The impact of policy uncertainty on innovation in the wind industry: evidence from EU countries

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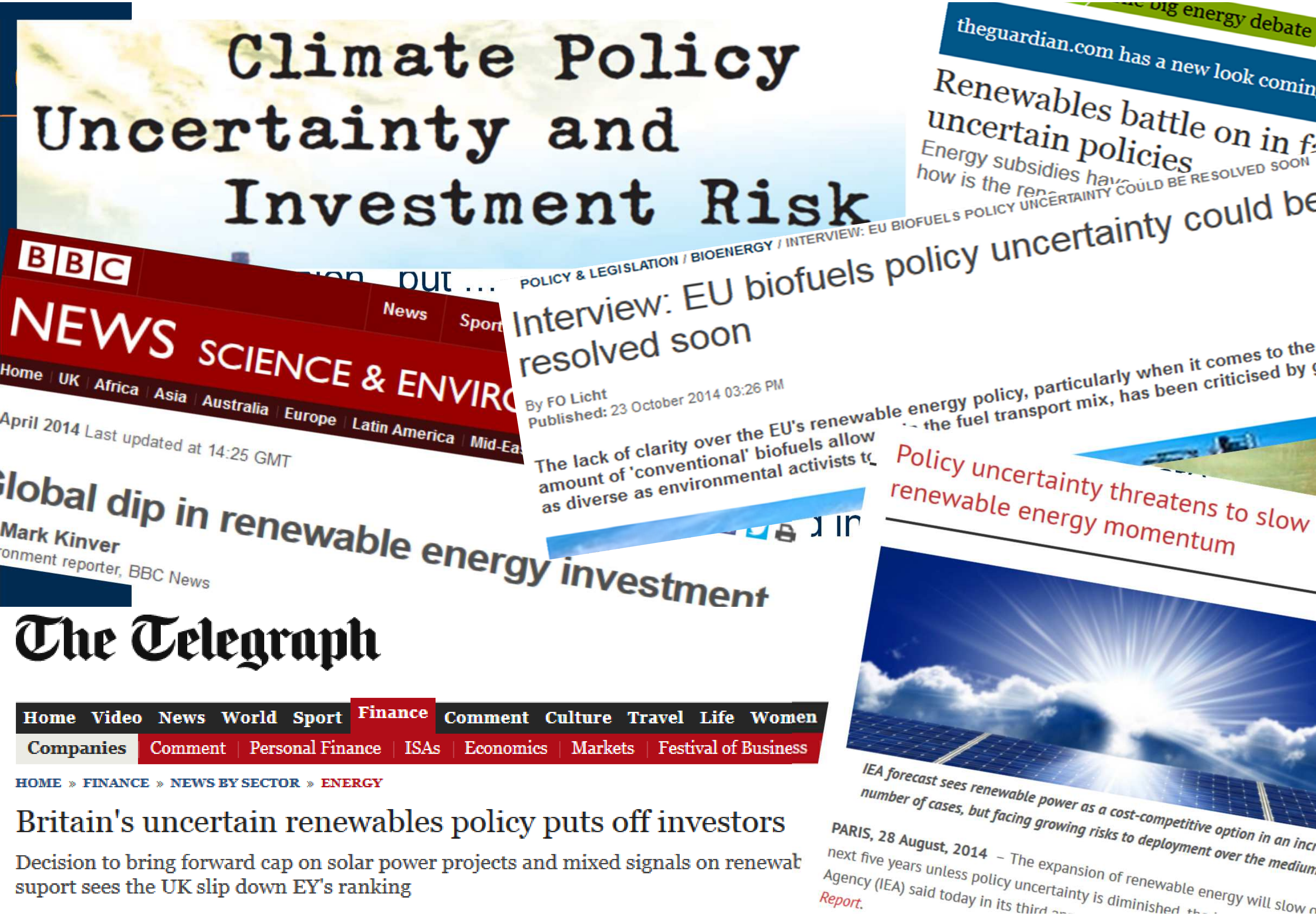
with V. Bosetti and P. Jockers

GGKP
Venice 2015



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onment reporter, BBC News
POLICY & LEGISLATION / BIOENERGY / INTERVIEW: EU BIOFUELS POLICY UNCERTAINTY COULD BE RESOLVED SOON
Interview: EU biofuels policy uncertainty could be resolved soon
By FO Licht
Published: 23 October 2014 03:26 PM
The lack of clarity over the EU's renewable energy policy, particularly when it comes to the
amount of 'conventional' biofuels allow the fuel transport mix, has been criticised by
as diverse as environmental activists to
Policy uncertainty threatens to slow renewable energy momentum
IEA forecast sees renewable power as a cost-competitive option in an incr
number of cases, but facing growing risks to deployment over the medium
PARIS, 28 August, 2014 – The expansion of renewable energy will slow
next five years unless policy uncertainty is diminished
Agency (IEA) said today in its third
Report.
The Telegraph
Home Video News World Sport Finance Comment Culture Travel Life Women
Companies | Comment | Personal Finance | ISAs | Economics | Markets | Festival of Business
HOME » FINANCE » NEWS BY SECTOR » ENERGY
Britain's uncertain renewables policy puts off investors
Decision to bring forward cap on solar power projects and mixed signals on renewab
suport sees the UK slip down EY's ranking

1.

Green Innovation, Policy and Uncertainty

We fill this gap in the literature

- Horizon 2020: embeds the idea of a Greener economy and invests in the transformation of the energy system (SET Plan 2008)
- But private investments needed to pass “valley of death” (Funding from the private sector: 70% of the total R&D in SET Plan priorities; European Industrial Initiatives)

“All I'm saying is that wind power isn't all it's cracked up to be.”

Key policy question :

How does policy uncertainty affect incentives to innovate?

2.

Focus on Wind Technologies in the EU

- **EU leads the world in wind installed capacity ("Mature" REN)**
- **Wind is second largest renewable in EU**
- **Globally, operation costs decreasing**
  - LCOE decreased (78 $/MWh in 2013), but variation is high
- **Received widespread policy support (feed-in and RECs)**
- **Annual turnover of major suppliers ~ 20 billion Euros in 2012**
  - BUT Ernst & Young Wind Attractiveness Index in EU countries declined
    - Italy 38 in 2013, Spain 37 in 2013
    - China 78 in 2013, United States 68 in 2013

3. Empirical Approach: Variables and Estimation

$$\text{Inno}= f(\boldsymbol{Policy}, \boldsymbol{Uncertainty}_{\boldsymbol{policy}}, \boldsymbol{Other\ factors})$$

Innovation: measured using patents (rather standard in the literature)

Policy and Policy Uncertainty: measured with a novel approach (next slides)

Estimation Technique:

- Panel data (18 European countries between 1995 to 2009)
- GMM Fixed Effect estimator (Woolridge 1991) for count data
- *Ceteris paribus*: covariates include govt RD&D, energy prices, time trend, propensity to patent

$$\mathrm{E}(\boldsymbol{I}_{i,t} | \boldsymbol{P}_{i,t}\ \boldsymbol{U}_{i,t}\ \boldsymbol{X}_{i,t}) = \exp(\beta_{\mathbf{0}} + \beta_{\mathbf{1}} \boldsymbol{P}_{i,t} + \beta_{\mathbf{2}} \boldsymbol{U}_{i,t} + \boldsymbol{X}'\beta) + \rho_{i,t}$$

4. Empirics: Measuring Policy and Uncertainty

Capacity additions at time t are the result of policy in support of wind energy, but also

1. Wind attractiveness
2. Decreases in costs arising from technological innovation and learning

Regress capacity additions on measures of (1) and (2)

$$\Delta \mathrm{CAPACITY}_{i,t} = \exp(\alpha + \beta_1 \mathrm{WA}_{i,t} + \beta_2 \ln(\mathrm{COST}_{i,t-1}) + \gamma_i + \varepsilon_{i,t})$$

- Use error as proxy for policy stringency (linearizing)
- Error measures changes capacities not explained by changes in economic conditions or variations in generation costs
- Hence it is arguably attributable to policy shocks

Policy volatility

- take the absolute value of the error term, normalize it by Δ capacity, and calculate the coefficient of variation

$$VOL\_EXO_{i,t} = \frac{\sqrt{\frac{1}{3}\sum_{s=0}^{2}\left[\omega_{i,t} - \left(\frac{1}{3}\sum_{s=0}^{2}\omega_{i,t-s}\right)\right]^2}}{\frac{1}{3}\sum_{s=0}^{2}\omega_{i,t-s}}$$

5. Results

	Own Innovation Claimed Priorities	Own Innovation Claimed Priorities	Own Innovation Claimed Priorities	Own Innovation Claimed Priorities
Knowledge Stock	0.190***	0.191***	0.205***	0.195**
	[0.000653]	[0.00681]	[0.00405]	[0.0129]
Policy	**0.0120*** **	**0.0119** **	**0.0126** **	**0.0131** **
	[0.00384]	**[0.0464]**	**[0.0237]**	**[0.0220]**
Uncertainty	**-0.126** **	**-0.125*** **	**-0.123*** **	**-0.136*** **
	[0.0111]	**[0.00742]**	**[0.00748]**	**[0.00110]**
Law and Order	2.274**	2.275**	2.271**	2.657***
	[0.0152]	[0.0157]	[0.0122]	[0.00467]
Price of Gas		0.00622	-0.0696	4.29e-05
		[0.982]	[0.779]	[1.000]
Access to Credit			0.0348	0.0283
			[0.292]	[0.427]
Public R&D Wind				2.997
				[0.131]
Trend	YES	YES	Yes	YES
Observations	164	164	164	140

Variable	Obs	Mean	Std. Dev.	Min	Max
Policy	164	0.0696489	4.400554	-28.86036	16.1876
Uncertainty	164	-0.6433893	0.7705623	-4.411947	0.24358

6. Quantification and Conclusions

Main empirical results

1. Positive effect of environmental policy on wind innovation confirmed
2. This is counterbalanced by negative impact of policy volatility on innovation, which can offset (1)
3. [Take with care: preliminary] *Specifically, if policy increased by one standard deviation, the "average" country's innovation level would increase by roughly 5%. If at the same time uncertainty increases by one standard deviation, the country's innovation level would decrease by 5% with respect to the initial level*
4. Current work focuses on robustness of these results

Main policy implication:

1. Ability of EU countries to become hubs of green growth will greatly depend on the stability of policy signals to investors.
2. Long-term planning and commitment is key in this respect
3. Policy implementation with frequent changes means eroding the inducement effect of policy mechanisms

Thank you

Comments/suggestions welcome

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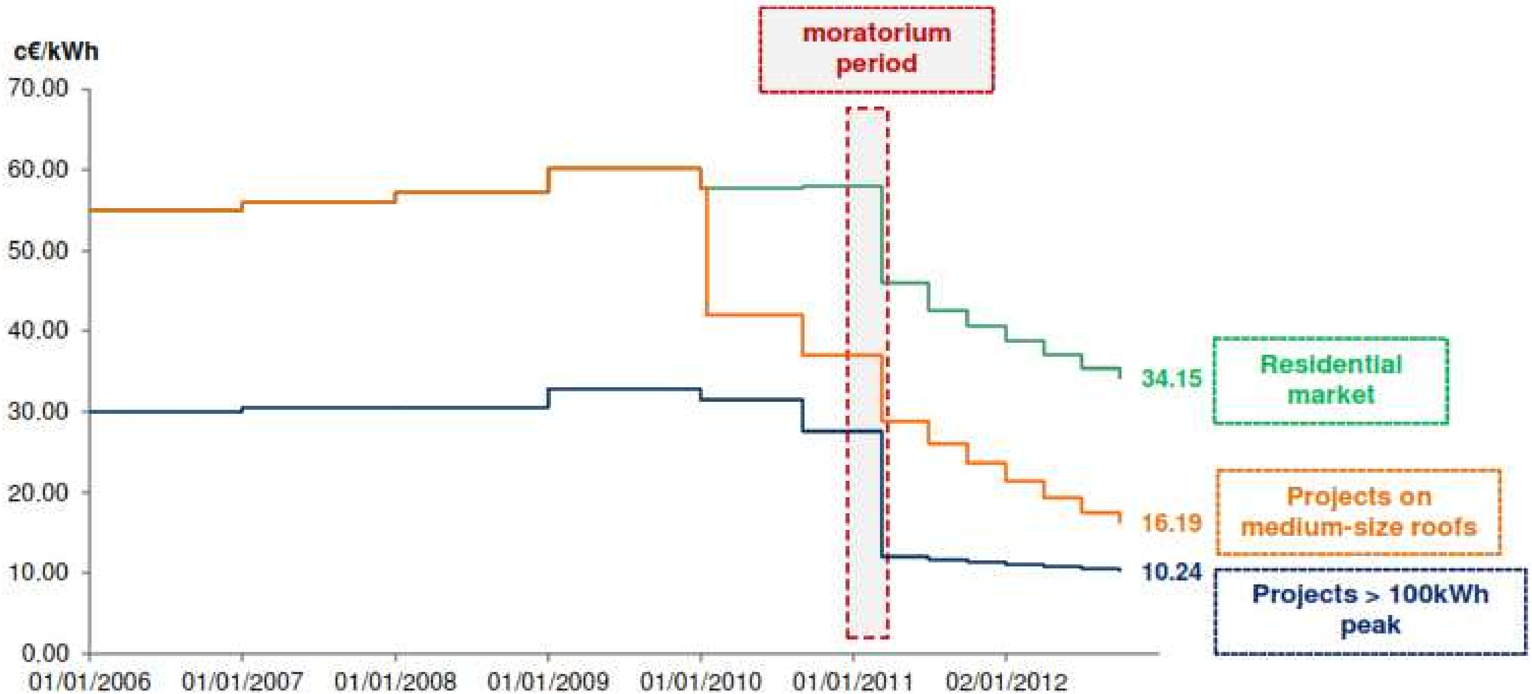
French moratorium



Source: www.photovoltaique.info, *"France, territoire Solaire"*, Observatoire de l'énergie solaire photovoltaïque en France and Kurt Salmon, 2012

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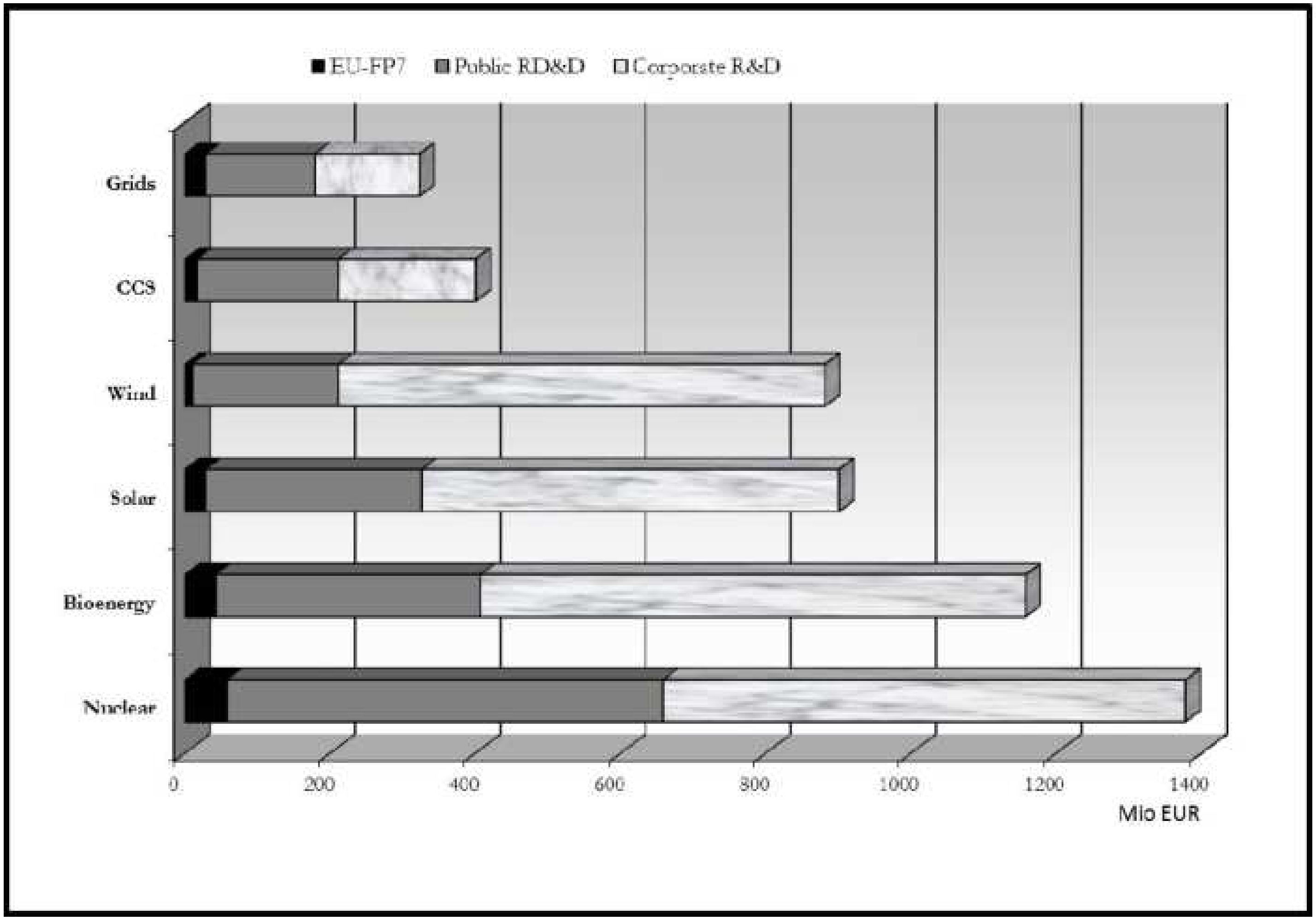
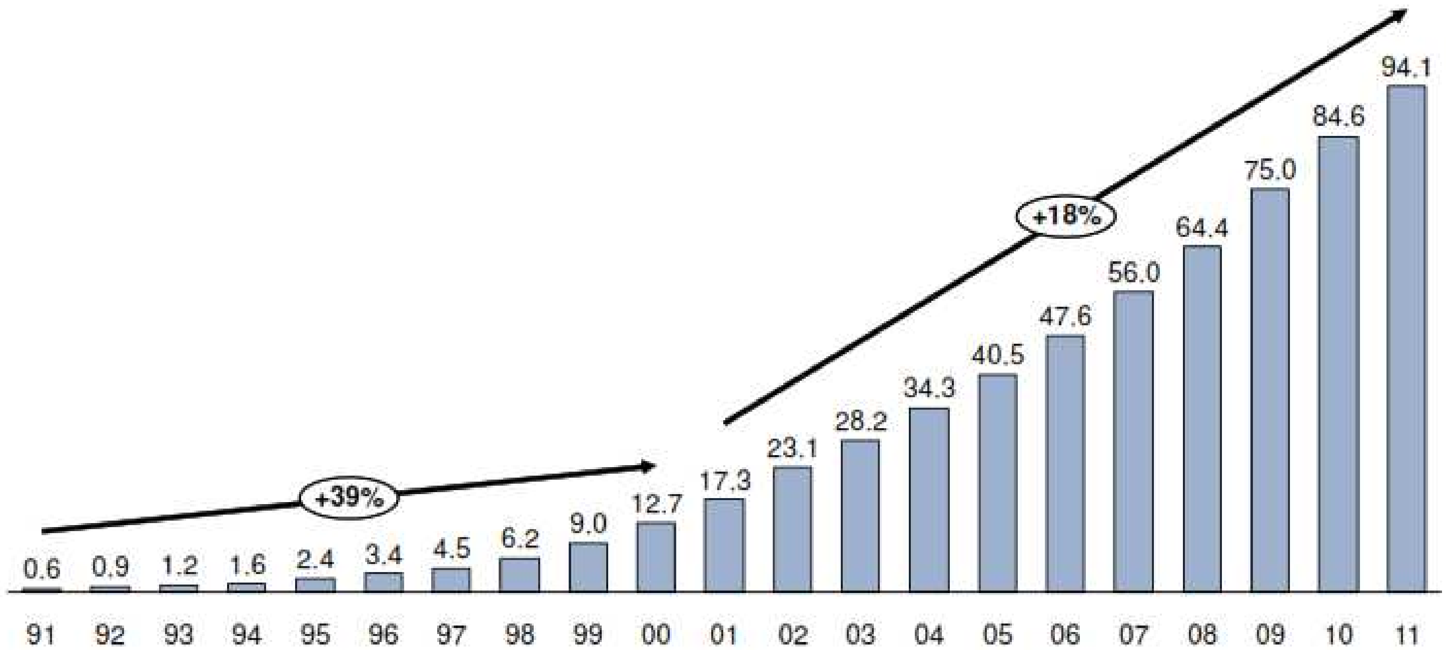
RES-E RD&D investment by source of funds



Increase in wind capacity in the EU

Figure 4: Annual evolution of wind installed capacity in Europe (in GW), 1991-2011



Source: Bloomberg New Energy Finance (BNEF),
Note: percentages show compound annual growth rates (CAGR)

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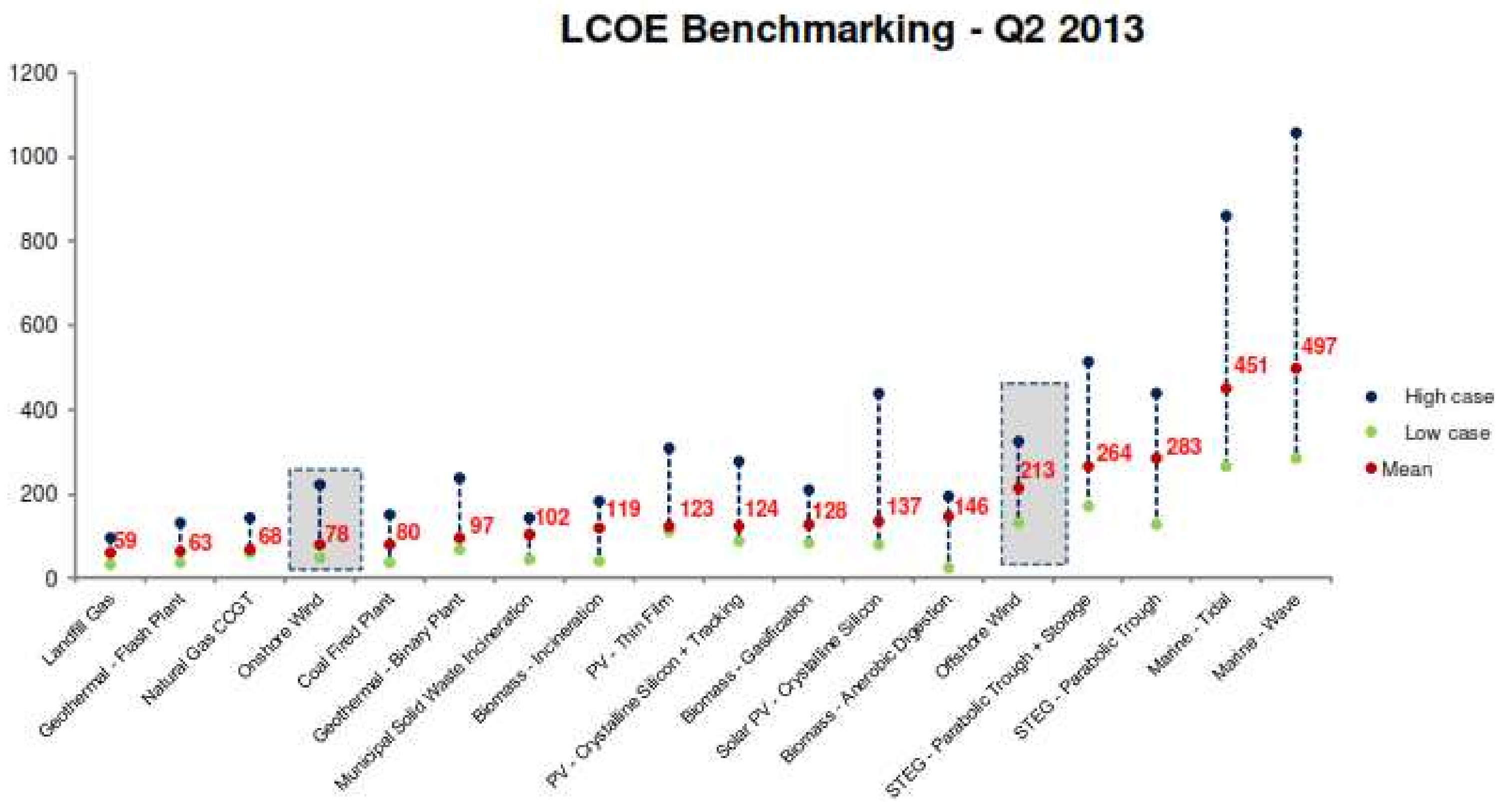
LCOE for wind -- 2013

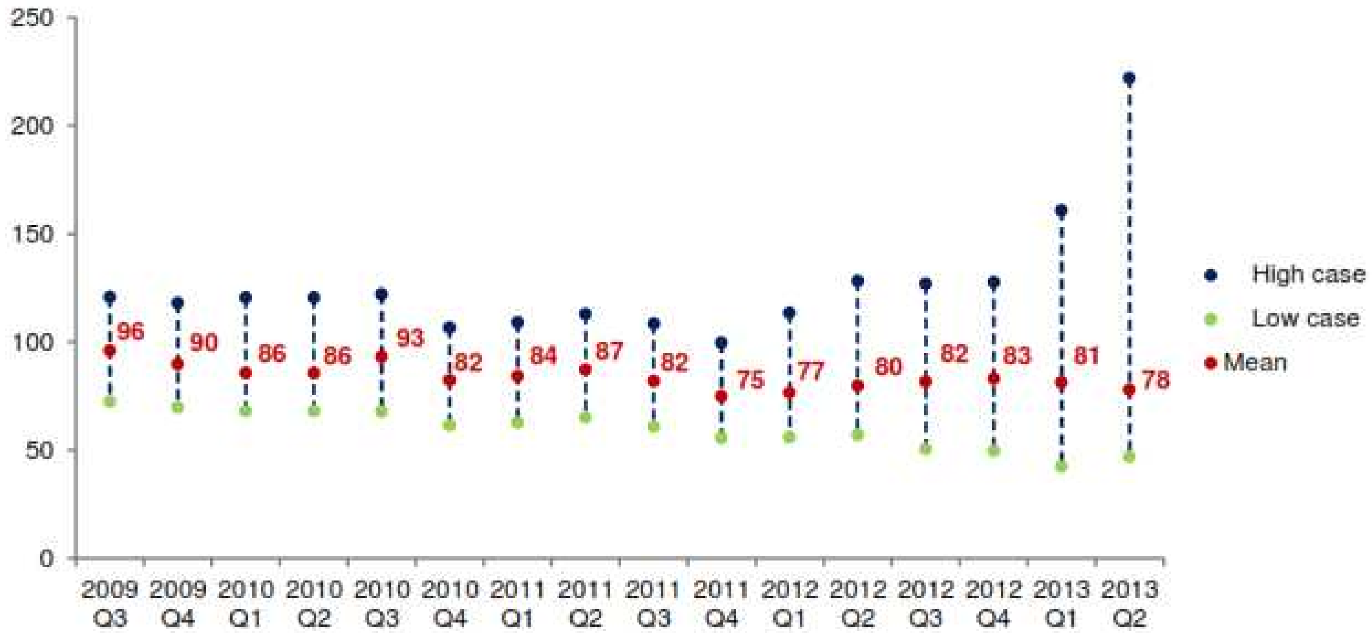
Figure 7: Comparative Levelized Costs of Energy (LCOE) as of Q2 2013, in \$/MWH



Source: Bloomberg New Energy Finance (BNEF)

Evolution and uncertainty of LCOE for wind

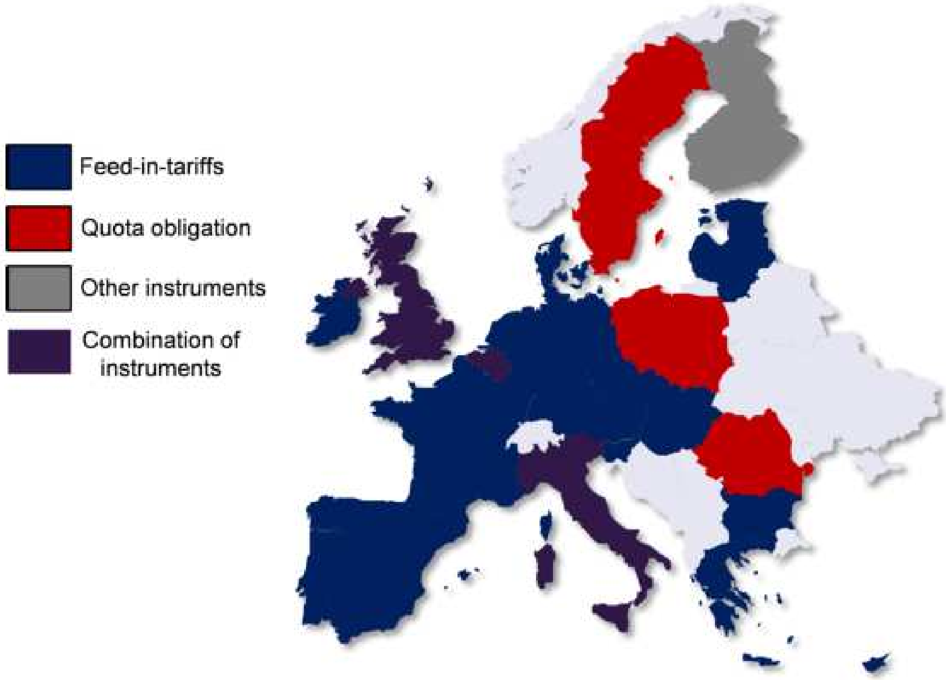
Figure 9: Evolution of wind Levelized Costs of Energy (LCOE) from 2009 to 2013, in \$/MWH



Source: Bloomberg New Energy Finance (BNEF)

Policy support to RES-E

Figure 12: Main RES-E support instruments in the EU 27



Source: Energy Economics Group & Fraunhofer ISI, Evaluation of different feed-in-tariff design options – Best practice paper for the International Feed-In-Cooperation, December 2010

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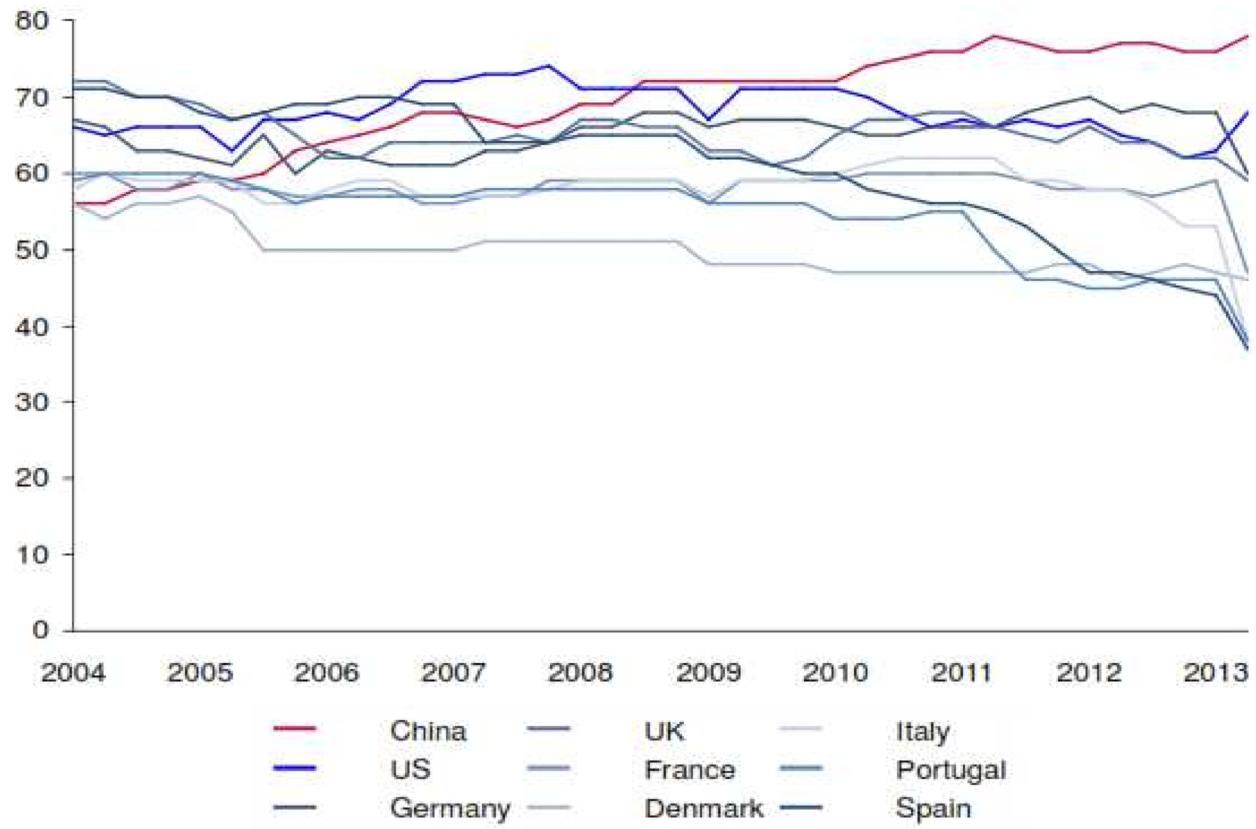
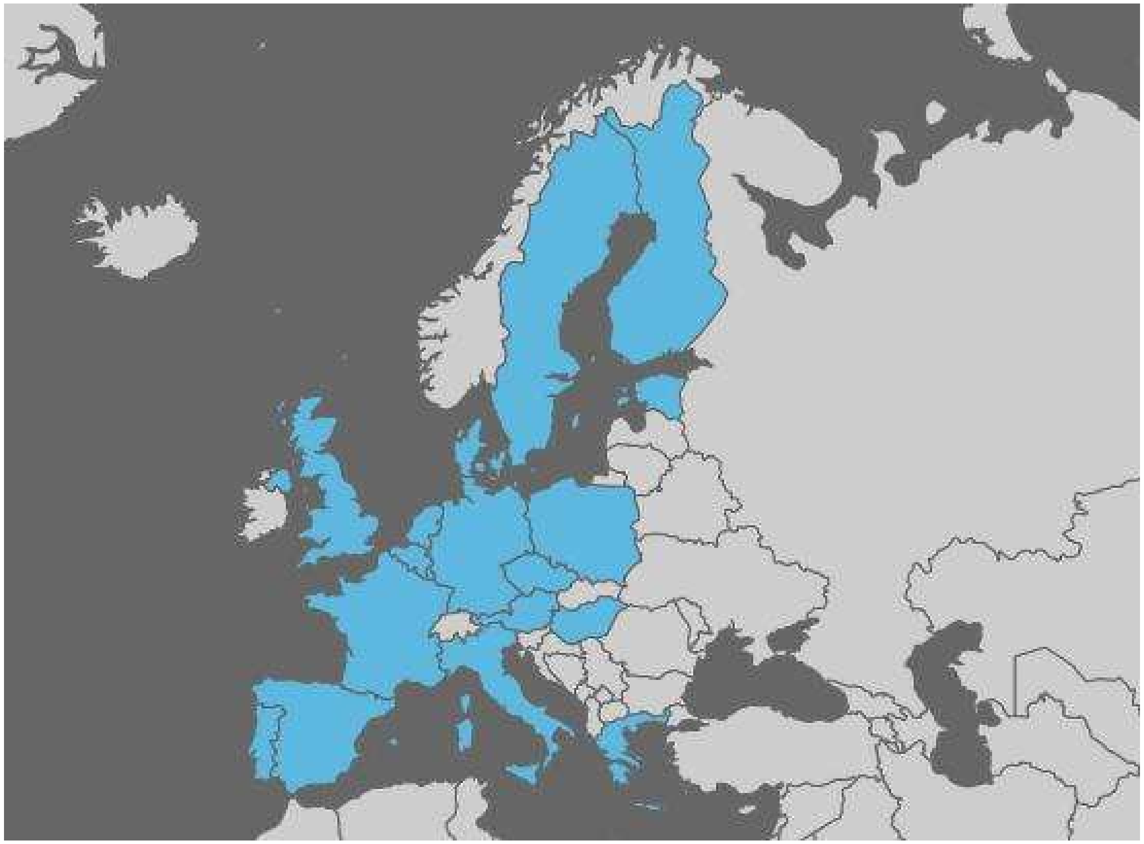
Attractiveness of wind market

Figure 27: Ernst & Young Wind Attractiveness Index (2004-2011)



Source: Bloomberg New Energy Finance (BNEF)

Sample



Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain, Sweden and the United Kingdom

Determinants of capacity additions

Wind Attractiveness ("effective" wind potential):

$$WA_{i,t} = \sum_{r=1}^{r=n} WIND\ POTENTIAL_r . GDP_{r,t} . \frac{AREA_r}{TOTAL\ AREA_i} . \frac{1}{1{,}000}$$

- Regional wind potential
- Regional GDP
- Capacity additions are higher where wind resources are more abundant and where economy is more developed
- Cleaned from feedback effect: innovation in wind not likely to affect regional GDP or size

Cost:

$$COST_{i,t} = 100\left(1 - \left(1 - \exp\left(-0.15 \ln\left(\frac{CUMULATED\ CAPACITY_t}{CUMULATED\ CAPACITY_{1995}}\right)\right)\right)\right)$$

- Normalized to 100
- Doubling of capacity yields around ~10% cost decrease

Exogenous policy shock indicator

Explanatory variables:	Dependent variable: Annual added wind capacities (ln)
IV Indicator	0.00260**
	[0.0209]
$\ln(Cost_{t-1})$	-4.095***
	[0]
Constant	19.18***
	[0]
Country fixed effects	YES
Observations	211
R-squared	0.789

Robust p-values in brackets

*** p<0.01, ** p<0.05, * p<0.1

We find that coefficients for our Cost and IV indicator variables are significant at respectively the 1% and 5% level. A decrease of 10% in our Cost indicator results in an increase of ~32% in added capacity per year. As expected, the sign of the coefficient for the IV Indicator is positive. The R-squared of the regression is 0.79, implying that policy volatility explains roughly 21% of the variations in annual capacity additions.

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