source: UBS estimates

43GW of unsubsidised solar systems by 2020E

Installed solar capacity in Europe could triple to 120GW by 2020E

We estimate that by 2020, 43GW of additional unsubsidised solar systems might be installed in the main markets Germany, Spain and Italy. In combination with continued subsidised solar installations (mainly in Germany, but also in Italy), we estimate 120GW of solar capacity to be installed by 2020 in the three markets, about three times the capacity currently installed.

Chart 32: Increase of unsubsidised solar capacity, 2012-20E (GW)



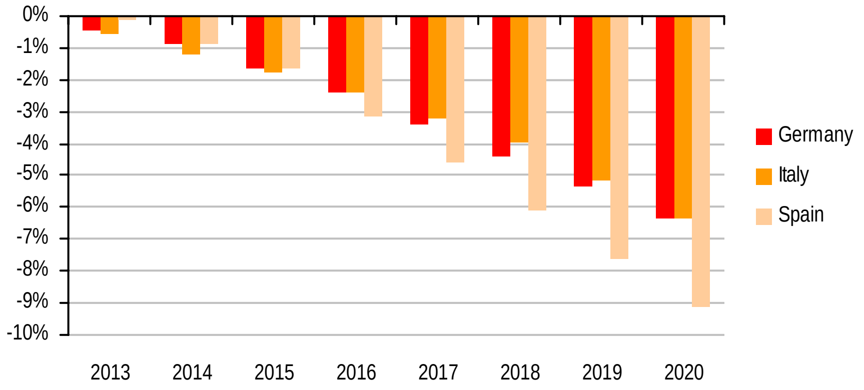
Source: UBS estimates

6-9% additional demand reduction by 2020E

Significant contribution to demand destruction for conventional generators

The fact that capacity additions in Spain and Italy are not as high as in Germany does not say much about the negative consequences for demand from conventional generators. Given higher load factors in southern Europe, less installed capacity is required to generate the same amount of electricity. As can be seen in the chart below, we expect that additional solar capacity will lead to a decline in overall demand in the range of 6-9% between 2013 and 2020.

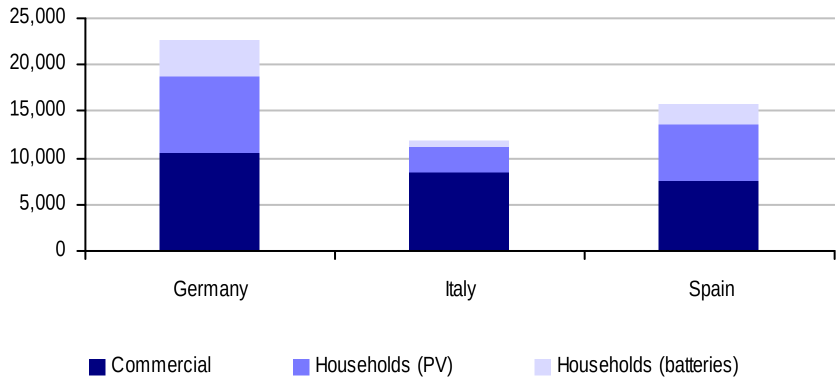
Chart 33: Cumulative demand reduction, 2013-20E



Source: UBS estimates

Compared with households, companies are generally able to replace a larger part of their electricity consumption with solar power. We thus expect a significant share of the demand reduction to originate in the commercial sector. However, in Germany and Spain, PV in the household sector will also likely play an important role due to high retail tariffs, which also render battery storage more attractive.

Chart 34: Electricity demand reduction due to consumption of self-generated solar power by 2020E (GWh)



Source: UBS estimates

The decrease in demand for electricity from thermal generation (ex must-run capacity nuclear and hydro) means that average thermal load factors could drop 7-10% on the back of unsubsidised solar. We highlight this is a *ceteris paribus* analysis, ie, the downward pressure on thermal load factors from energy efficiency, weak GDP growth, etc, comes on top.

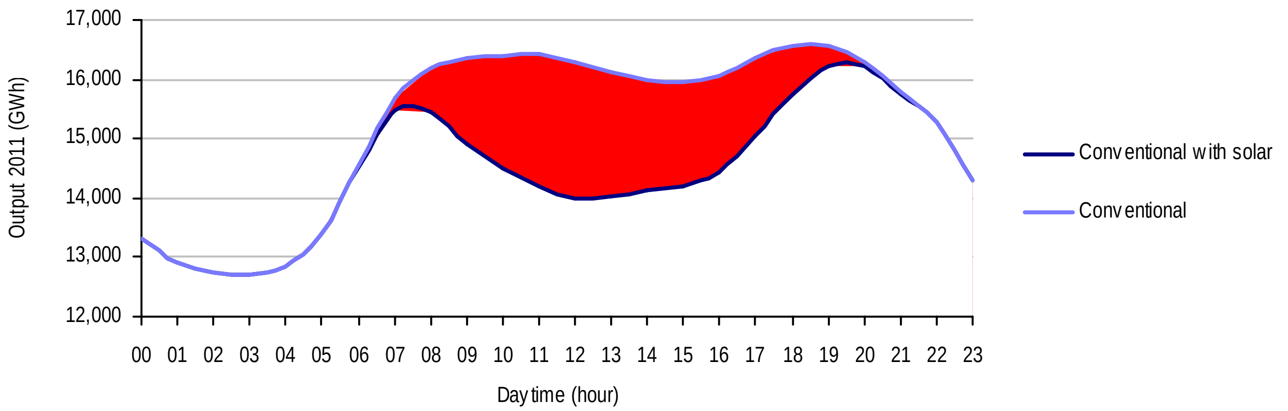
Table 13: Implied reduction in thermal load factors *all else equal*

	2013E	2020E
Germany		
Thermal output (TWh)*	332	311
Thermal capacity (GW)	87	87
Implied thermal load factor	44%	41%
Italy		
Thermal output (TWh)*	205	192
Thermal capacity (GW)	68	68
Implied thermal load factor	34%	32%
Spain		
Thermal output (TWh)*	78	71
Thermal capacity (GW)	40	40
Implied thermal load factor	22%	20%

Source: UBS estimates
* Conventional generation excluding nuclear and hydro.

We expect that unsubsidised solar capacity will replace around 20TWh of conventional output in Germany by 2020. This will come entirely in the form of reduced demand, and does not take into consideration excess solar power that might be fed into the grid. From a seasonal perspective, demand reduction would be significantly skewed towards the summer months due to the load factors of PV systems.

Chart 35: Large impact of unsubsidised solar on load curve of thermal generation (Germany, 2020E)

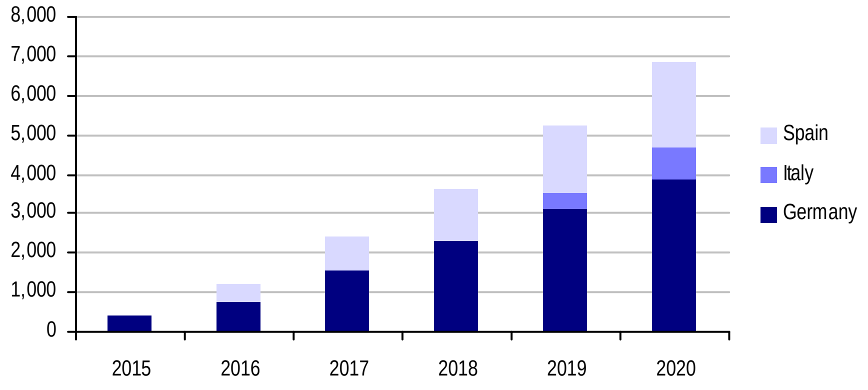


Source: UBS estimates
Note: 2011 is the reference year for the conventional generation curve.

Storage technologies shave the evening peak…

A PV system backed by a storage solution uses the solar power not immediately consumed to charge a battery. At a later point in time – when the sun is not shining – the system owner satisfies his or her electricity needs out of the battery. In most cases, this will be during the evening when the sun has set. Our estimates on increasing battery capacity originate entirely from the household sector. For the reasons outlined above, we do not assume commercial enterprises will apply batteries to store solar power in the near term.

Chart 36: Consumption of battery-stored solar power (GWh)



Source: UBS estimates

Table 14: Conventional generation and stored solar power during evening hours in Germany (18:00-23:00)

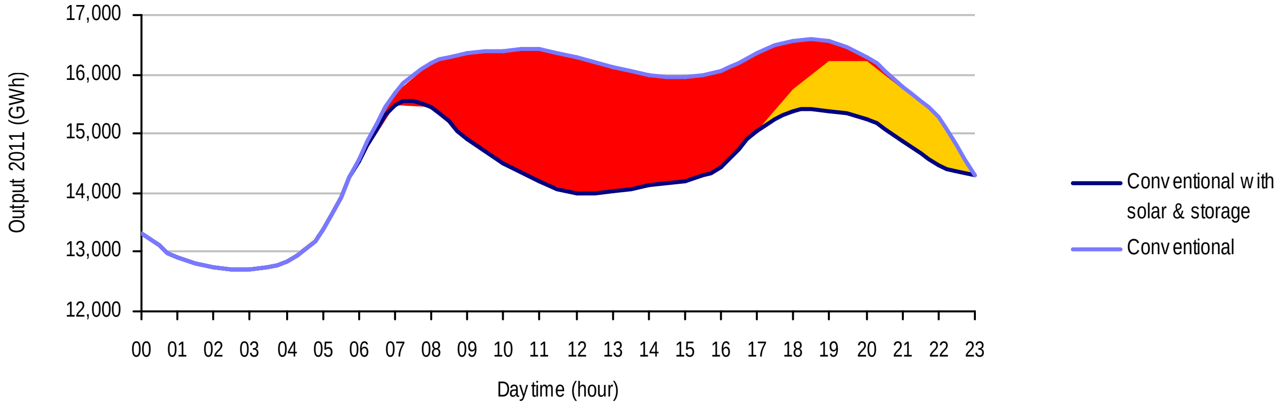
	Annual output (GWh)	Average capacity (GW)
Conventional generation, 2011	80,500	44.1
PV power from batteries, 2020	3,889	2.1
Stored PV power as % of total generation	4.8%	4.8%

Source: UBS estimates

Batteries could reduce demand from conventional generators by 5% during evening hours

If storage solutions were applied at a large enough scale, the evening peak, which is mainly caused by households, could get shaved to a certain extent. According to our estimates, by 2020, storage solutions will, on average, replace around 2.1GW of conventional capacity during the evening peak (18:00 to 23:00). This would put further pressure on the load factor of peak plants, especially gas-fired plants and pump storage units, as well as power prices. As a (smaller) positive effect, the peak shaving of solar around midday would be less pronounced compared with a scenario without batteries.

Chart 37: Impact of unsubsidised solar on thermal generation even larger in combination with battery systems (Germany, 2020E)



Source: UBS estimates
Note: The red area is the reduction in conventional output due to solar generation; the yellow area represents the peak shaving effect of solar battery systems.

...and the morning peak is not safe either

Once a battery system has been installed, it may not only serve as storage for excess solar power: On most days, the battery will be empty after it has been used to satisfy energy needs during the evening peak. It can be recharged during the night and used as energy source during the morning peak. Given that battery products based on the li-ion technology have high cycling capabilities, there is no additional cost from cycling the battery twice a day. As several utilities offer a night tariff lower than peak prices, consumers would actually save this spread and lower demand during the morning peak.

We have not included this additional earnings opportunity from double-cycling in our model, but we highlight that this has the potential to shave the morning peak just like it shaves the evening peak, with similar implications: Utilities would realise lower power prices and the load factor of peak plants would suffer.

Table 15: Batteries help to optimise cost for grid electricity, irrespective of solar

Daytime tariff (80% usage) in €¢/kWh	18.0
Off-peak tariff (20% usage) in €¢/kWh	14.0
Consumption-weighted average tariff in €¢/kWh	17.2
Average cost with 30% usage of off-peak tariff (battery) in €¢/kWh	16.8
Gross savings on electricity bill	-2.3%

Source: UBS estimates

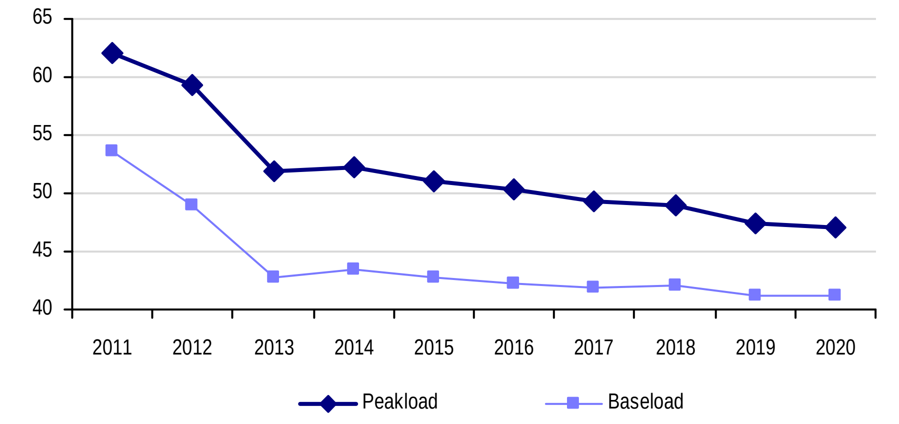
Power prices to decline further

We have updated our central European power generation model for our higher solar capacity growth forecast. Our 2020 estimate now stands at 102GW, which is 15GW higher than our previous number. Unsurprisingly, the outlook for conventional power plants is set to worsen further. Our main findings are:

102GW solar in central Europe by 2020E, 17% higher than our previous estimate

- All else equal, the German base-load power price should drop to €41/MWh by 2020E (we assumed €43/MWh previously), some 10% below the current 1-year forward.

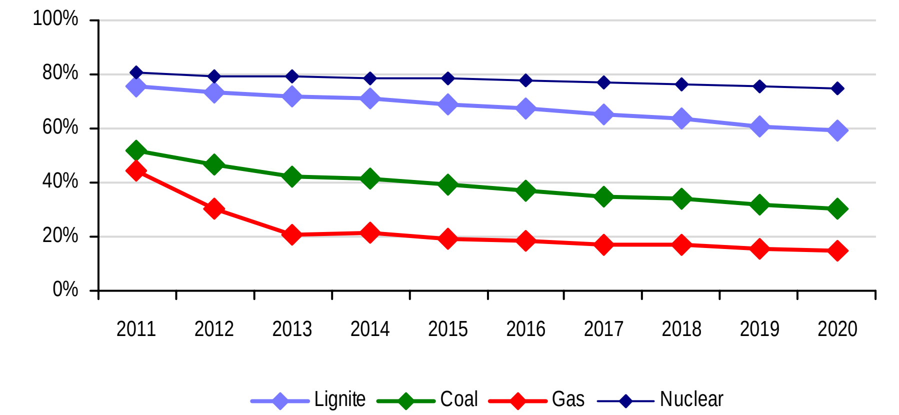
Chart 38: German base-load price to decline another 10%, all else equal (€/MWh)



Source: UBS estimates

- The load factor of lignite plants should drop from 72% to 59%, and the load factor of hard coal plants from 47% to 31% by 2020E.

Chart 39: Drop in load factors most pronounced for coal and lignite plants



Source: UBS estimates

- The overall EBITDA from conventional power generation should decline by 48% over 2012-20E.

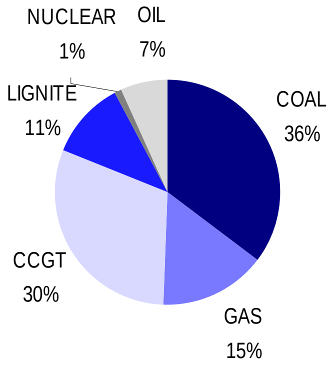
Table 16: EBITDA of conventional plants to decline by half (€/kW)

	2012E	2013E	2014E	2015E	2016E	2017E	2018E	2019E	2020E	2020E vs 2012E
Nuclear	128.8	82.8	84.5	76.8	71.7	66.4	64.2	56.2	53.9	-58%
Lignite	114	95	98	92	89	85	85	78	77	-32%
Coal	47	40	40	35	33	30	30	25	24	-49%
CCGT	19	11	13	11	9	8	8	6	5	-72%

Source: UBS estimates

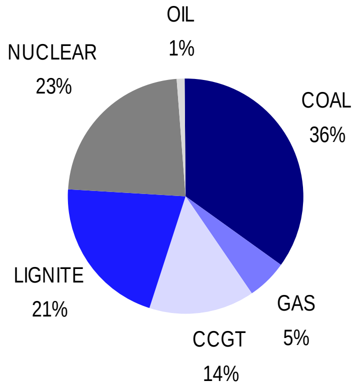
- The share of base-load plants (nuclear and lignite) as price-setting marginal plants in the spot market should increase from 12% to 44% in 2020E, driving spot prices down.

Chart 40: Price-setting technologies, 2011



Source: EEX, UBS estimates

Chart 41: Price-setting technologies, 2020E



Source: UBS estimates

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Neutral	**Hold/Neutral**	42%	35%
Sell	**Sell**	9%	18%
UBS Short-Term Rating	**Rating Category**	**Coverage[3]**	**IB Services[4]**
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Sell	**Sell**	less than 1%	0%

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2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
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4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

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CEZ Group[4]	CEZP.PR	Sell	N/A	Kc644.90	14 Jan 2013
E.ON[5, 16]	EONGn.DE	Sell	N/A	€14.20	14 Jan 2013
Enagas[5, 13, 16]	ENAG.MC	Neutral	N/A	€17.32	14 Jan 2013
Enel[2, 4, 5, 16]	ENEI.MI	Neutral	N/A	€3.22	14 Jan 2013
GDF Suez[2, 4, 5, 16]	GSZ.PA	Buy	N/A	€15.43	14 Jan 2013
Iberdrola[2, 4, 5, 16]	IBE.MC	Neutral	N/A	€4.08	14 Jan 2013
PGE	PGE.WA	Buy	N/A	PLN19.36	14 Jan 2013
RWE[2, 4, 5, 16]	RWEG.DE	Sell	N/A	€29.70	14 Jan 2013
Verbund AG[16]	VERB.VI	Neutral	N/A	€17.50	14 Jan 2013

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