Solar Energy Support in Germany
A Closer Look

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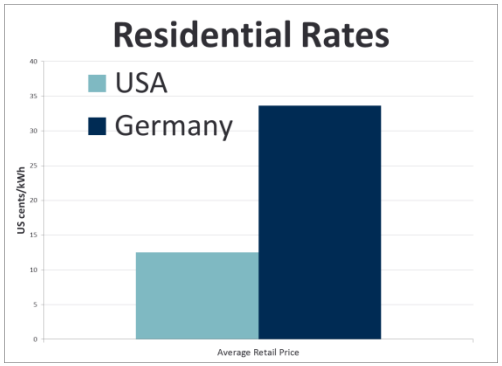
The 4 slide summary

Germany's renewable energy (RE) policy reflects existing legal and political realities

- German policy must be seen in a national (and European) context:
  - Aggressive RE development as part of essentially eliminating GHG emissions by 2050 is part of German and EU law.
  - There is high popular support for
    - Phasing out nuclear power
    - Reducing GHG emissions
  - Energy policy also motivated by desire to reduce dependence on imported fuels, esp. from Russia
- This is different from the USA (legally and politically)
- The question is therefore **NOT** whether Germany's renewable policy is expensive, but whether (or which elements of policy) are efficient (relative to other policies achieving the same legal/political goals)
- What lessons can be learned depends on what non-price goals the US is willing/committed to achieving

Expensive, but not (very) harmful

- Residential rates are high, but would be so without RE support (e.g. due to much higher taxes), and residential bills are similar to US, due to (much) higher EE, smaller houses, etc., arguably at similar standards of living



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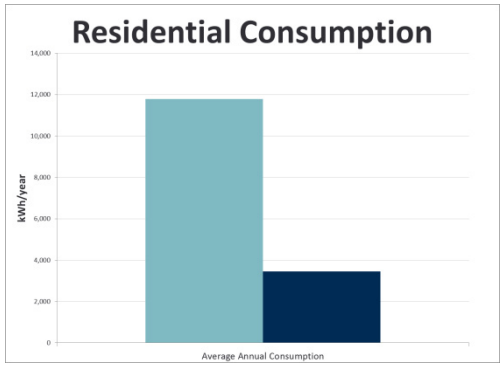

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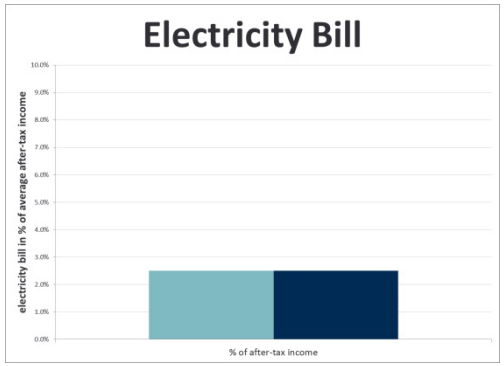
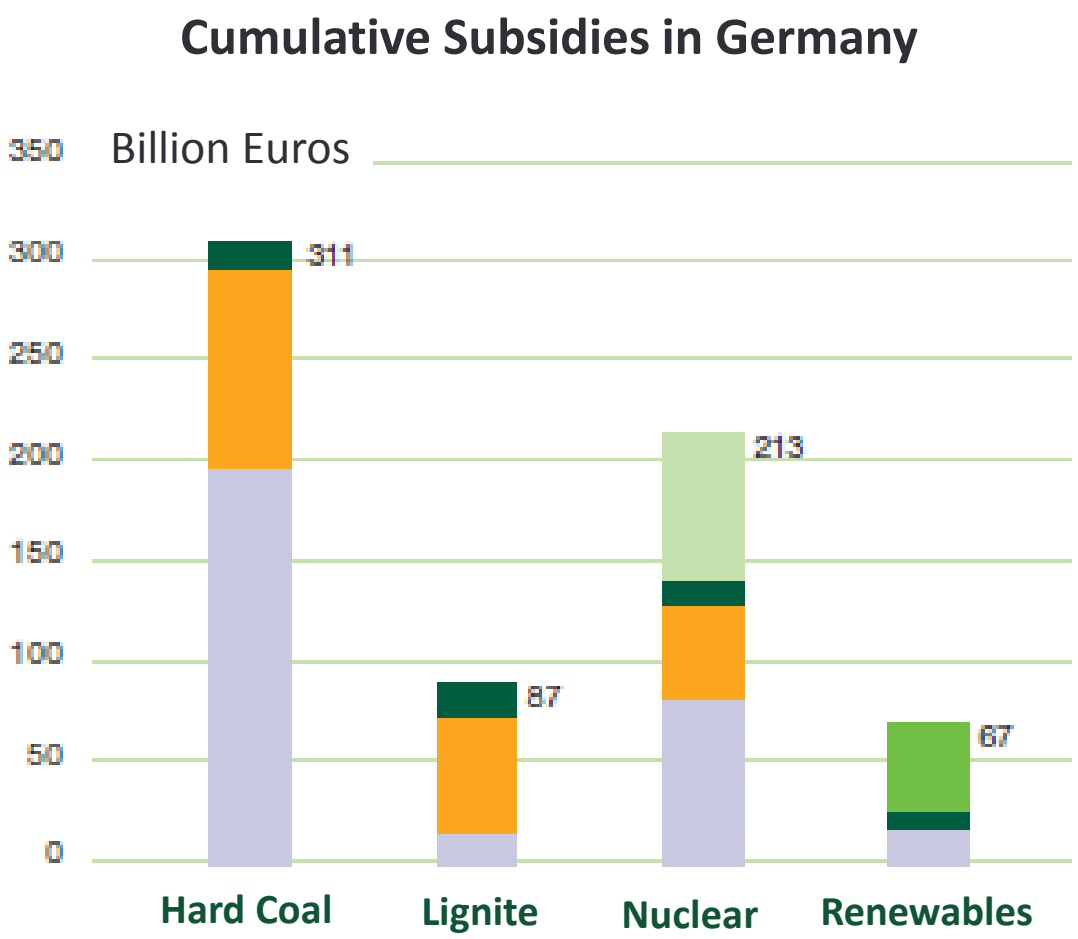


- Industrial rates are in line with Europe, higher than US (no cheap shale gas), but this doesn't seem to hurt German competitiveness
  - Unemployment rate in Germany are lower and have declined faster than in the US (and in all other larger EU countries)
  - Share of exports in GDP has increased at twice the US rate since 1990

Energy Transformations tend to go along with subsidies



- Germany has subsidized coal and nuclear much more than RE to-date
- Renewables are catching up, but ultimately order of magnitude comparable
- US energy support history pretty similar
- **Bottom line: we subsidize change, and with good theoretical reason, even though also with risks**

Source: Reproduced from Figure 2, Forum Ökologisch-Soziale Marktwirtschaft e.V., Was Strom wirklich kostet, August 2012.

It's too easy to blame it on Germany…

- Cost progress in RE and related (storage, etc.) will increasingly put conventional and central station power under pressure, not only in Germany.
- German utilities are suffering since they live **through a period of disruptive technological change.**
- Germany's support for renewables and phase out of nuclear is likely speeding up this transition, but it will likely come anyway.
- Climate change concerns will ultimately force regulatory action in the US as well and the risk of catastrophic climate change likely makes paying more now (relative to status quo) a cheap insurance program
- The US electricity landscape will fundamentally change (is already changing)
  - We can learn from Germany by observing a country a bit further along the path
    - Silver lining: following allows for better program design/smoother transition
  - Focusing on problems with German policy means being much less well prepared for similar disruption impacting US markets.

More Details

Summary of PV support in Germany (until now)

- Fixed payment (cents/kWh) for 20 years
  - Level has been decreasing
  - Originally periodic reviews, now automatic monthly FIT degressions and additional degressions if installations > defined corridor (as of Aug 1, 2014 2.5 GW p.a.)
  - increasingly incentives to market directly and receive essentially a CfD (difference between market revenues and FIT)
- Priority dispatch
- TSOs are required to buy solar PV generation, sell on wholesale market: Difference collected from ratepayers through a renewables levy ("EEG-Umlage")
- Exemptions from paying (some of the) renewables levy for trade sensitive, electricity intensive and large industrial consumers

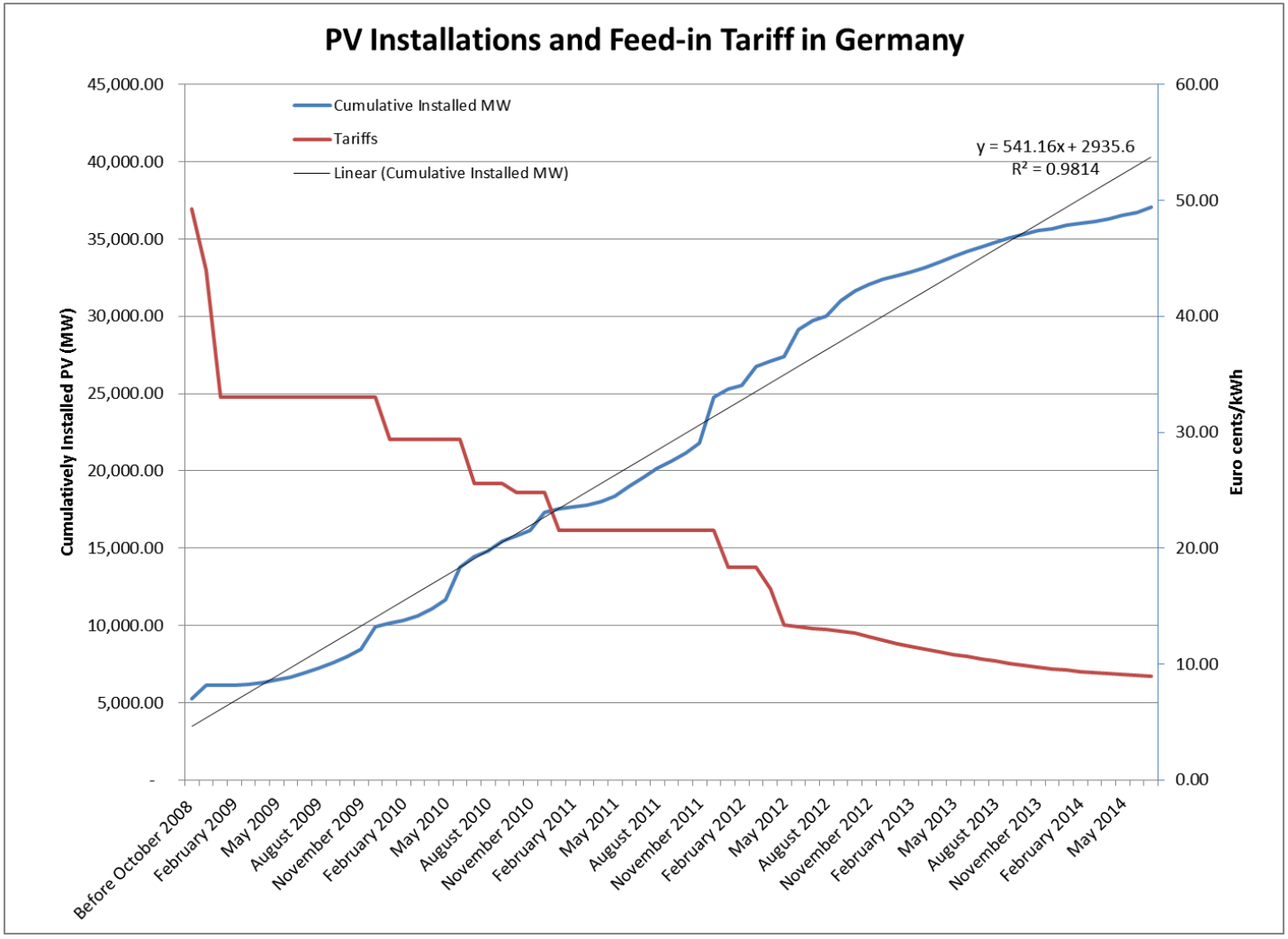
Reforms (As of Aug 1, 2014)

- FIT system phased out and replaced by market premium
  - Small systems are exempt (<500kW until 2016, <100kW after)
  - Market premium set administratively for another 1-2 years
  - From 2017 auctions with winners setting market premium
    - Some RE capacity contracted from abroad
- No market premium payments during negative pricing events
  - 6 hours or longer -> no market premiums during the entire negative pricing period.
  - Smaller installations exempt (<500kW)
- Self-consumption non longer exempt from renewables levy
  - RE > 10kW installed after 8/1/2014 pays 40% of the renewables levy
  - Fossil self-generation pays 100% of renewables levy
  - Note: DG resources are separately metered

[Hopefully] non-controversial facts

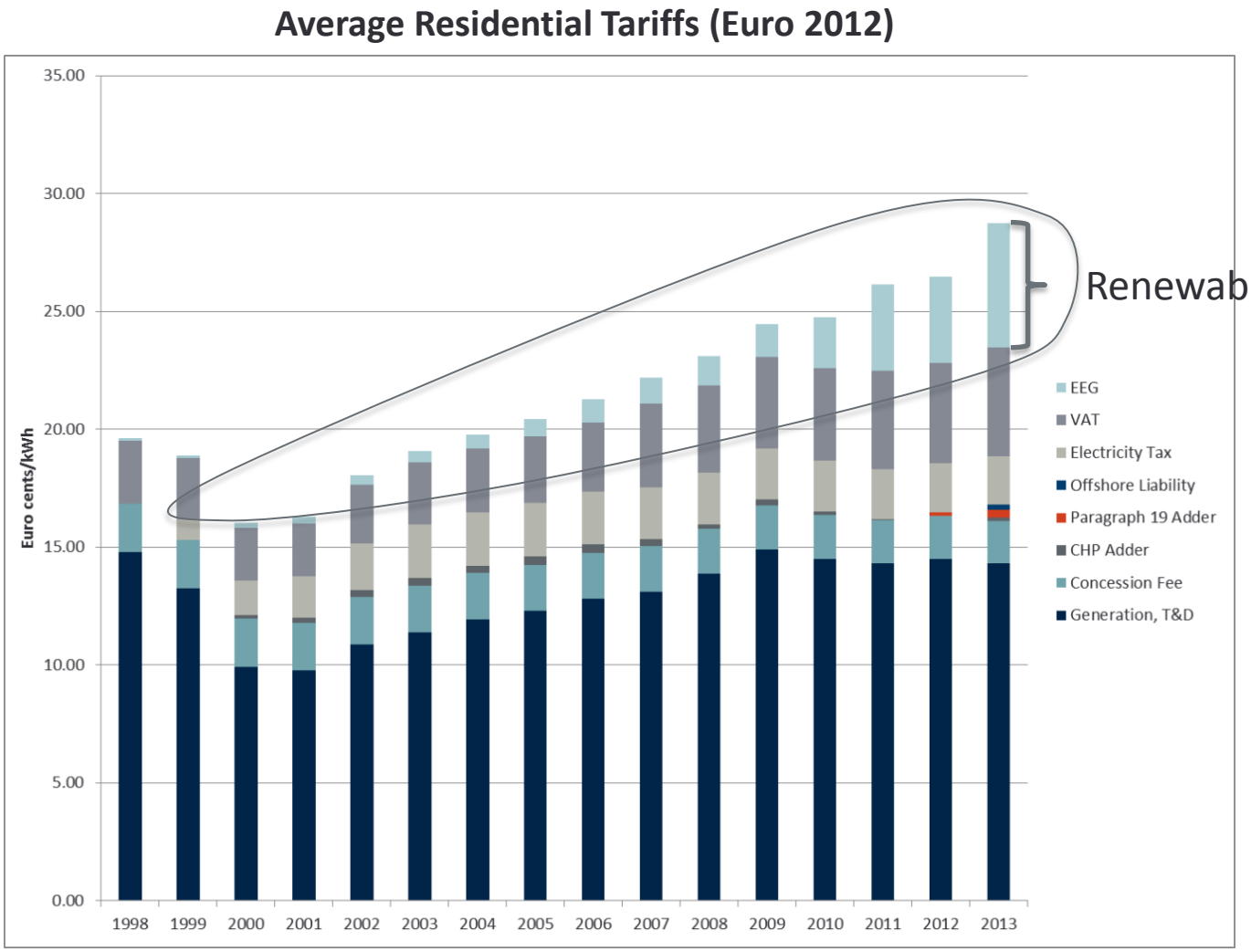
- Germany's RE production (mostly wind, solar PV and some biomass) have increased dramatically
- The expansion of solar PV in the 2009-2012 period was significantly faster than had been expected.
- Given the design of FITs, this locks in significant payments for the next 20 years.
- Germany' residential rates are among the highest in the world
- Ex-post (and perhaps ex-ante), one could have designed a better FIT system
- Larger amounts of intermittent renewable resources change wholesale markets (prices and operations)
- Larger amounts of intermittent RE and DG require different investments in T&D
- [?] Wholesale price "suppression" likely not sustainable
- [?] A solid carbon price should be part of any effort to lower GHG emissions

Decreases in FIT levels mirror cost declines and increases in installations



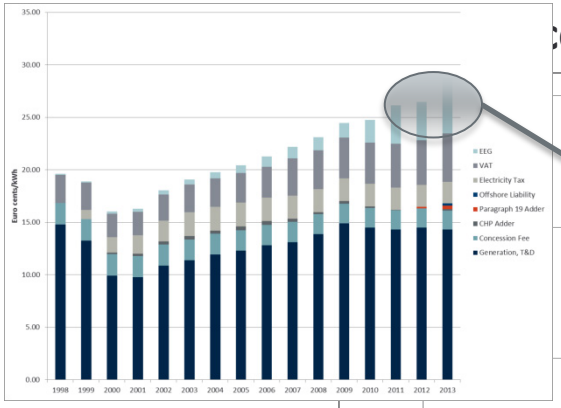
Source: Bundesnetzagentur, The Brattle Group analysis

Residential tariffs are high and have increased alongside the renewables levy

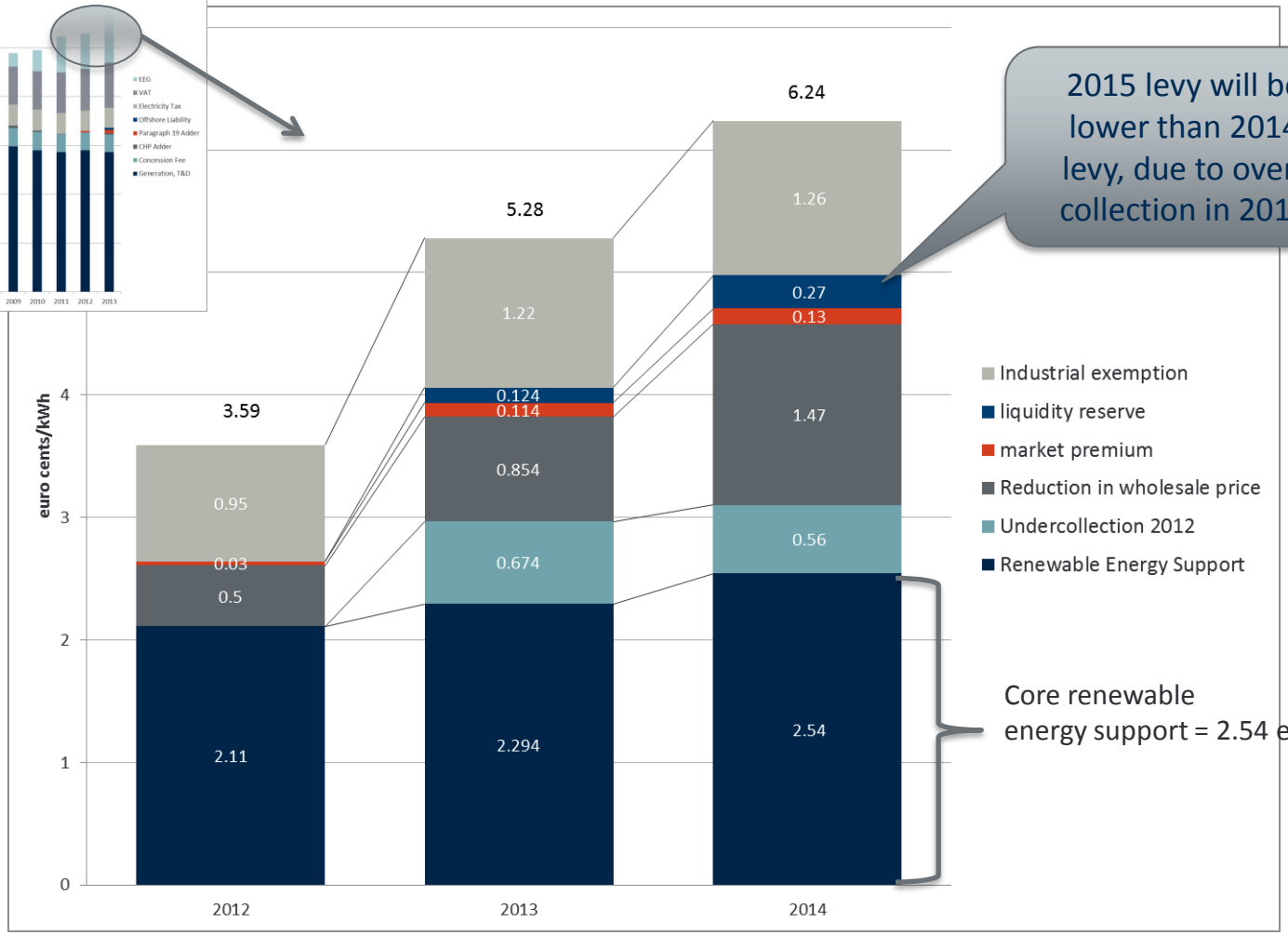


Sources: BDEW Strompreisanalyse November 2013, Worldbank (GDP Deflators), The Brattle Group

A closer look at the renewables levy shows RE levy composed of several components



composition of renewables levy (nominal)

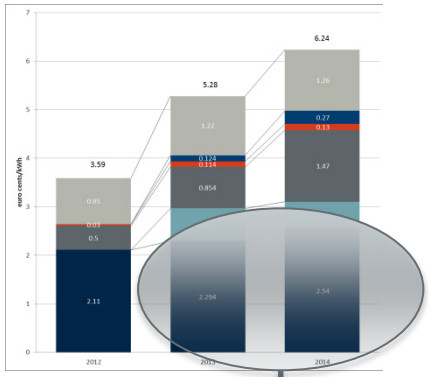


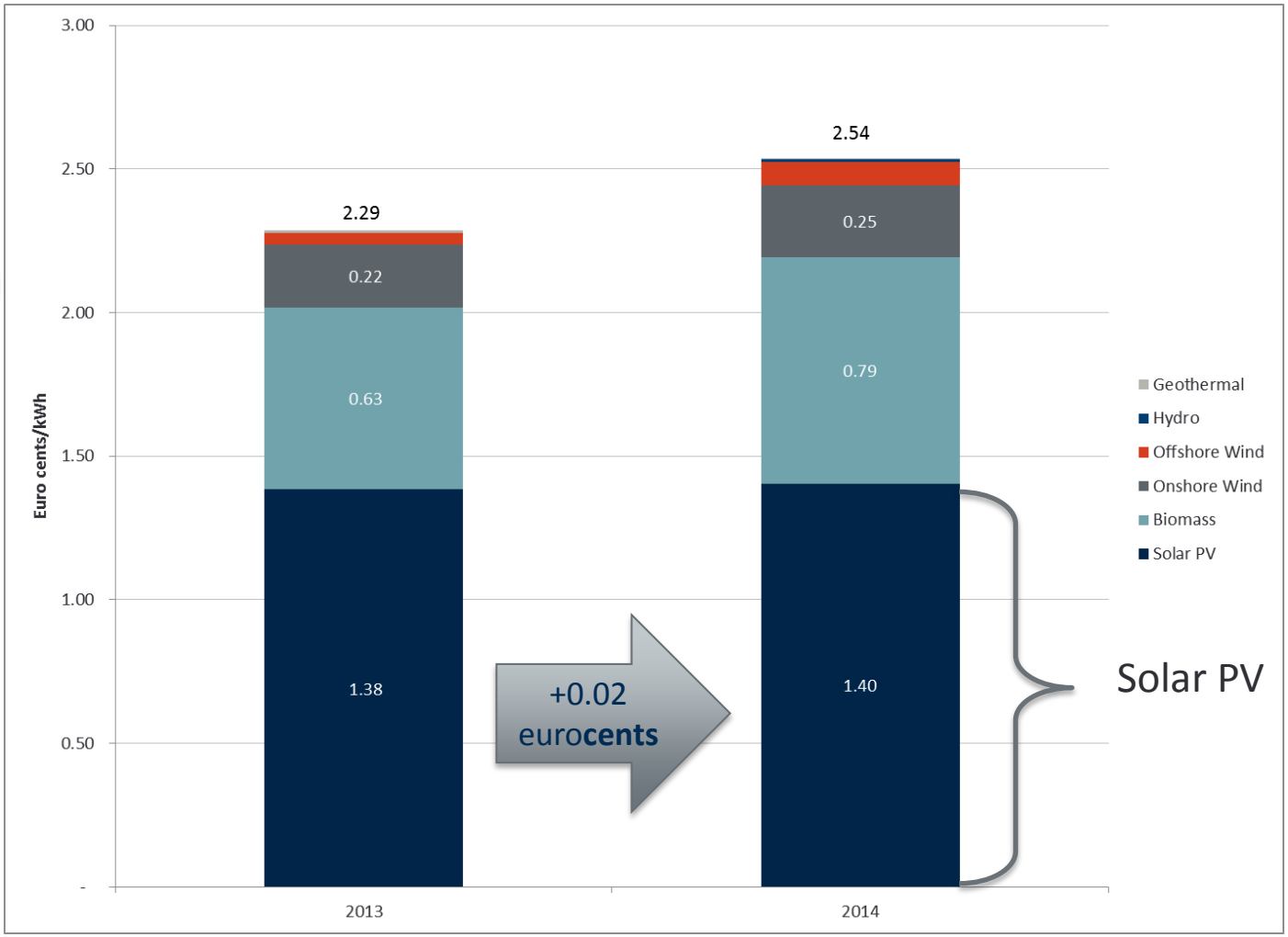
2015 levy will be lower than 2014 levy, due to over-collection in 2014

Core renewable energy support = 2.54 euro cents

Source: Bundesverband Erneuerbare Energien, BEE-Hintergrund zur EEG-Umlage 2013, The Brattle Group

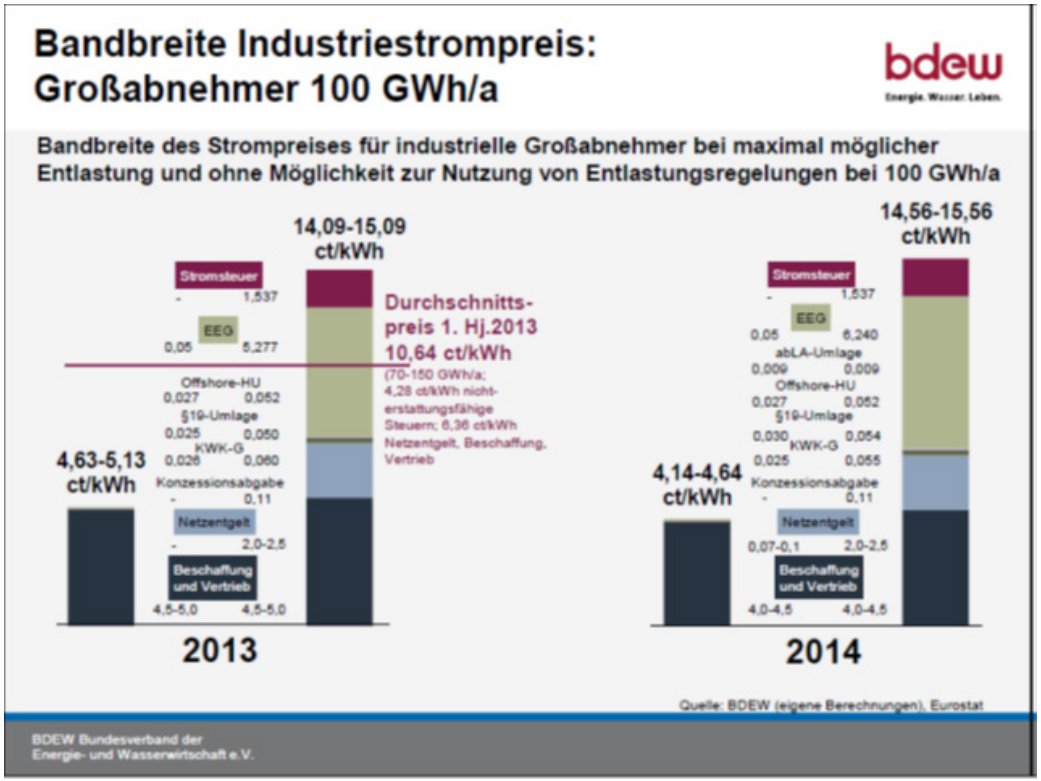
A further decomposition shows that of the 2.54 eurocents about 1.4 are for PV support





Sources: Bundesverband Erneuerbare Energie, The Brattle Group analysis

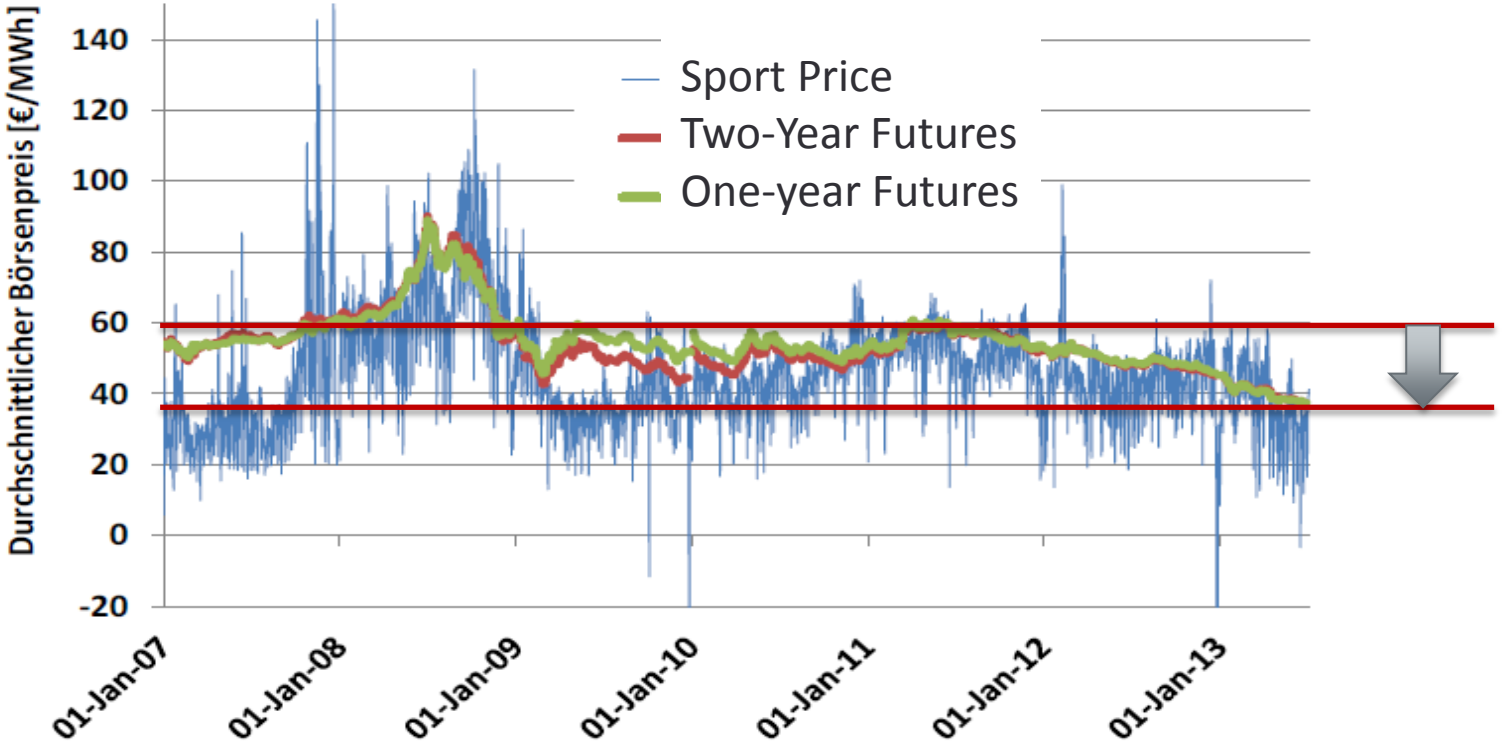
Industry rates are similar to other countries and vary significantly



Source: Reproduced from Figure 32, bdew, Energie-Info: Erneuerbare Energien und das EEG: Zahlen, Fakten, Grafiken (2014).

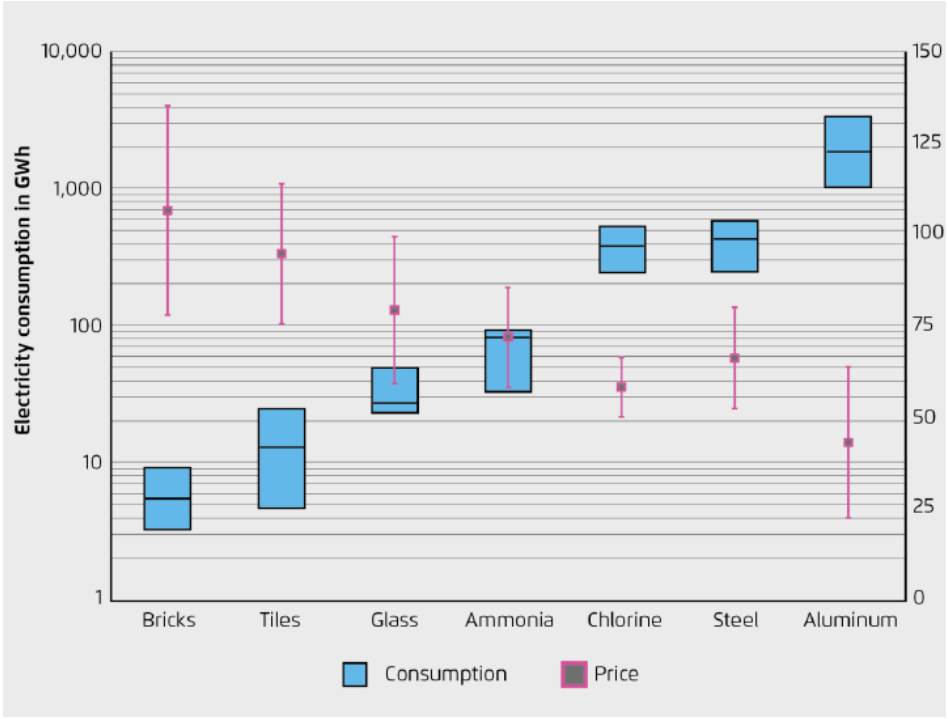
- Large energy-intensive industrial users in trade-sensitive industries are partially/entirely exempt from RE levy
- Some can access wholesale market directly (where prices have dropped – see below)
- Leads to average rates in line with competition
- But requires cross-support from residential, commercial and smaller industrial customers

PV contributed to lower wholesale prices, which benefit large industrial consumers

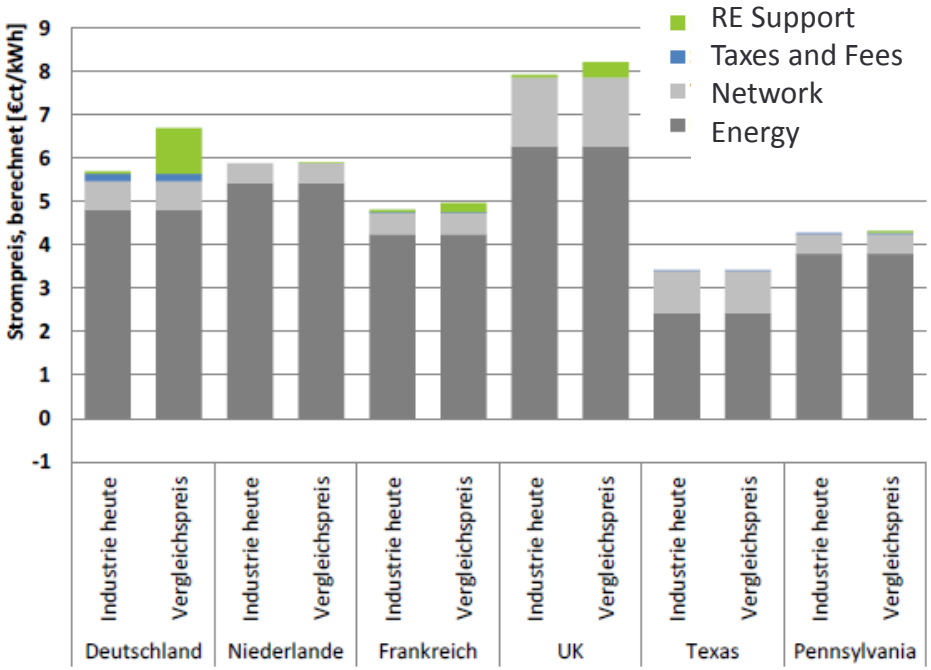


- Significant decline in average prices since 2007 (more since 2008/09)
- Represents savings to consumers
- Large industrials buying directly on wholesale markets benefit in particular
- Likely not sustainable for ever, since fossil generation needed to balance system does not earn enough

Especially if exempt from RE levy and with direct access to wholesale markets

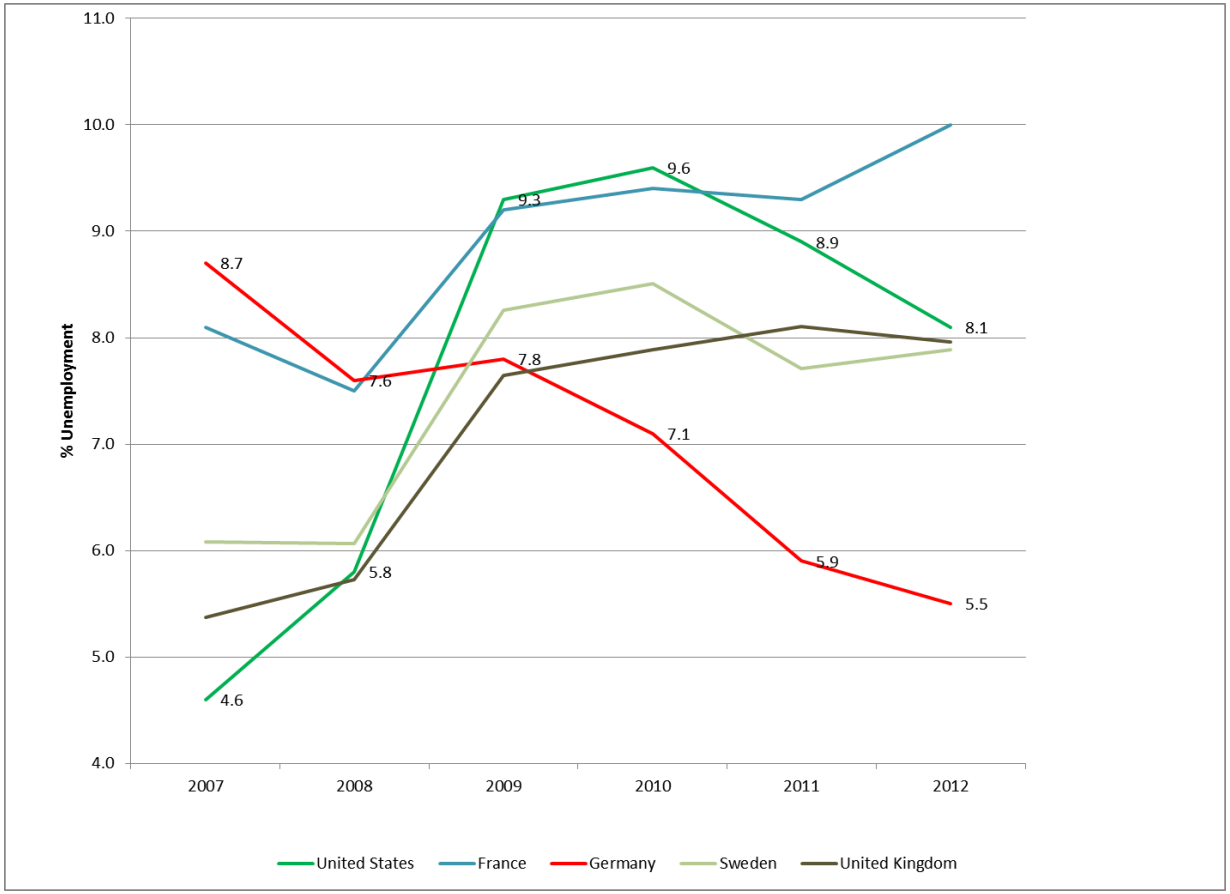


Example: Avg. Industry Prices for Steel Production



Sources: Reproduced from Figure 3, Agora Energiewende, Comparing Electricity Prices for Industry, March 2014. Reproduced from Figure 8, Ecofys/Fraunhofer ISI, Strompreise und ihre Komponenten: Ein internationaler Vergleich, April 2014

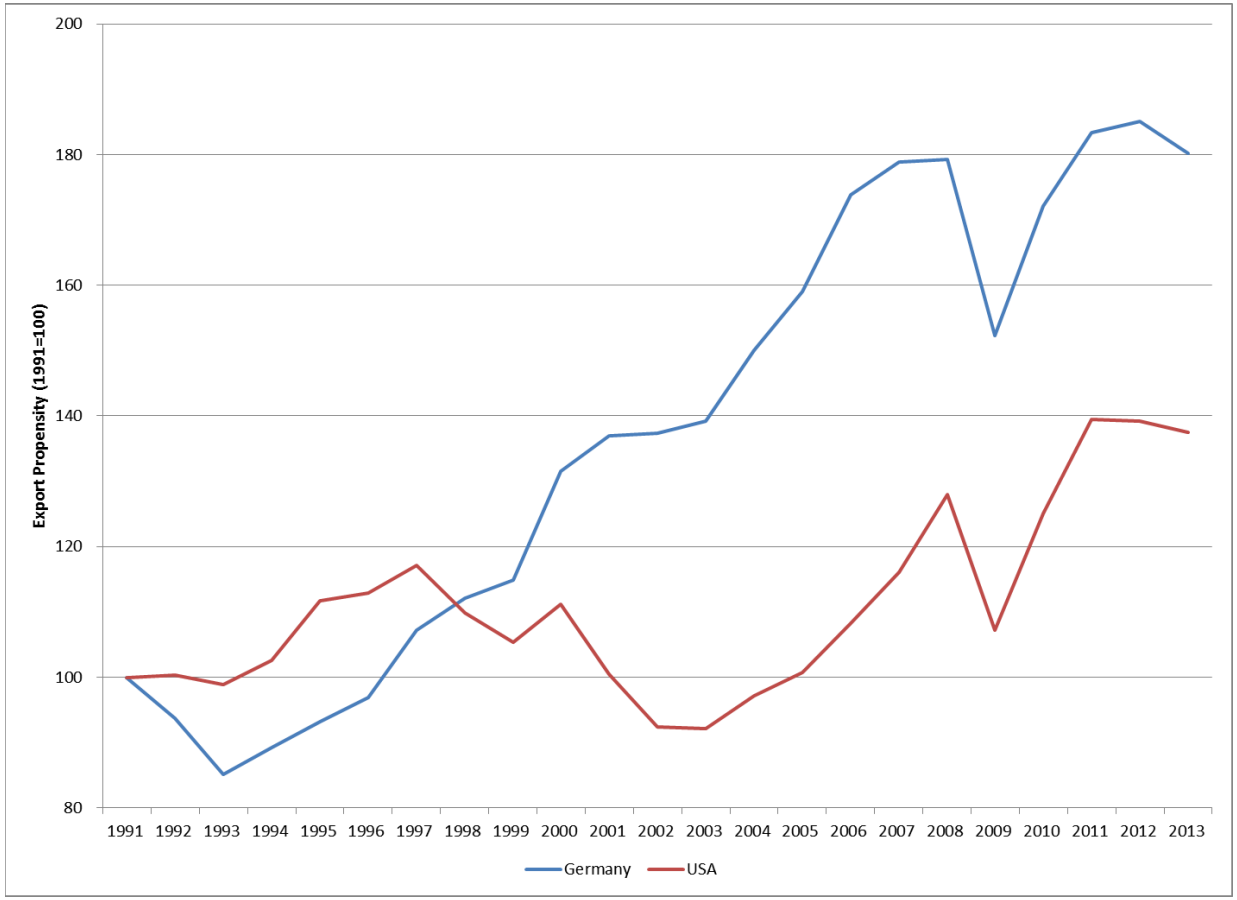
Low industrial rates mean so far no noticeable impact on Germany's unemployment…



Sources: United States Department of Labor, Bureau of Labor Statistics; Monthly employment rates adjusted to US concepts.

Unemployment rate in Germany declined during large increase in PV and RE levy

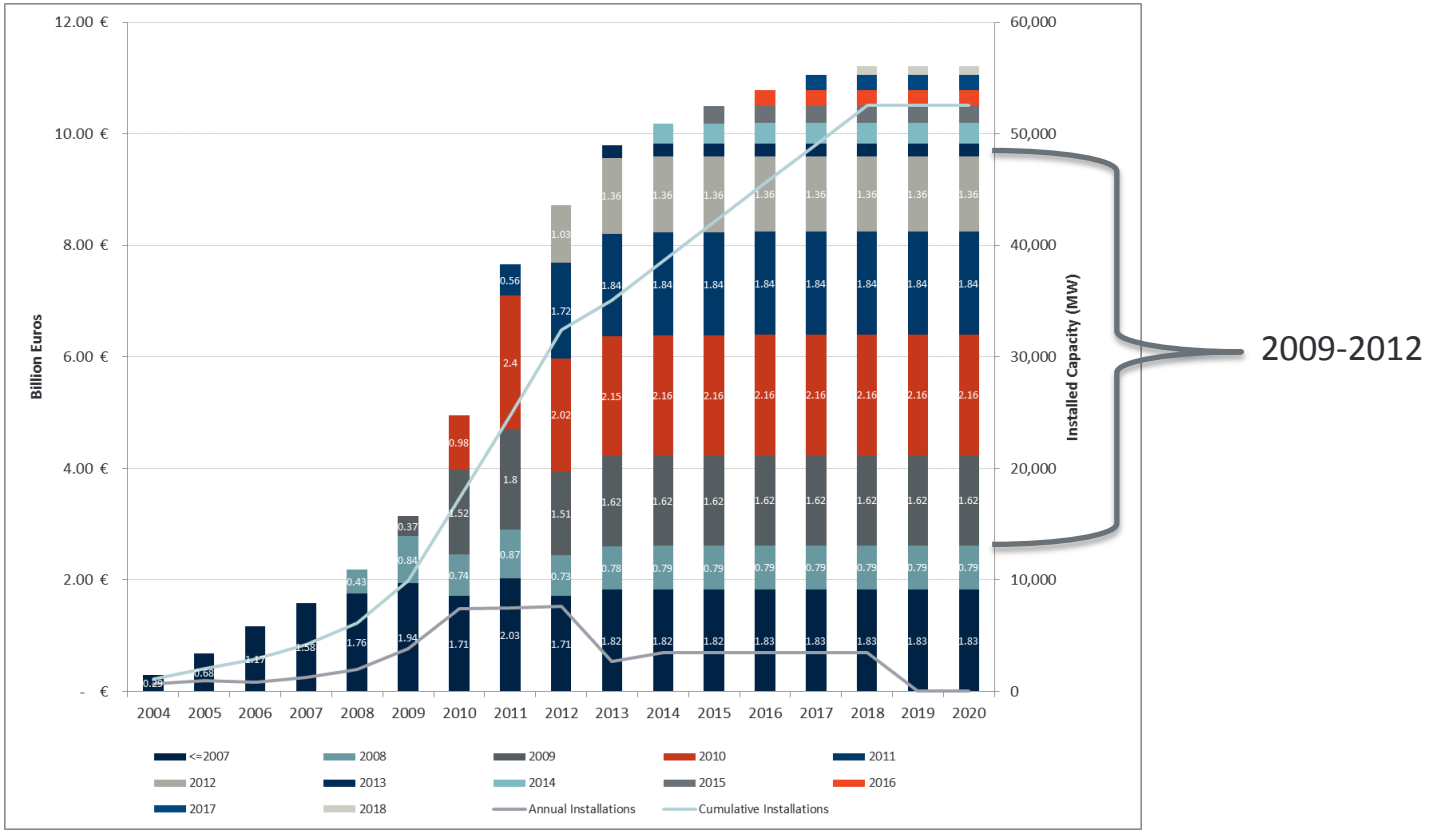
…and Germany has been increasing its export propensity (share of exports in GDP)



Sources: United States Department of Commerce, Bureau of Economic Analysis, Statistisches Bundesamt, The Brattle Group analysis.

RE is likely not CAUSAL in a major way, but so far has not been detrimental either.

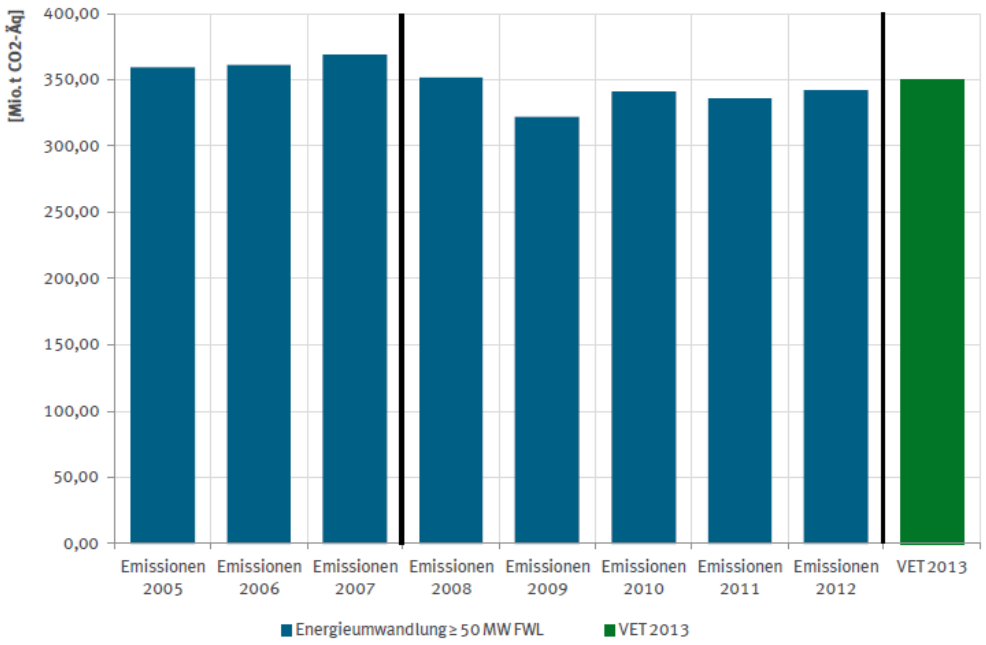
FIT payments for solar PV largely due to 2009-2012 period, but now peaking



Sources: Bundesnetzagentur, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Vorbereitung und Begleitung der Erstellung des Erfahrungsberichts 2014, Vorhaben IIc Stromerzeugung aus Solarer Strahlungsenergie gemäß § 65 EEG, Zwischenbericht, February 2014, *The Brattle Group* analysis.

- FITs didn't adjust fast enough in the past, but going forward would work fine
- Does not mean a well-designed FIT is not a good policy instrument

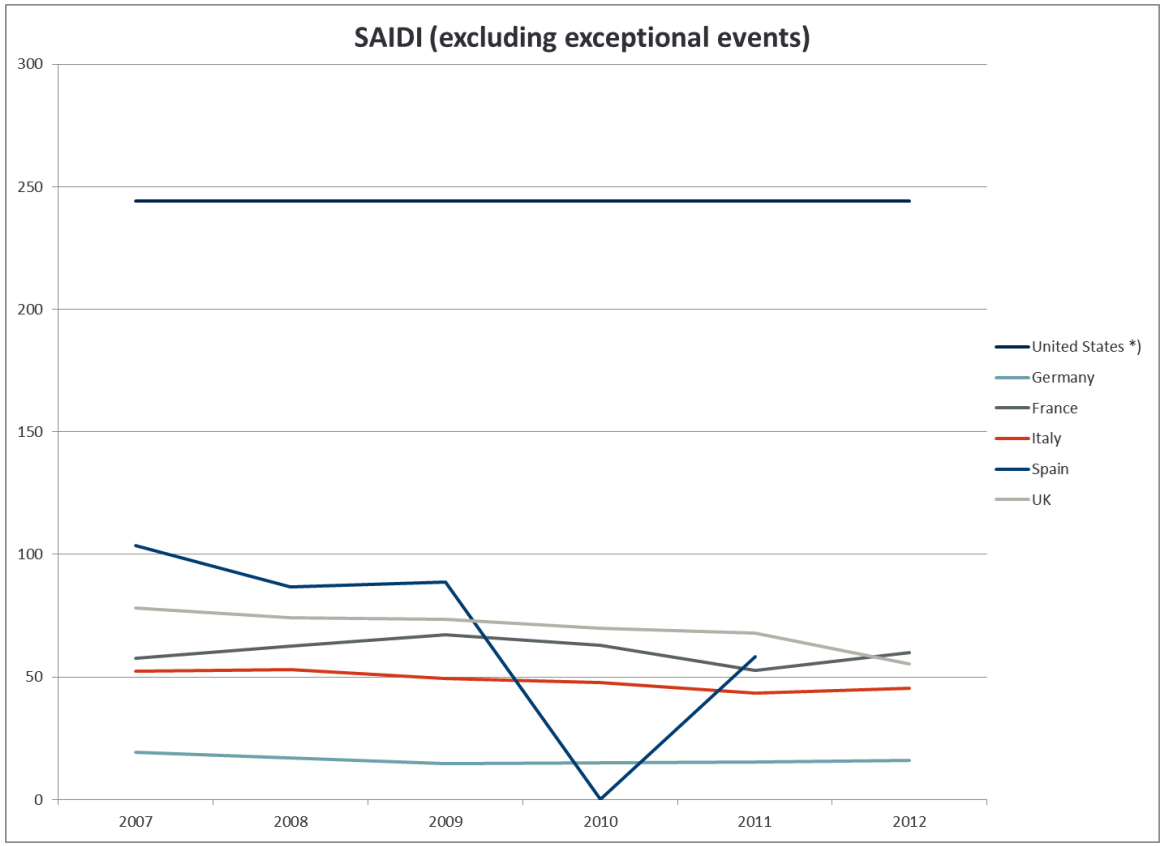
GHG emissions have increased relative to recession low, but not due to RE/PV



- 2009 is not a good base year due to financial crisis
- Increases due to fuel switching from gas to coal (and partial nuclear shut down following Fukushima)
  - Cheap coal prices due to US shale gas boom
  - Expensive EU gas prices
  - Low CO2 prices in EU ETS
- Coal generation is increasing somewhat, but no new projects being planned
  - Current projects due to EU ETS rule change proposals in 2007

Absent RE policies, GHG emissions would likely have increased more

Germany enjoys a highly reliable electric system and has improved during PV boom



- Only 10% of the typical US outages
- Driven significantly by undergrounding of distribution system and higher investments in transmission and distribution

Key Observations – Systems with high RE share

- RE generation now approaches 30%, at or above threshold generally deemed to cause problems
- Integration costs have been increasing, but overall reliability is extremely high and integration costs are (still) a small component of overall costs
  - Short term cost increases due to mismatch between system infrastructure and high RE penetration
    - Increasing curtailments and redispatch (still only +/- 1%), now costing about € 33/€150 million p.a. respectively (FIT payments for PV alone €10 billion)
    - Additional reserves needed (doubled from 3 to 6 GW)
      - Between 3-4% of capacity (additional reserves 3.5% of RE capacity)
- IF future system is close to 100% RE, need the system to change
  - Fix energy and ancillary services markets (slow)
  - Integrate European markets (ongoing, but slow)
  - Perhaps create a capacity market (ongoing discussions)
  - Build more T&D infrastructure (ongoing, perhaps €50 billion by 2030)
  - Improve incentives for RE to participate in markets (main focus of 2014 reforms)

Conclusions

- Important to keep in mind that Germany is committed to phasing out nuclear power and fossil resources (very large popular support)
- Given this broadly supported goal:
  - FIT program has **generally** worked very well
    - Revenue certainty has allowed for a rapid increase in installations and development of competitive/innovative solar industry at rapidly declining costs
    - Exempting big industry from levy unpopular, but likely smart policy – has kept even electricity intensive industry competitive
  - Biggest problem has been one element of FIT design
    - Should have had a FIT that adjusts quicker/automatically
    - More or less fixed now, but late in the game, given that PV costs are close to the cost of other new generation
- Reform move RE much closer to market, necessary for higher RE penetration
  - Allows RE to participate in A/S and perhaps provides better signals re location and generation (negative price hours)
  - **BUT** removes revenue certainty for fixed cost investments, likely increasing costs
  - **BUT** should not be the only area of action (fixing energy and A/S markets, fixing transmission and distribution infrastructure, perhaps capacity mechanism, etc. should have equal priority)

Some alternative lessons for the US

- The changes to the German electricity system, in response to a rapid and large ramp up of RE, provide insides into what WILL happen in the US (and elsewhere)
  - Even without GHG issues, RE (wind and solar) will increasingly compete with conventional sources
    - Is and will increasingly hurt existing fossil generation
    - Will require re-designing wholesale markets
    - Will challenge traditional utility business models
- Yes, one could have designed a better FIT system, but
  - FITs (best of class) are likely far more effective and efficient than the patchwork of state and federal policies in the US
- RE subsidies are likely a part of an electricity sector transformation strategy – nothing new
  - Historic coal and nuclear subsidies far exceed current level of RE subsidies, and ultimately are probably comparable
  - GHG externality is not the only one – most major technological changes don't happen in the market by themselves

About Me

- Energy economist with 20 years professional experience
- Heads *The Brattle Group*'s climate change practice
- Specializes in issues broadly motivated by climate change concerns (renewable energy, energy efficiency, energy storage, the interaction between electricity, gas and transportation, and carbon pricing and the impact these changes have on existing assets, market structures, and long-term planning needs for electric utilities)
- Works in North America, Europe and the Middle East/Asia
- MBA Columbia University, Ph.D. Business Economics Harvard University
- Born in Germany, lived in Germany, France and the United States

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About The Brattle Group

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Our services to the electric power industry include:

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- Transmission

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