

SOLAR PV ROOFTOP POLICIES AND STRATEGIES: THE GERMAN EXPERIENCE

RENEWABLES: A KEY DRIVER FOR CLEAN
ENERGY TRANSITION SOLAR PV ROOFTOP

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ECOFYS

The logo for ECOFYS, featuring the company name in a bold, blue, sans-serif font. Below the text is a green graphic element consisting of a curved line that starts under the 'E' and ends under the 'S', resembling a stylized wave or a swoosh.

A Navigant Company

AT A GLANCE: ECOFYS, A NAVIGANT COMPANY



Global consulting company founded in 1984 with the **mission** to enable **sustainable energy for everyone** – since 2016, Ecofys has been part of **Navigant's global Energy practice**



Ecofys has **five offices** in four countries: Utrecht, the Netherlands; Cologne & Berlin, Germany; Brussels, Belgium; London, United Kingdom – as part of Navigant, our experts are based in **more than 20 offices in the US and Canada, Hong Kong, and the Middle East**



We have over **600 experts** skilled in energy, climate, environment, economy, communication, law, and psychology.



Our strength lies in our strategic understanding of complex energy and climate transition issues: Ecofys **connects the dots** within the triangle between **governments, energy players, and energy-intensive end-users**



Ecofys supports the **German Federal Ministry for Economic Affairs and Energy (BMWi)** in strengthening **energy policy dialogue** with the countries of the **Arabian peninsula**.

GERMANY IS EMBEDDED IN THE EUROPEAN ELECTRICITY SYSTEM

■ „Electrical“ neighbours



Germany at a glance

- Population: 82 million
- Largest economy in Europe, 4th largest in the world
- Gross electricity production 2016: 648,4 TWh
- Primary energy consumption 2016: 13.383 PJ
- Overall installed electricity generation capacity in 2017: 202 GW
- Installed RE capacity: 109 GW
- Installed PV capacity: 42,7 GW

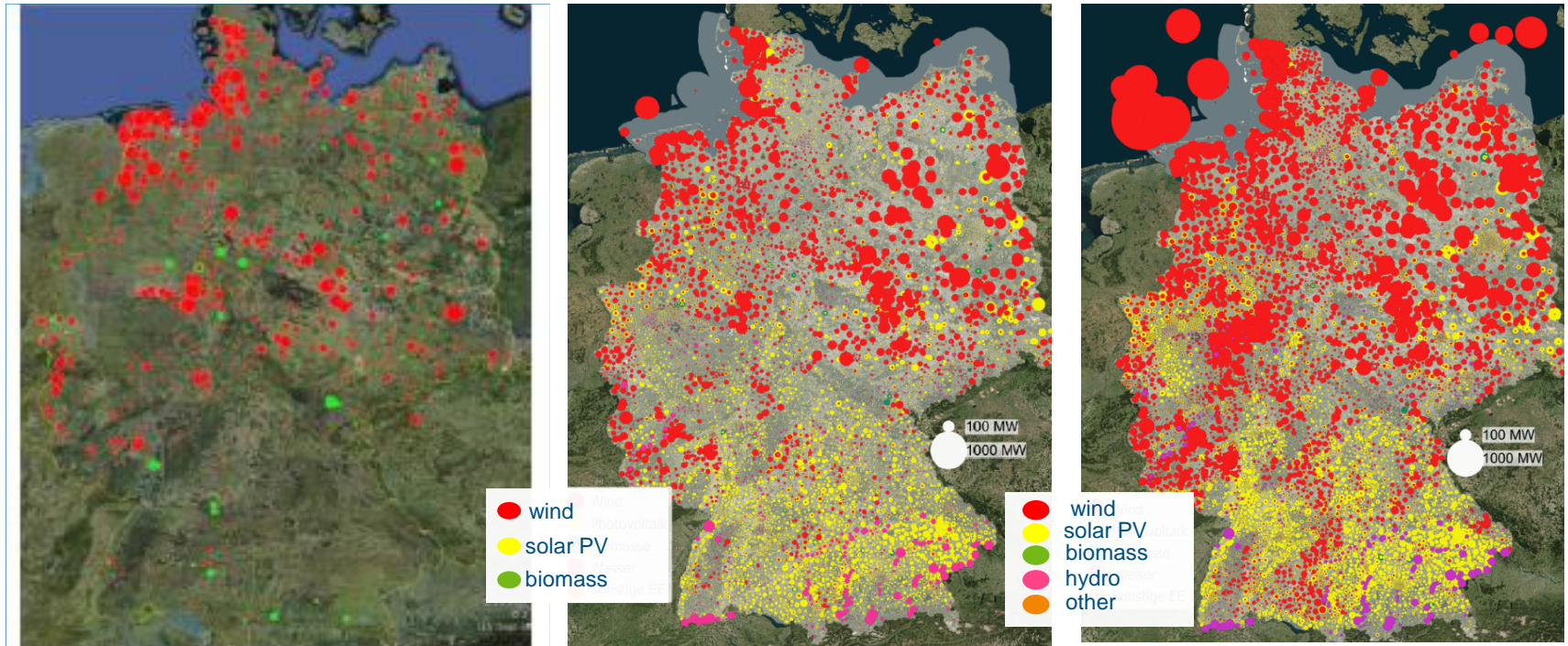
Source: BMWi, 2015, AGEF 2017, Statista 2017

CONDITIONS FOR SOLAR PV ARE MOST FAVORABLE IN SOUTHERN GERMANY

2000

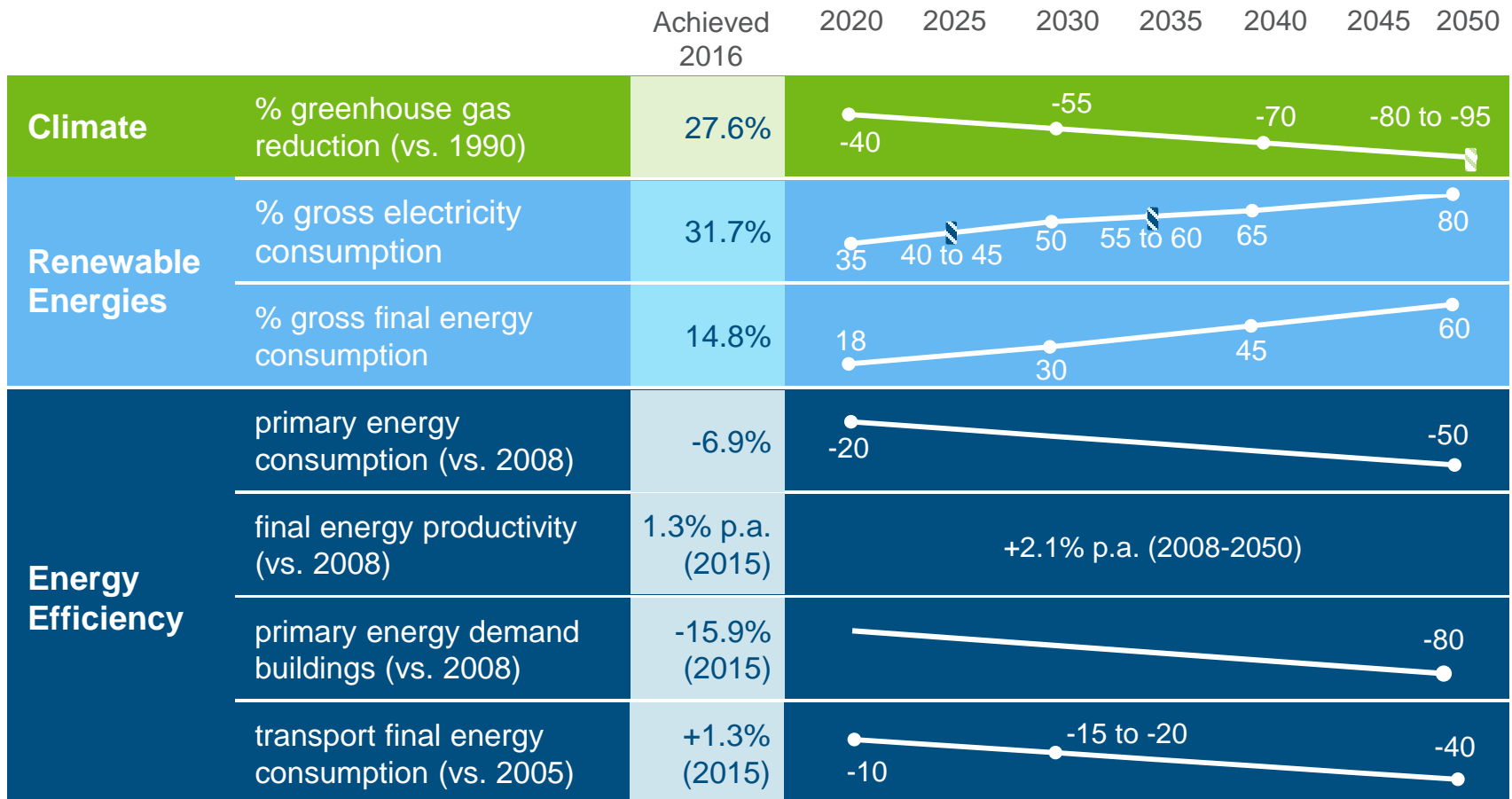
2013

2025



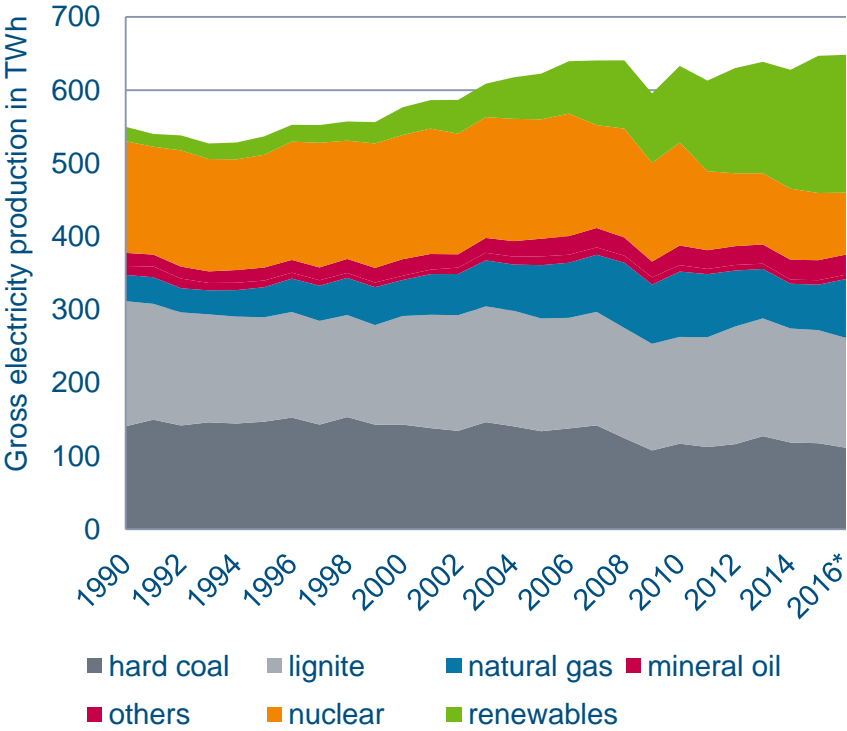
Source: 50Hertz Transmission GmbH 2016

THE ENERGIEWENDE REPRESENTS THE LONG-TERM ENERGY AND CLIMATE STRATEGY OF GERMANY

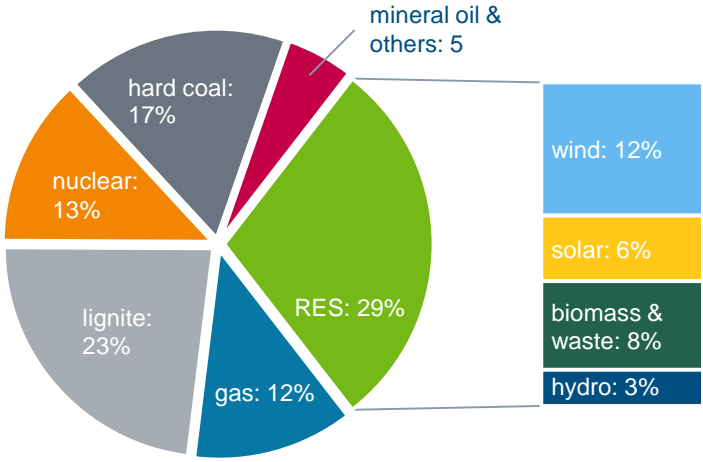


Source: BMWi 2016, UBA 2017

RENEWABLES HAVE BECOME GERMANY'S NO. 1 SOURCE OF ELECTRICITY



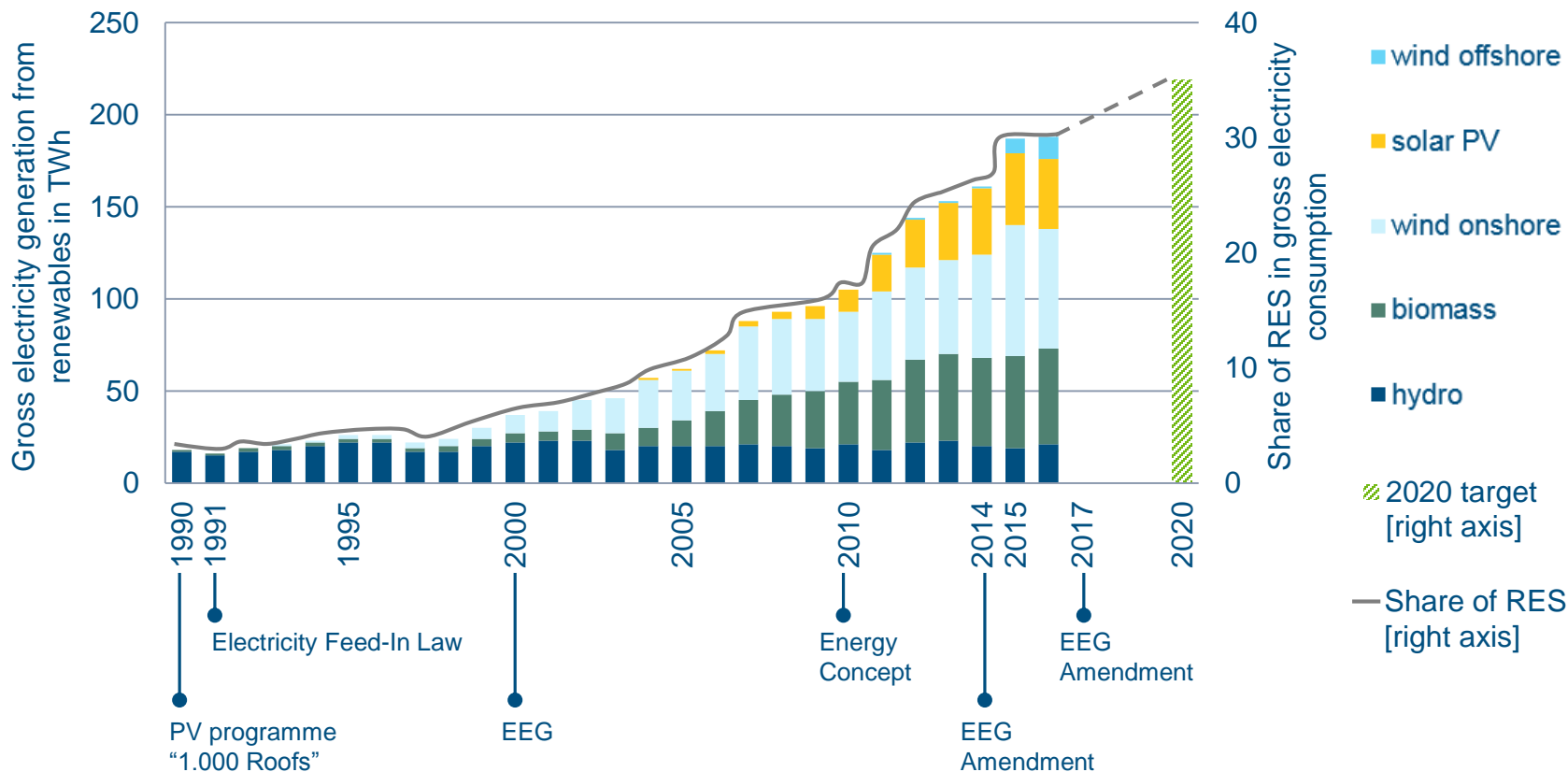
Electricity mix in 2016
(648.4 TWh in total)



* preliminary data
rounded figures

Source: Ecofys 2017 based on BMWi 2016, AGEb 2017

CONTINUOUSLY DEVELOPED POLICIES HAVE FOSTERED THE DEPLOYMENT OF RENEWABLES



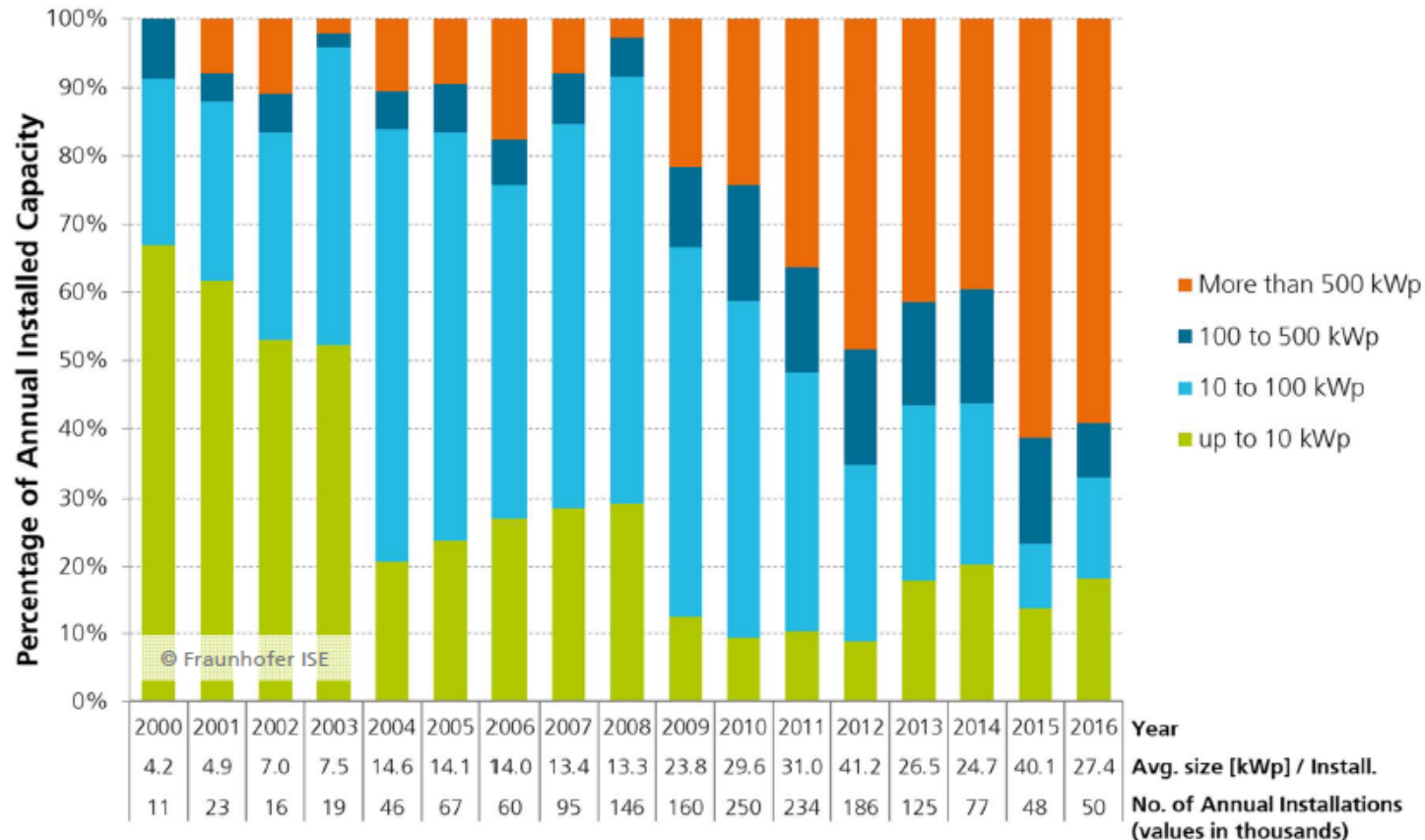
Source: Ecofys 2016 based on AGEESStat 2016

RESIDENTIAL INSTALLATIONS ARE A KEY SEGMENT OF THE GERMAN SOLAR PV ROOFTOP MARKET

Capacity		Market share (Capacity)	Market share (Installations)	Typical operator/ Owner	Estimated share of self consumption
< 10	kWp	30%	70%	private person	30%
10 – 40	kWp	30%	25%	private person, farmer, SME, public sector	40%
40 – 100	kWp	13%	3%	private person, farmer, SME, public sector	40%
100 – 1,000	kWp	23%	1.5%	farmer, SME, public sector, fund, enterprise	40%
≥ 1,000	kWp	4%	0.5%	fund, enterprise	20%

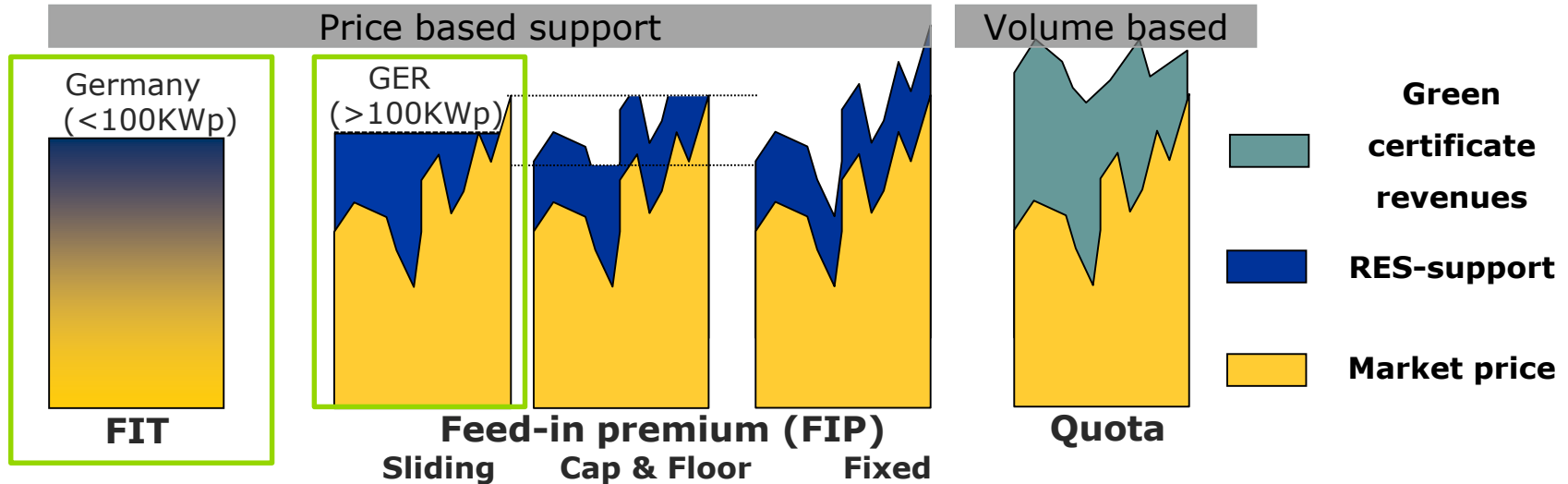
Source: ZSW 2015

THE SHARE OF LARGER PV INSTALLATIONS IN GERMANY IN ANNUAL INSTALLED CAPACITY INCREASES



Data: up to 2008: extrapolation from utilities data; since 2009: Bundesnetzagentur. Graph: PSE AG 2017

POLICY MAKERS HAVE TO DECIDE WHETHER PRICES OR CAPACITY VOLUME OF THE SUPPORT SCHEME SHOULD BE FIXED



Fixed feed-in tariff (FIT)

- Fixed tariff (€/MWh)
- Guaranteed during lifetime or x years
- Purchase obligation

Feed-in premium (FIP)

- Fixed, capped or sliding premium (€/MWh)
- Guaranteed during lifetime or x years
- Power sold on conventional markets

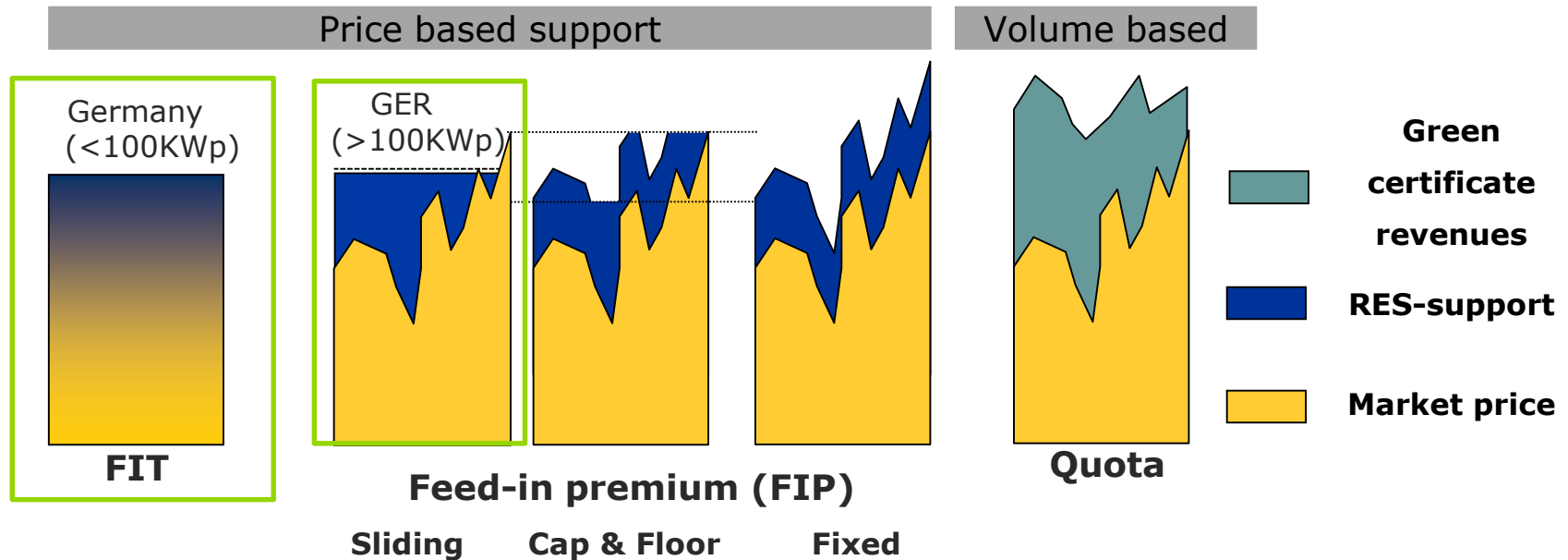
Government fixes price, market decides quantity

Quota

- Obligation for suppliers:
 - Minimum RES-E share
 - Increasing over time
 - Penalty
- Tradable certificates for RES-E production, submitted to authority
- Power sold on conventional markets

Government fixes quantity, market decides price

FEED-IN TARIFFS/PREMIUMS CAN BE DEFINED ADMINISTRATIVELY OR THROUGH COMPETITIVE BIDDING (AUCTION)



„Classic“ FIT/FIP:
government defines support level

Germany (<750KWp)

Auctioning of FIT/FIP:
market defines support level

Germany (>750KWp)

Green certificates:
market defines support level

GERMAN FEED-IN TARIFF SCHEME PROVIDES SECURE INVESTMENT CONDITIONS AND ASSURES COST RECOVERY

Guaranteed tariffs for a period of **20 years** to cover levelized costs of electricity

- **Risk minimization** for investors

Remuneration **per kilowatt-hour**

- Incentive to maximize energy production for plant operators

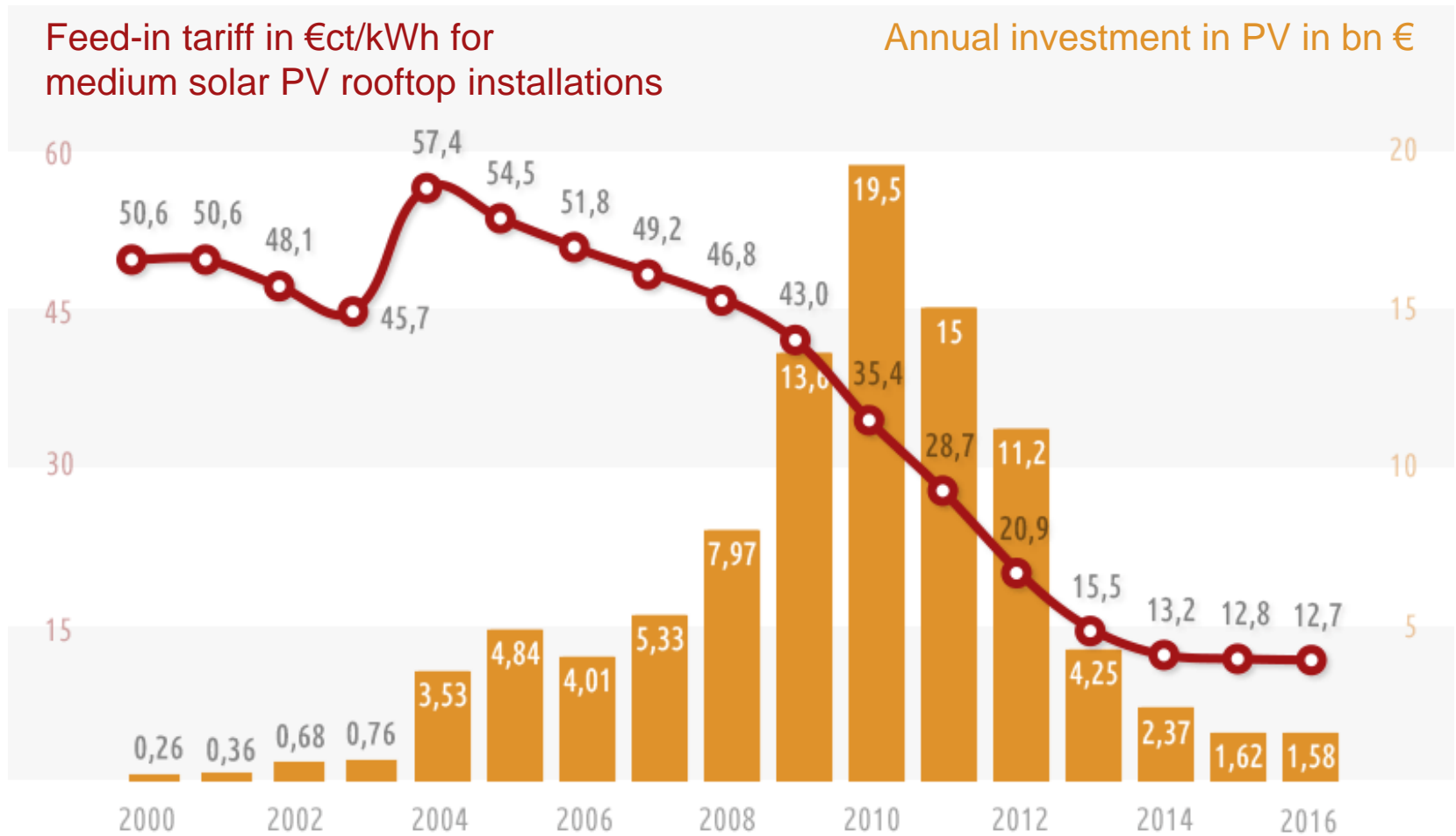
Monthly digression of feed-in tariffs for new installations; higher installed capacity (observed period: 6 months) leads to lower tariffs

- Incentive to innovate and reduce costs
- Indirect control of capacity expansion (target of 2.5 GW/a of PV)
- If capacity additions are below target corridor, tariff remains stable/increases slightly

Financing of the scheme through **levy per kWh consumed**

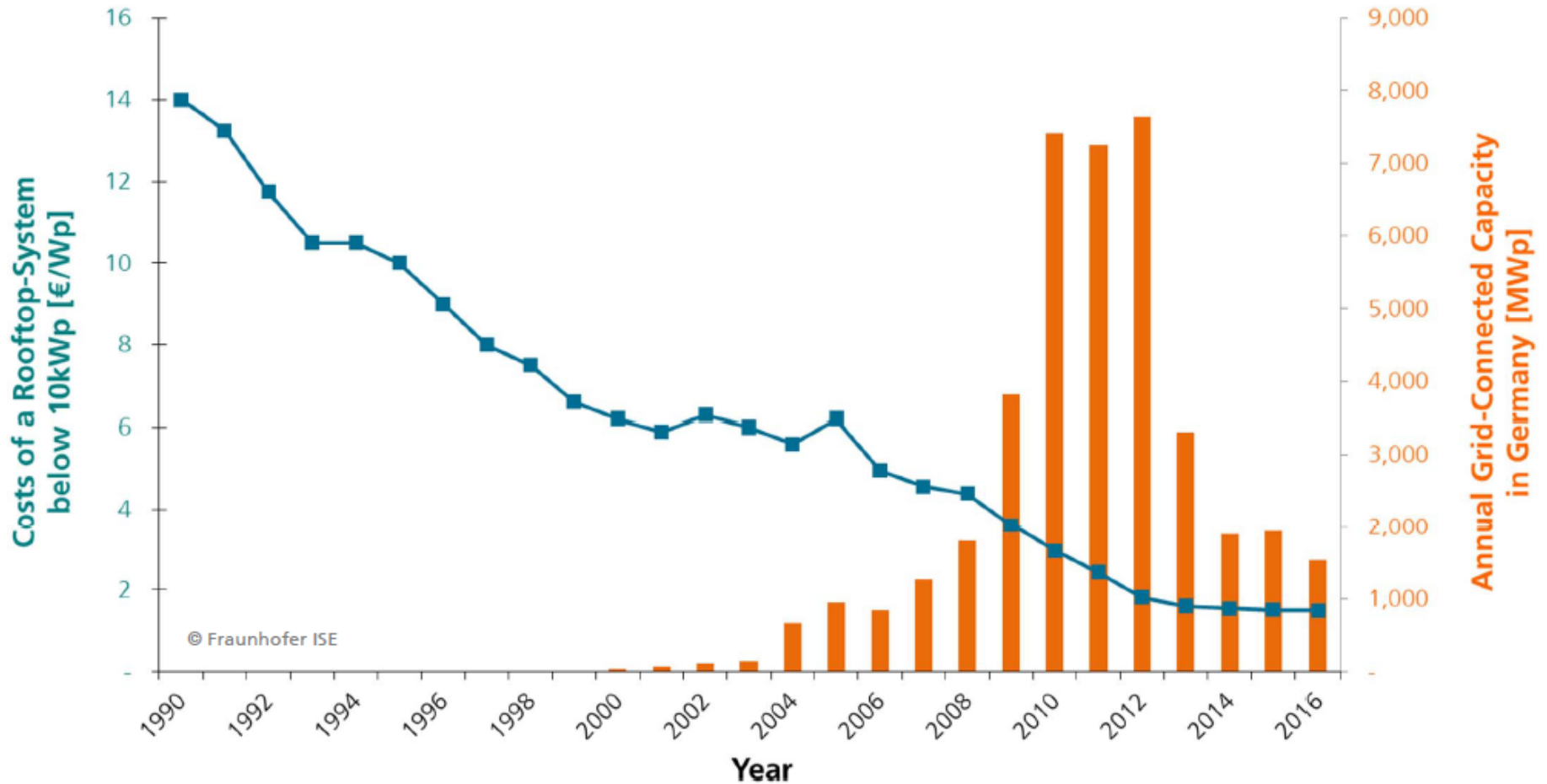
- Stable stream of income
- Outside political sphere (no tax/budget)
- Industry exemptions exist, burden on consumers & small businesses

FEED-IN TARIFFS TRIGGERED IMPORTANT INVESTMENTS IN PV IN GERMANY – PEAKED IN 2010-2012



Source: Strom Report 2016

PRICE DECLINE IN ROOFTOP PV SYSTEMS AND MAJOR PEAK IN CAPACITY ADDITIONS 2010-2012



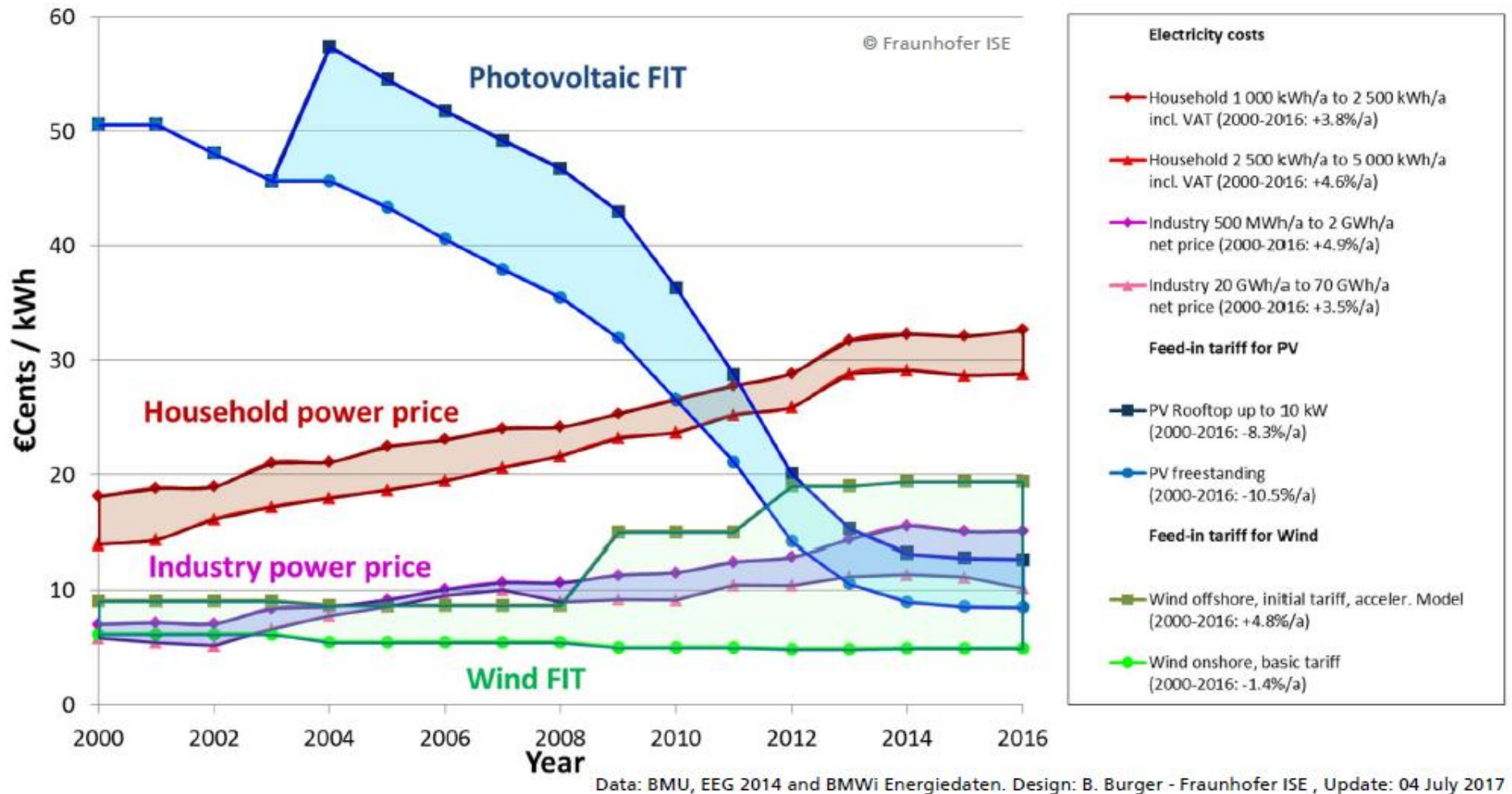
Data: BSW-Solar, BNA. Graph: PSE AG 2017

THE SUPPORT SYSTEM FOR PV IN GERMANY IS ADAPTING TO MORE COMPETITIVE RENEWABLES

- EEG 2017 sets a fixed expansion corridor for RE (2,5 GW PV per annum)
- 2018 will see first combined auctions for PV and wind

Capacity	Policy instrument	Current support level	Autoconsumption
< 10 kWp	FiT, administratively set	EUR 12,20ct	No EEG levy on auto-consumption
10 – 40 kWp	FiT, administratively set	EUR 11,86ct	40% of EEG levy paid on auto-consumed electricity
40 – 100 kWp	FiT, administratively set	EUR 10,61ct	40% of EEG levy paid on auto-consumed electricity
100 – 750 kWp	FiP, administratively set (mandatory direct marketing)	EUR 8,84ct	40% of EEG levy paid on auto-consumed electricity
≥ 750 kWp	FiP, tendered	EUR 4,91ct (average, auction in Oct 2017)	No auto-consumption allowed.

DECLINING FIT FOR PV AND RISING ELECTRICITY PRICES IN GERMANY MAKE AUTO-CONSUMPTION RELEVANT



EASY AND FAST PERMITTING AND INSTALLATION REDUCE COST OF ROOFTOP SOLAR IN GERMANY

- Fast and easy process of permitting/inspection and interconnection (online registration, no permitting fee or inspection required), leads to significantly lower cost of installation than, e.g. in the US
- Dense network of installers, high number of installations led to learning and reduced transaction cost

Step	Small Rooftop PV	Medium and Large Rooftop PV
Permitting (building code)	No permit required	Generally no permit required
Planning and permitting (grid)	Few days	Grid connection request: 8-10 weeks Planning for installation (in parallel): <500 kW: min. 2 weeks 0,5-1MW: min 3 weeks
Installation	Few days	>500 kW: 3 weeks and less 0,5-1MW: 3 to 4 weeks

Data Source: BMWi 2015/ZSW

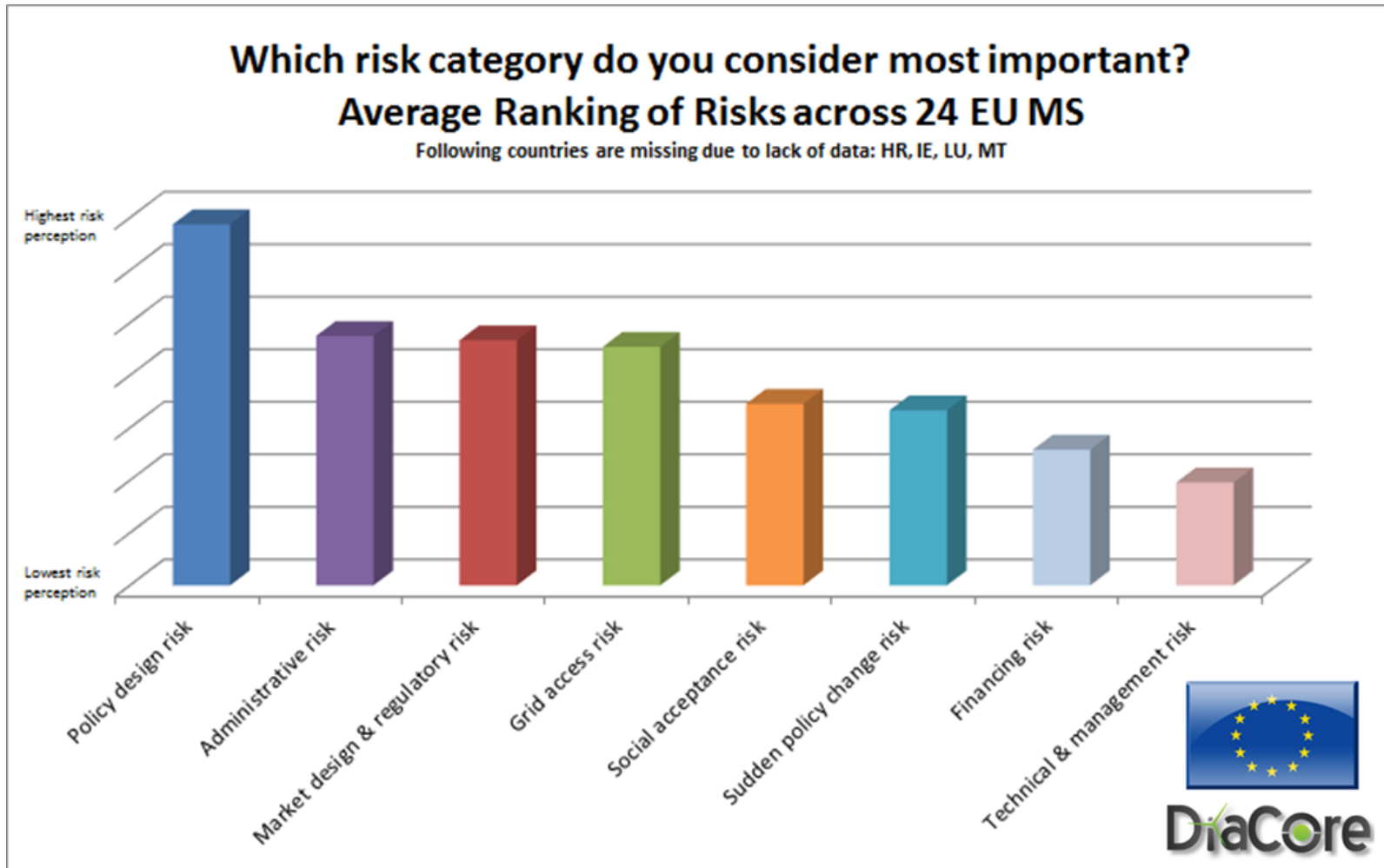
ADVANTAGEOUS FINANCING CONDITIONS FACILITATE INVESTMENT IN ROOFTOP SOLAR

- German Bank for Reconstruction (Kreditanstalt für Wiederaufbau, **KfW**) offers **low-interest loans for RE installations through commercial banks**
- Program 270: Max. EUR 50 million
 - Up to 20 year **guaranteed rates**
 - Starts from 1,2%, **interest-free period at the start of the loan**
 - May finance **100% of investment**
- Program 275: Special program for **PV & storage**, interest rates from 1,1%, up to 13% grant

- Attractive financing offers are also available from commercial banks – strong regulatory framework reduces risk
- Investment can be depreciated over 20 years
- VAT can be recovered through tax declaration



POLICY, ADMINISTRATION AND MARKET DESIGN UNCERTAINTY ARE MAJOR RISKS, INCREASING COST OF RE



Source: DiaCore Project 2016

CORNERSTONES OF GERMAN (ROOFTOP) PV SUPPORT POLICY

KEY DRIVERS

1. **Long-term certainty and risk mitigation** through levy-financed feed-in tariffs covering cost and guaranteed for 20 years and **priority feed-in** for renewables
2. Gradual shift to **market integration** – through direct marketing, market premium and auctions - for (larger) PV rooftop installations
3. **Low administrative burden** for installers and owners of rooftop PV
4. Easy **access to low-cost finance** through public bank KfW
5. **Low cost of permitting and installation** compared to other jurisdictions
6. Strong **societal and political consensus** creates positive investment climate



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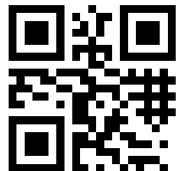
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BACKUP SLIDES

RENEWABLES HAVE BECOME QUITE CHEAP. WHY IS THERE STILL A NEED FOR SUPPORT?

Challenges of competing in the wholesale market

- Investors and lenders ask for investment certainty (high share of capital costs, low operating costs)
- Electricity infrastructures and markets have not been designed to accommodate RES-E (merit order effect, need for grid reinforcement, etc.)
- No level playing field for RES-E in some countries (e.g. market power of large utilities)
- Some RES-E technologies still going through learning curve
- External costs of fossil/nuclear power not fully internalised

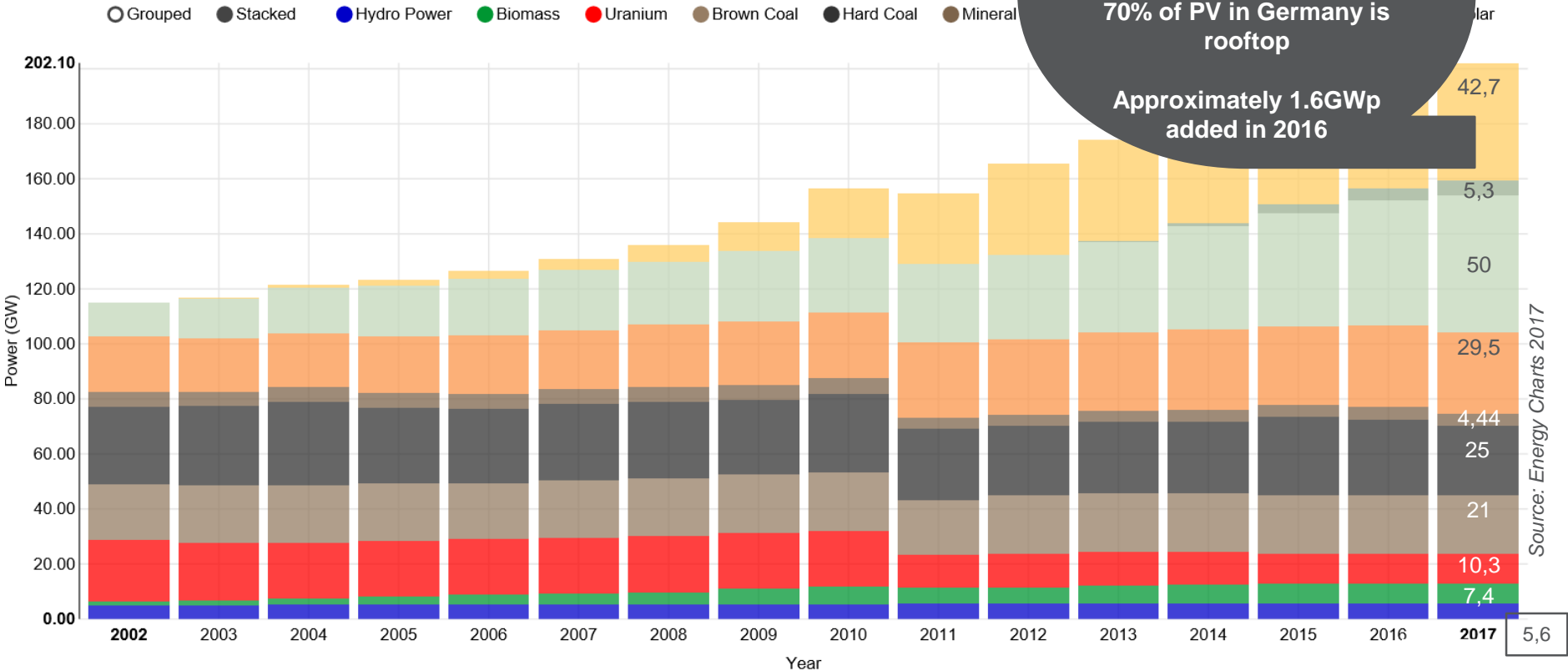
Grid parity of RES-E on distribution level already reached in many countries, but question who pays for system services and consumer levies (e.g. for RES).

MORE THAN HALF OF GERMANY'S INSTALLED CAPACITY IS RENEWABLE

Corresponds to about 13% of the world's installed PV capacity.

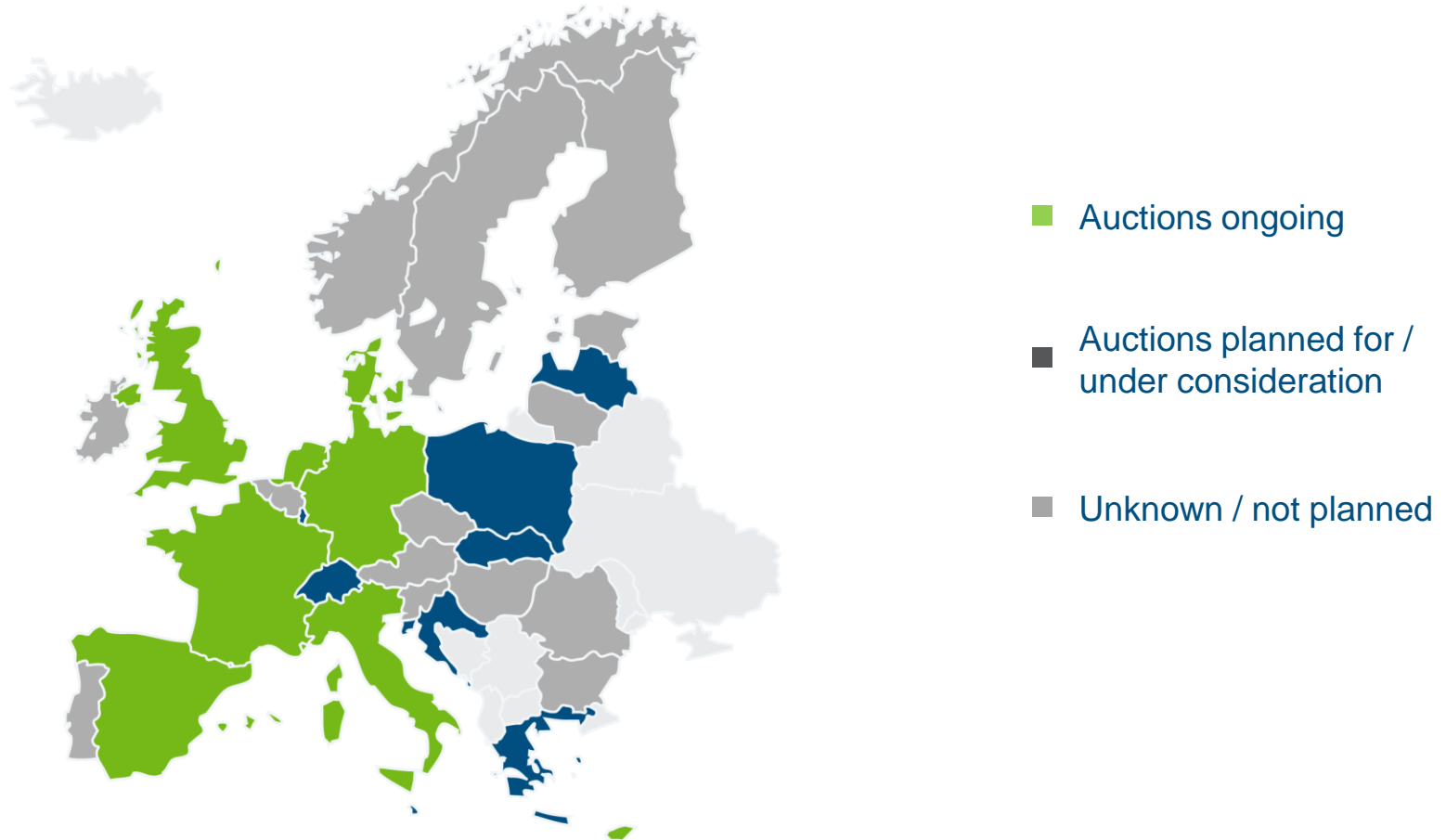
70% of PV in Germany is rooftop

Approximately 1.6GWp added in 2016



Datasource: AGEE, BMWi, Bundesnetzagentur
 Last update: 03 Dec 2017 13:35

EU MEMBER STATES INCREASINGLY INTRODUCE AUCTIONS TO DETERMINE SUPPORT LEVELS



Source: Ecofys 2016

GENERAL OPPORTUNITIES AND CHALLENGES OF AUCTIONS FOR RENEWABLES

Opportunities

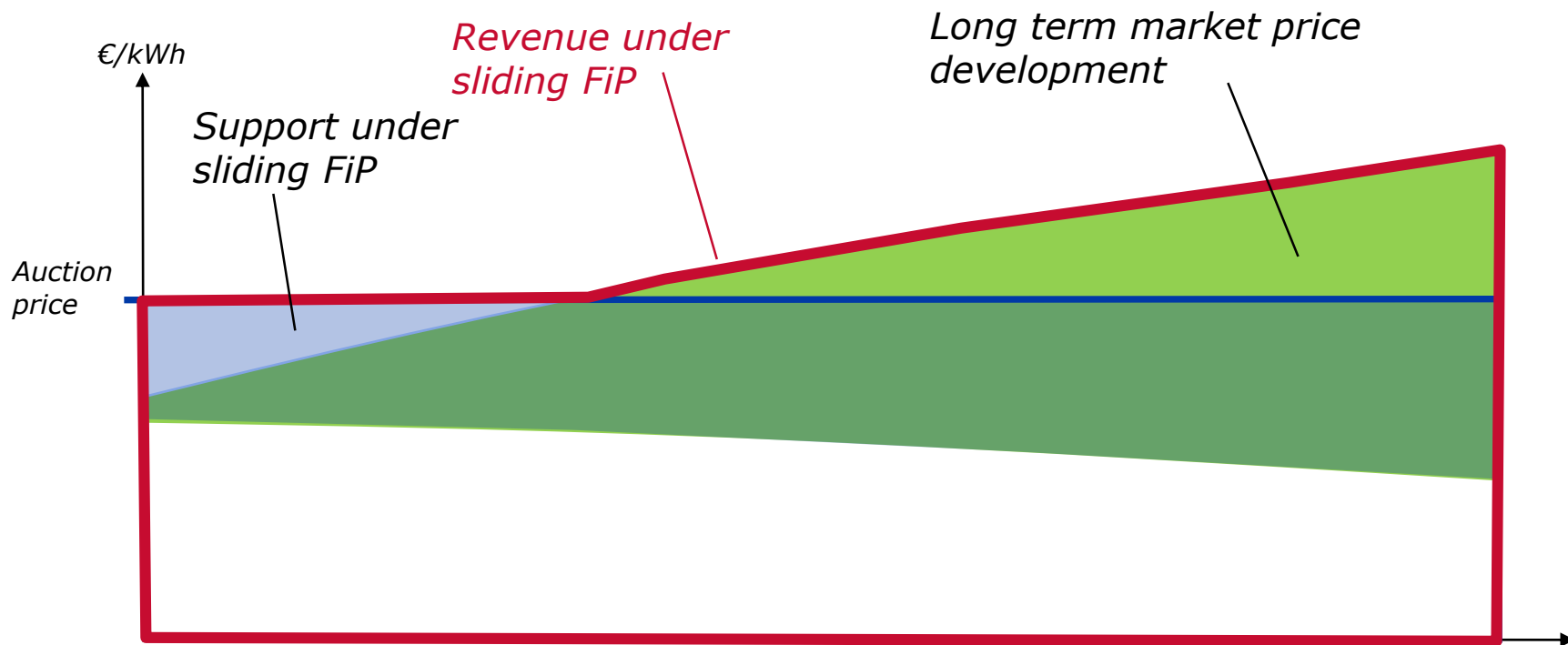
- > Control of maximum volume and support cost
- > Support level is determined by the market, not the administration
- > Competition between RES-E producers may lower prices (compared to administrative FIT/FIPs)
- > Potential to discover real production cost of RES-E

Challenges

- > Ensuring sufficiently high realisation rates/target fulfilment
- > Higher risk for RES-E producers than administrative FIT/FIP, favouring bigger market actors
- > Risk of underbidding or “winner’s curse” leading to prices below costs and non-realisation of projects
- > Risk of strategic behaviour (collusion) leading to high prices and support costs

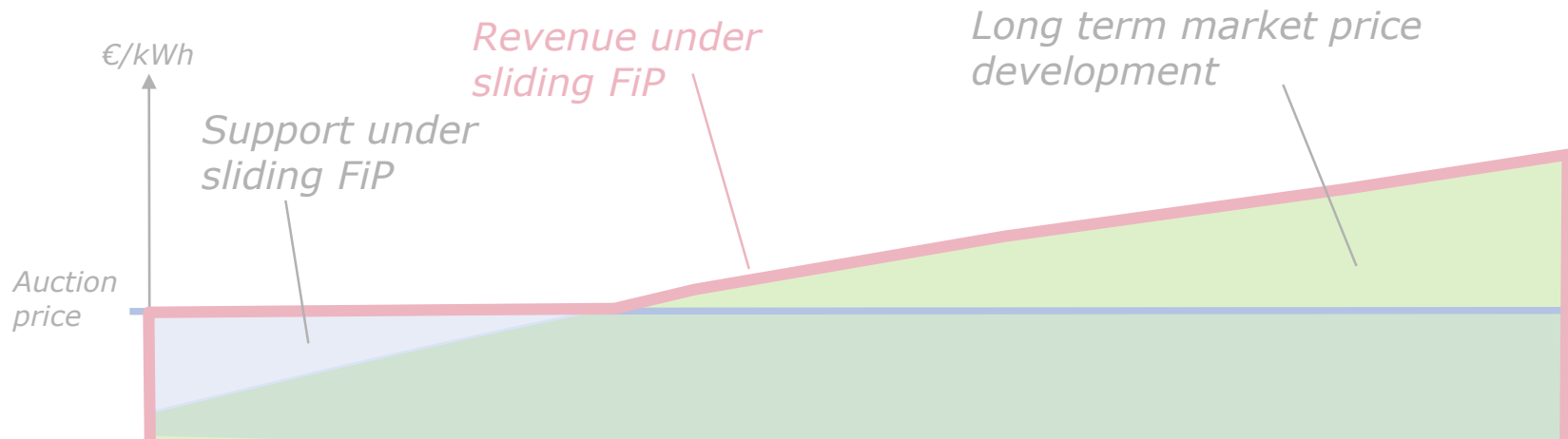
DESPITE ZERO-BIDS IN GERMANY, DEVELOPERS STILL RECEIVE REVENUE FROM MARKET

Revenue and support under a sliding market premium



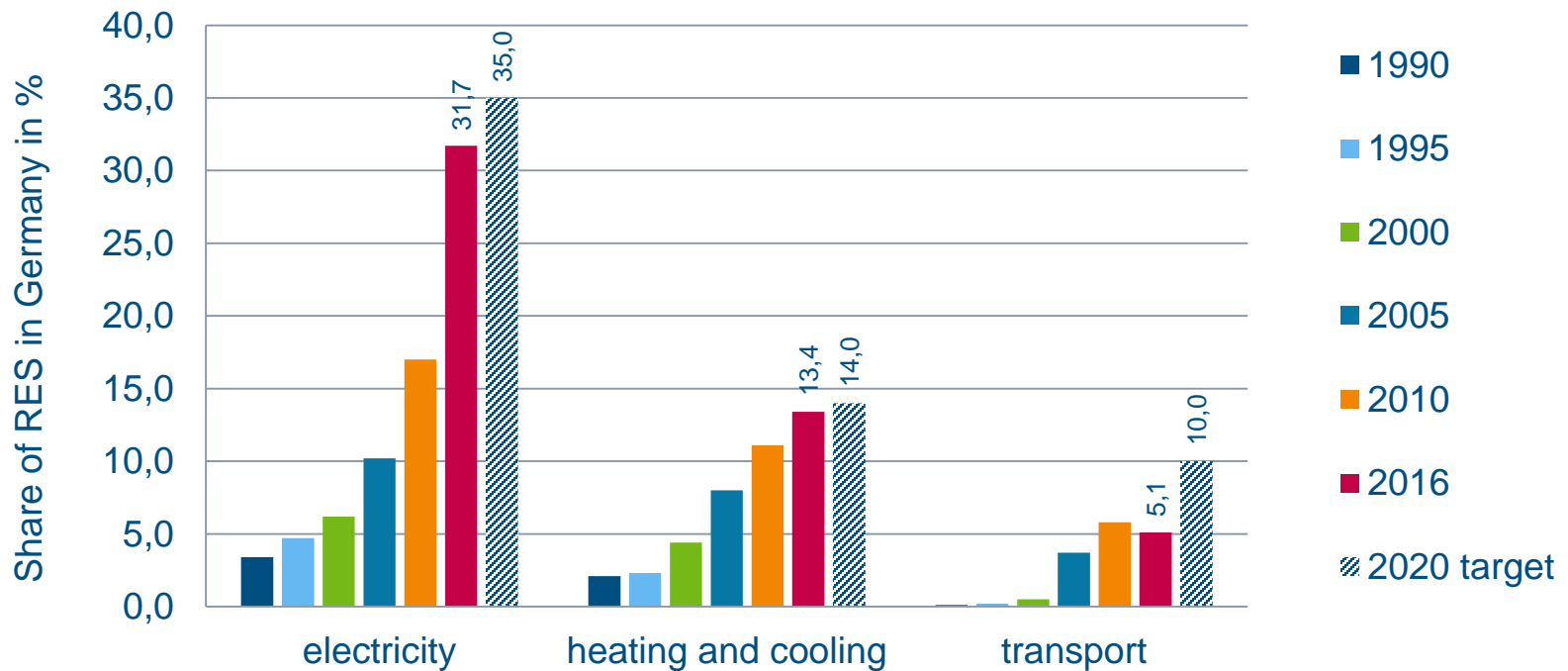
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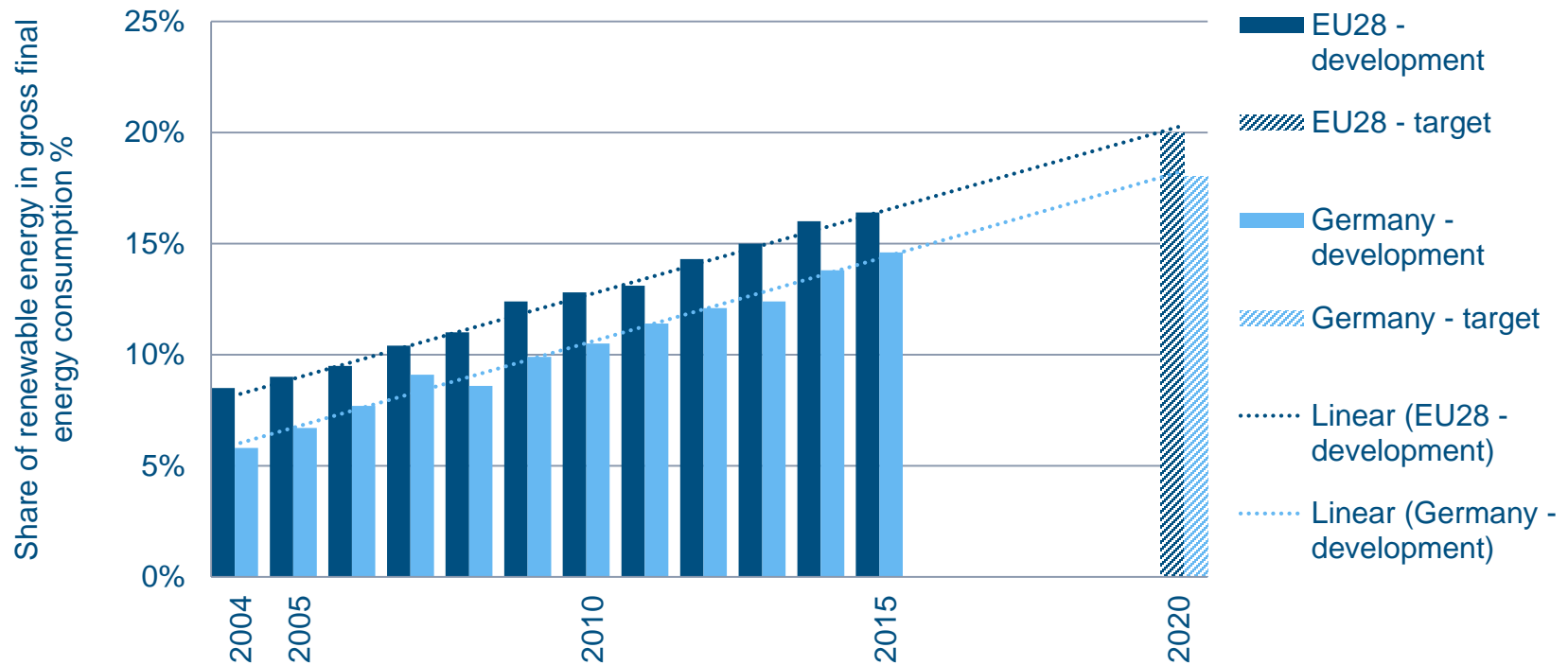
- Revenue under sliding FiP is not given by the auction price only, but also by market price
- “Zero bids” mean that project will be built without a subsidy.
- Developers still receive revenue from the sale of electricity

SHARE OF RENEWABLES HAS GROWN IN ALL SECTORS, BUT FASTEST IN ELECTRICITY



Source: Ecofys based on AGEE-Stat 2016, BMWi 2016, Agora 2017

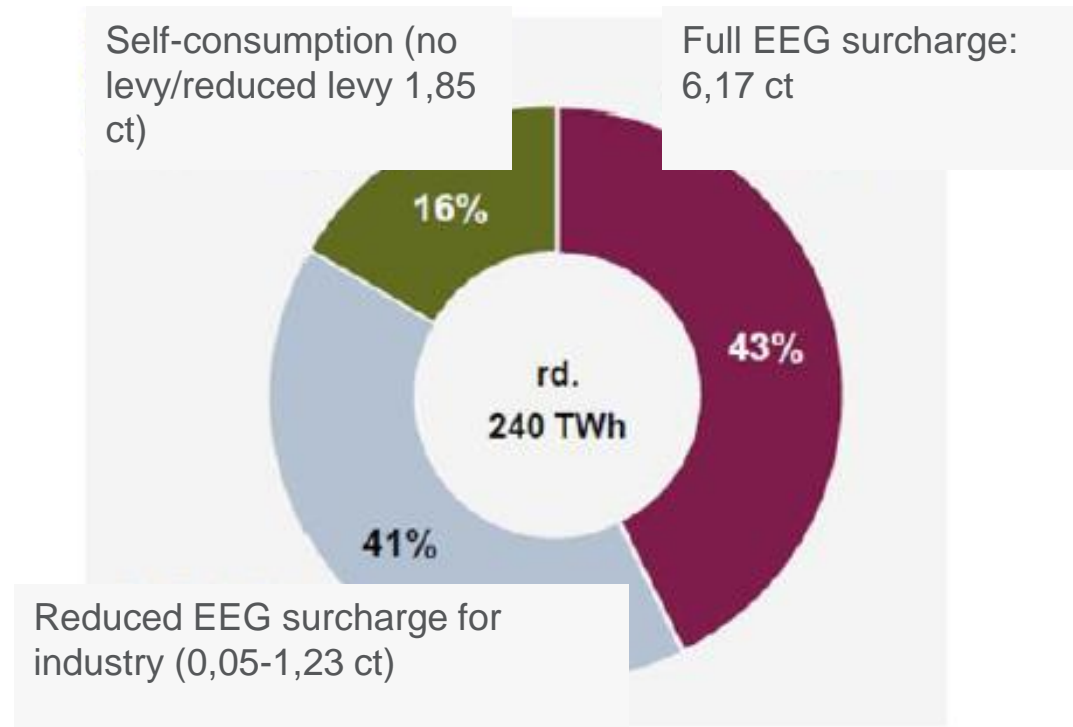
THE EU AND GERMANY ARE ON TRACK TO ACHIEVE THEIR RENEWABLES GOALS



Source: Ecofys 2016 based on Eurostat 2016 and EC 2017

INDUSTRY EXPOSED TO COMPETITION IS EXEMPTED FROM EEG LEVY

- Energy-intensive industries are exempted from the EEG surcharge to a large extent
- Exemptions worth 4.8 billion euros in 2015
- Large share of electricity consumption in Germany is exempted from surcharge



Source: Fraunhofer ISE 2017 (Recent Facts about PV in Germany)

THE PRICE OF SOLAR PV ROOFTOP INSTALLATIONS IN GERMANY IS DECLINING

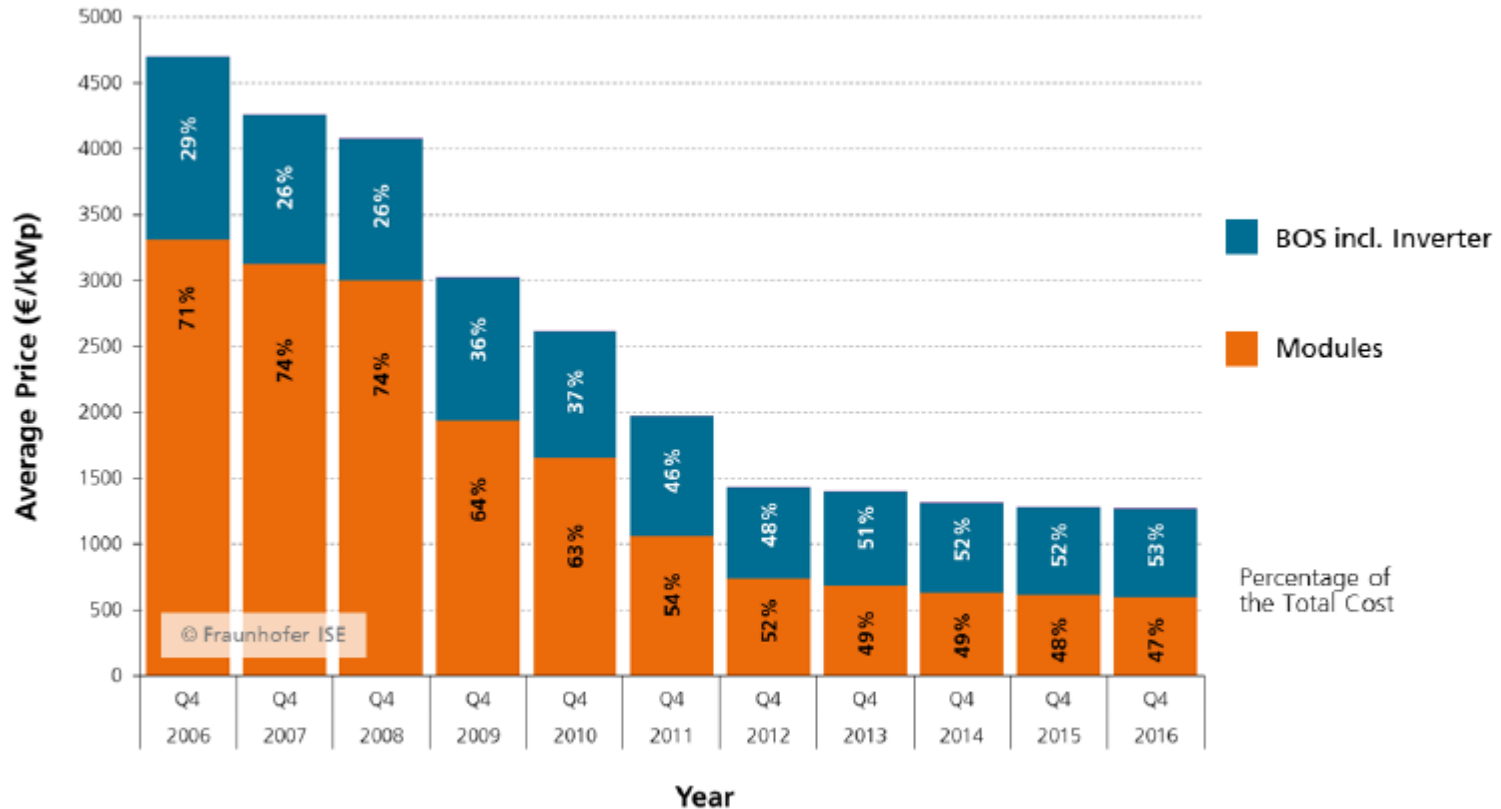


Figure 3: Average end customer price (net system price) for installed rooftop systems with rated nominal power from 10 - 100 kWp, data from BSW, plotted by PSE AG.

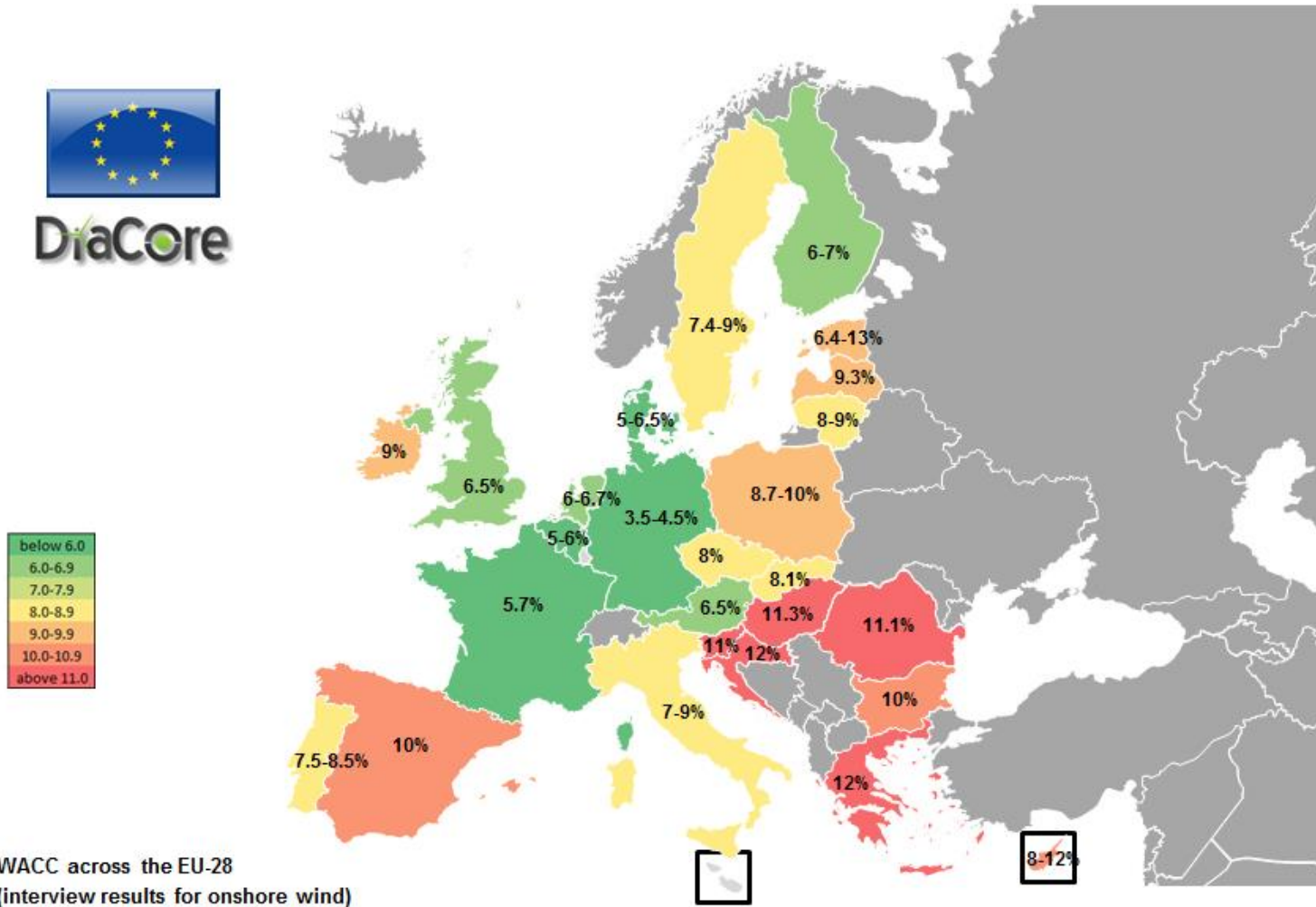
Source: Fraunhofer ISE 2017 (Recent Facts about PV in Germany)

MONTHLY DEGRESSION OF FIT IS COMMUNICATED IN ADVANCE BY THE REGULATOR (BNETZA)

Start of operation	Solar PV installations on buildings and noise protection walls		
	Up to 10 kWp	Up to 40 kWp	Up to 100 kWp
01.01.2017 *	12,30	11,96	10,69
01.02.2017 **	12,30	11,96	10,69
01.03.2017 **	12,30	11,96	10,69
01.04.2017 **	12,30	11,96	10,69
01.05.2017 **	12,27	11,93	10,66
01.06.2017 **	12,24	11,90	10,63
01.07.2017 **	12,20	11,87	10,61
01.08.2017 **	12,20	11,87	10,61
01.09.2017 **	12,20	11,87	10,61
01.10.2017 **	12,20	11,87	10,61
01.11.2017 **	12,20	11,87	10,61
01.12.2017 **	12,20	11,87	10,61
01.01.2018 **	12,20	11,87	10,61

Source: Data Source: BNetzA

COST OF CAPITAL IS VERY LOW IN GERMANY, EVEN COMPARED TO EUROPEAN NEIGHBOURS



A PLATEAU HAS BEEN REACHED FOR TOTAL SUPPORT COST OF PV PER YEAR

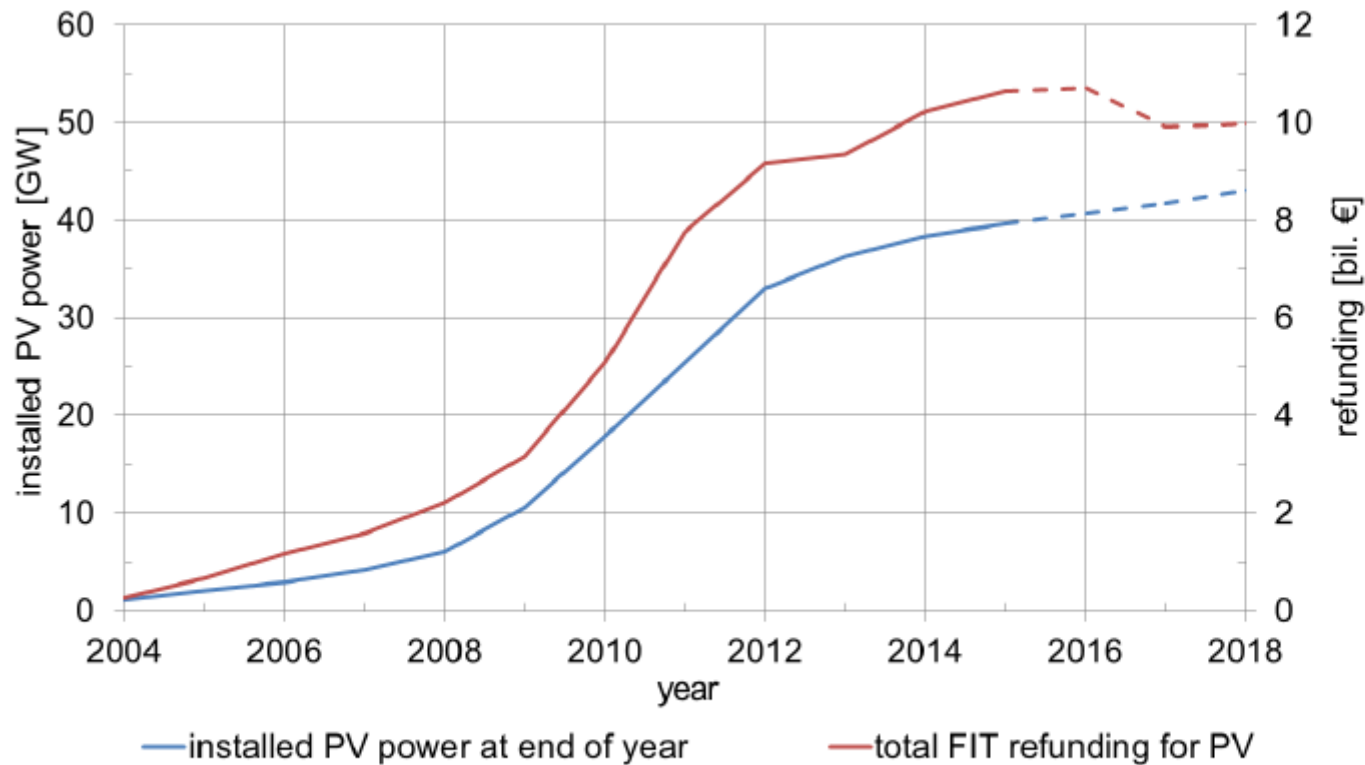
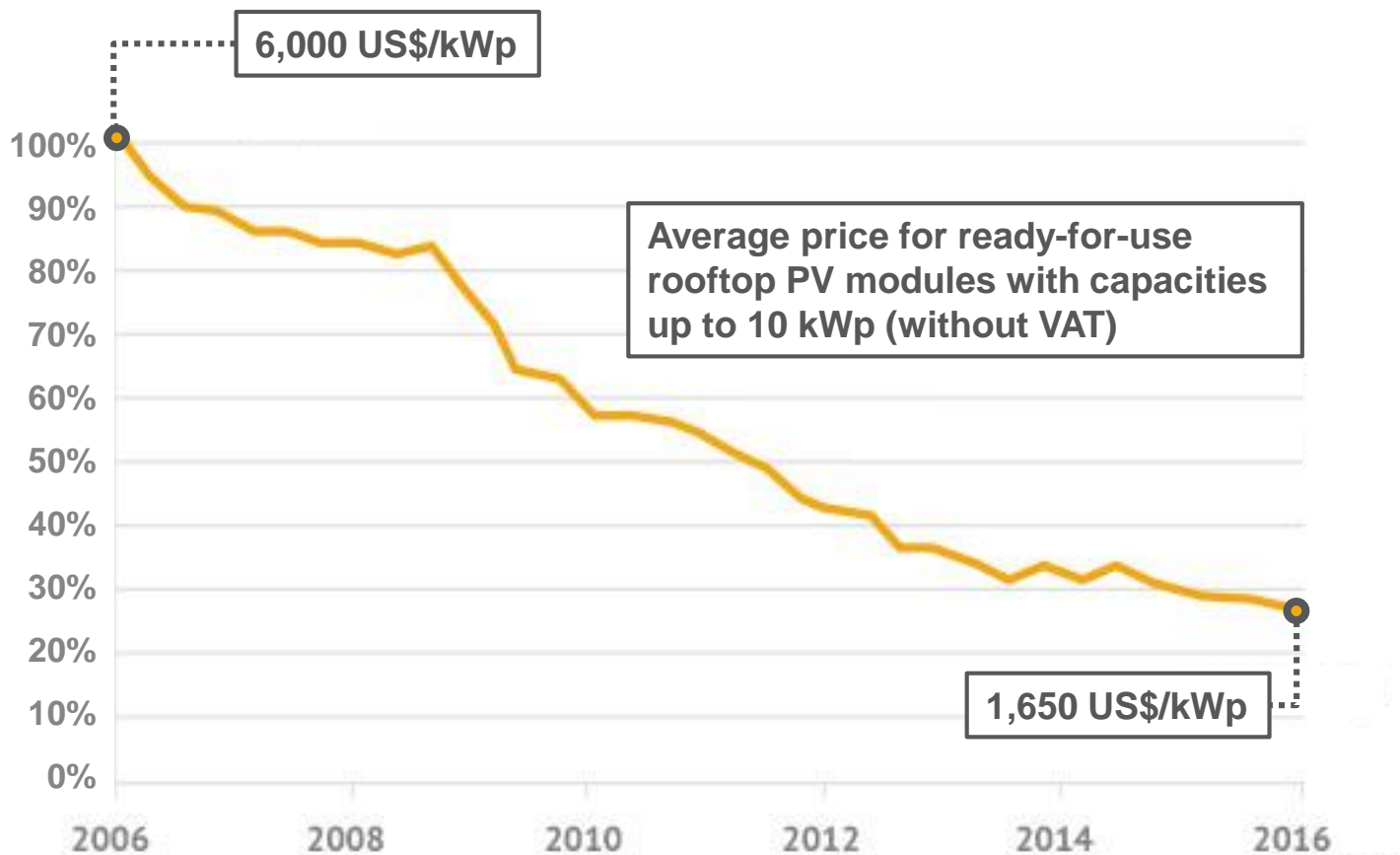


Figure 6: PV expansion and total feed-in tariff (Data from [BMW1]), annual figures and prognosis of German grid operators [ÜNB].

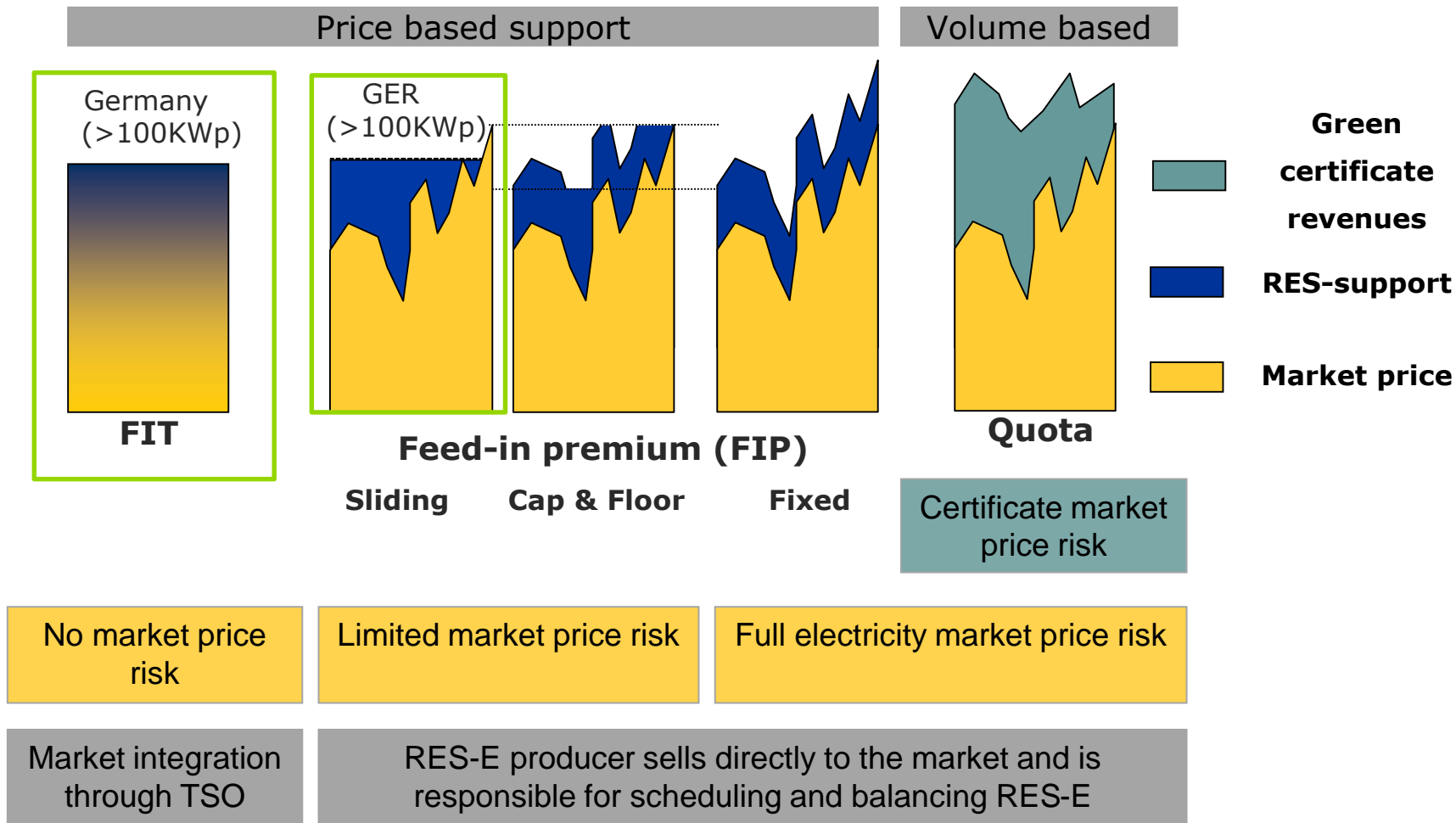
Source: Fraunhofer ISI 2017 (Recent Facts about PV in Germany)

PRICES FOR SOLAR PV ROOFTOP MODULES ARE MORE THAN 72 PERCENT LOWER THAN IN 2006



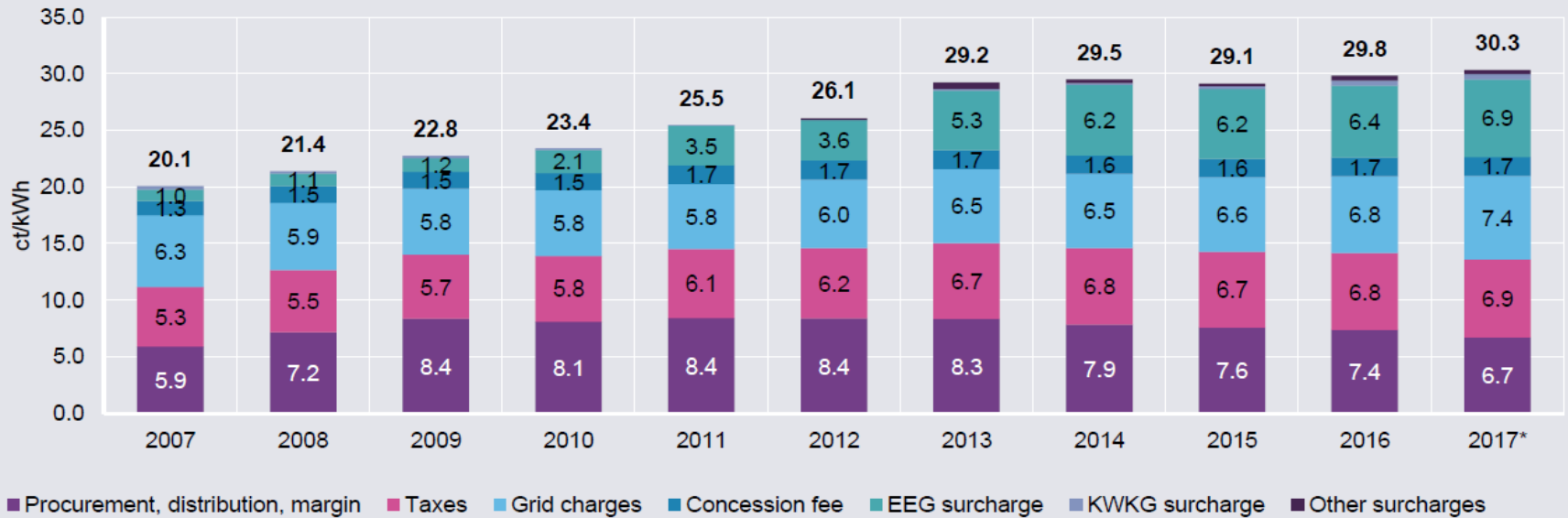
Source: BSW-Solar 2016

THE MAIN SUPPORT SCHEMES EXPOSE PLANT OPERATORS TO DIFFERENT LEVELS OF RISK



HOUSEHOLD ELECTRICITY PRICES HAVE RISEN – LARGEST PART IS MADE UP BY LEVIES, CHARGES AND TAXES

Average electricity prices for a 4-person household (3500 KWh annual use), 2007-2017



Graph: Agora Energiewende 2017:
Data Source: BMWi