

A photograph of a wind farm at sunset. The sun is low on the horizon, casting a golden glow over the scene. Several wind turbines are visible against the sky, and a field of crops is in the foreground. A dark grey banner with a green vertical bar on the left side is overlaid on the bottom of the image, containing the title text.

Merit order effect: the case of PV in Europe

September 2014

Henri Gouzerh

Merit order effect: the case of PV in Europe

Table of contents

1. About Green Giraffe Energy Bankers
2. The Merit Order Effect
3. Methodology and results
4. Conclusion



A specialist advisory boutique focused on renewable energy

We get deals done

Deep roots in renewable energy finance

- Launched in 2010 by experienced finance specialists with a **strong and proven track record** in the renewable energy sector
- 25 professionals with offices in Utrecht (the Netherlands), Paris (France), London (United Kingdom) and Hamburg (Germany)
- Built on a multi-disciplinary skill set including **project & structured finance, M&A, legal & tax expertise**



More than € **6,000,000,000** funding raised for renewable energy projects in **4 years**



25 professionals in **4 countries**

High quality, specialised advisory services

- Focus on projects where we can actually add value
- We include sector-specific tasks in our scope in addition to traditional debt or equity advisory (such as modelling, project contracting and strategic advisory services)
- Priority given on **getting the deal done!**



A unique **track record** in **offshore wind**

An active presence in the market

PFI global financial advisor 2013

	Company	1	2	3	Total	Overall
1	Ernst & Young	10	57	23	90	425
2	PWC	22	49	19	90	239
3	KPMG	0	41	23	64	64
4	Credit Agricole	15	0	17	32	46
5	BNP Paribas	13	2	10	25	69
6	SBI Capital	17	7	0	24	29
7	HSBC	13	2	8	23	50
8	BTMU	8	0	12	20	21
9	SMBC	14	0	12	20	21
10	GGEGB	13	0	0	13	23
11	Taylor DeJongh	5	7	0	12	25
12	Societe Generale	8	1	2	11	21
13	TASC	6	3	0	9	15
14	Standard Chartered	9	0	0	9	12
15	Greengate	6	0	1	7	20

Ranked by the number of new active mandates won in 2013

1= Privately owned sponsors
 2= Government or government owned sponsors
 3= Bidders in a competition

Inspiratia financial advisor H1 2014

	Company	USD M	Share
1	PWC	4,722	8.0%
2	Green Giraffe Energy Bankers	4,615	7.8%
3	HSBC	4,336	7.4%
4	KPMG	3,108	5.3%
5	Credit Agricole	1,721	2.9%
6	Macquarie Capital	1,694	2.9%
7	RebelGroup	1,577	2.7%
8	Delphos International	1,523	2.6%
9	Deloitte	1,362	2.3%
10	ANZ	1,020	1.7%

Financial Advisor league table derived from project finance deal values in social infrastructure, transport and renewables transactions, H1 2014

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Table of contents

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2. The Merit Order Effect
3. Methodology and results
4. Conclusion



2. The Merit Order Effect

Purpose of the study

What is the net cost of Renewables?

- Costs
 - Intermittency: priority of dispatch, physical constraint on the system operator
 - Grid reinforcement works
 - Support schemes: translating into relatively high (though decreasing) LCOE
- Benefits
 - Reduction of negative externalities: pollution (non monetary metric), energy dependency (security of gas supply)
 - Reduction of wholesale (market) prices, also called the merit order effect (MOE)

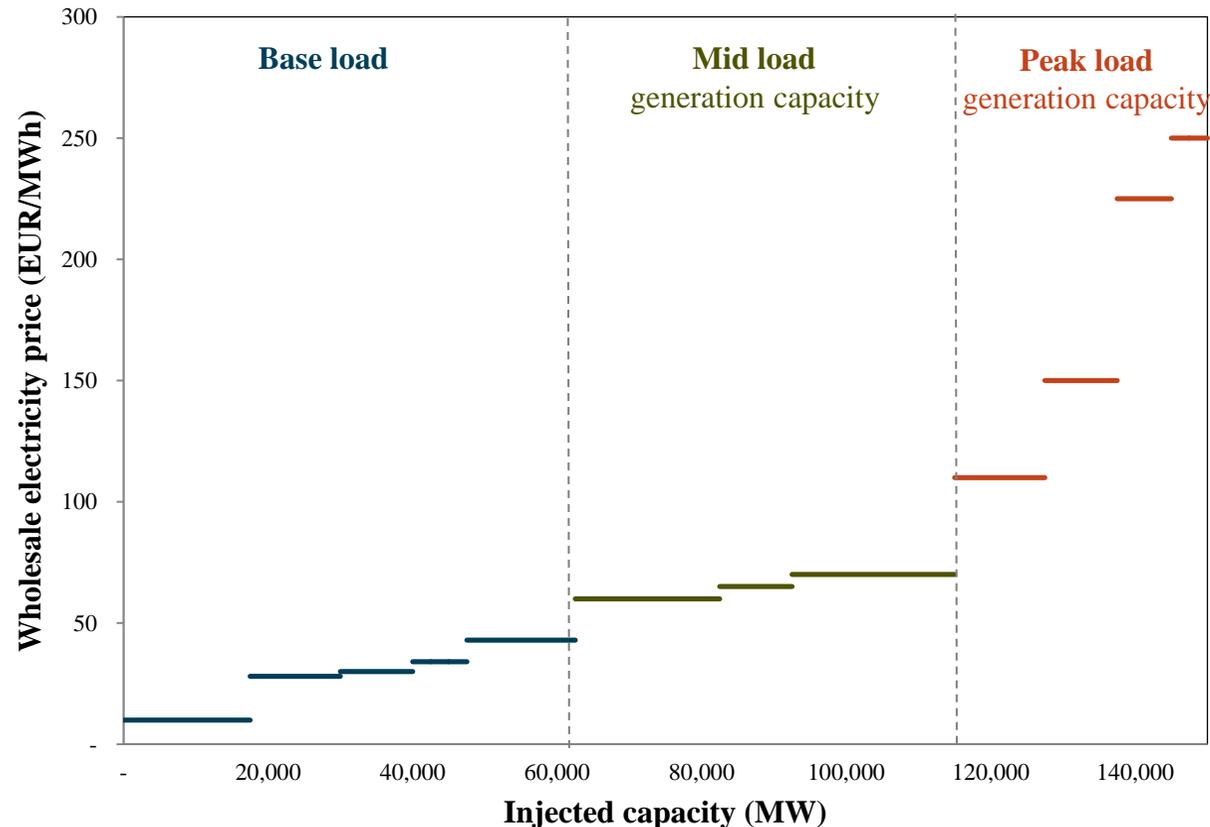
This study focuses on the MOE only

- Focus on Germany, Austria, France, Switzerland and Italy (GAFSI)
- Period of study 2006-2013

This study builds on a 2013 paper from M.Gourvitch, M.Gouzerh, M.Carton and M.Masson on “Quantitative analysis of the merit order effect from photovoltaic production in Italy”

2. The Merit Order Effect

The Merit Order Curve (MOC)



Electricity markets

- Electricity demand is inelastic (long term contracts)
- Supply: base, mid & peak load
- Market coupling to improve markets integration

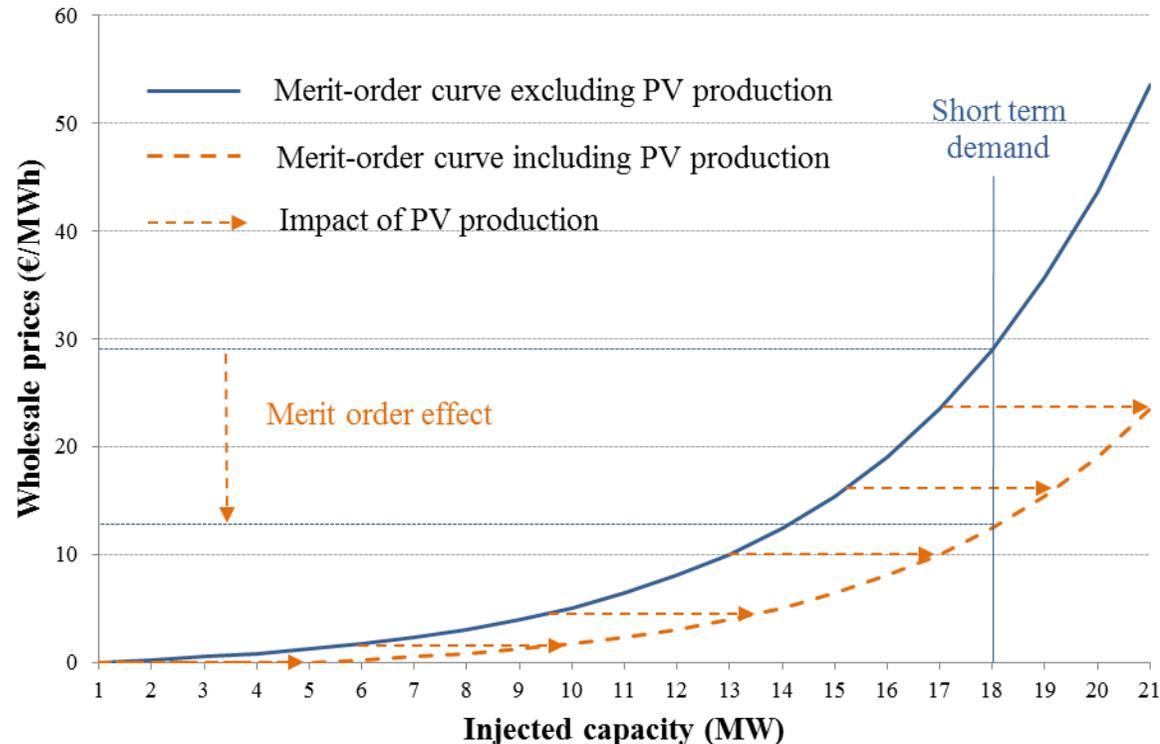
“Uniform pricing”: prices are imposed on all producers and is therefore set by the most expensive power producer able to satisfy the demand

MOC: sorting energy sources in growing order of marginal cost

Electricity wholesale prices are determined as the intersection of the instantaneous demand and the MOC, representing the marginal cost for a given production

2. The Merit Order Effect

Impact of PV production



Assumptions

- Acceptable penetration rate (about 3% in GAFSI)
- GAFSI wholesale prices: weighted average price of the market prices by respective electricity consumption
- No negative prices within GAFSI (less than 0.1%)
- Limited interconnection with neighbouring countries (net exports at 1% of GAFSI electricity production in 2013)
- Limited self-consumption
- All electricity is traded on the spot market (internalisation in long term OTC contracts)

PV production shifts the MOC rightward thus decreasing the spot price for a given demand

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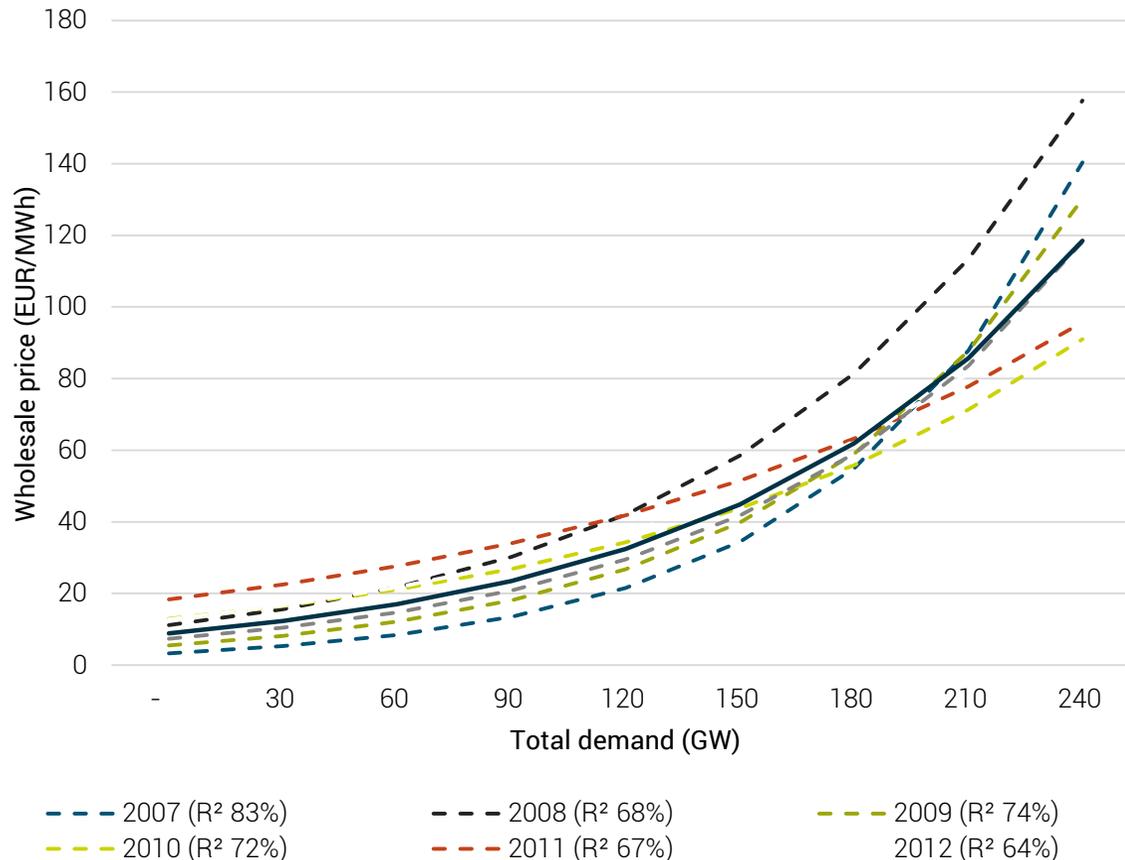
Table of contents

1. About Green Giraffe Energy Bankers
2. The Merit Order Effect
3. Methodology and results
4. Conclusion



3. Methodology and results

Price fixing model



Data

- Solar PV production based on the GeoModel irradiation data for 60 cities across GAFSI
- ENTSOE consumption data
- Wholesale prices from EPEX

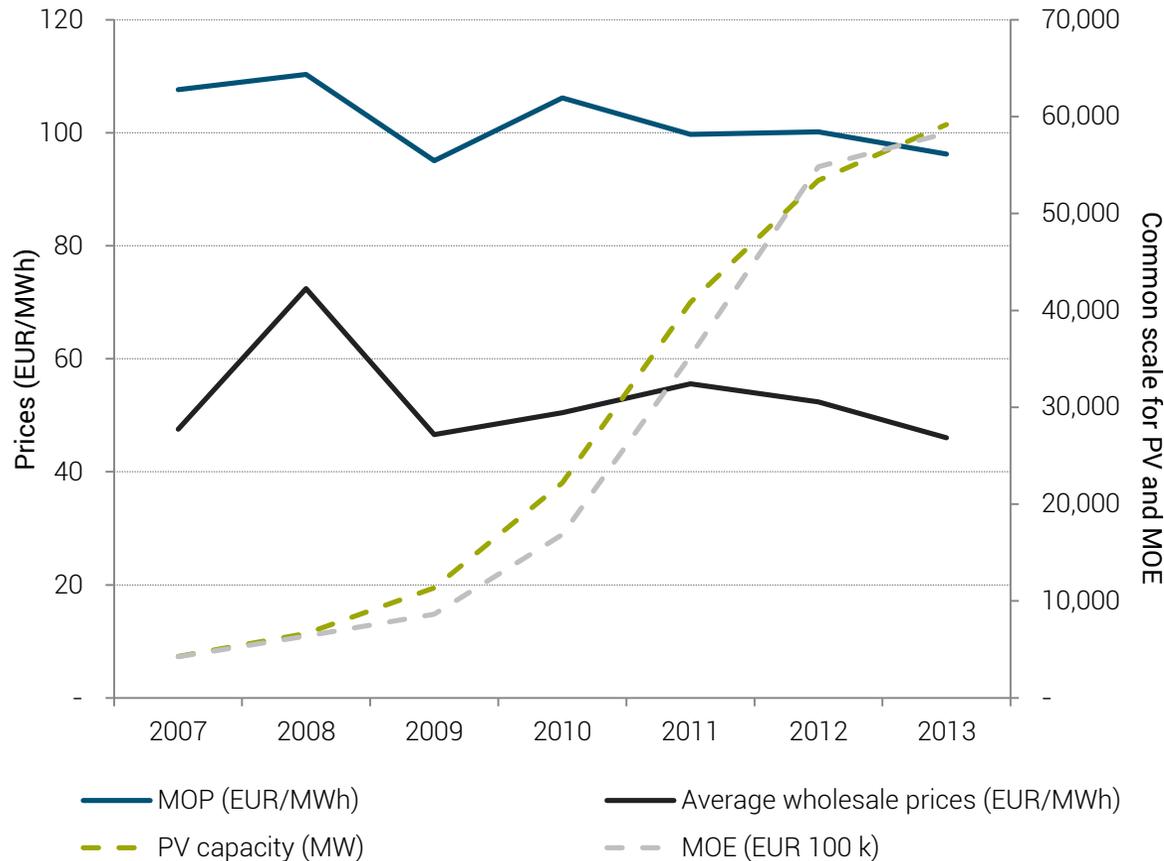
Results

- Constant MOC (2007-2013)
- Exponential shape
- 70% correlation factor for GAFSI (compared to 57% for Germany alone)
- Stable energy mix

The 2007-2013 MOC for GAFSI is a satisfactory price fixing proxy to estimate electricity prices had there not been any PV production

3. Methodology and results

Results



Main findings

- MOE around EUR 20 bn over 2007-2013
- Merit Order Price (MOP) 100 EUR/MWh of PV produced (on top of spot price)
- Without PV, average spot prices would have been 3% higher (1.5 EUR/MWh)

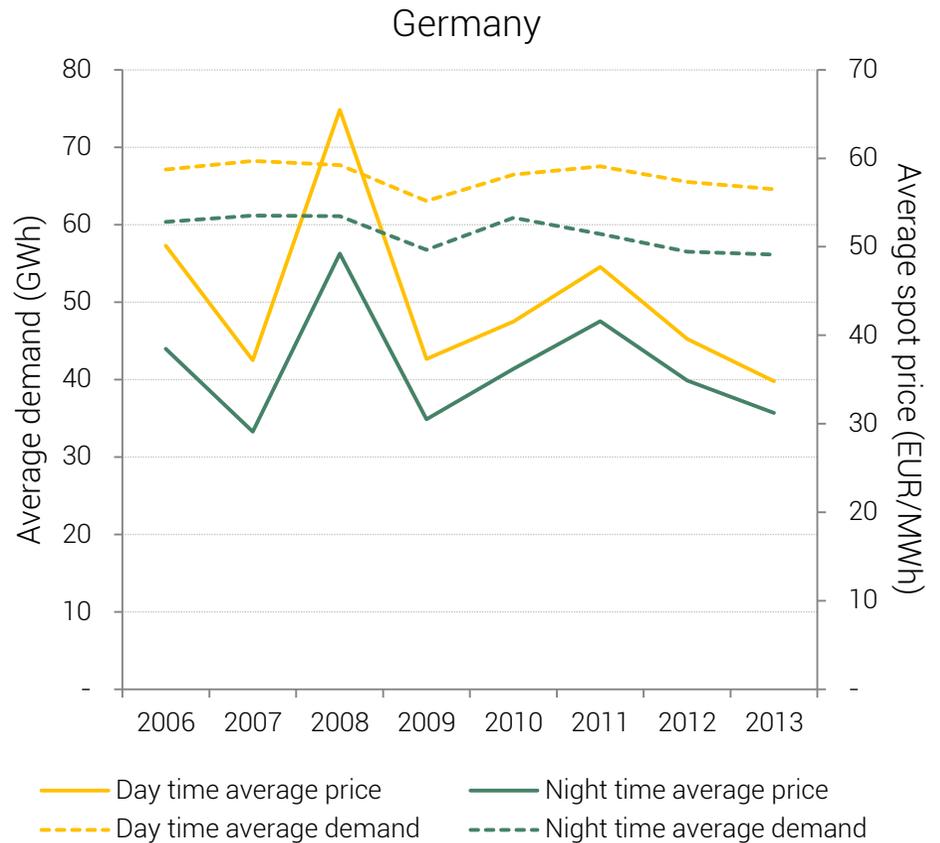
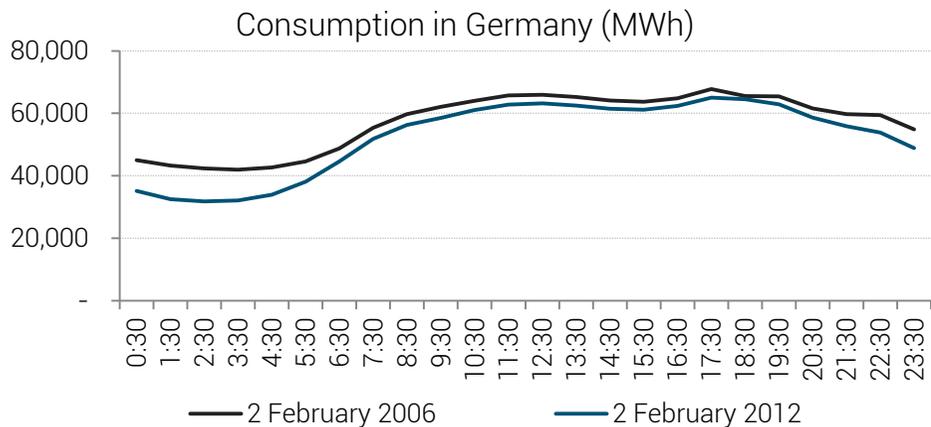
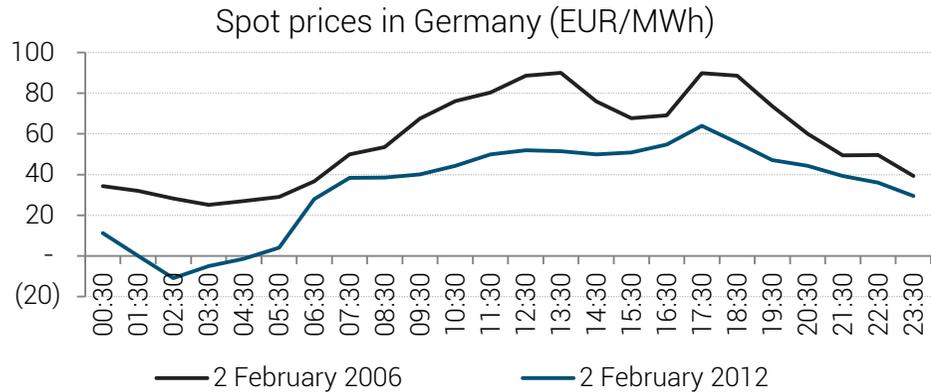
Statistical robustness

- Simulate random irradiation profiles across the 60 cities of GAFSI
- 4 billion random irradiation simulations
- MOE (resp. MOP) increases (resp. decreases) with PV installed capacity
- Predominant metrics: correlation with consumption (++) vs PV penetration rate (+ starting 2011)

PV generation does reduce wholesale prices significantly

3. Methodology and results

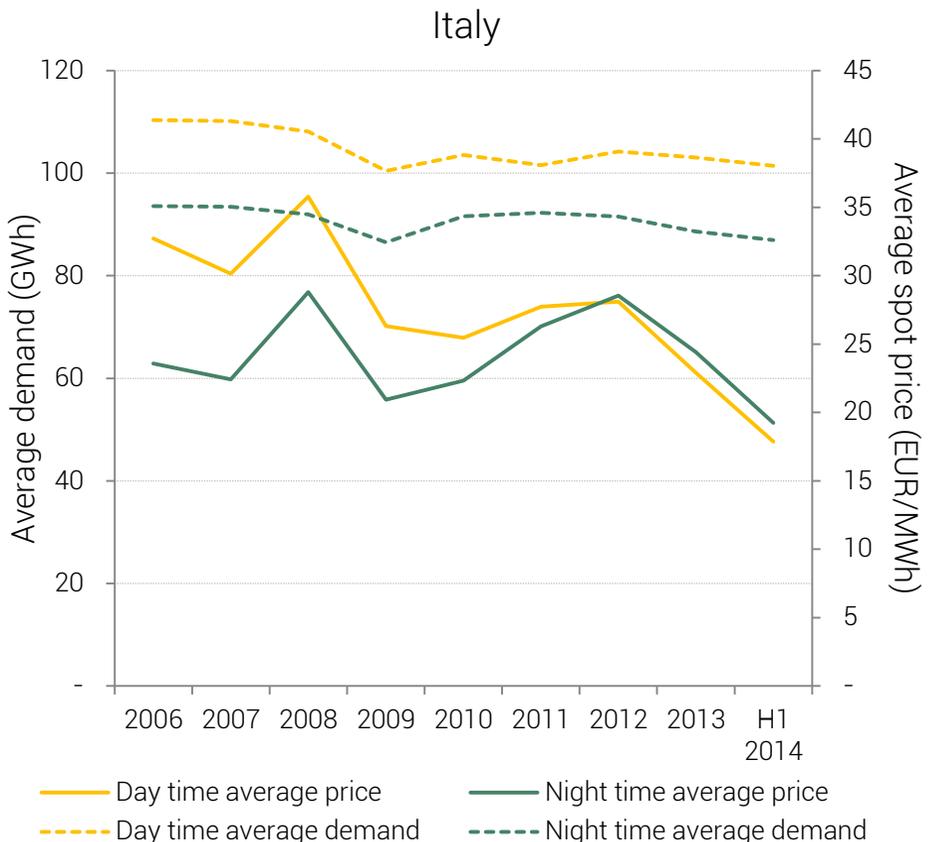
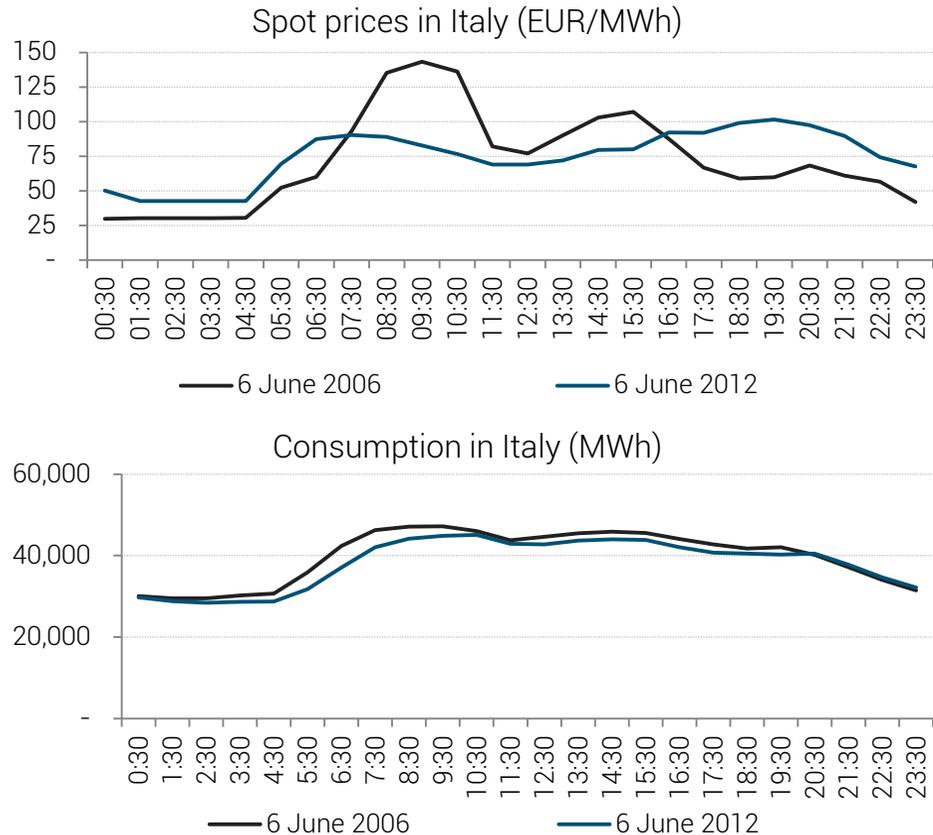
Are wholesale prices actually decreasing?



Wholesale prices in Germany are varying in accordance with electricity demand

3. Methodology and results

Are wholesale prices actually decreasing?



In Italy, starting in 2012, night time prices tend to de-correlate from electricity demand and rise above daytime price on average

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Table of contents

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4. Conclusion



5. Conclusion

Summary

I

The Merit Order Effect is the savings for end consumers linked to the downward pressure on wholesale prices due to PV production

II

Focus on Germany, Austria, France, Switzerland, Italy
(closed system, market coupling, highly correlated price fixing model)

III

MOE has amounted to EUR 20 bn over 2007-2013

IV

If the MOE could have been captured between 2007-2013, PV producers could have been remunerated 100 EUR/MWh on top of wholesale spot price at no cost for society

V

Average wholesale prices would have been 3% higher had there been no PV production
(equivalently 1.5 EUR/MWh)

5. Conclusion

Opening

I

MOE savings could be allocated to finance support schemes (capacity mechanisms) and grid infrastructure works for instance

II

The MOE is not a net loss for utilities as they benefit from it through distribution

III

Potential improvements of the study: (i) include wind, (ii) take account of self consumption, (iii) take account of exports and imports

IV

Net benefits of PV: this study only focused on market (wholesale) prices

5. Conclusion

Acknowledgments

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Debt advisory



Equity advisory



Modelling

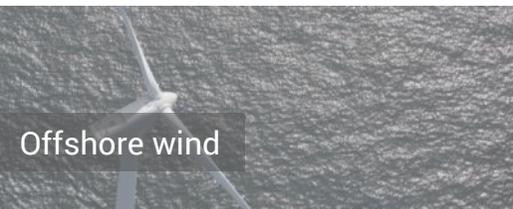


Strategic advisory



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Offshore wind



Onshore wind



Solar power



Biomass