

# CMCC WEBINAR

November 27, 2018 - h.12:30 pm CET

## “Low-carbon energy finance – new research results and their implications for modelers and policy makers”

**Tobias S Schmidt** - *Presenter*  
*Energy Politics Group (ETH Zurich)*

**Bjarne Steffen** - *Presenter*  
*Energy Politics Group (ETH Zurich)*

**Elena Verdolini** - *Moderator*  
*RFF-CMCC European Institute  
on Economics and the Environment (EIEE)*



To investigate and model our **climate system** and its interactions with **society** to provide reliable, rigorous, and timely **scientific results**, which will in turn stimulate sustainable growth, protect the **environment**, and **develop science driven** adaptation and **mitigation policies** in a **changing climate**



## MISSION



# NETWORK



# RESEARCH DIVISIONS

Advanced Scientific Computing (ASC)

Climate Simulation and Prediction (CSP)

Economic analysis of Climate Impacts and Policy (ECIP)

Impacts on Agriculture, Forests and Ecosystem Services (IAFES)

Ocean modeling and Data Assimilation (ODA)

Ocean Predictions and Applications (OPA)

Risk Assessment and Adaptation Strategies (RAAS)

REgional Models and geo-Hydrological Impacts (REMHI)

Sustainable Earth Modelling Economics (SEME)



# TOPICS

Modelling  
Policy Adaptation  
Agriculture Society  
Predictions Impacts  
Hydrogeology  
Forests Simulations  
Oceans Ecosystems  
Computing  
Services





**Publications**



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# Q&A session

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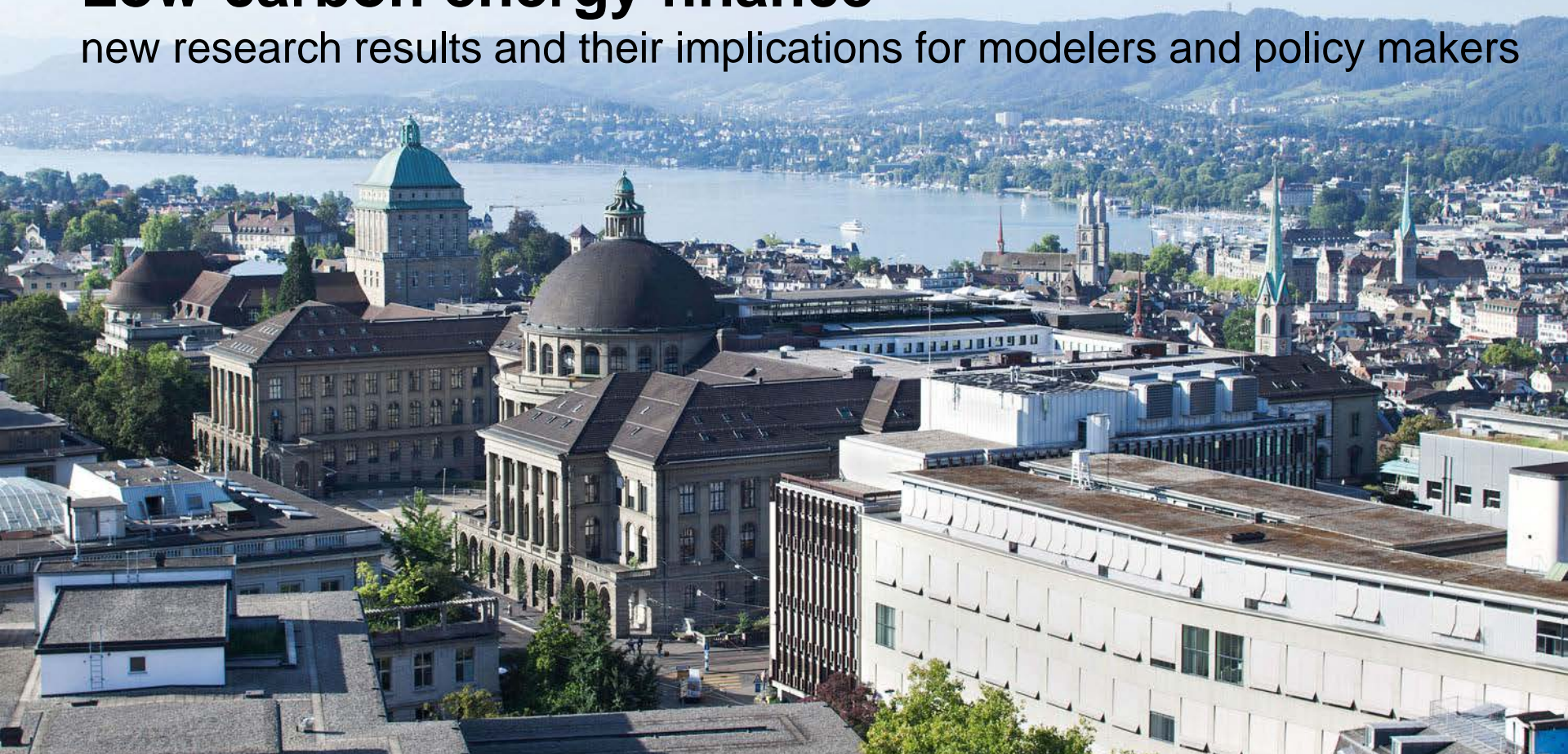


CMCC webinar, Zurich, Nov 12, 2018

Prof. Tobias Schmidt, Dr. Bjarne Steffen, Energy Politics Group, ETH Zurich, [www.epg.ethz.ch](http://www.epg.ethz.ch)

# Low-carbon energy finance

new research results and their implications for modelers and policy makers

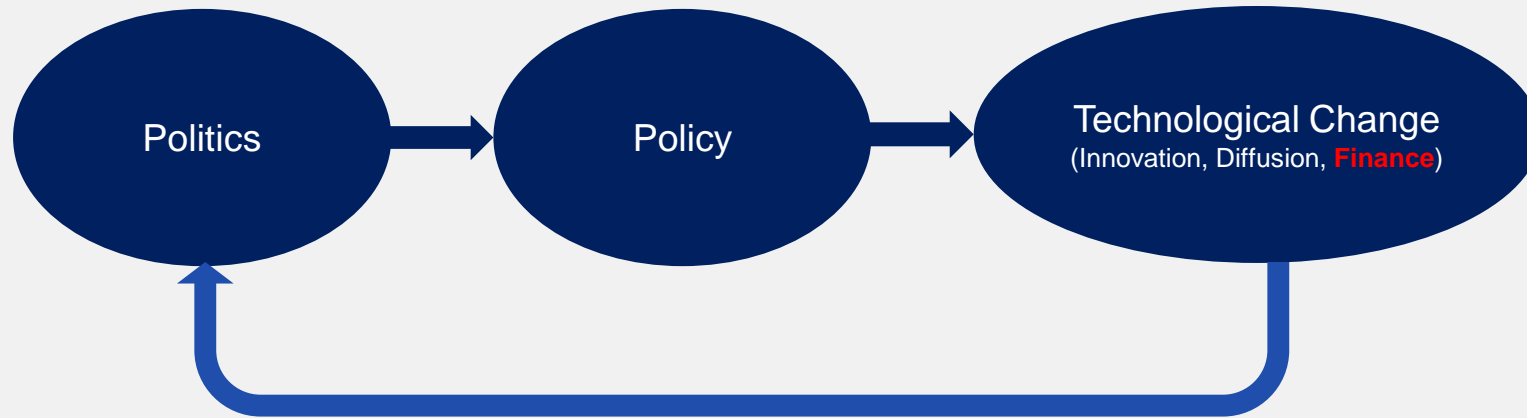


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730403, as well as from the European Research Council under grant number 313553. It has also received funding by the Swiss State Secretariat for Education, Research and Innovation (SERI) [contract number 16.0222] and ETH Foundation. The opinions expressed & arguments employed herein do not necessarily reflect the official views of the Swiss Government. The project was also supported by a seed grant from ETH Zurich foundation.



# EPG's research framework: Analyzing the co-evolution of policy with technological change

Energy sector

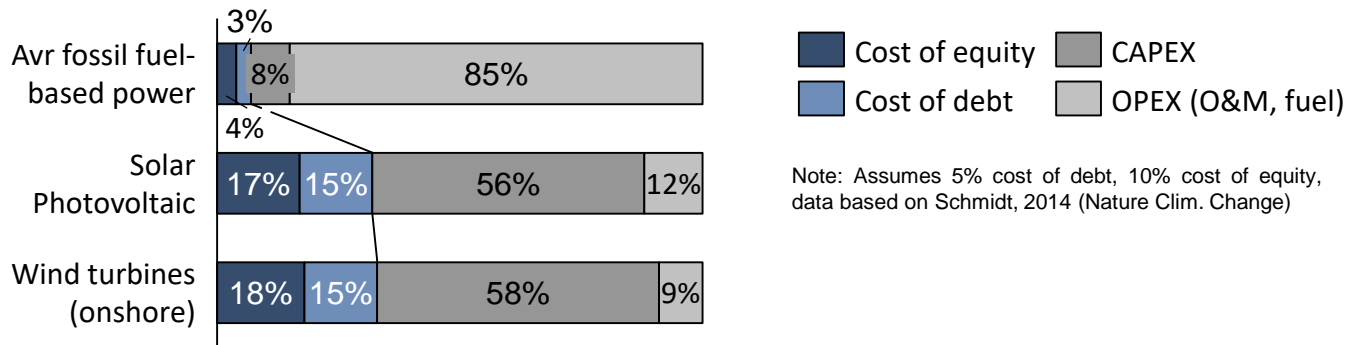


We are an interdisciplinary team of engineers, economists, and political scientists

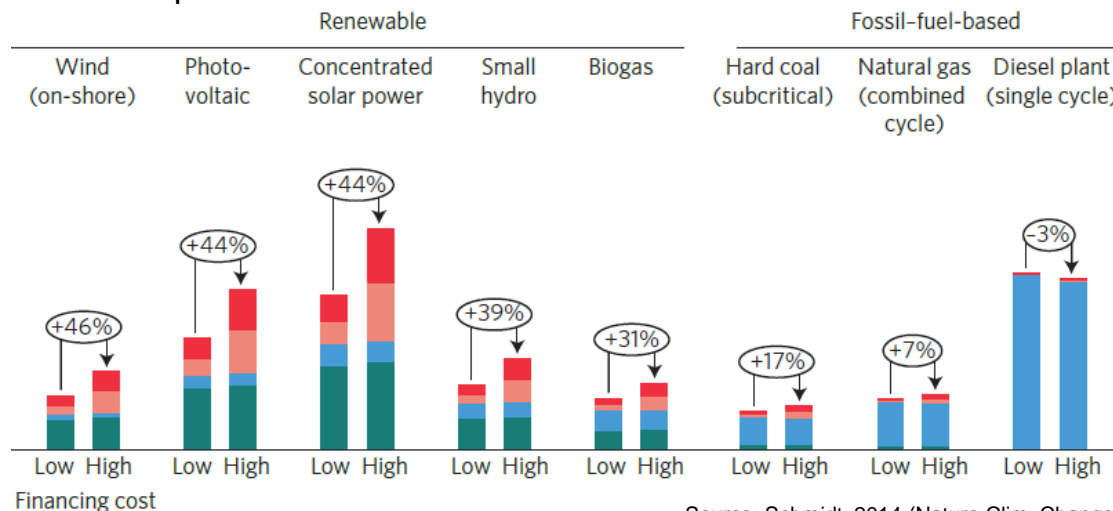


# Financing is more relevant for low-carbon energy technologies, due to their higher capital intensity

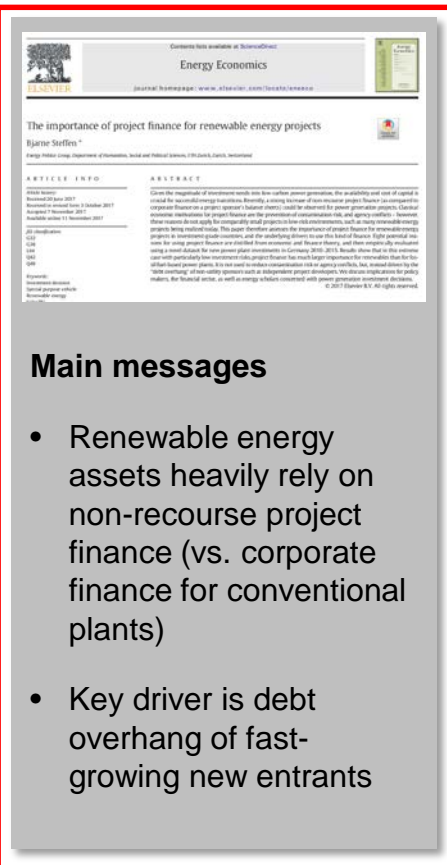
Percentage of different cost components in LCOE



Impact of increased cost of capital on LCOE

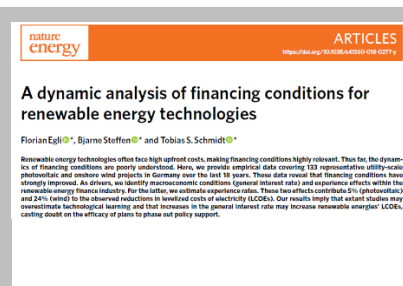


# The four papers of this talk and their key messages



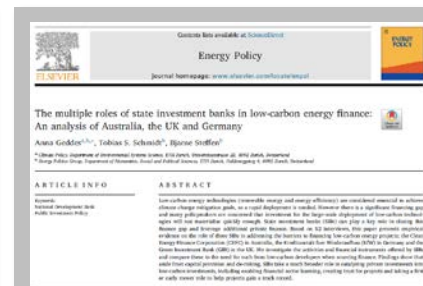
**Main messages**

- Renewable energy assets heavily rely on non-recourse project finance (vs. corporate finance for conventional plants)
- Key driver is debt overhang of fast-growing new entrants



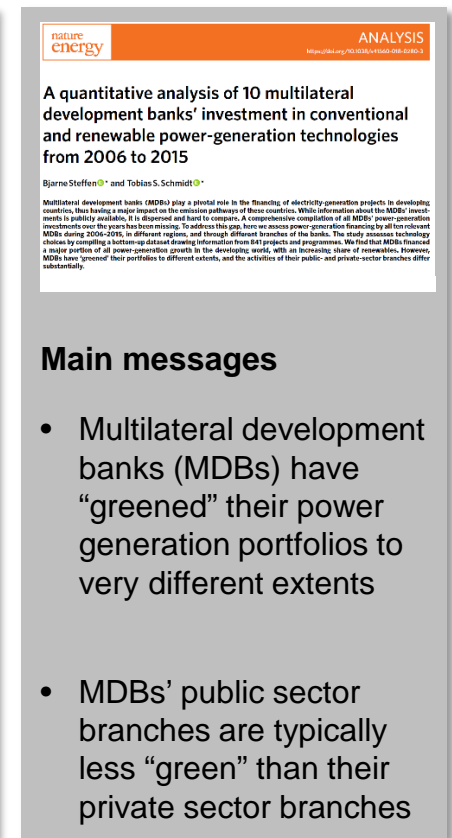
**Main messages**

- The cost of capital for project-financed renewable energy assets has fallen substantially over the last 15 years
- We detect a financing experience curve (investors also learn)



**Main messages**

- “Green” state investment banks (SIBs) help in overcoming investors’ aversion against new energy assets
- SIBs found to crowd-in private finance rather than crowd-out



**Main messages**

- Multilateral development banks (MDBs) have “greened” their power generation portfolios to very different extents
- MDBs’ public sector branches are typically less “green” than their private sector branches

# Project finance: A niche of capital markets, but not for RE

## Corporate Finance (CF)

### Financing of new project on the balance sheet of the sponsor

- Using assets and cash flows from existing firm to guarantee additional credit provided by lenders
- Cost of capital determined by sponsor solidity



## Project Finance (PF)

### Creating a special purpose vehicle (SPV) to incorporate new project

- No guarantee from sponsor's assets, lenders depend on cash flows of new project alone
- Cost of capital cost determined by project cash flows and risks

*Very often used for wind & solar*

**Classical economic motivations for PF do not hold for renewables in OECD countries**

**Thus study addresses research questions:**

1. How important is project finance for renewable energy projects in developed, low-risk countries?
2. What are the drivers and underlying reasons to use project finance in such settings?

# Quantitative analysis of extreme low-risk case DE

Case selection: Germany



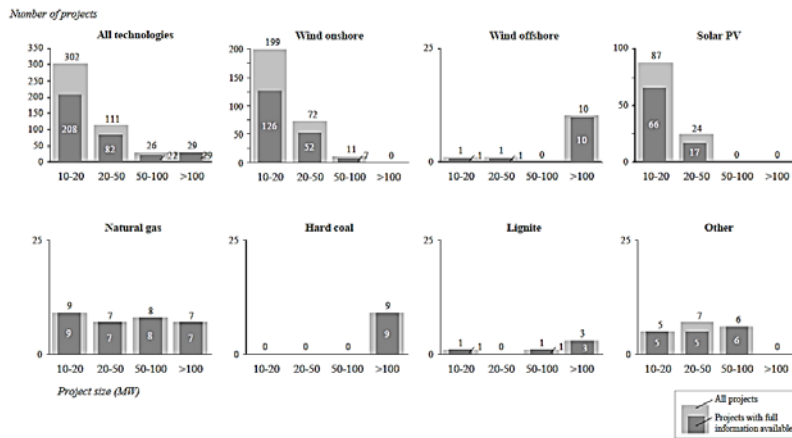
Data: Utility-scale projects 2010–2015

Polar type sampling: DE as extreme example of low-risk environment for renewables

- «Best-in-class» as per UNDP
- Well-developed capital markets

Analysis of new dataset, combining asset list from grid regulator with financial info from trade register

- Showing finance structure in population
- Regression analysis to identify drivers



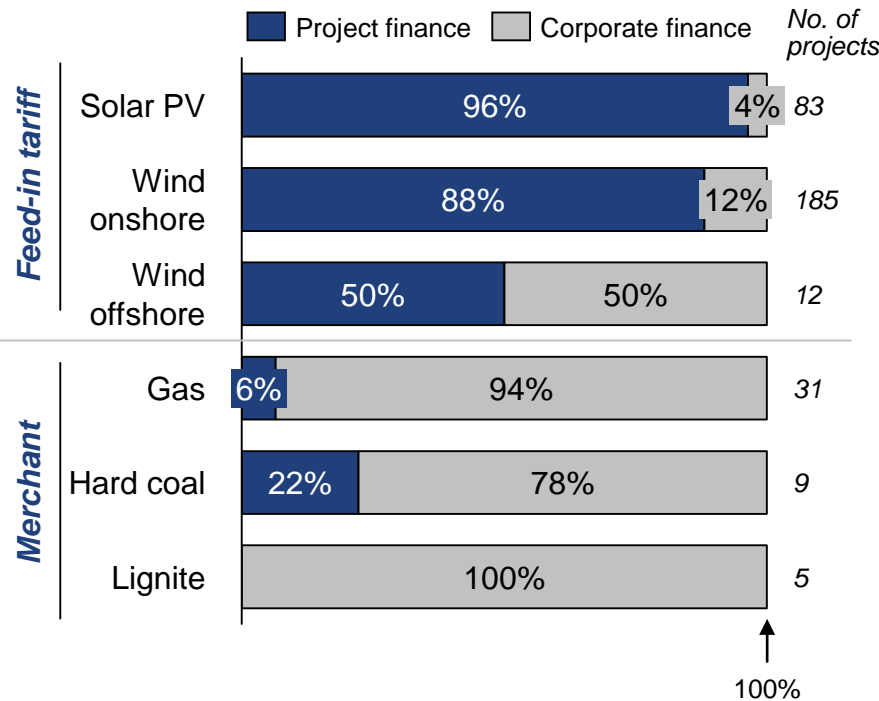
	A	B	C	D	E	F
	(all sponsors)	(all sponsors)	(all sponsors)	(all sponsors)	(all sponsors)	(only RegMun)
<b>Project size</b>						
Installed capacity	2.271 (2.175)	2.758 (2.483)	1.944 (2.636)	4.051* (2.436)	3.611 (3.370)	0.458 (3.090)
Installed capacity squared	-1.038 (0.854)	-1.804 (1.157)	-1.299 (0.916)	-1.618* (0.969)	-1.633 (1.322)	0.296 (1.047)
<b>Project risk</b>						
Merchant risk (no feed-in tariff)	-2.559*** (0.771)	-2.190*** (0.803)	-2.702*** (0.886)	-4.824*** (0.642)	-0.935 (1.438)	-3.827 (3.513)
Renew. tech. risk <sup>b</sup> (wind offshore)	-2.391* (1.268)	-2.596* (1.394)	-2.012 (1.898)	-3.347** (1.422)	-2.663 (1.907)	-1.607 (1.811)
<b>Technology controls</b>						
Hard coal		2.396 (2.786)				
Solar PV		2.673*** (1.026)				
<b>Free CF pot.<sup>a</sup></b>					4.049*** (1.478)	4.724* (2.473)
<b>Sponsor type</b>						
Big four utility	-0.810 (0.876)	-0.458 (0.903)	-0.787 (0.866)		-0.662 (1.016)	
Regional/municipal utility	-0.425 (0.833)	-0.555 (0.874)	-0.393 (0.852)		-0.474 (0.962)	
Foreign utility/IPP	0.948 (1.038)	1.073 (1.039)	0.940 (1.025)		1.250 (1.208)	
Project developer	2.371*** (0.812)	2.024** (0.926)	2.400*** (0.839)		2.297** (0.933)	
Industry	-0.620 (1.017)	-0.913 (0.987)	-0.573 (1.046)		-1.057 (1.152)	
Cooperative/individuals	3.604*** (1.259)	3.541*** (1.283)	3.623*** (1.263)		3.638*** (1.348)	
Horizontal joint venture	1.381* (0.722)	1.889** (0.803)	1.368* (0.715)	0.147 (0.835)	2.239** (0.974)	1.749 (1.264)
<b>Interaction terms</b>						
Installed capacity × Merchant risk				0.194 (0.560)		
Big four utility × No merchant risk					-2.313*** (0.761)	
<b>Year fixed effects</b>	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R <sup>2</sup>	0.522	0.534	0.523	0.429	0.578	0.347
Observations	292	287	292	341	276	64

<sup>a</sup>RegMun = Regional/municipal utility <sup>b</sup>Renew. tech. risk = Renewables technology risk <sup>c</sup>Free CF pot. = Free cash flow potential  
\*statistically significant at 10%; \*\*significant at 5%; \*\*\*significant at 1%

# Results: High share of PF for RE, driven by new players

## Renewables with much lower risk than fossil fuels – still, use more project finance

German power generation projects 2010–2015



## Key reason: small balance sheets of new players in industry

Results from regression analysis on rationales to use project finance



**Negative financial synergies with existing business**

- ~~1. Contamination risk~~
- 2. Debt overhang
- ~~3. Securitization~~



**(Further) market imperfections**

- ~~4. Information asymmetry btw. sponsor & lender~~
- 5. Agency owners & mgrs

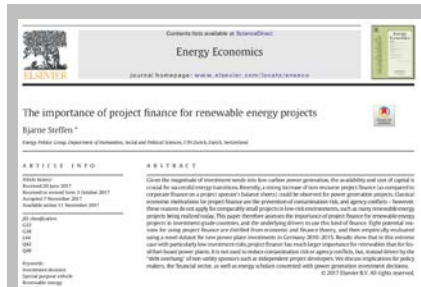


**Considerations regarding org. structure**

- ~~6. Horizontal joint ventures~~
- 7. Independence civic prjcts

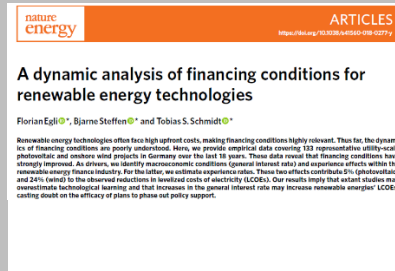
Steffen, B. (2018), The importance of project finance for renewable energy projects, *Energy Economics* (69), 280–294.

# The four papers of this talk and their key messages



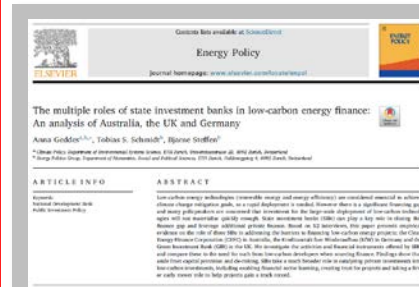
## Main messages

- Renewable energy assets heavily rely on non-recourse project finance (vs. corporate finance for conventional plants)
- Key driver is debt overhang of fast-growing new entrants



## Main messages

- The cost of capital for project-financed renewable energy assets has fallen substantially over the last 15 years
- We detect a financing experience curve (investors also learn)



## Main messages

- “Green” state investment banks (SIBs) help in overcoming investors’ aversion against new energy assets
- SIBs found to crowd-in private finance rather than crowd-out



## Main messages

- Multilateral development banks (MDBs) have “greened” their power generation portfolios to very different extents
- MDBs’ public sector branches are typically less “green” than their private sector branches

# Literature lacked an analysis of the financing cost dynamics of renewables

Our research questions

1. How and why did solar PV and wind onshore financing conditions in DE change over time?
2. What is the effect of these changes on their generation costs (LCOE)?

*Challenges:*

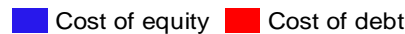
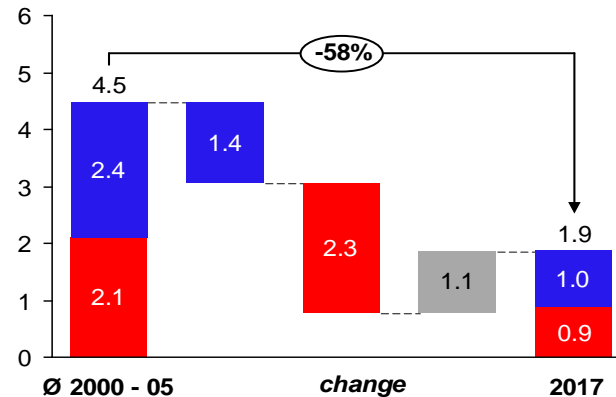
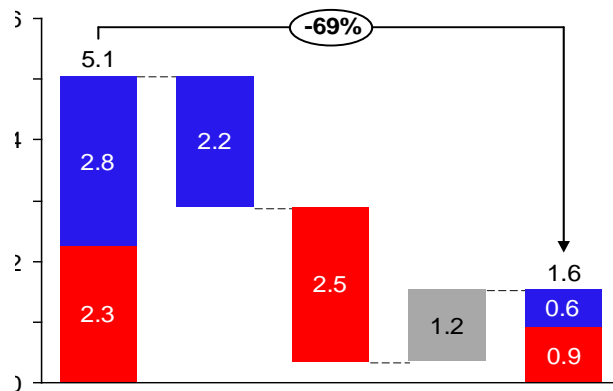
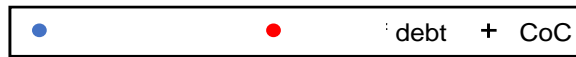
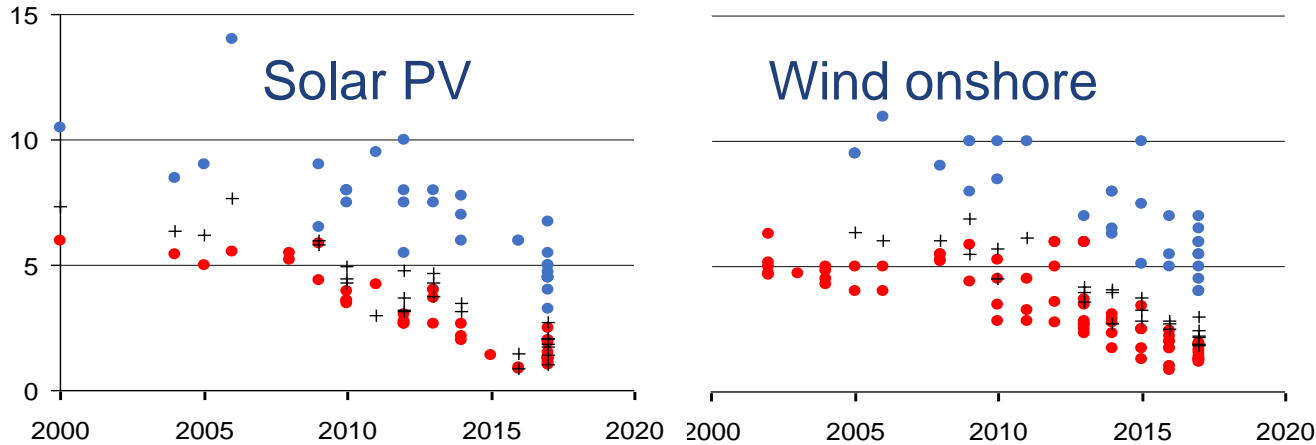
- *Scarce data, as financial details of project finance deals not disclosed*
- *For “why” part: Interest rate levels affected by multitude of drivers*



# We focus on Germany and use a mixed-method approach, taking four steps

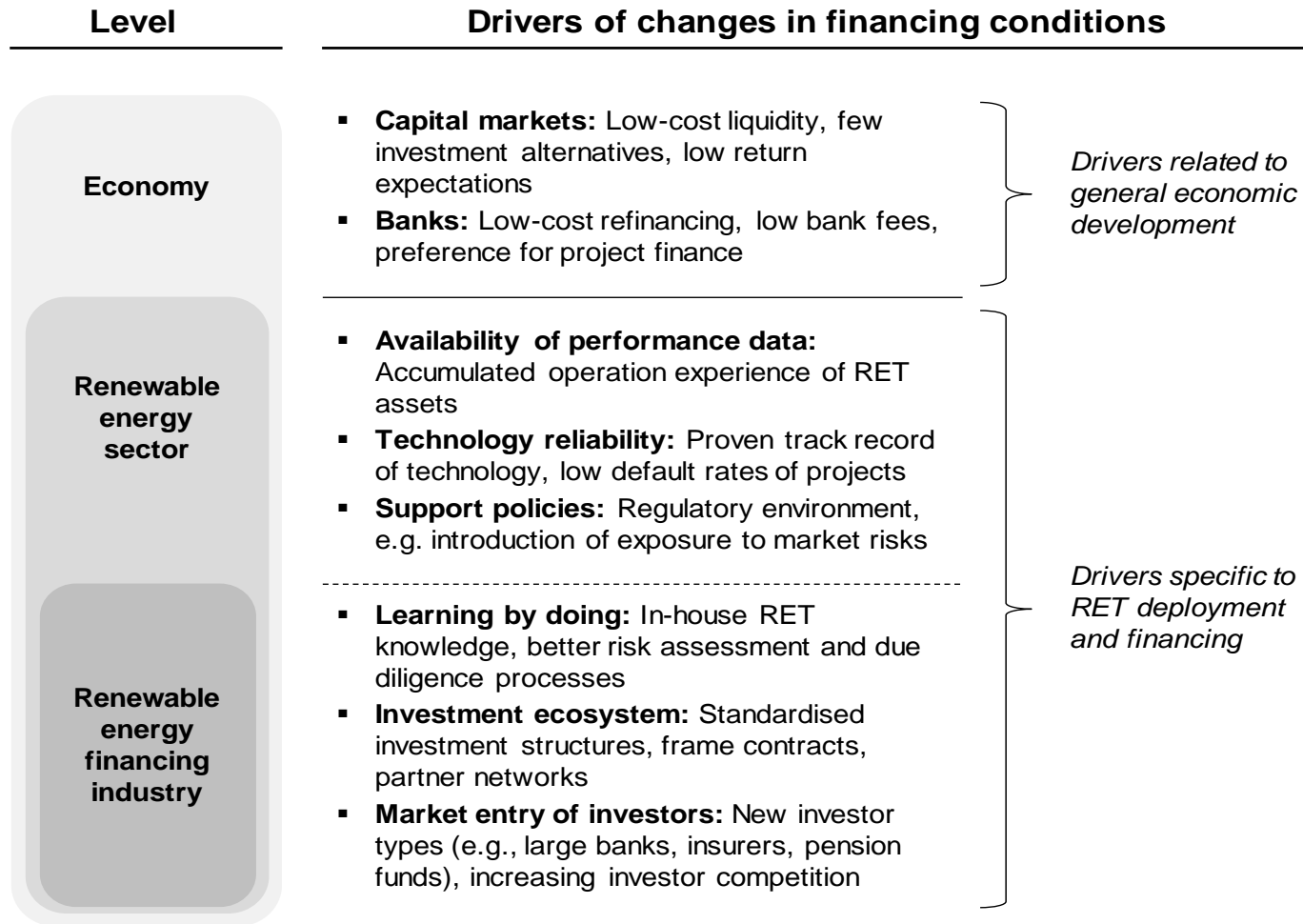
- 1 **Descriptive: Elicitation and mapping of project finance data**
  - Cost of equity, cost of debt/debt margin
  - Leverage, loan tenor, debt service coverage ratio
- 2 **Qualitative: Investor interviews to identify drivers for changes**
  - Semi-structured interviews, grounded theory-type coding of arguments
- 3 **Quantitative: Regression analysis for experience curves**
  - Various specifications of dependent and independent variables
- 4 **Model-based: Split-up of LCOE into technology cost effects**
  - Calibration of levelized cost of electricity (LCOE) in different settings

# Step 1: Historic development of the cost of capital



Egli, F., Steffen, B., Schmidt, T. S. (2018). A dynamic analysis of financing conditions for renewable energy technologies. Nature Energy, available online

## Step 2: We detect drivers on 3 levels



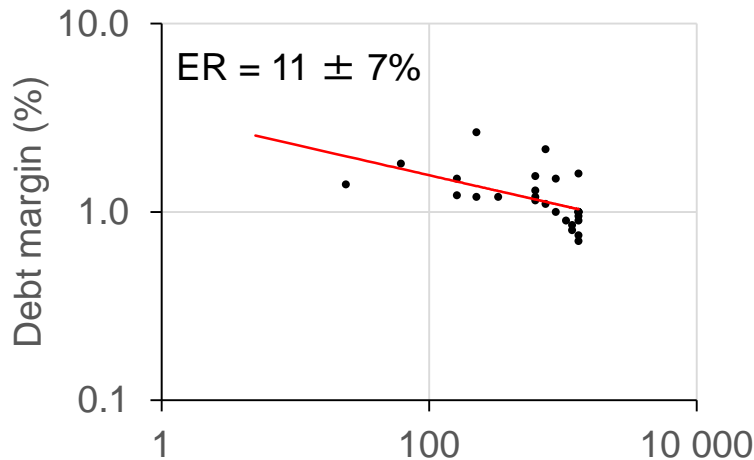
# Step 3: We estimate the experience and general interest rate effects

Identification of experience effect:

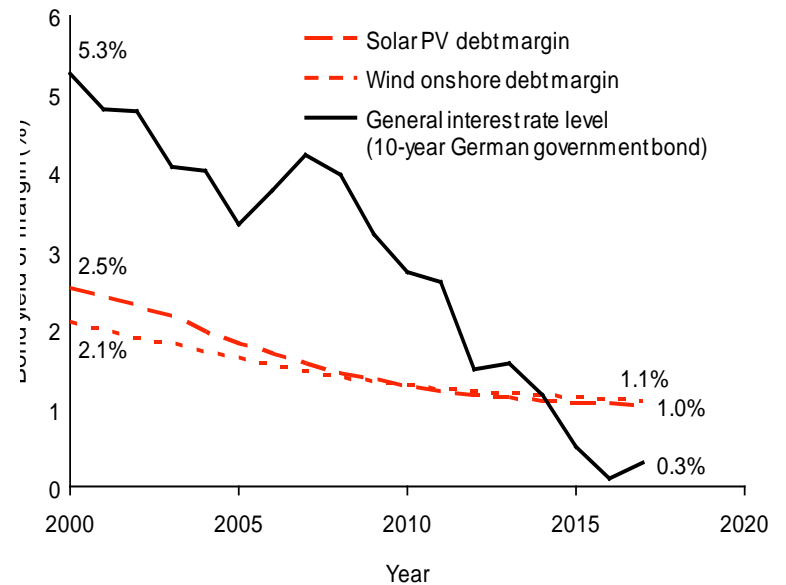
$$DebtMARGIN(I_t) = DebtMARGIN(I_0) \left( \frac{I_t}{I_0} \right)^{-b_1}$$



Solar PV

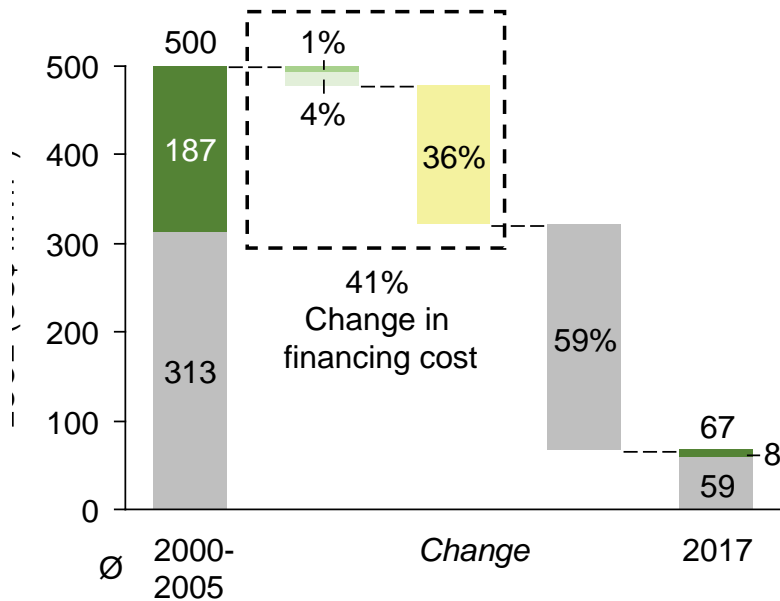


Comparison of experience effect and general interest rate level

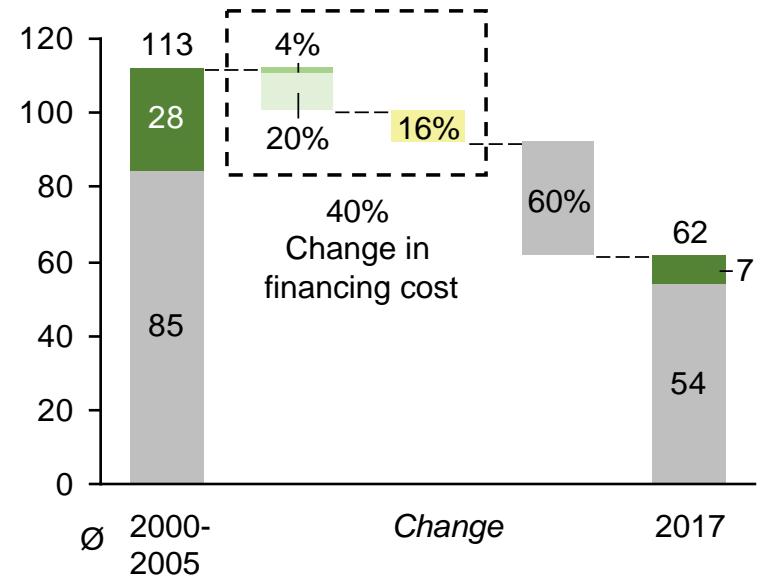


# Step 4: We identify the effect of the CoC dynamics on the LCOE

Solar PV



Wind onshore



**Change in financing cost from**

■ Experience effect

■ General interest rate effect

■ Lower capital expenditures

# The four papers of this talk and their key messages

Contents lists available at ScienceDirect  
Energy Economics  
journal homepage: www.elsevier.com/locate/eneeco

**The importance of project finance for renewable energy projects**  
Bjarne Steffen\*

Energy Policy (Energy Department of Economics, Social and Political Science, ETH Zürich, Zürich, Switzerland)

ARTICLE INFO  
Article history:  
Received 10 June 2017  
Received in revised form 1 October 2017  
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Available online 13 November 2017

ABSTRACT  
Given the magnitude of investment needs for low-carbon power generation, the availability and cost of capital is critical for successful energy transitions. Identifying a strong driver of low-carbon project finance is accordingly important. However, a project's "bankable" status is crucial for power generation projects. Current literature emphasizes the impact of finance on the generation of investment costs and capacity utilization. However, these results do not fully consider the impact of project finance on the investment costs and capacity utilization of projects being multi-phased. This paper therefore analyzes the importance of project finance for renewable energy projects in investment costs, capacity and the utilization of power over the last 15 years. First, we analyze the cost for energy project finance and justify that from economic and finance theory, and then empirically investigate using a novel dataset for non-project finance investments in Germany (2002–2015). Results show that at the same time as with particularly low investment costs, project finance has much larger responses for renewables than for other fossil power plants. It is not only investment costs but also capacity utilization, but, instead driven by the "bankable" status of the energy operators such as independent project developers. We discuss implications for policy makers. The financial sector, as well as energy vehicles concerned with power generation investment decisions.  
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## Main messages

- Renewable energy assets heavily rely on non-recourse project finance (vs. corporate finance for conventional plants)
- Key driver is debt overhang of fast-growing new entrants

nature energy  
ARTICLES  
http://dx.doi.org/10.1016/j.eneeco.2017.08.027

**A dynamic analysis of financing conditions for renewable energy technologies**  
Florian Egli<sup>a</sup>, Bjarne Steffen<sup>a</sup> and Tobias S. Schmidt<sup>b</sup>

Renewable energy technologies often face high upfront costs, making financing conditions highly relevant. Thus the dynamics of financing conditions are poorly understood. Here, we provide empirical data covering 123 representative utility-scale photovoltaic and onshore wind projects in Germany over the last 15 years. These data reveal that financing conditions have strongly improved. As drivers, we identify macroeconomic conditions (general interest rates) and experience effects within the renewable energy financing industry. For the latter, we estimate experience ratios. These two effects contribute 5% (photovoltaic) and 24% (wind) to the observed reductions in levelized costs of electricity (LCOEs). Our results imply that activist studies may overestimate technological learning and that increases in the general interest rate may increase renewables' LCOEs, casting doubt on the efficacy of plans to phase out policy support.

## Main messages

- The cost of capital for project-financed renewable energy assets has fallen substantially over the last 15 years
- We detect a financing experience curve (investors also learn)

Contents lists available at ScienceDirect  
Energy Policy  
journal homepage: www.elsevier.com/locate/enepol

**The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany**  
Aana Godwin<sup>a</sup>, Tobias S. Schmidt<sup>b</sup>, Bjarne Steffen<sup>a</sup>

Energy Policy (Energy Department of Economics, Social and Political Science, ETH Zürich, Zürich, Switzerland)

ARTICLE INFO  
Article history:  
Received 10 June 2017  
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Available online 13 November 2017

ABSTRACT  
Low-carbon energy technologies (renewable energy and energy efficiency) are considered essential to achieve climate change mitigation goals, yet a rapid deployment is needed. However, there is a significant financing gap and many governments are interested in increasing the investment for the large-scale deployment of low-carbon technologies and have implemented specific energy finance mechanisms (state-owned banks) to help close the financing gap. However, gaps and benefits of state investment banks (SIBs) are not well understood. This paper presents empirical evidence on the role of three SIBs in addressing the financing of low-carbon energy projects: the Australian Infrastructure Bank (AIB), the UK Infrastructure Bank (UKIB) and the German Infrastructure Bank (GIB) in the UK. We investigate the activities and loans of investment banks offered by SIBs and compare them to the market for each bank's respective development when receiving finance. Findings show that state-owned banks provide a much broader role in expanding private investments into their respective markets, including enabling financial sector financing, resulting from the private and public sectors or each sector role in their portfolio guide a track record.

## Main messages

- “Green” state investment banks (SIBs) help in overcoming investors’ aversion against new energy assets
- SIBs found to crowd-in private finance rather than crowd-out

nature energy  
ANALYSIS  
http://dx.doi.org/10.1016/j.eneeco.2017.08.025

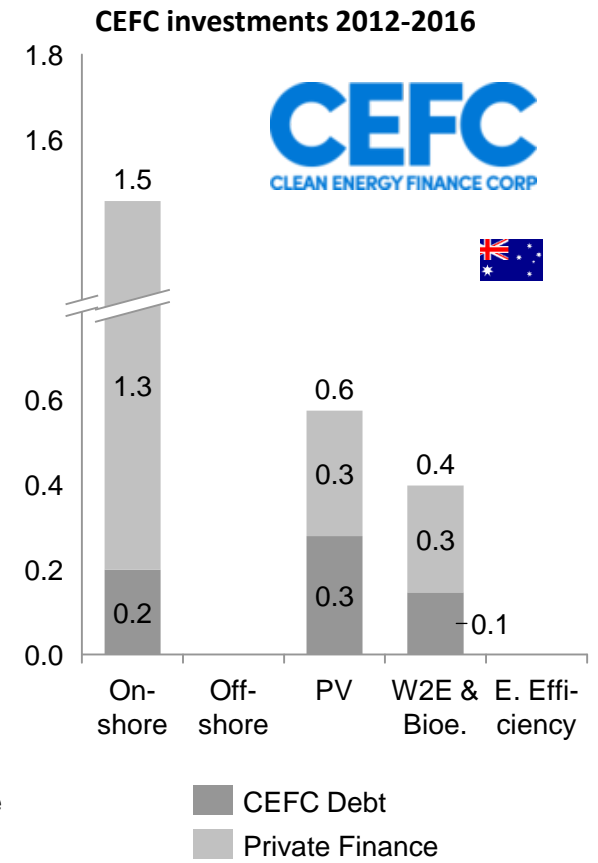
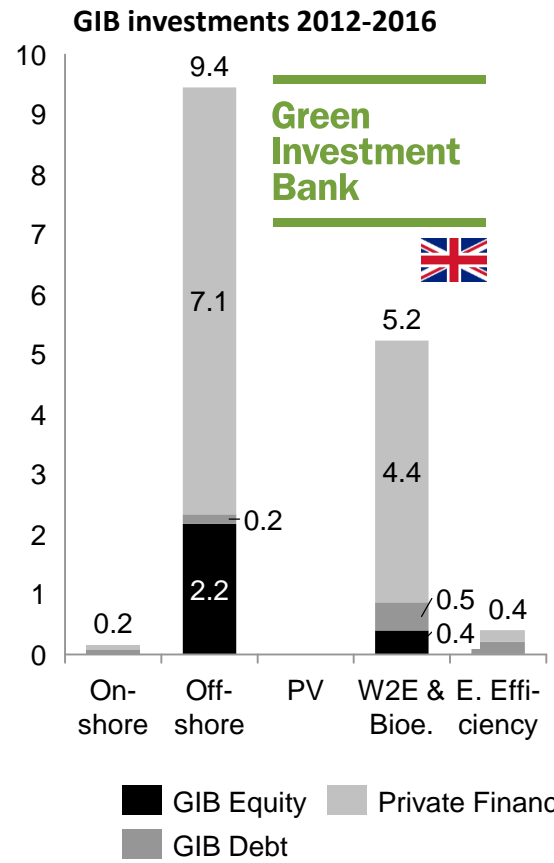
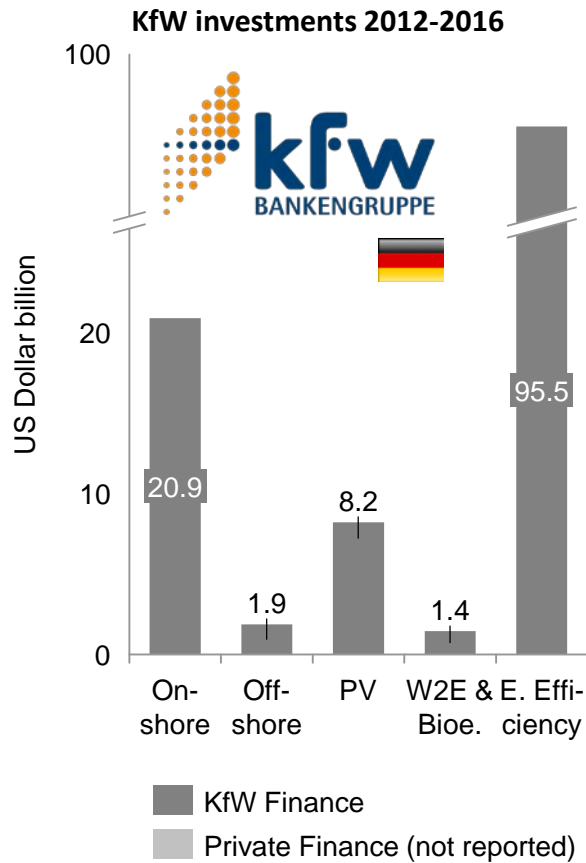
**A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015**  
Bjarne Steffen<sup>a</sup> and Tobias S. Schmidt<sup>b</sup>

Multilateral development banks (MDBs) play a pivotal role in the financing of electricity generation projects in developing countries, thus having a major impact on the energy pathways of these countries. While information about the MDBs' investments is publicly available, it is dispersed and hard to compare. A comprehensive compilation of all MDBs' power-generation investments over the past ten years is thus missing. To address this gap, here we assess power-generation financing by all ten MDBs during 2006–2015, in different regions, and through different branches of the banks. The study assesses technology choices by compiling a bottom-up dataset drawing information from 183 projects and programmes. We find that MDBs financed a major portion of all power-generation growth in the developing world, with an increasing share of renewables. However, MDBs have “greened” their portfolios to different extents, and the activities of their public- and private-sector branches differ substantially.

## Main messages

- Multilateral development banks (MDBs) have “greened” their power generation portfolios to very different extents
- MDBs’ public sector branches are typically less “green” than their private sector branches

# SIB: We compare three state investment banks in DE, UK, AU



Geddes, A., Schmidt, T.S., Steffen, B. (2018), The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany, *Energy Policy* 115, 158–170.

# Qualitative case study allows to identify effective mechanisms



## Case selection and method

### Comparative study of 3 cases

- Industrialized countries w/ SIB heavily involved in RE finance
- GIB in UK, and CEFC in AU: Green SIB on national level, with 5 years track record
- KfW in DE: Not exclusively green SIB, but largest RE investor

### Data iteratively analyzed

- Semi-structured interviews with 56 interviews from investors (SIB and others) and developers
- Qualitative content analysis to identify key themes by mapping developer demands to bank offerings

Category	Organisation <sup>a</sup>	Technology Focus <sup>b</sup>	Country <sup>c</sup>	Interviewee's Role	
Developer	1	Project Developer	Wind, Solar PV	AU	Head of Business Development
	2	Project Developer	WtE	AU	Chief Executive Officer
	3	Project Developer	WtE	AU	Managing Director
	4	Project Developer	WtE	AU	Managing Director
	5	Project Developer	Bioenergy, WtE	GB	Independent developer
	6	Project Developer	Wind, Bioenergy	GB	Managing Director
	7	Project Developer	WtE	GB	Managing Director
	8	EPC, OEM	Wind, Solar PV	AU	Business Development Manager
	9	IPP	Wind	AU	Executive General Manager
	10	IPP	Wind, Hydro	AU	Executive Manager, Development
	11	IPP	Renewables	AU, GB, DE	Chief Financial Officer
	12	IPP	Solar PV	DE	Project Developer
	13	IPP	Bioenergy	GB, DE	Independent developer
	14	IPP	Wind, Solar PV	GB, DE	Manager, ESG
	15	IPP	Wind, Solar PV	GB, DE	Executive General Manager
	16	IPP	WtE, Bioenergy	GB, DE	Head of Origination
	17	OEM	Wind, Solar PV	AU	Head Structured Finance
	18	OEM	Small-scale wind	AU, GB, DE	General Manager
	19	OEM	Renewables	AU, GB, DE	Sales Manager, Renewables
	20	OEM	Renewables	AU, GB, DE	Senior VP Project Development
	21	OEM	Wind	GB, DE	Senior Investment Manager
	22	Utility	Renewables, FFs	DE	Managing Director
	23	Utility	Renewables, FFs	DE	Head Business Development
	24	Utility	Wind, Solar PV	GB, DE	Business Development Manager
	25	Utility	Wind, Solar PV	GB, DE	Managing Director
Investor	26	Commercial Bank	Renewables, FFs	AU	Executive General Manager
	27	Commercial Bank	Renewables, FFs	AU	Senior Consultant
	28	Commercial Bank	Renewables, FFs	AU, GB, DE	Director Corporate Clients
	29	Commercial Bank	Renewables, FFs	AU, GB, DE	Consultant, Green Banking Expert
	30	Commercial Bank	Renewables, FFs	GB, DE	Consultant, Innovative Finance
	31	Gov't funding entity	Renewables	AU	Transactions and Development
	32	Green Bank	Renewables	GB, DE	Relationship Manager, Arranger
	33	Invest. Advisors	Renewables	AU	Principal Financial Advisor
	34	OEM investors	Renewables, FFs	AU, GB, DE	Managing Director
	35	Invest. platform	Renewables	GB	Managing Director
	36	SIB	Renewables, EE	AU	Division Director
	37	SIB	Renewables, EE	AU	Researcher
	38	SIB	Renewables, EE	AU	Department Director
	39	SIB	Renewables, EE	AU	Associate Director
	40	SIB	Renewables, FFs	DE	Department Director
	41	SIB	Renewables, EE	GB	Department Head
	42	SIB	Renewables, FFs	GB, DE	Investment Officer
43	SIB	Renewables, FFs	GB, DE	Project Assessor	
44	SIB	Wind, Renewables	GB, DE	Team Head, Wind Power	
45	Sustainable Bank	Renewables	GB, DE	Chief Financial Officer	
46	VC Investor	Renewables, FFs	AU, GB, DE	Director	
Expert <sup>d</sup>	47	Consultancy	Renewables	AU, GB, DE	Arranger, Due Diligence
	48	Consultancy	Renewables, FFs	GB, DE	Associate Principal, Energy
	49	Consultancy	Wind	GB, DE	Senior Consultant, Power Market
	50	Consultancy	Wind	GB, DE	Partner, Energy and Resources
	51	Energy Think-tank	Renewables	GB	Director, Finance, Energy Policy
	52	Envir. Consultancy	Renewables, FFs	GB, DE	Principal Consultant
	53	Envir. NGO	Renewables, FFs	AU, GB, DE	Director of Strategy and Finance
	54	Legal Consultancy	Renewables	AU	Partner, Project Finance, Energy
	55	Legal Consultancy	Renewables	AU	Senior Associate, Project Finance
	56	Legal Consultancy	Renewables	AU, GB, DE	Partner, Arranger



# Results: SIBs take four key roles, well beyond capital provision

## A. Capital Provision and De-risking Roles

- Direct funding for crucial gaps, concessional or commercial terms
- De-risking instruments (e.g., guarantees)



## C. Signaling Role

- SIB reputation crowding-in private equity and debt
- “SIB participation signal” with effect on financing cost



## B. Educational Role

- Specialist internal expertise (e.g. accurately assessing risks)
- Financial innovation and standardization



## D. First or Early Mover

- Early movers with respect to new technologies (in the country), new deal structures, new manufacturers and developers





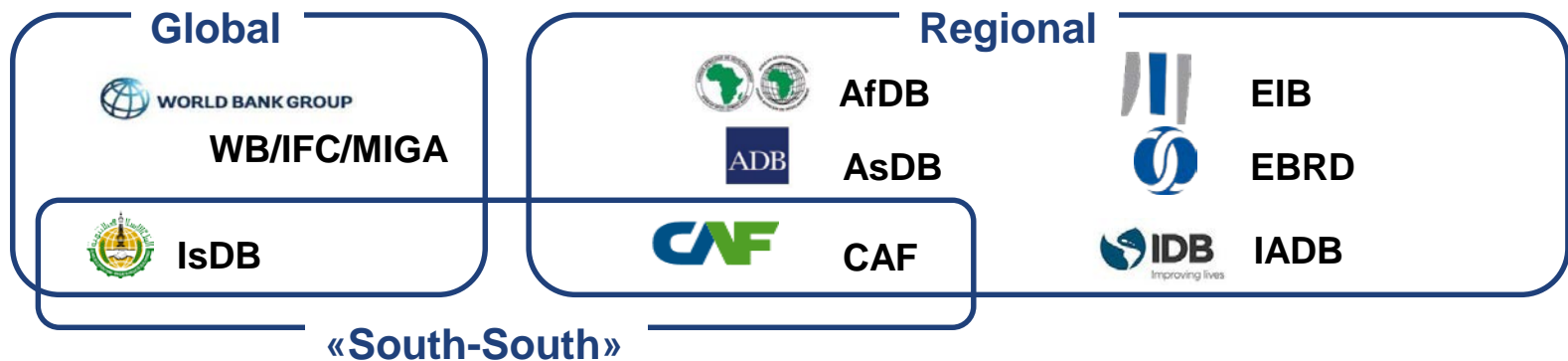
# MDB: Multilateral dev. banks are major investors in power plants

Power generation pathway of developing countries crucial for climate change

Could multilateral development banks (MDB) take the role of SIB in dev. countries?

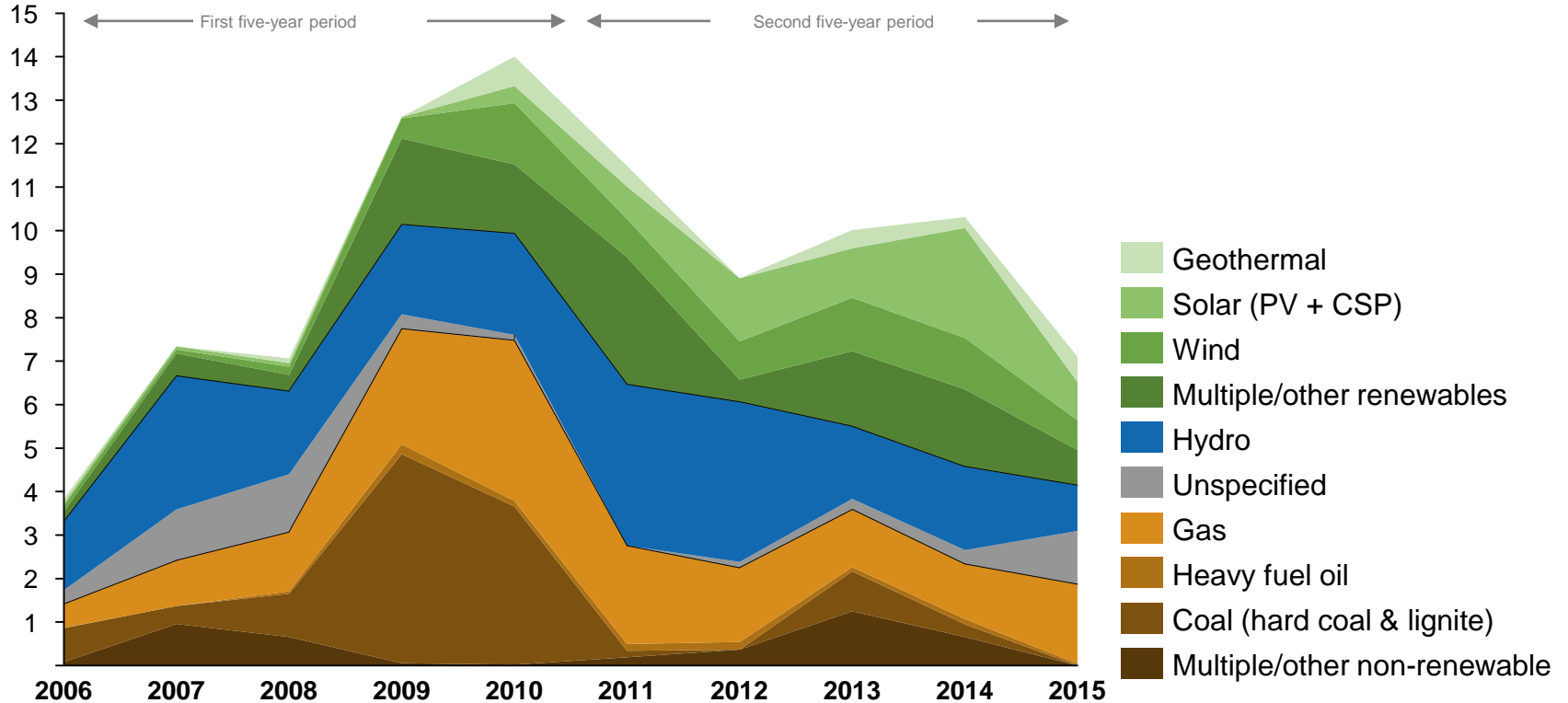
- Long track record in power generation financing, and toolbox with de-risking and invest instruments
- Ambitious goals for climate finance – yet also competing policy areas and interest
- The role of MDB in financing high- and low-carbon assets is poorly understood

We conduct bottom-up analysis of 857 projects and programs 2005–15  
+ complementary interviews with 12 experts from 6 MDBs



# New RE investment rose from ~10% to ~50% of all MDB power generation invest

Total financial commitments (excluding guarantees)  
(USD<sub>2015</sub> billion)



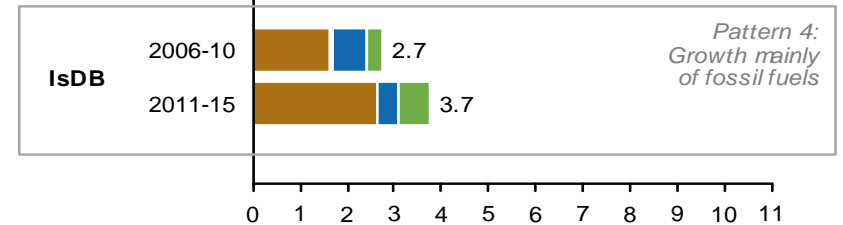
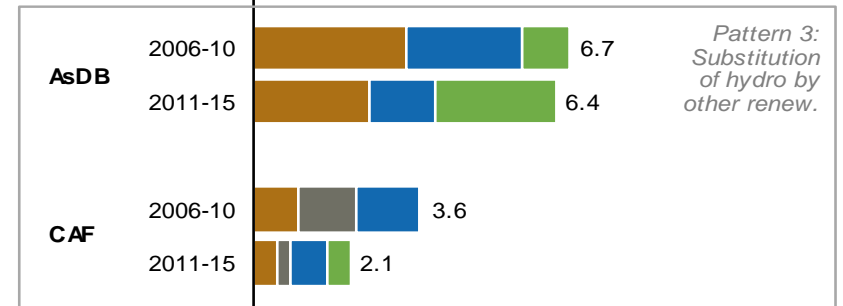
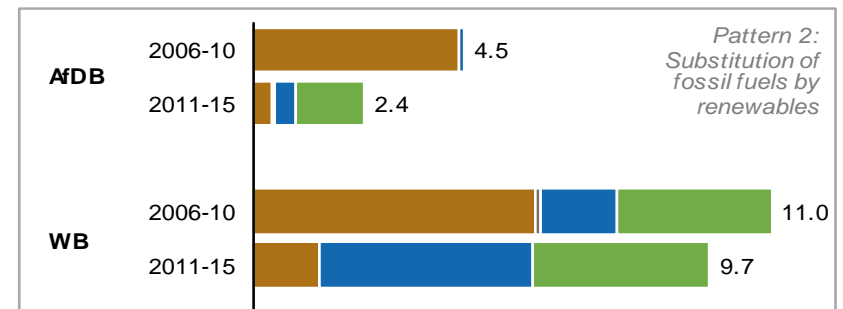
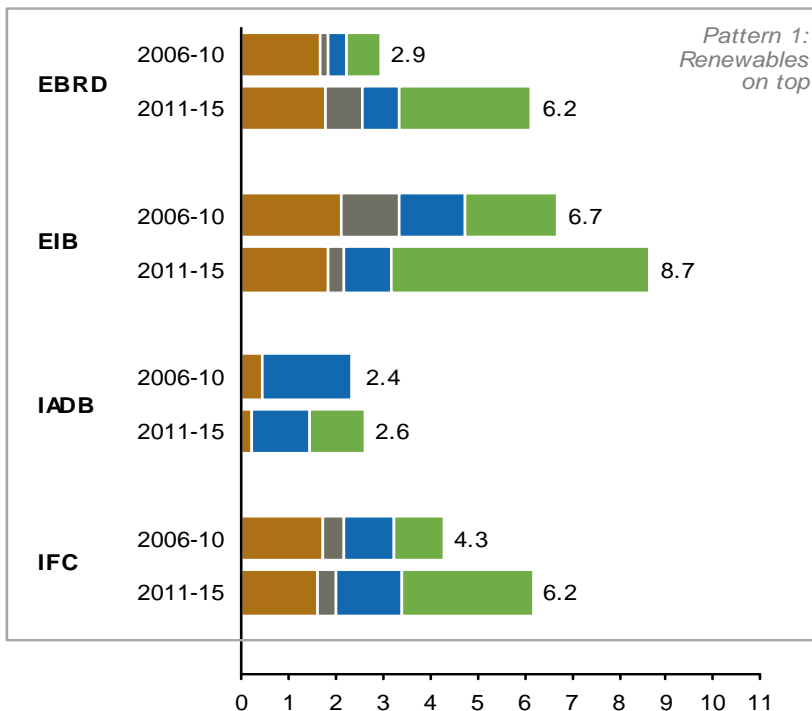
Share (%)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Renewables	55%	51%	38%	36%	46%	76%	73%	62%	74%	56%
Renewables excl. hydro	13%	9%	11%	20%	29%	44%	32%	45%	56%	42%

Source: Steffen, B.; Schmidt, T.S. (2018). A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015. *Nature Energy*.

# Different patterns – often RE invest “on top” of conventionals

**Total commitment for power generation projects by MDB**  
 USD<sub>2015</sub> billion, based on bottom-up analysis of project data

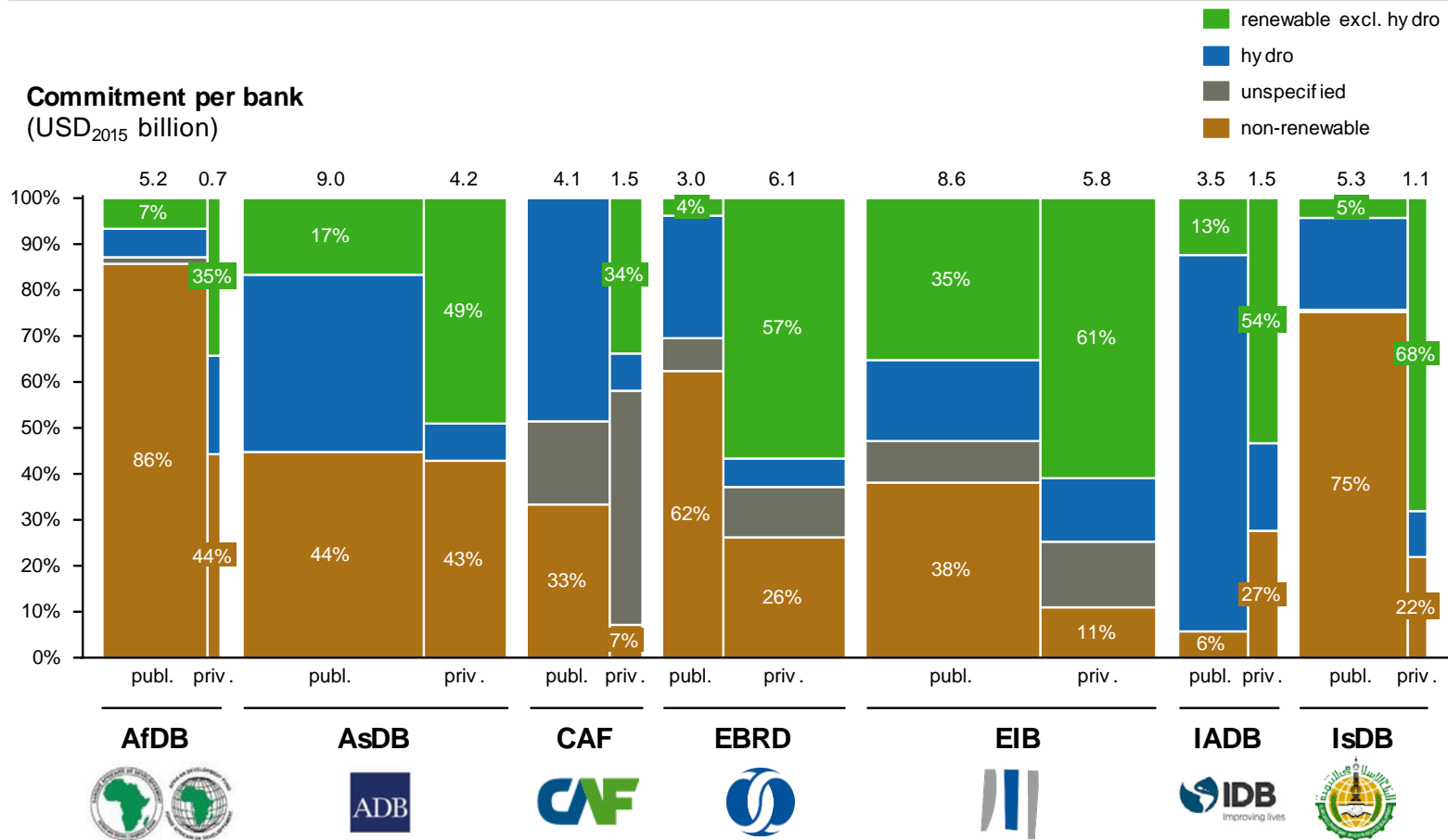
■ non-renewable    ■ hydro  
■ unspecified    ■ renewable excl. hydro



Source: Steffen, B.; Schmidt, T.S. (2018). A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015. *Nature Energy*.

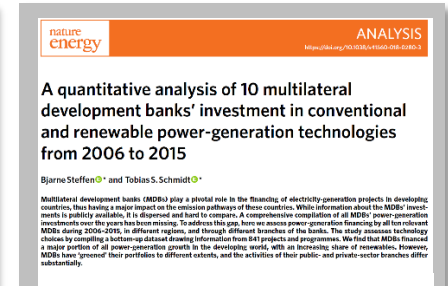
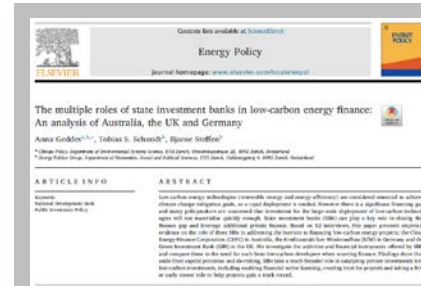
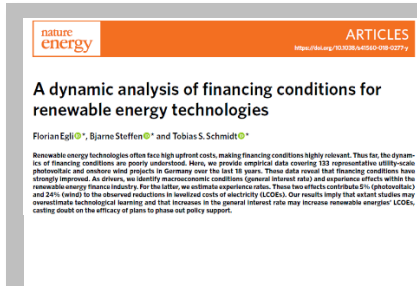
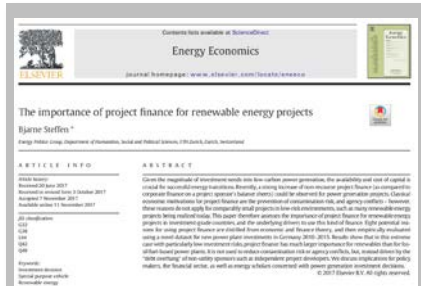
# Stark differences between public and private sector branches

Financial commitments to power-generation technologies by branches of regional MDBs  
10 years 2006–15



Source: Steffen, B.; Schmidt, T.S. (2018). A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015. *Nature Energy*.

# Wrap-up: Key implications for modelers and policymakers



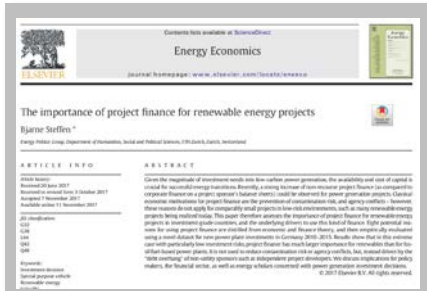
## Key implications for policymakers

- Renewables rely on project finance, hence *banks* are important actors in financing decisions, and cost of capital (interest payments & dividends) are project-specific
- Reductions in cost of capital have been a key driver for the lower LCOE of renewables that are observed globally, driven both by financing experience and the general interest rate level
- Public banks (such as SIB and MDBs) can be a powerful policy instrument to enhance financing conditions and lower cost of capital for new technologies

## Key implications for modelers

- For comparably new, capital-intensive technologies such as renewables, technology- and time-specific cost of capital need to be considered (times of a uniform discount rate should be over)

# Further details – and underlying data – are freely available

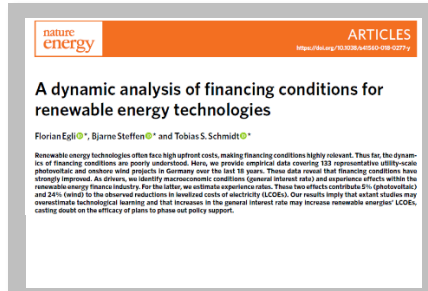


**Energy Economics**  
The importance of project finance for renewable energy projects  
Bjarne Steffen\*

**ARTICLE INFO**  
ABSTRACT  
Cover the implementation of investment needs into low-carbon power generation, the availability and cost of capital is crucial for the implementation of investment. However, a strong financial return is required for investment in renewable energy. This paper examines the importance of project finance for renewable energy projects in investment decisions, and the underlying drivers to use the kind of finance. Eight potential reasons for using project finance are identified from economic and finance theory, and then empirically evaluated using a novel dataset for new power plant investments in Germany 2010–2015. Results show that the most important and particularly low investment risk project financing for technology-specific investments is the availability of project finance. In the next step, results demonstrate that the general market, but, instead of being the high cost of equity, of the underlying project such as independent power production, are the main determinants for project financing. For financial firms, as well as energy investors concerned with power generation investment decisions, the underlying drivers for financial firms, as well as energy investors concerned with power generation investment decisions.

*Steffen, B. (2018), The importance of project finance for renewable energy projects, Energy Economics (69), 280–294.*

Free pre-print version  
**Project level data available**

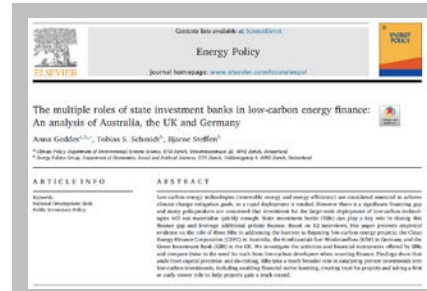


**ARTICLES**  
A dynamic analysis of financing conditions for renewable energy technologies  
Florian Egli<sup>1</sup>, Bjarne Steffen<sup>2</sup> and Tobias S. Schmidt<sup>3</sup>

**ABSTRACT**  
Renewable energy technologies often face high upfront costs, making financing conditions highly relevant. Thus far, the dynamics of financing conditions are poorly understood. Here, we provide empirical data covering 123 representative utility-scale photovoltaic and onshore wind projects in Germany over the last 16 years. These data reveal that financing conditions have strongly improved. As drivers, we identify macroeconomic conditions (general interest rates) and corporate effects within the renewable energy markets industry. For the latter, we estimate experience ratios. These two effects contribute to 53% (macroeconomy) and 24% (ratio) to the observed reductions in levelized costs of electricity (LCOEs). Our results imply that extant studies may overestimate technological learning and that increases in the general interest rate may increase renewable energy's LCOEs, casting doubt on the efficacy of plans to phase out policy support.

*Egli F, Steffen B, Schmidt TS (2018), A dynamic analysis of financing conditions for renewable energy technologies, Nature Energy*

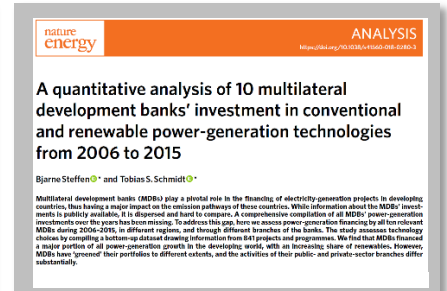
Free read-only access



**Energy Policy**  
The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany  
Aneta Geddes<sup>1,2</sup>, Tobias S. Schmidt<sup>3</sup>, Bjarne Steffen<sup>4</sup>

**ARTICLE INFO**  
ABSTRACT  
Low-carbon energy technologies (renewable energy and energy efficiency) are considered essential to achieve climate change mitigation goals, as a result of the Paris Agreement. However, there is a significant financing gap and energy production is constrained due to government-led support for the high initial deployment of low-carbon technologies. This article examines the role of state investment banks (SIBs) and financing institutions globally. Based on 52 interviews, this paper provides empirical evidence on the role of SIBs in achieving the targets in financing low-carbon energy projects. The Global Energy Finance Corporation (GEFCO) in Australia, the National Endowment for Democracy (NED) in Germany, and the Green Investment Bank (GIB) in the UK. We investigate the activities and financial instruments offered by SIBs and compare these to the need for such financing from low-carbon developers when sourcing finance. Findings show that SIBs tend to support private and development banks in a much broader role in supporting private companies than their other investments, including providing financial advice, brokering, meeting from the project and taking a role in early revenue risk in high-potential opportunities.

*Geddes, A., Schmidt, T.S., Steffen, B. (2018), The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany, Energy Policy 115, 158–170. (free open access)*



**ANALYSIS**  
A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015  
Bjarne Steffen<sup>1</sup> and Tobias S. Schmidt<sup>2</sup>

**ABSTRACT**  
Multilateral development banks (MDBs) play a pivotal role in the financing of electricity-generation projects in developing countries, thus having a major impact on the energy pathways of these countries. While information about the MDBs' investments is publicly available, it is dispersed and hard to compare. A comprehensive compilation of all MDBs' power-generation investments over the years has been missing. To address this gap, here we assess power-generation financing by all ten relevant MDBs during 2006–2015, in different regions, in different branches of the banks. The study assesses technology choices by compiling a bottom-up dataset drawing information from 843 projects and programmes. We find that MDBs financed a major portion of all power-generation growth in the developing world, with an increasing share of renewables. However, MDBs have 'loosened' their portfolios to different extents, and the activities of their public- and private-sector branches differ substantially.

*Source: Steffen, B.; Schmidt, T.S. (2018). A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015. Nature Energy.*

Free read-only access  
**Project level data available**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730403, as well as from the European Research Council under grant number 313553. It has also received funding by the Swiss State Secretariat for Education, Research and Innovation (SERI) [contract number 16.0222]. The opinions expressed & arguments employed herein do not necessarily reflect the official views of the Swiss Government. The project was supported by a seed grant from ETH Zurich foundation.



# Q&A session

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# Forthcoming Webinar

**Climate services in the finance sector: insights for users and providers of climate data and information**

**December 12, 2018 – h. 11.00 am CET**

**Speaker: Robin Hamaker-Taylor** – Policy and risk analyst, Acclimatise

**Discussant: Adriaan Perrels** – Finnish Meteorological Institute

**Moderator: Jaroslav Mysiak** – CMCC, RAAS Division



Thank you for attending this CMCC webinar.

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If you have any further question about the webinar, please email: [webinar@cmcc.it](mailto:webinar@cmcc.it)