Financing Power: Impacts of Energy Policies in Changing Regulatory Environments

Seminar on research in energy economics, Paris

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Dr. Nils May

26.02.2020

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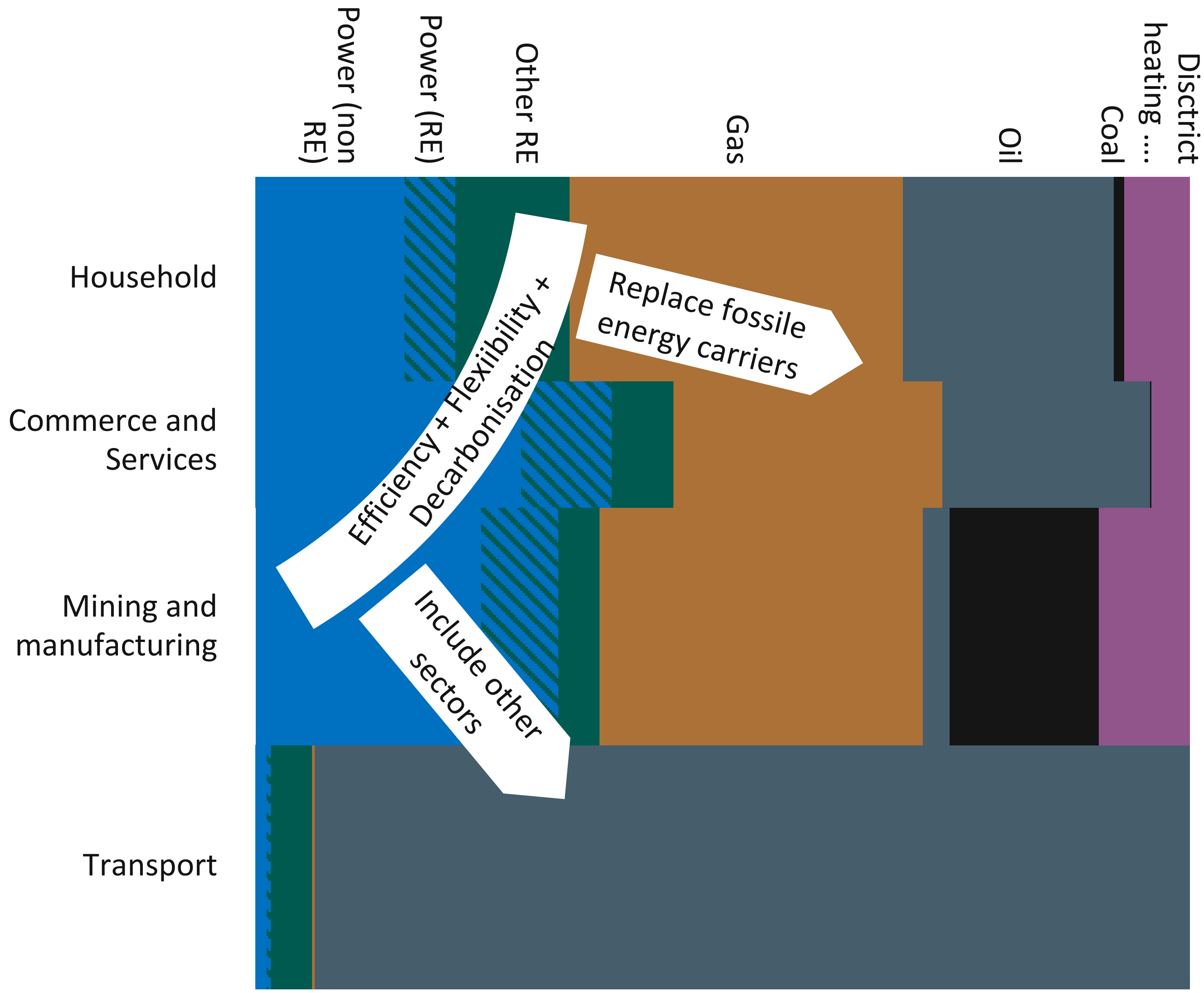
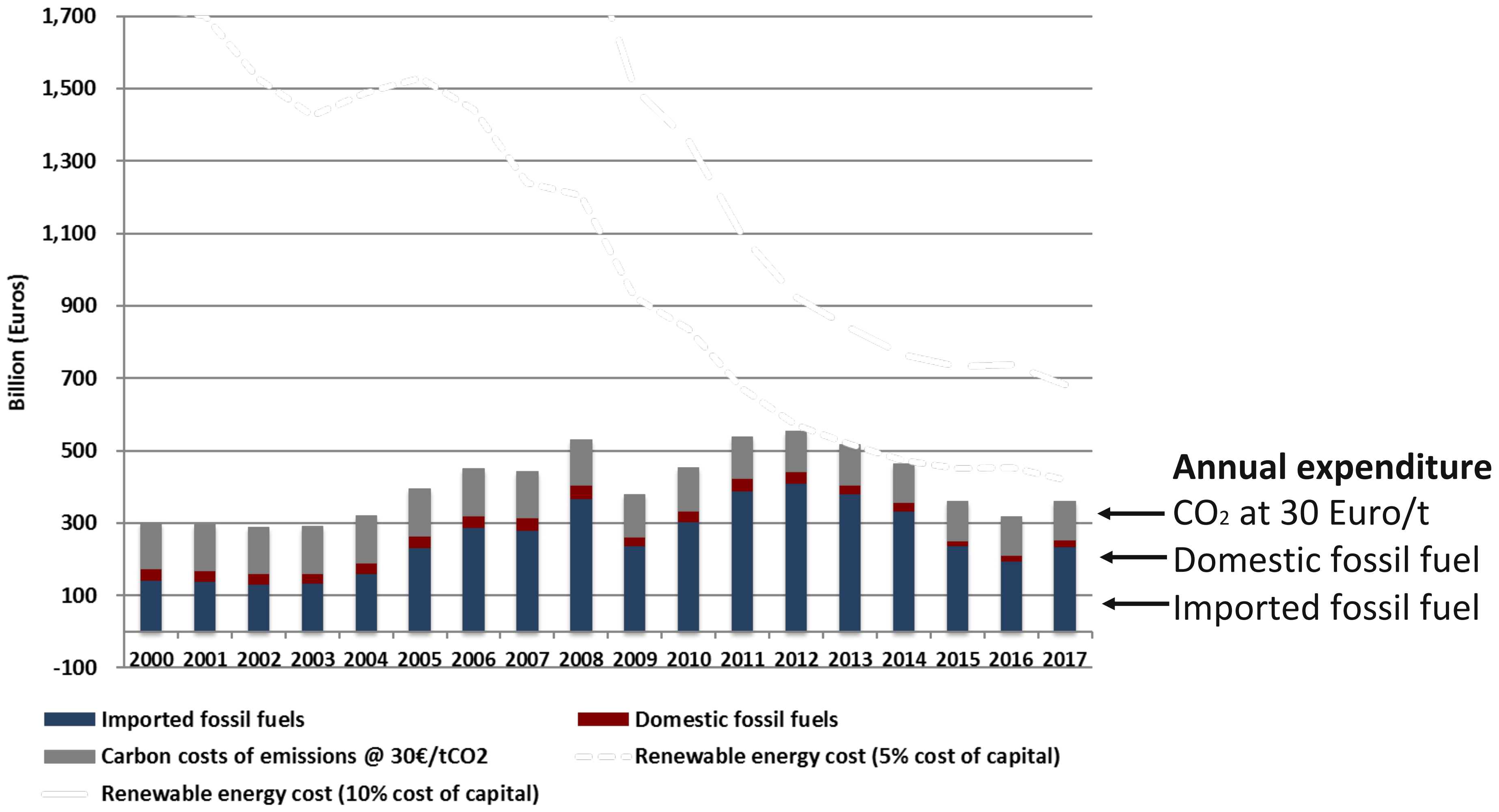
Moving beyond today's electricity demand : Flexibility and efficiency for reliable, affordable, and climate friendly energy services



Basierend auf: AG Energiebilanzen (2016)

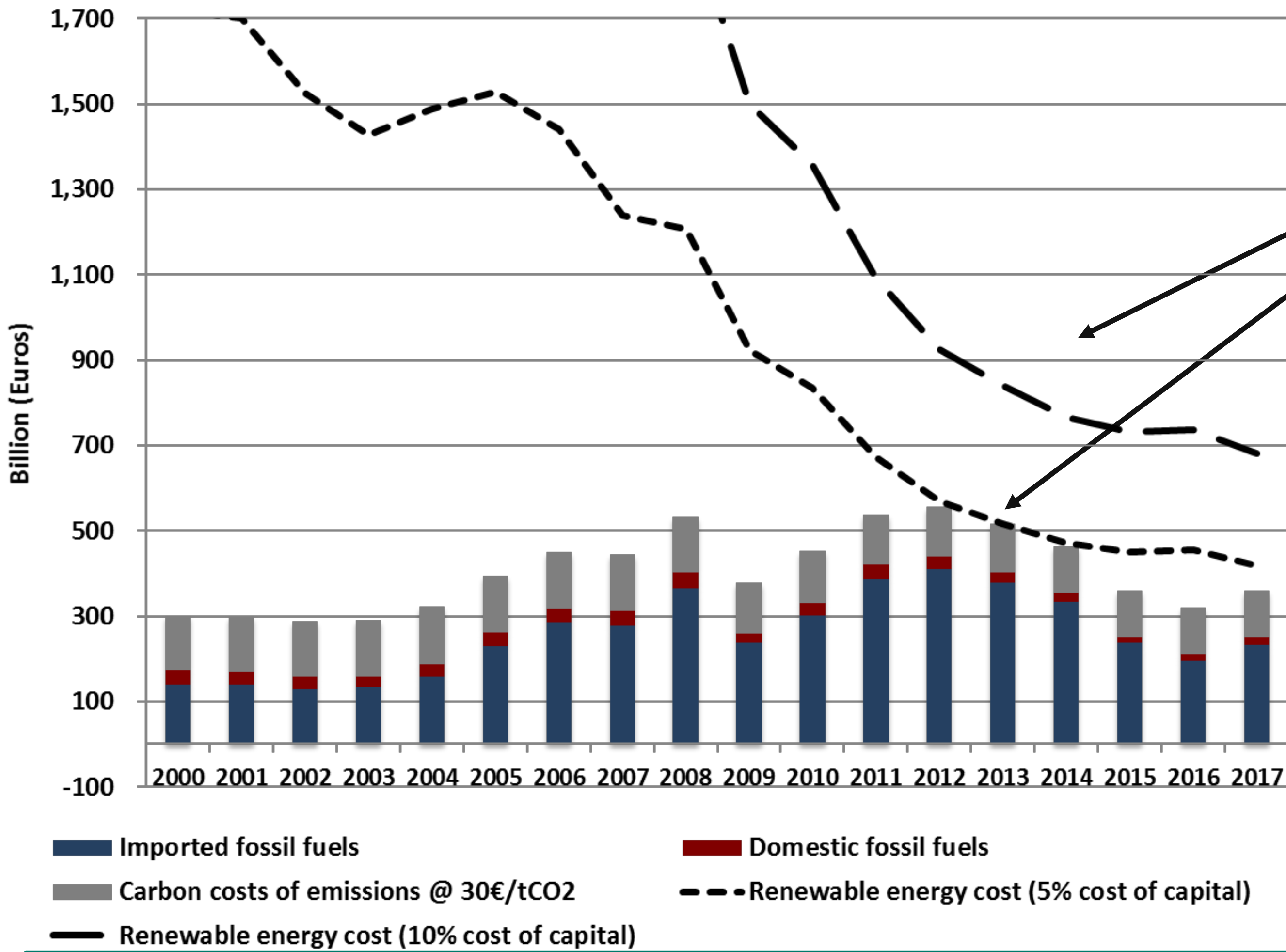
Neuhoff, Ruester and Schwenen (2016). Power Market Design beyond 2020: Time to Revisit Key Elements? The Energy Journal

Overall fossil fuel bill in the EU



DIW Berlin Calculations based on BP Statistical Review of World Energy; Energy Statistics for the EU-28; Bundesverband Solarwirtschaft e. V.; IEA; European Wind Energy Association; Bundesamt für Wirtschaft und Ausfuhrkontrolle, first published in Energy Journal (2016)

Use renewables to stabilize energy costs



Annuitized Investment for wind and solar generation at scale to replace fossil fuels at

- 10 % capital costs
- 5 % capital costs

Annual expenditure

- CO_2 at 30 Euro/t
- Domestic fossil fuel
- Imported fossil fuel

Illustration excludes system costs

Similar cost level for serving demand with new wind and solar as with fossil fuel: Low capital costs key to unlock renewable potential

DIW Berlin Calculations based on BP Statistical Review of World Energy; Energy Statistics for the EU-28; Bundesverband Solarwirtschaft e. V.; IEA; European Wind Energy Association; Bundesamt für Wirtschaft und Ausfuhrkontrolle, first published in Energy Journal (2016)

Outline

1. Financing costs of project developers
2. Financing costs of off-takers of long-term renewable energy contracts
3. Changes in effects with falling technology costs

Financing costs of project developers

1 Policy effects on financing

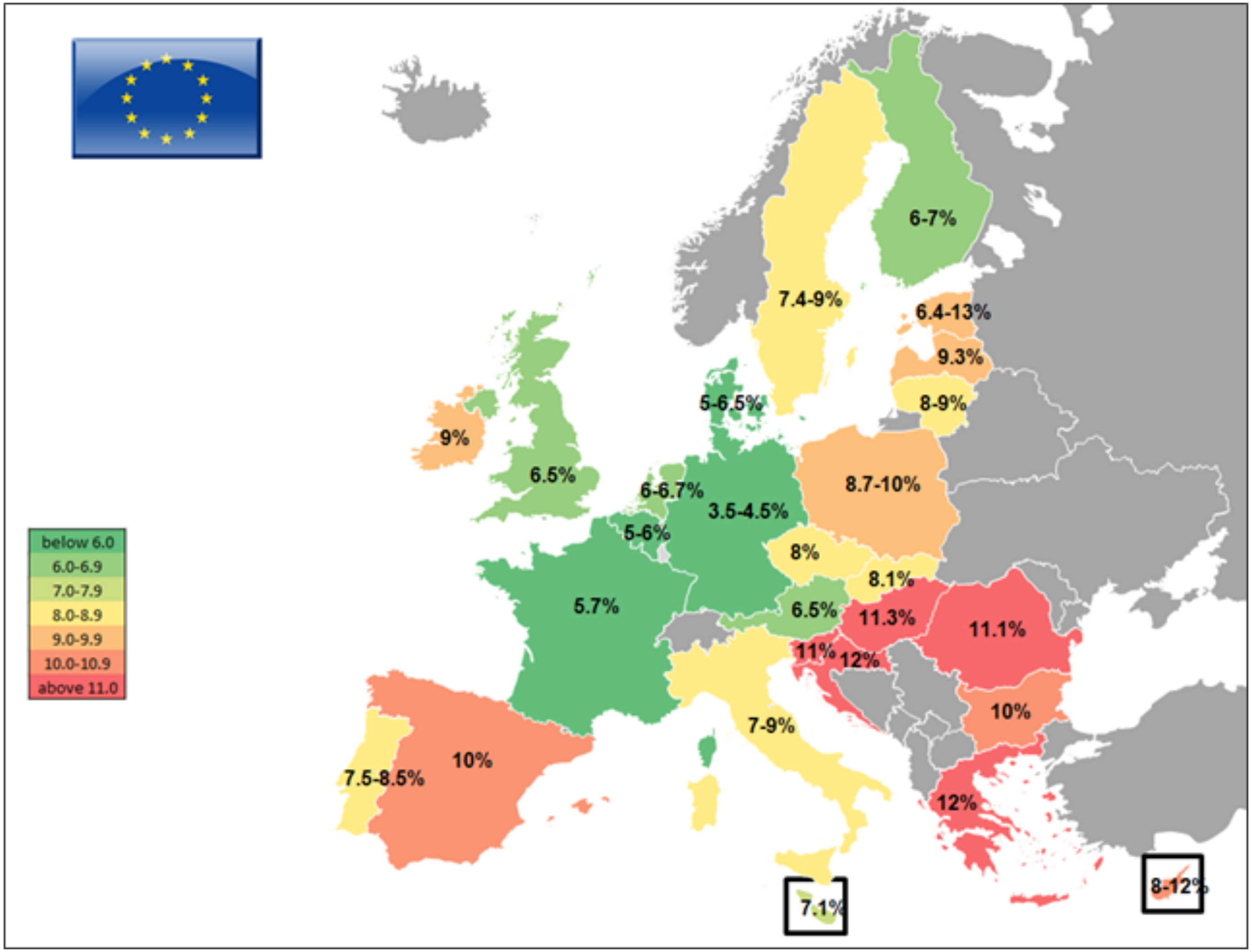
- **Overall research question:** How do different support policies affect the costs of renewables?
- **Research question I:** What is the impact of support policies on project developers' financing costs?
- **Case studies:** Butler and Neuhoff (2008), Klobasa et al. (2013), Tisdale et al. (2014)
- **Theoretical assessments:** Boomsma and Linnerud (2015), Couture and Gagnon (2010), Kitzing (2014), NERA (2013)
- **Further differences between policies and investors:** Bürer and Wüstenhagen (2009), Haas et al. (2011), Helms et al. (2015), Lüthi and Wüstenhagen (2012), Schmalensee (2012)

→ Using interview data on the financing costs of onshore wind power in 23 EU countries in 2014, based on Diacore (2015)

Policies and revenue sources for renewable energy projects

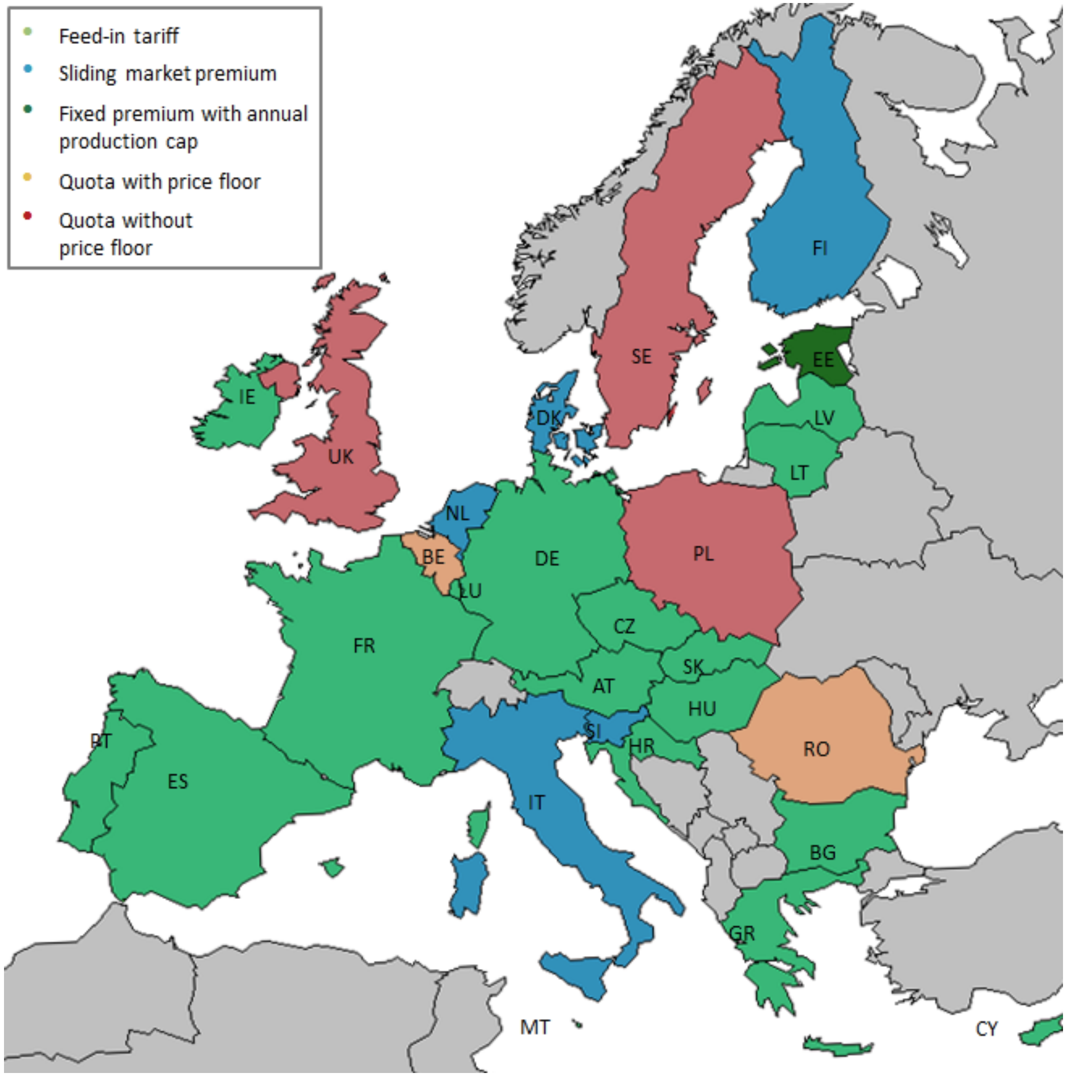
- Feed-in tariff
- Sliding premium
- Fixed premium
- Green certificates
- No remuneration

Capital costs for wind power in the EU in 2014



Based on DIACORE (2016): The impact of risks in renewable energy investments and the role of smart policies

Renewable energy policies in 2014



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Main estimation

- **Dependent variable:** Financing costs are driven by national factors → Estimating the risk premium, i.e. the financing costs minus country-specific risk-free rates
- **Baseline estimator:** OLS estimator with interpretations of relative answers

$$risk\ premium_i = \alpha + \beta_1 FIP + \beta_2 TGC + X\delta + u_i$$

- α: constant
- β_1: FIP-dummy
- β_2: TGC-dummy
- $X\delta$: vector and coeff. of control variables
- u_i: error term
- i: interview observation

- **Robustness checks:** Alternative interpretations, interval estimator

Regression results

Table 2: OLS estimation results

	(1) Level	(2) Level	(3) Log	(4) Log
Dep. var: risk premium				
Sliding feed-in premium	-0.290		-0.176	
	(0.501)		(0.187)	
Tradable green certificates	1.209**	1.306**	0.269**	0.328***
	(0.417)	(0.389)	(0.095)	(0.087)
No policy	2.274***	2.341***	0.453***	0.494***
	(0.438)	(0.421)	(0.097)	(0.087)
Retrosp. changes	-0.139	-0.082	-0.048	-0.013
	(0.366)	(0.361)	(0.088)	(0.083)
Tenders	1.030	0.887	0.304	0.217
	(0.608)	(0.575)	(0.156)	(0.130)
Equity investor	-0.266	-0.293	-0.048	-0.065
	(0.323)	(0.320)	(0.080)	(0.074)
Utility employee	-0.336	-0.316	-0.093	-0.080
	(0.539)	(0.528)	(0.126)	(0.118)
Banker	-0.708	-0.729	-0.263	-0.275
	(0.507)	(0.535)	(0.192)	(0.212)
N	53	53	53	53

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed feed-in tariff and the Belgian and Romanian TGC systems with significant price floors are the baseline policy. In columns 2 and 4, also the feed-in premium is in the baseline. Academic/Consultants are the baseline respondent group.

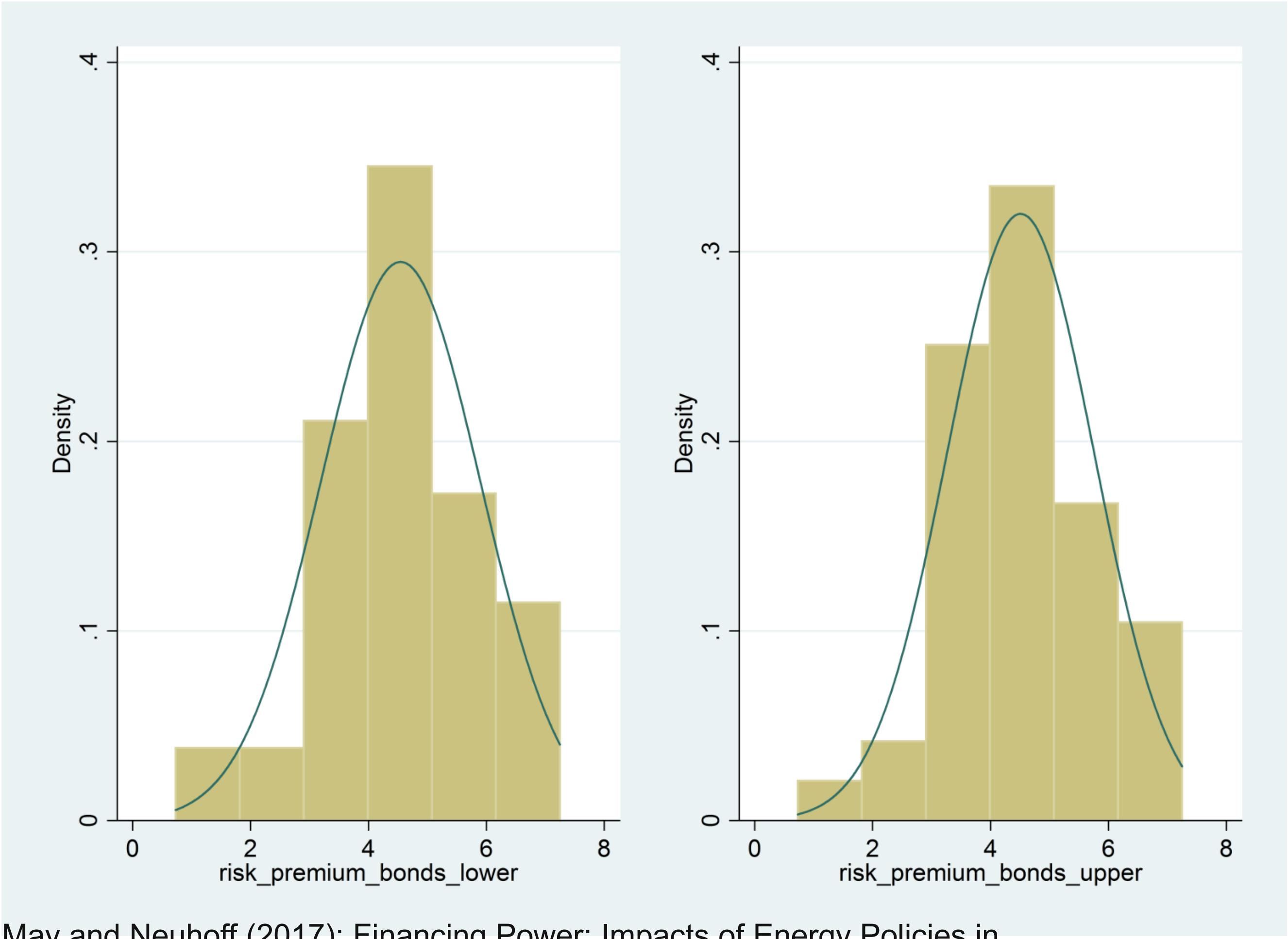
Green certificate schemes are associated with an **increase in financing costs by 1.2-1.3 percentage points**

Robustness checks

Try **different interpretations** of what is meant:

- **Different absolute codings** than before
- **Relative codings**, i.e. ``slightly higher'' meaning 5 percent higher, ``higher'' 10 percent higher, and ``much higher'' as 20 percent higher
- **Assume a normal distribution** of values and assume that the unspecified values adhere to same distribution as specified values: Interval estimator

Interval regression: Normality assumption



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Shapiro-Wilk test does not reject normality of known values in the level specification.

Interval regression: Results

Table 3: Interval regression estimation results

	(1)	(2)	(3)	(4)
	Level	Level	Log	Log
Dep. var: risk premium				
Sliding feed-in premium	-0.030		-0.130	
	(0.535)		(0.228)	
Tradable green certificates	1.213**	1.222**	0.292**	0.333**
	(0.417)	(0.414)	(0.094)	(0.108)
No policy	2.477***	2.484***	0.528***	0.557***
	(0.458)	(0.451)	(0.105)	(0.110)
Retrosp. changes	-0.212	-0.207	-0.047	-0.023
	(0.354)	(0.354)	(0.092)	(0.092)
Tenders	0.867	0.851	0.270	0.203
	(0.604)	(0.534)	(0.177)	(0.125)
Equity investor	-0.320	-0.323	-0.057	-0.069
	(0.304)	(0.311)	(0.080)	(0.078)
Utility employee	-0.369	-0.366	-0.122	-0.107
	(0.522)	(0.516)	(0.129)	(0.119)
Banker	-0.592	-0.592	-0.229	-0.230
	(0.496)	(0.500)	(0.198)	(0.208)
N	53	53	53	53

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed feed-in tariff and the Belgian and Romanian TGC systems with significant price floors are the baseline policy. In columns 2 and 4, also the feed-in premium is in the baseline. Academic/Consultants are the baseline respondent group.

Interval regression results are very similar to OLS regression results.

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Financing costs of off-takers of long-term RES contracts

Effect on financing costs of off-takers

Without implicit long-term contracts between project developers and energy consumers, **project developers sign long-term contracts with private off-takers** (Finon, 2011, Baringa, 2013, Newbery, 2016).

Research question II:
Which effects does signing long-term contracts have on the off-takers?

Long-term contracts

Without implicit long-term contracts between developers and consumers, energy suppliers and consumers carry the price risks.

Rating agencies view energy suppliers‘ exposure to long-term contracts as liabilities Standard & Poor‘s, 2017, Baringa, 2013)
→ Lead to **worse financial parameters**
→ Lead to **worse credit rating**
→ Lead to **higher re-financing costs**

→ Signing long-term contracts can lead to **additional costs for energy retailers / industry**

Impacts of long-term contracts

Off-takers re-financing costs

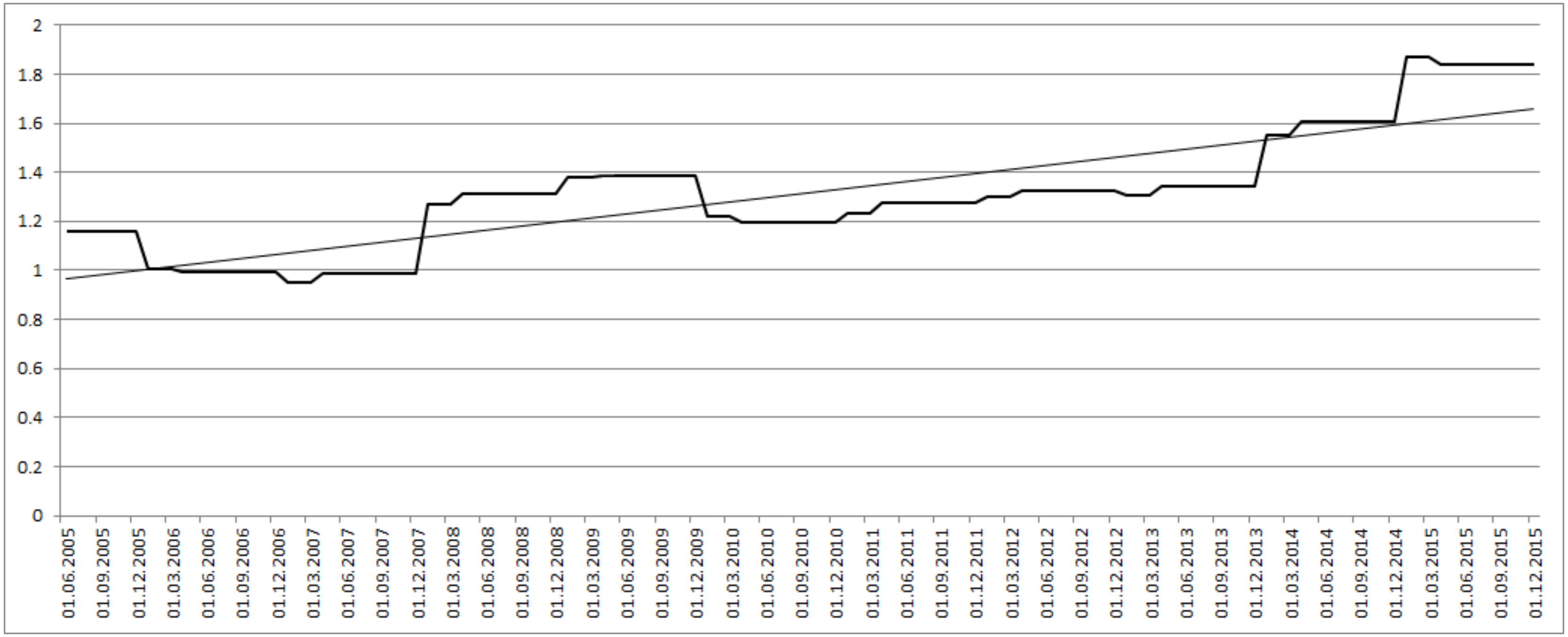
$$c(d, e) = r_{debt}(g(d, e))d + r_{equity}(g(d, e))e$$

- c: overall re-financing costs
- r: capital costs
- g: rating grade
- d: debt
- e: equity

- Long-term contracts evaluated as **'imputed debt'** (Standard & Poor's, 2017, Baringa, 2013)
- The increase in debt-equity ratio worsens the **credit rating**
- The worse credit rating increases the **interest rate** on all debt

Long-term contracts increase off-takers' re-financing costs

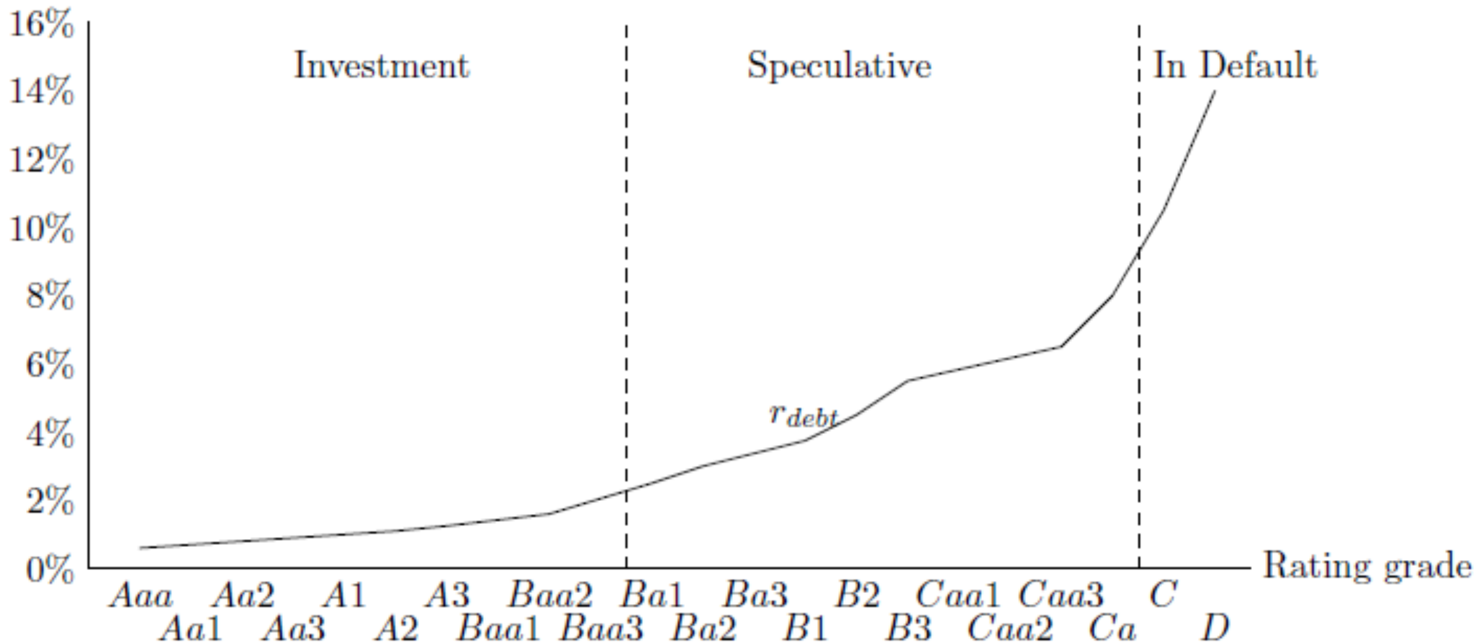
Debt-equity ratios of the twelve largest EU utilities over time



May and Neuhoff (2017): Financing Power: Impacts of Energy Policies in Changing Regulatory Environments. Revise & Resubmit at The Energy Journal.

EU utilities‘ debt-equity ratios have grown across the board.

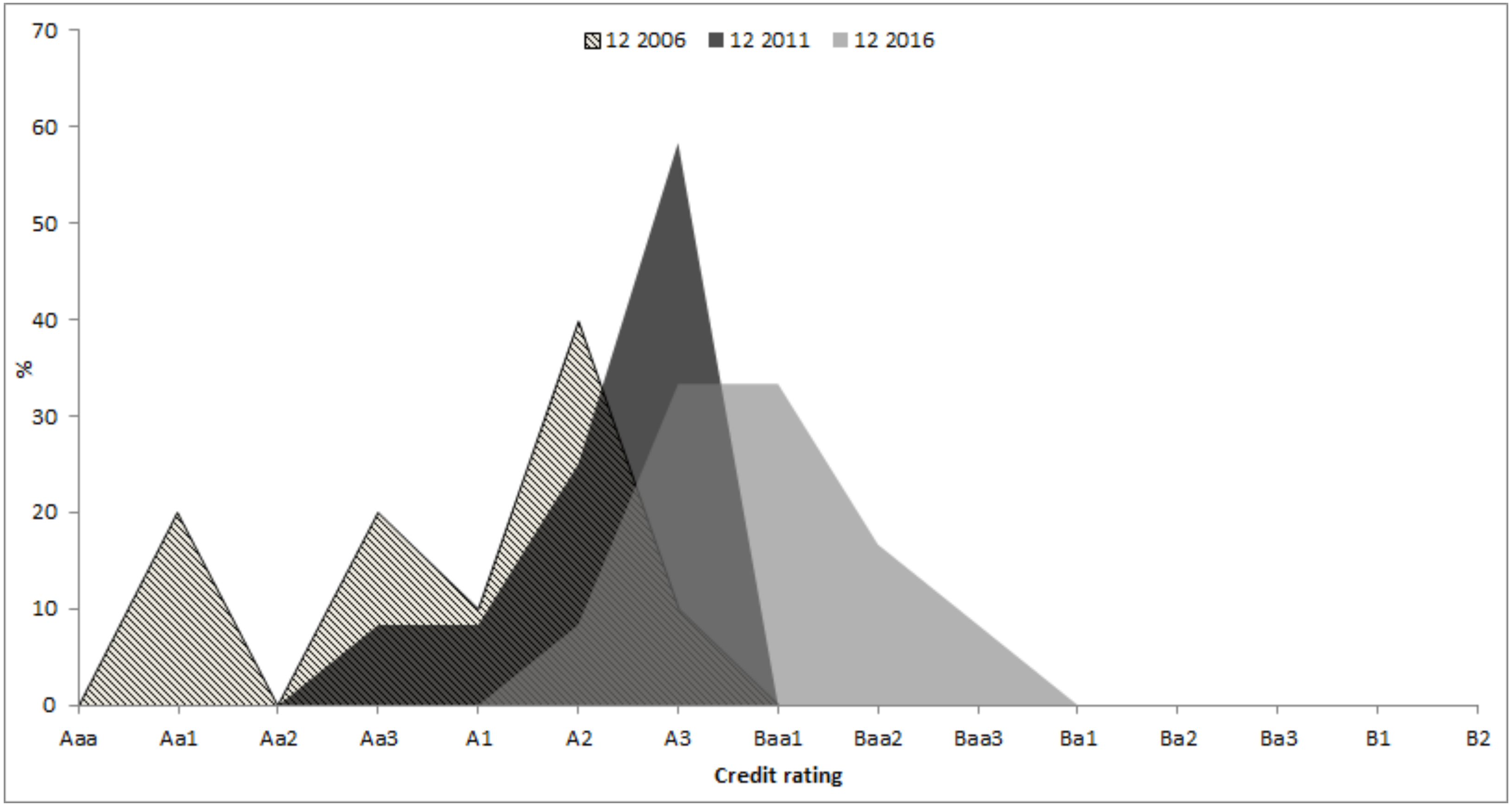
Default spread as function of credit rating



May and Neuhoff (2017): Financing Power: Impacts of Energy Policies in Changing Regulatory Environments. Revise & Resubmit at The Energy Journal.

Worsening ratings have stronger impacts for worse initial ratings.

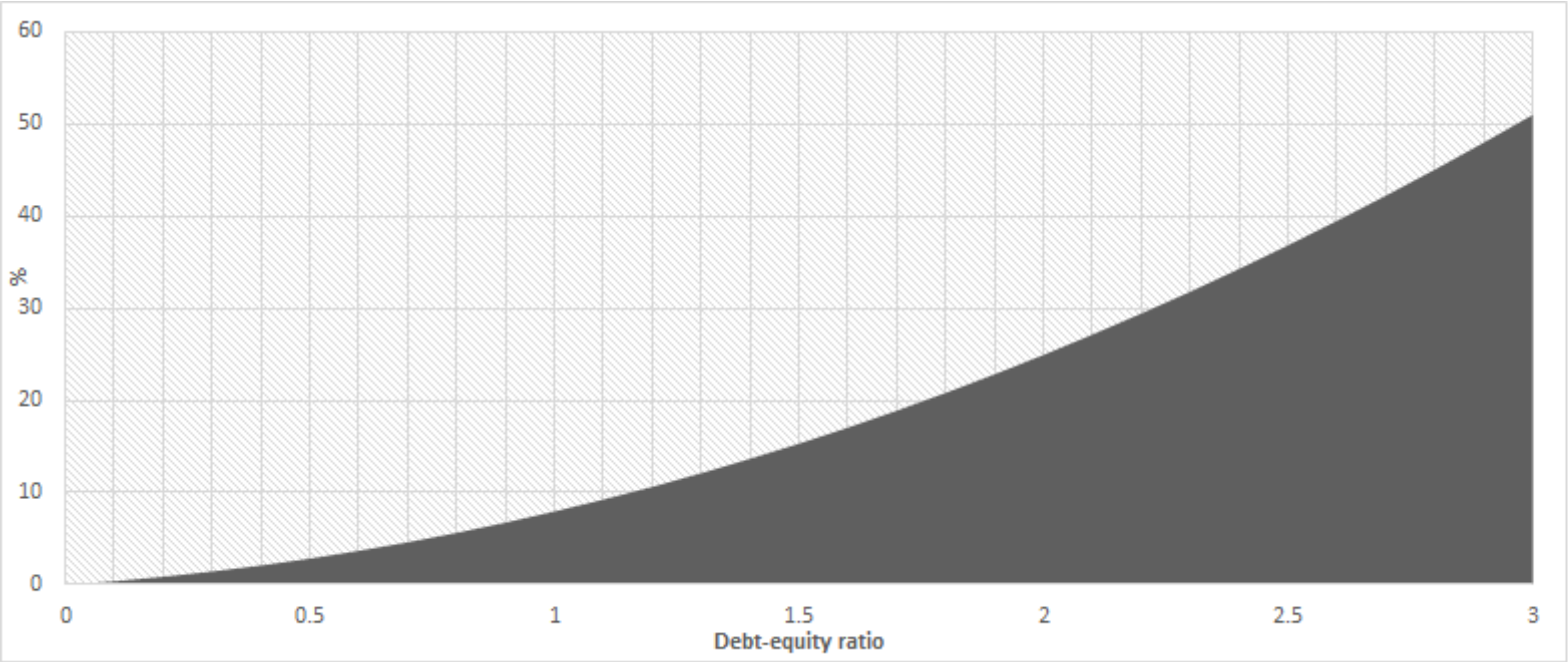
Credit ratings of the twelve largest EU utilities over time



May and Neuhoff (2017): Financing Power: Impacts of Energy Policies in Changing Regulatory Environments. Revise & Resubmit at The Energy Journal.

EU utilities‘ ratings have deteriorated across the board.

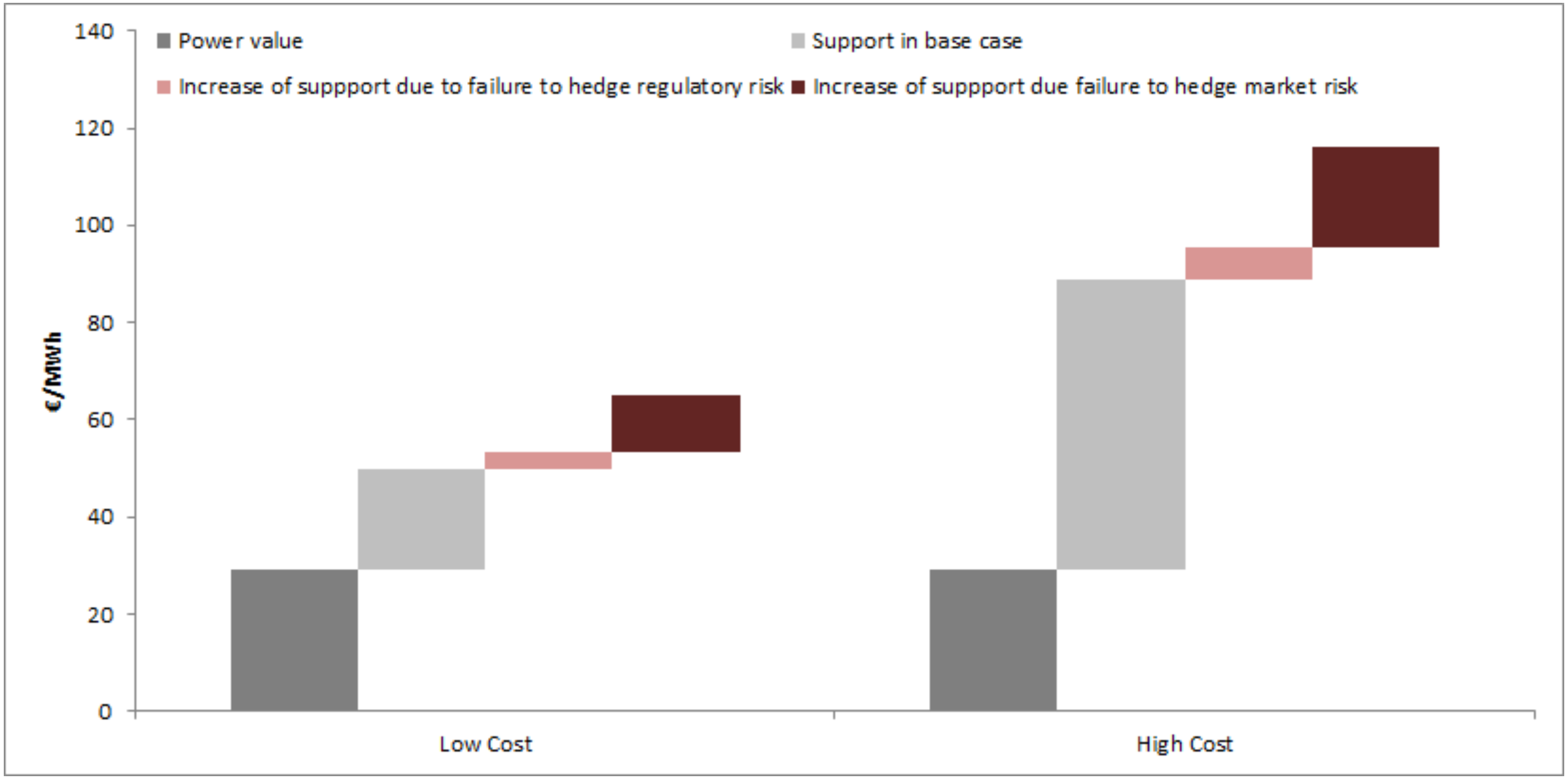
Extra costs of private power purchase agreements for new investments



May and Neuhoff (2017): Financing Power: Impacts of Energy Policies in Changing Regulatory Environments. Revise & Resubmit at The Energy Journal.

The additional costs stand at around 20% of contract value for current average debt-equity ratios of 1.85.

Cost comparison between policies for two scenarios

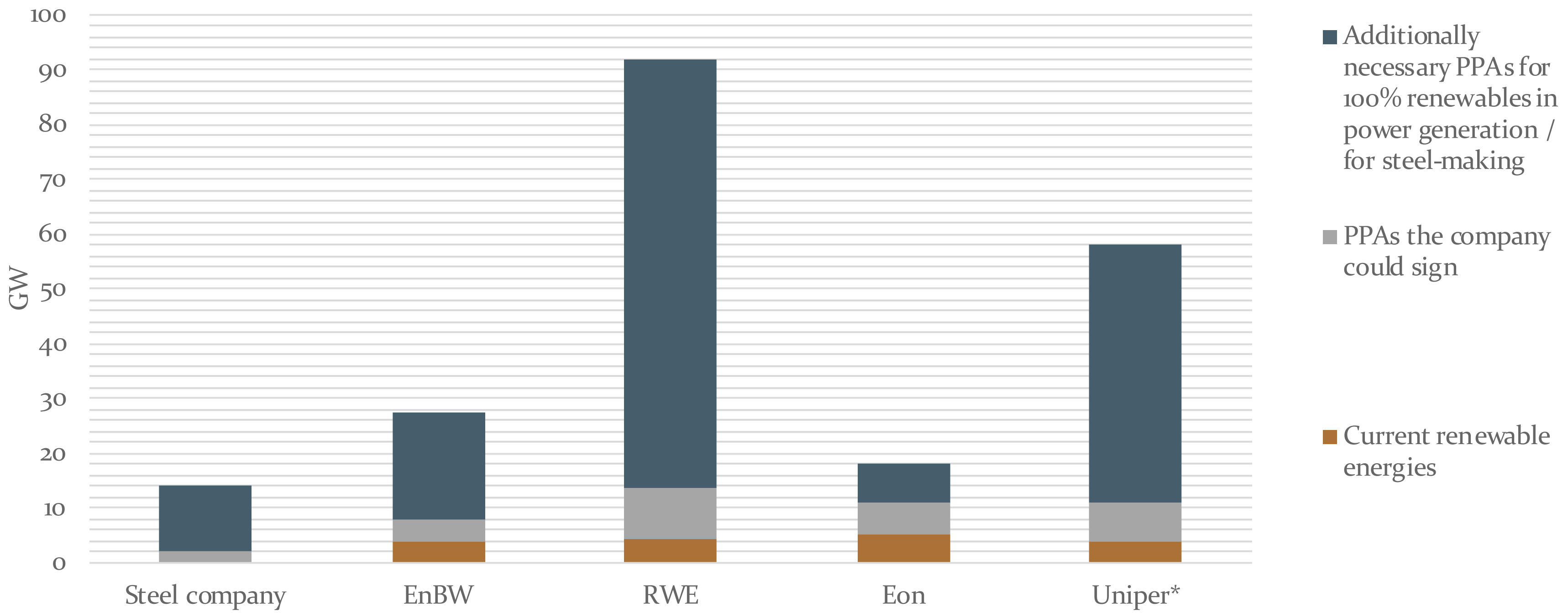


May and Neuhoff (2017): Financing Power: Impacts of Energy Policies in Changing Regulatory Environments. DIW Discussion Paper

Green certificate schemes increase the costs of renewable energies from e.g. 50€ per MWh to 65 €/MWh, or from 90€/MWh to 117€/MWh

Potential of power purchase agreements

Assumptions: debt-equity ratio may worsen by 0.5; only 50% of value of electricity counted as liability (lower end of Standard & Poor's range)



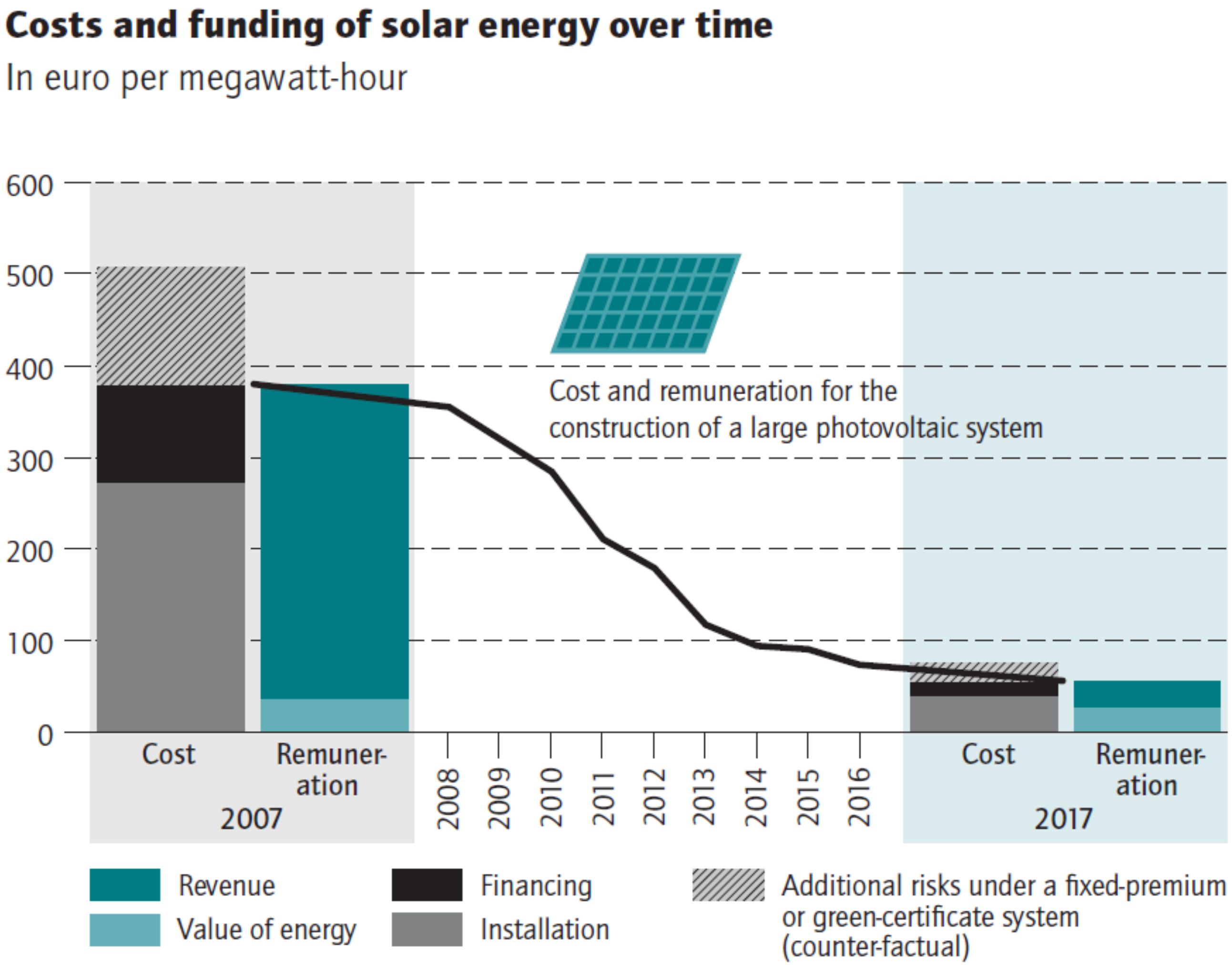
* Renewable energy share approximated

PPAs for new installations are a far way from decarbonizing industry and utilities.

Source: May and Neuhoff (2019): Private langfristige Stromabnahmeverträge (PPAs) für erneuerbare Energien - kein Ersatz für öffentliche Ausschreibungen. DIW Aktuell

Changing policy effects with falling technology costs

Cost decline of large scale photovoltaics



May, Jürgens and Neuhoff (2017): Renewable energy policy: risk-hedging is taking center-stage. DIW Weekly Report.

Market risks have gained importance relative to regulatory risks

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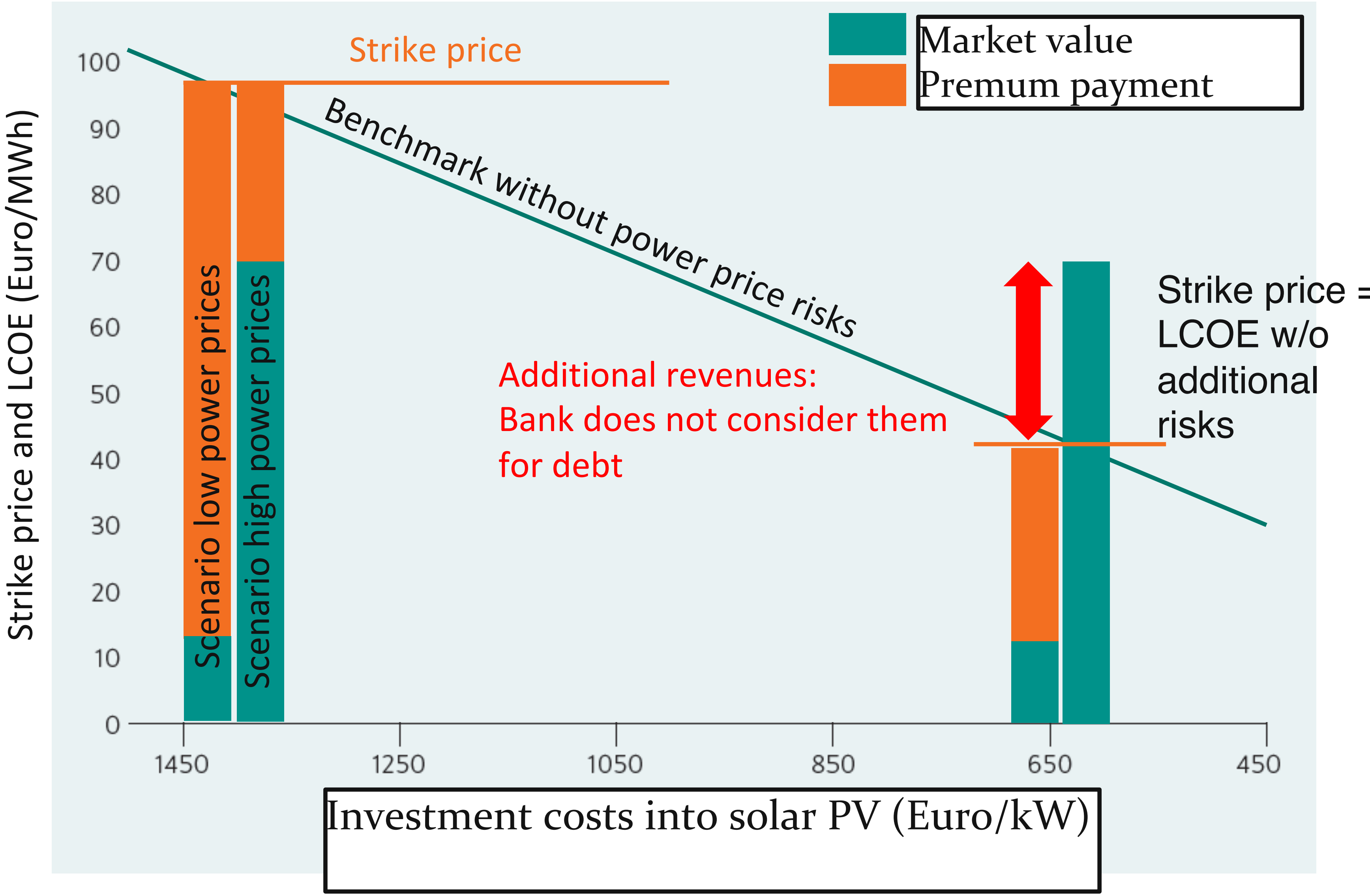
Sliding premium with falling costs



Assumption: Equity for uncertain revenues, 7% equity costs, 2% debt costs

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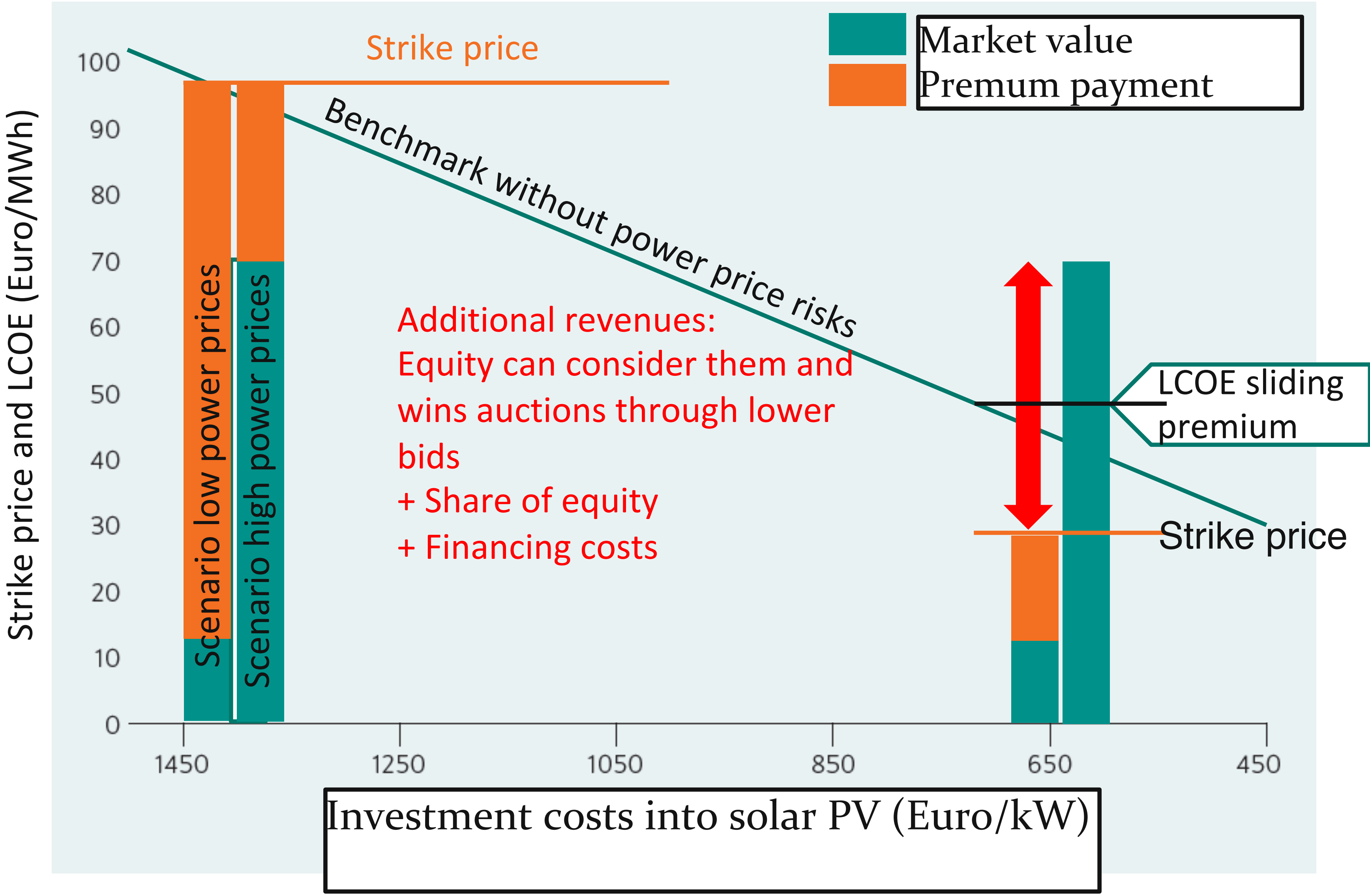
9 Sliding premium hedges risks ever less



Assumption: Equity for uncertain revenues, 7% equity costs

Approach

Financing model of the financing structure and costs of renewable energy investments:

- **How much debt and equity can be raised** to finance investments under a certain policy?
- How does this translate into **financing costs**?
- How does this translate into **levelized cost of electricity**?
- How does this translate into **support costs and power price revenues**?

Based on Neuhoff, K., May, N., and Richstein, J. (2018): Financing Renewable Energies in the Age of Falling Technology Costs. DIW Discussion Paper.

Approach: Example for sliding feed-in premium

1. Calculation of debt that can be raised based on secure revenues

$$D = \frac{Y(R_o - V)}{a_d}$$

2. Calculation of equity

$$E = \frac{Y}{a_e}\int_{R_o}^{2P+2V} \frac{(P-V)-R_o}{2(P+V)}\,dp = \frac{Y}{a_e}\int_{0}^{2P+2V-R_o} \frac{p}{2P}\,dp = \frac{Y}{a_e}\frac{(2P+2V-R_o)^2}{4(P+V)}$$

$$= \frac{Y}{a_e}\left(P - R_o + \frac{{R_o}^2}{4P}\right)$$

p	Realized net-market value, uniformly distributed between [0;2P]	**P**	Average net-market value
$R_{s,o,f}$	Reference price for symmetric, one-sided, fixed premium	$\overline{C_{s,o,f}}$	Average cost to consumer per MWh
I	Investment cost (per MW)	**Y**	Yield – in full load hours per year
D	Debt in financing structure (per MW)	**E**	Equity in financing structure (per MW)
r_d	Interest rate on debt	**r_e**	Return expectation on equity
a_d	Annual debt serving factor (for 20 years)	**a_e**	Annual equity serving factor (for 20 years)

Approach

3. Calculation of bid price in competitive auctions

$$R_o = 2P\left(1 - \frac{a_e}{a_d} + \sqrt{\left(1 - \frac{a_e}{a_d}\right)^2 + \frac{a_e}{Y}\frac{I}{P} - 1}\right)$$

4. Calculation of overall price (electricity plus support) to electricity consumers

$$\overline{C_r} = \frac{a_e}{Y} I + P\left(1 - \frac{a_e}{a_d}\right)\left(2\left(1 - \frac{a_e}{a_d}\right) + \sqrt{\left(1 - \frac{a_e}{a_d}\right)^2 + \frac{a_e}{Y}\frac{C}{P} - 1}\right)$$

p	Realized net-market value, uniformly distributed between [0;2P]	**P**	Average net-market value
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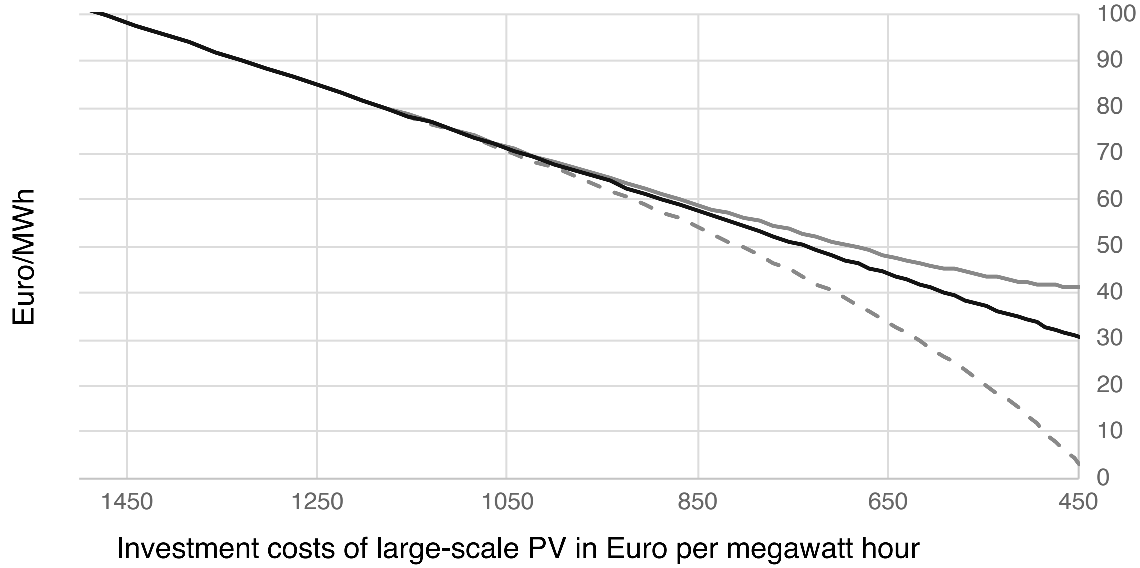
a_d	Annual debt serving factor (for 20 years)	**a_e**	Annual equity serving factor (for 20 years)

Total costs increase with increasing power price exposure



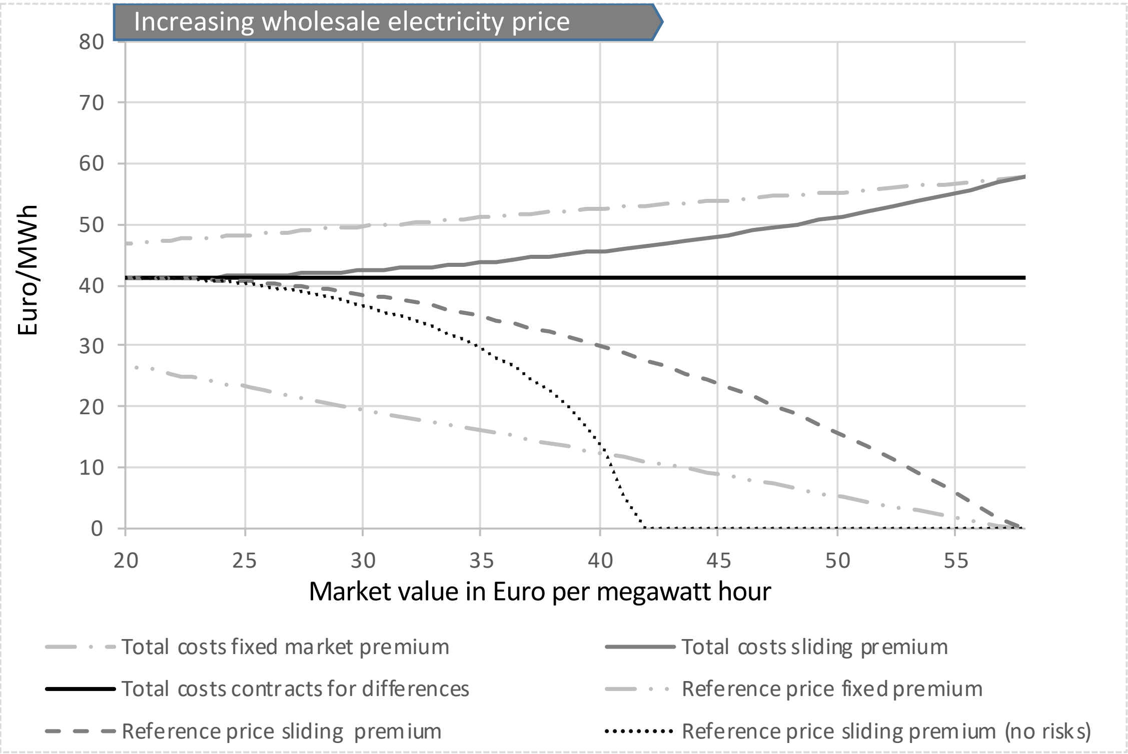
Higher (expected) market value increasingly affects the financing costs under sliding premia

→ Further consequences:

- → **Acceptance** issues: Electricity consumers are not symmetrically hedged against high power prices
- → **Larger investors benefit** from their larger equity
- → **Realization rates drop**, Winners‘ curse

Based on Neuhoff, K., May, N., and Richstein, J. (2018): Financing Renewable Energies in the Age of Falling Technology Costs.

Results: If nothing changes, everything will change



Sliding premium: As technology costs decline optionality kicks in, the sliding premium offers less hedging, financing costs increase, total cost increase.

Without long-term hedging 30% cost increase from

- Project revenue risk (1)
- Liabilty in LT Contracts (2)

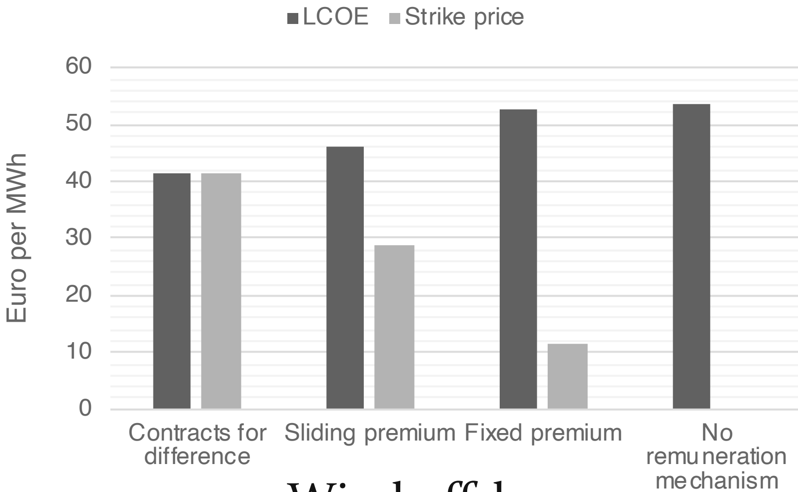
Matches overall assessments (3)

(1) Diacore review (2) Standard & Poor's (2017): Key Credit Factors For The Regulated Utilities Industry,
(2) Baringa (2013) PPAs for independent RE generators (3) Aurora Energy Research (2018), Energy Brainpool (2019), Enertrag (2019).

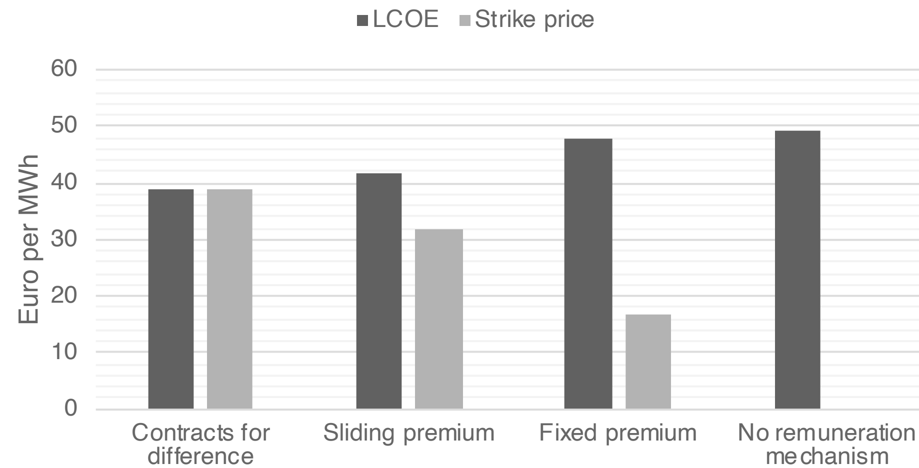
Based on Neuhoff, K., May, N., and Richstein, J. (2018): Financing Renewable Energies in the Age of Falling Technology Costs.

LCOE and strike prices by 2025

Solar PV



Wind onshore

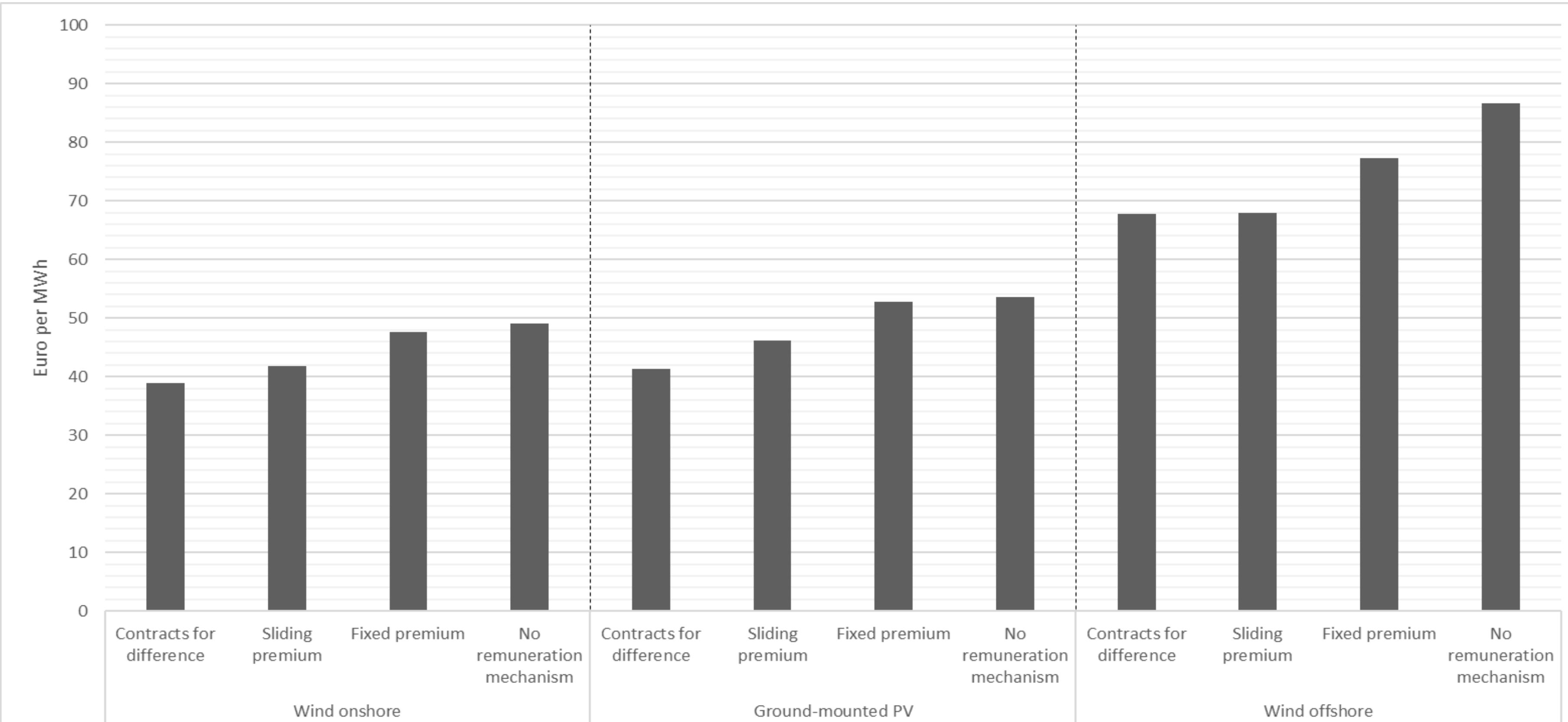


Wind offshore

Strike price and total costs of renewables provide differing assessments!

Based on Neuhoff, K., May, N., and Richstein, J. (2018): Financing Renewable Energies in the Age of Falling Technology Costs. DIW Discussion Paper.

Renewable energy costs in 2025 under various policies



Own calculations, based on cost parameters by Fraunhofer ISE (2018)

Based on Neuhoff, K., May, N., and Richstein, J. (2018): Financing Renewable Energies in the Age of Falling Technology Costs. DIW Discussion Paper.

Conclusion

Conclusion

Low financing costs are crucial for low-cost renewable energy deployment

Role of support policies has changed:
rather than covering extra costs, **risk-hedging is taking center-stage**

Fixed premia, **green certificate schemes** and abolishing remuneration schemes **imply significant extra costs** due to imperfect risk-hedging

Sliding premia used to be associated with low financing costs, but with decreasing technology costs, they lose their ability to hedge risks

Contracts for difference function as sliding premia used to: have renewables participate in wholesale electricity markets while hedging power price risks

Power Purchase Agreements can play a role in niches and for old installations – but not as drivers of energy transitions

Please DO get into contact: **nmay@diw.de**