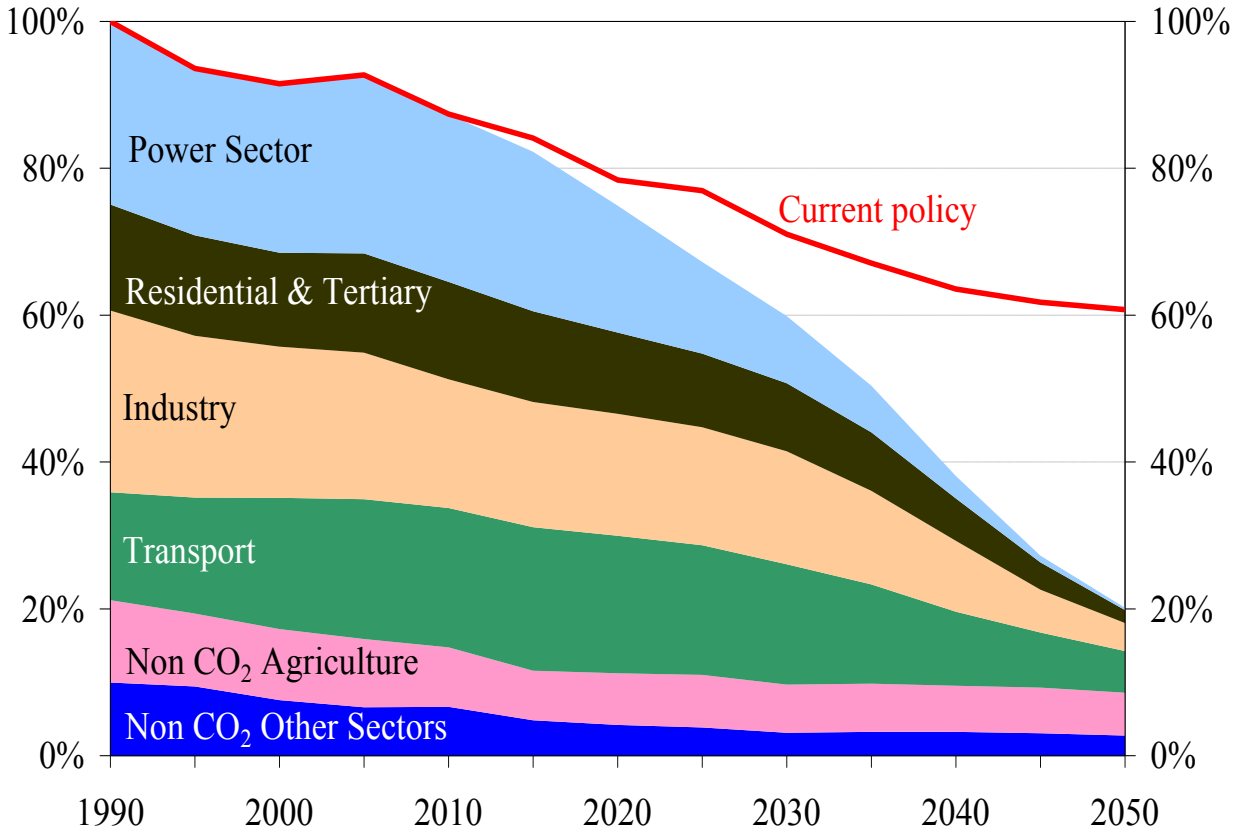
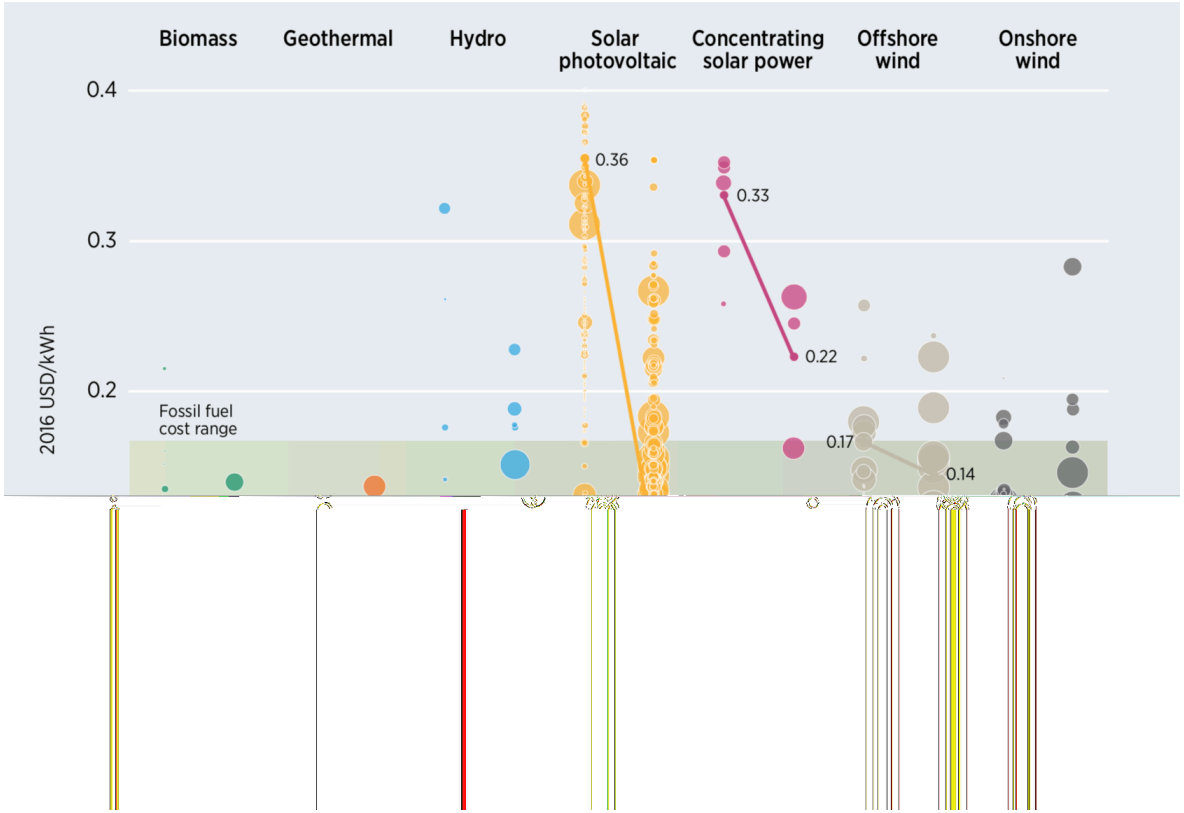
Decarbonising our economies



Roadmap for moving to a competitive low carbon economy

Source: EC(2011)

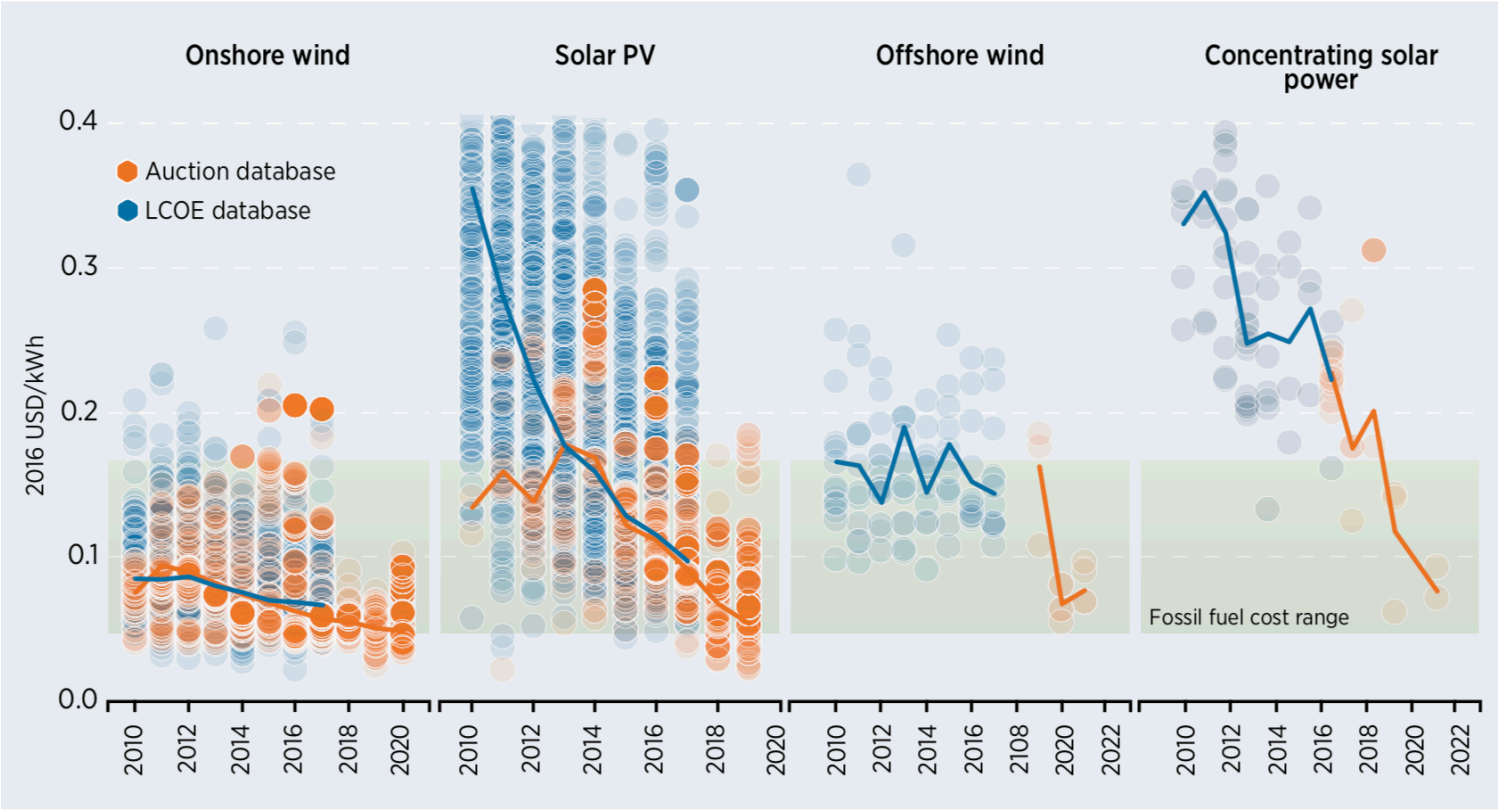
Electricity from renewables has become competitive with most fossil fuels



Global levelised costs of electricity for large-scale renewables 2010-2017

Source: IRENA (2017)

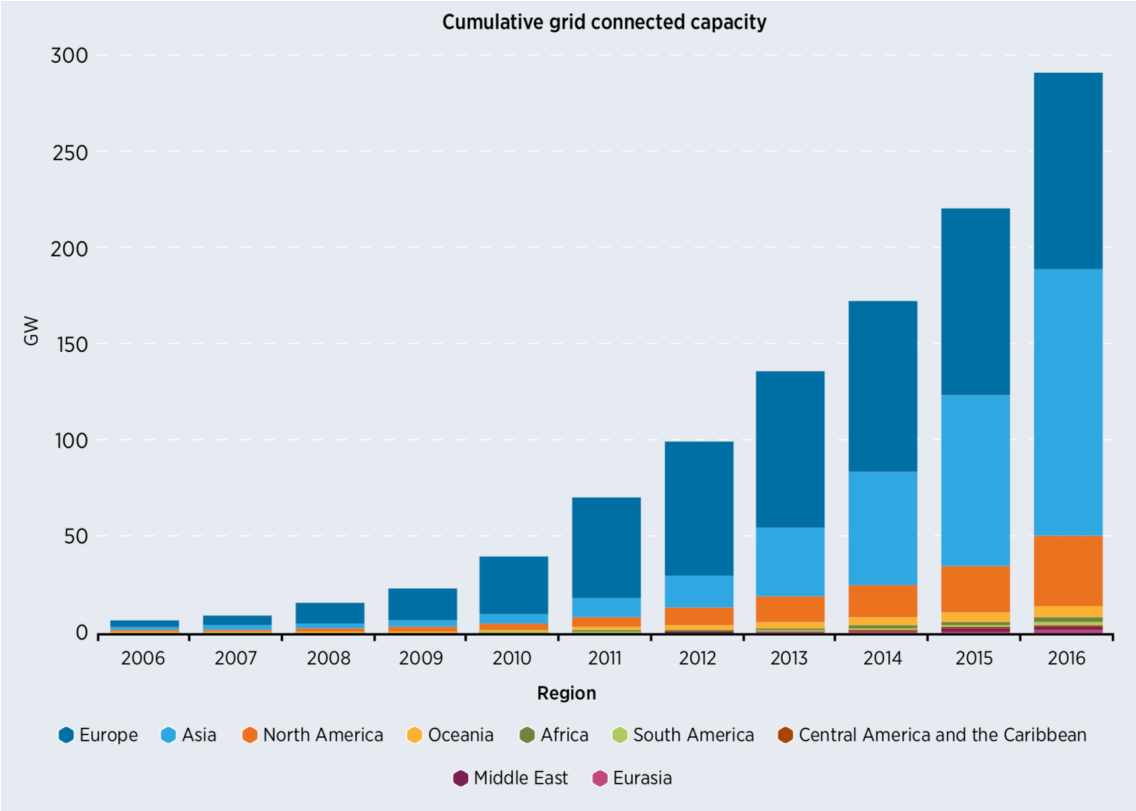
Future costs reductions expected



Levelised costs of electricity for wind, solar and concentrating solar, 2010-2020

Source: IRENA (2017)

Renewables are growing everywhere



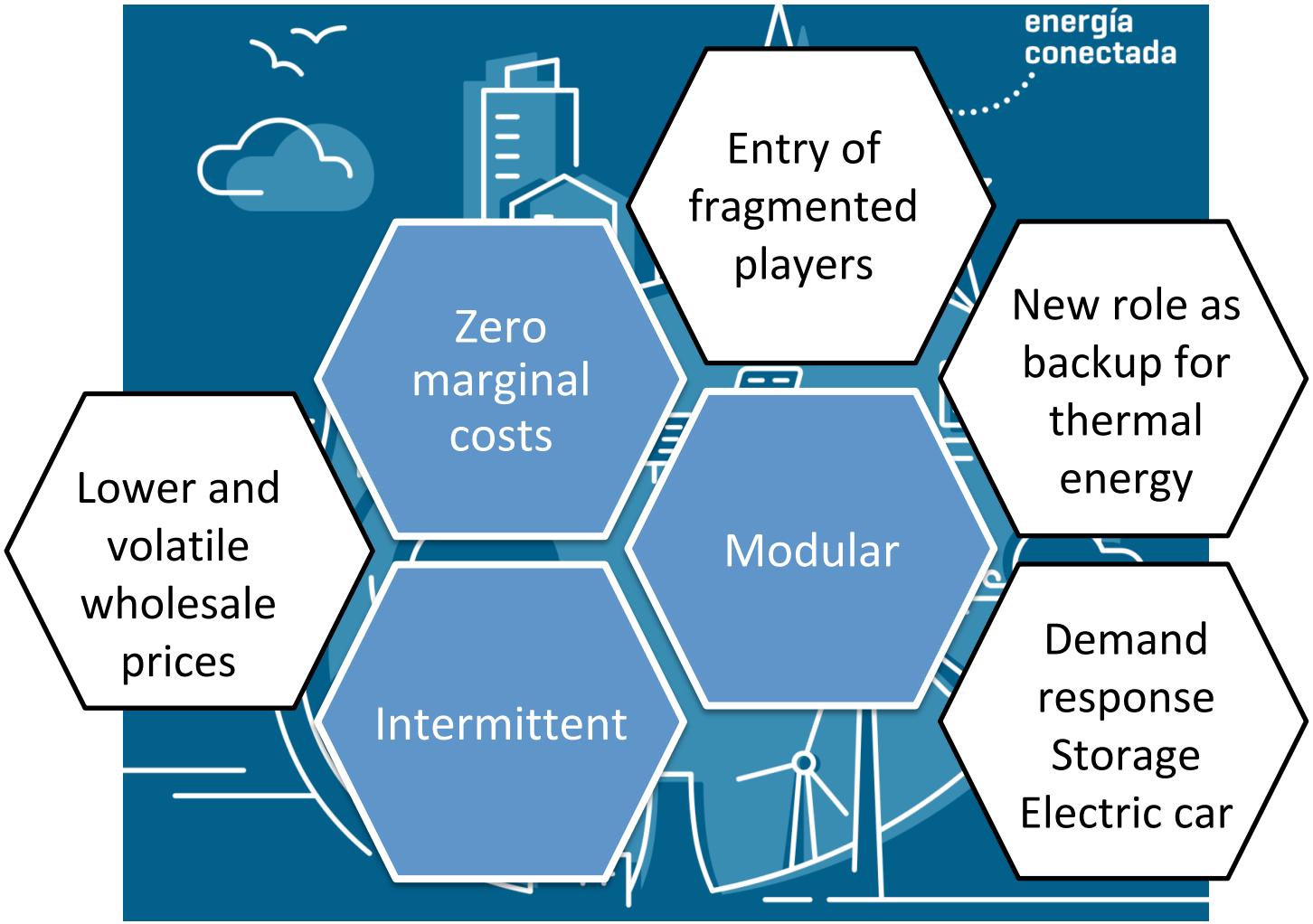
Cumulative solar PV capacity by region, 2006-2016

Source: IRENA (2017)

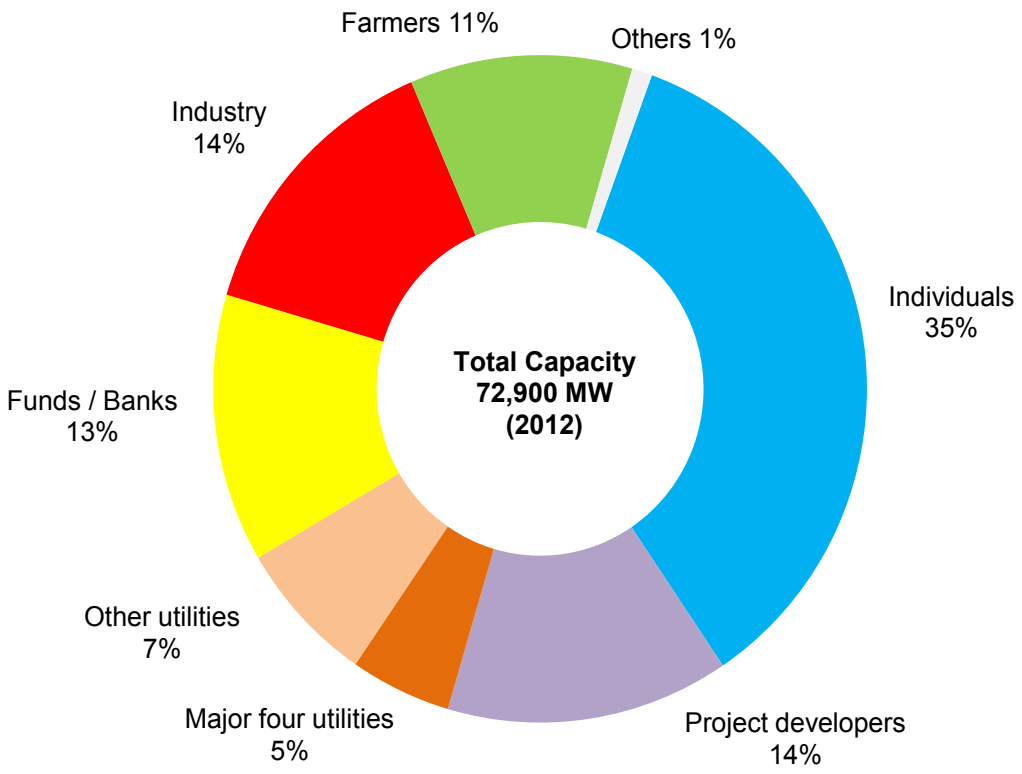
This Talk

- Renewables: a game changer
- The need for a new market design
- The renewable auction revolution
- Support schemes for renewables
  - Auctions
    - Design options
    - Case studies: Germany and UK
- Conclusing remarks
- [References]

Renewables: a game changer



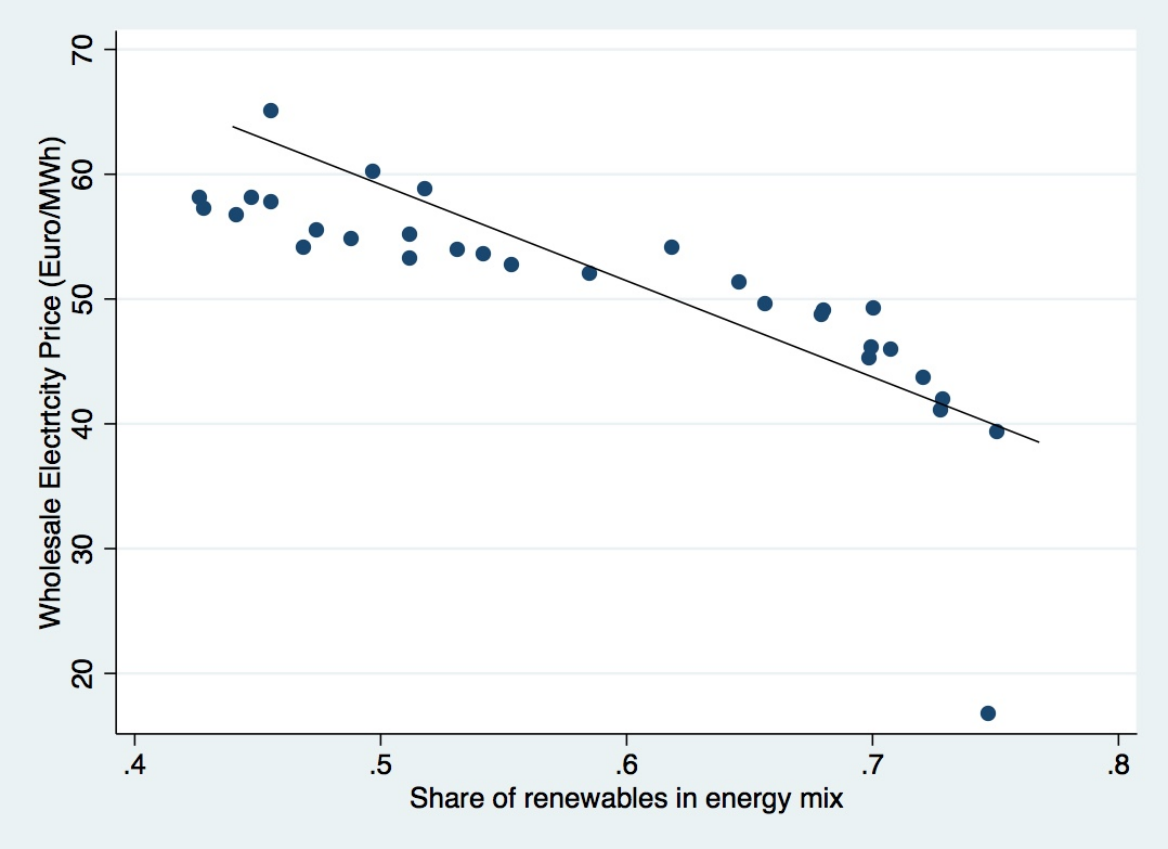
A more fragmented market structure



Breakdown of ownership patterns for renewable generation capacities in Germany, 2012

Source: Fabra et al. (2014)

Renewables depress electricity prices



Wholesale electricity prices in MIBEL versus the share of renewables in the mix, January 2018

Renewables depress electricity prices

Which are the drivers of electricity market prices?

	MODEL 1		MODEL 2	
Variable	**Day-ahead prices**	**Day-ahead prices**	**Day-ahead prices**	**Day-ahead prices**
Carbon price	0.22***	0.22***	0.19***	0.19***
Natural gas price	0.42***	0.42***		
Share of renewables	-0.09***	-0.11***	-0.10***	-0.12***
Import	0.16***	0.16***	0.15***	0.18***
Electricity demand	0.23***	0.24**	0.44***	0.54***
Oil price			0.33***	0.39***
R2	65%	68%	51%	64%
Country Fixed Effects	YES	YES	YES	YES
Estimation Method	FMOLS	DOLS	FMOLS	DOLS

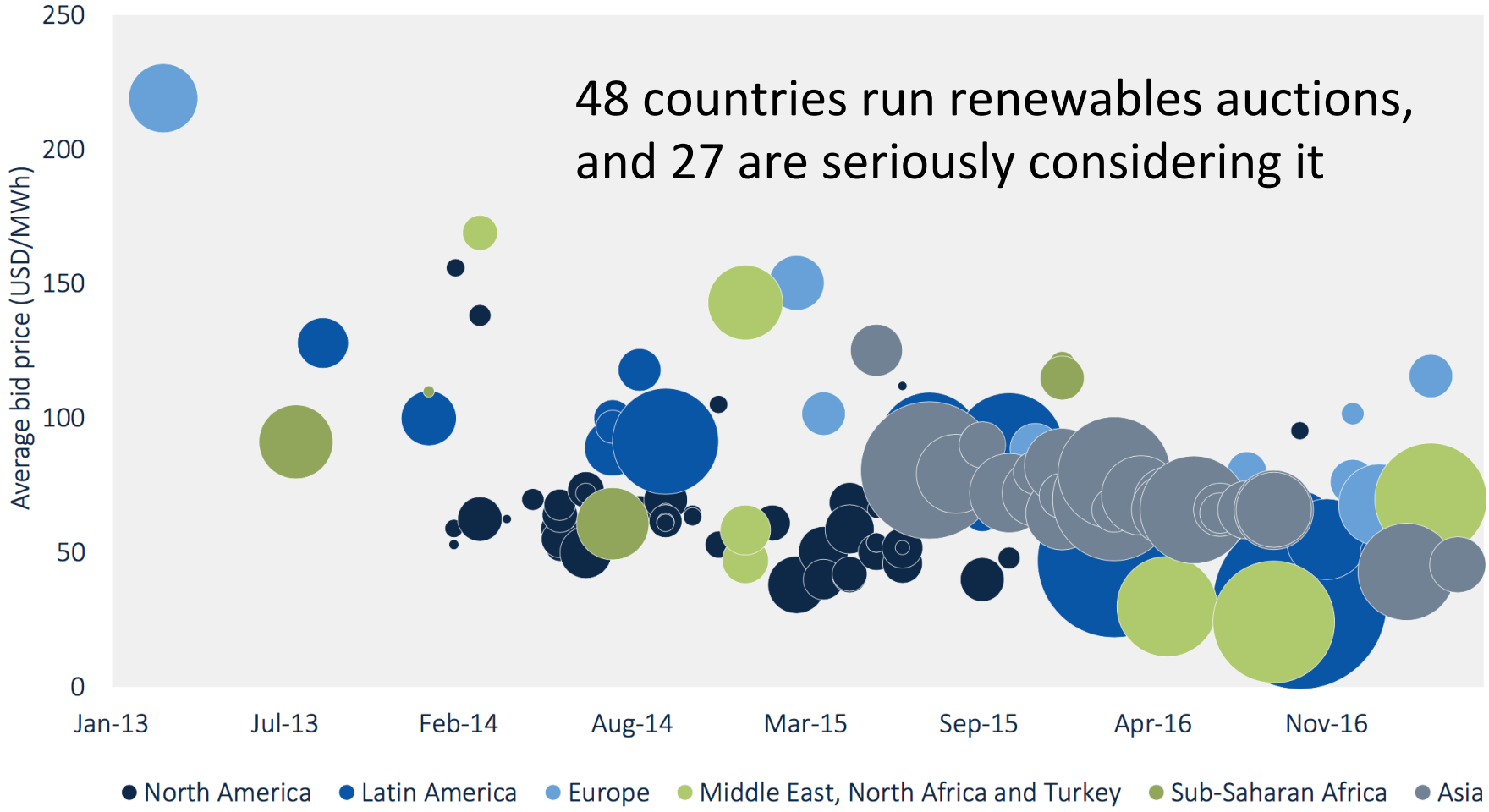
Day-ahead Electricity Prices in 13 EU countries, 2007-2014

Source: European Commission (2015)

Need to re-think market design

- Shift of focus from the short to the long-run
- Need to de-risk investments
- **Auctions for long-term contracts**
  - **Renewable energy**
  - Back up capacity
- Liquid spot markets
- Important role for System Operators
- Market integration through interconnections

The renewable auction revolution

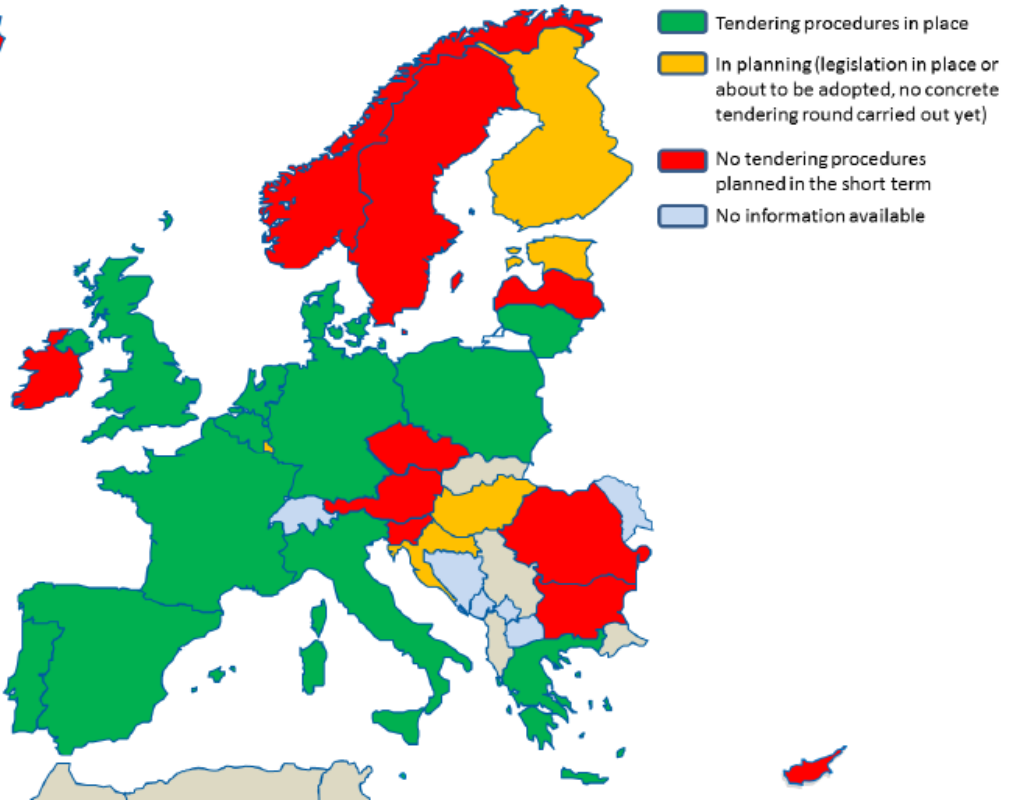


Global Tendered Projects by Bid Price and Capacity, 2014-2016

Source: GTM Research

The renewable auction revolution

In Europe, 13 countries use auctions for RES, 5 are in the process of implemeting them



Approaches setting support schemes

Objective: set cost-efficient support for RES

- **Administrative approach**
- **Competitive process:**
  - Certificate (quota) schemes
  - Auctions

Administrative approach

- price/quantity set by the administration

Challenges:

- **Asymmetric information**
  - Investment and operational costs
- **Specificities of each plant**
  - Location, maturity, etc.
- **Adjustment over time**
  - As costs of renewables go down
- **Credibility**
  - Vulnerable to retroactive cuts

Quota system (green certificates)

- Quantity based support scheme:
  - Demand side obliged to buy certificates
  - Supply side can sell certificates for every RES projects
  - Certificates can be traded bilaterally or through an exchange

Challenges:

- not very successful (UK, Italy, Poland… have abandoned it)
  - regulatory risks, leading to excess volatility and high capital costs
    - Newbery (2016): in the UK, move from ROCs to auctions reduces cost of capital from 6% to 3%, saving GBP 2.25billion/year
  - overcompensation for lower-cost technologies if technology neutrality

Design of Renewables Auctions

Design criteria

- **Eligibility of technologies:** technology-neutral vs. technology-specific
- **Contract design:**
  - payment per KW + market price, or
  - payment per kWh (Feed-in-Tariffs, Fixed premia, Floating premia, CfDs)

Other Design Criteria

Auction design options

- **Pricing rule:** pay-as-bid or uniform pricing
- **Selection criteria:** winning bidders are
  - **Price-based tenders:** those offering lowest prices
  - **Multi-criteria tenders:** combination of multiple criteria (volume, location, environmental impact, etc.)
- **Price caps/price floors:** max/min bid level
- **Frequency:** periodic versus ad-hoc
- **Volume to be tendered**

Other Design Criteria

Eligibility criteria

- **Participation:** size, type of candidates, national vs. cross-border
- **Prequalification:** financial securities, technical requirements such as building permits, land use planning

Others

- **Penalties for non-compliance** (or delays)
- **Tradability of support entitlements**

Technology neutrality vs. Technology specificity

- In technology neutral auctions, different RES compete against each other, with the aim of determining the most cost-efficient one.
  - In EEAG framework this is the default bidding scheme
  - Technology specific tenders only allowed under specific conditions: lack of competition or need to ensure diversity of RES technologies.
- Problems with tech-neutral auctions:
  - Over-compensation
  - Fail to support the long-run cost-efficient technologies
  - High concentration of RES installations in the same area (congestion)

Fixed vs Floating premia

Fixed premia:

- RES receives a fixed premium over the reference market price (€/MWh)
- Potentially combined with a capacity payment (€/MW)
- Certainty over the level of support
- Uncertainty over the level of total payment

Floating premia:

- The premium is inversily proportional to the market price
  - CfDs: premia can be negative
- Uncertainty over the level of support
- Certainty over the level of total payment

Fixed vs Floating premia

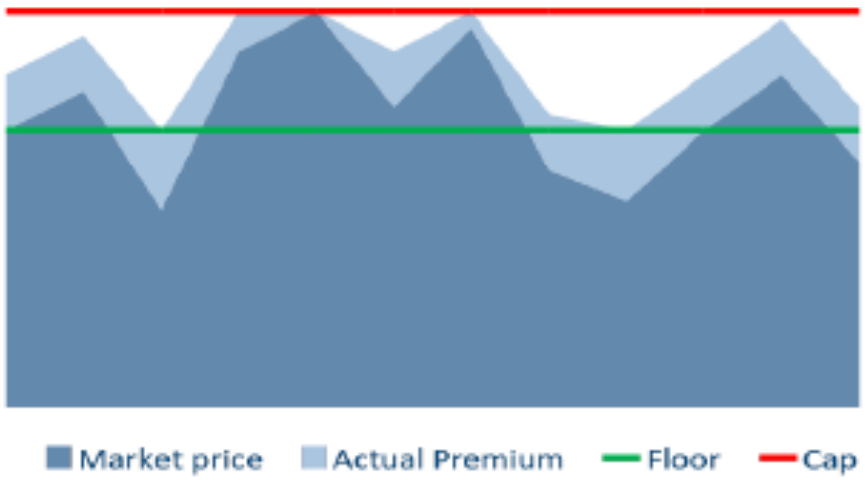
Main arguments in favour of fixed premia:

- Incentives to perform better
- Leveled playing field wtr conventional technologies

Main arguments in favour of floating premia:

- Because RES producers face little price variatna, costs of capital are reduced
- Newbery (2016) estimates this has saved the UK system 2.5B GBP

Fixed premia with a caps and floors



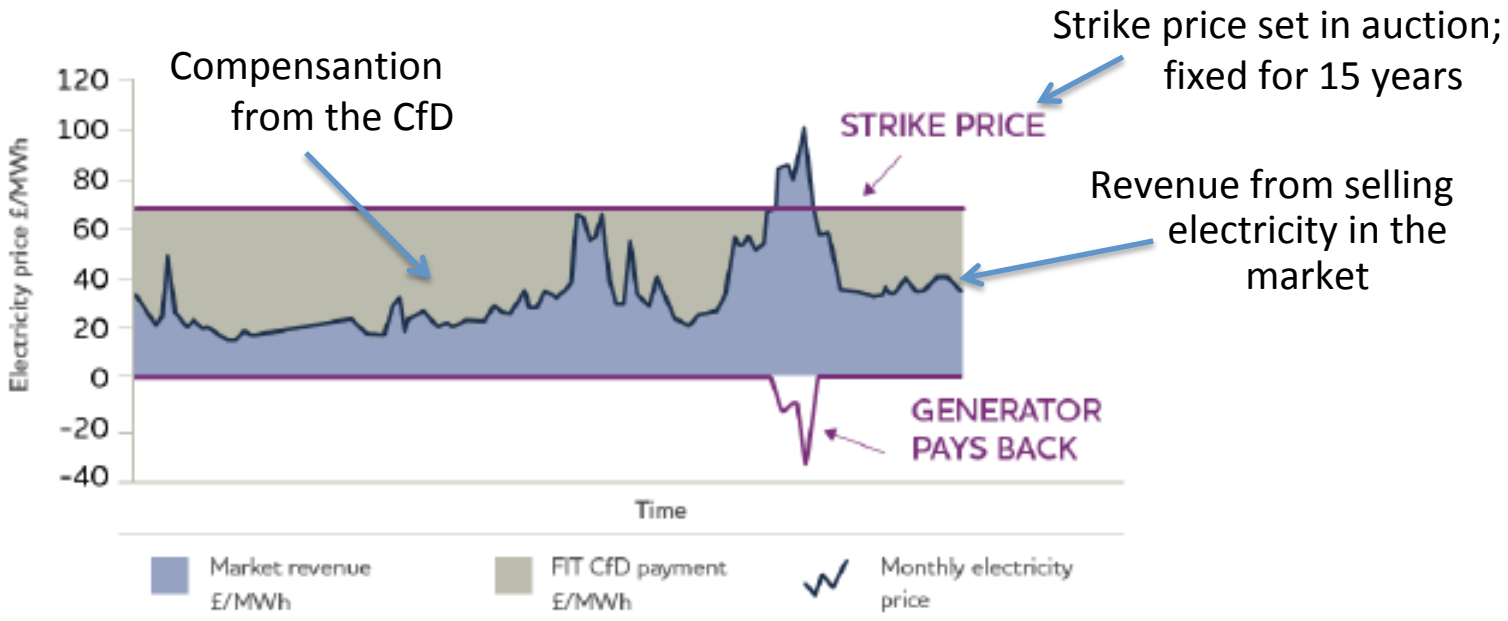
Fixed premia combined with price caps/floors:

- Reduces uncertainty for investors
- Avoids public support when market prices are high
- Choice of cap/floor is administrative: can be flawed as market conditions change over time

Pay-as-bid vs. Uniform pricing

- **Pay-as-bid**: winning projects paid according to their bid
- **Uniform pricing**: paid according to the highest bid
- If **competitive conditions**, both auctions are equivalent:
  - Pay-as-bid: bid close to the highest accepted bid= highest cost
  - Uniform: bid at your cost, resulting payment equals highest cost
- Otherwise, if **strategic behaviour**:
  - Incentives to overbid: risk of not winning vs incresed market price for all winning bids
  - Winners' curse: winning is bad news as others believe future costs will be higher

Case study: UK



FITs with Contracts for Differences (CfD)

- CfDs provide revenue certainty to RES investors
- Reduce the borrowing costs of financing RES projects
- Encourage competition both within and between generation technologies
- Improve the affordability for consumers (generator pays back if high market price)

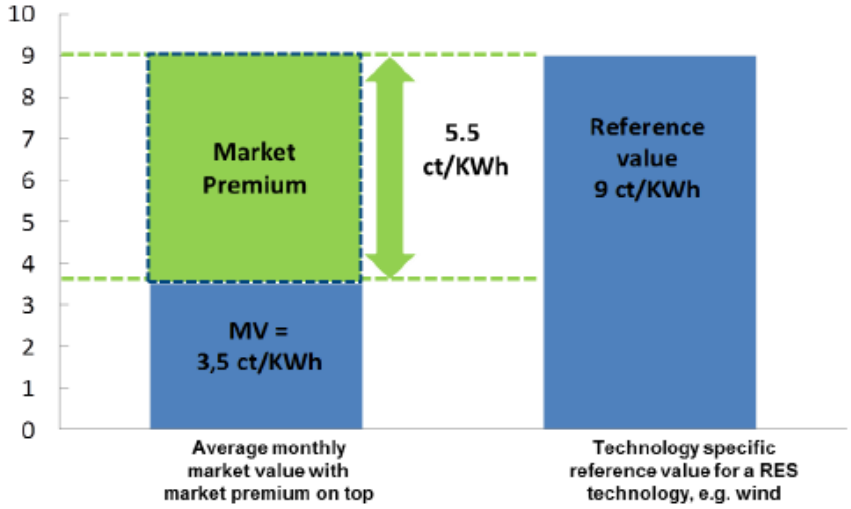
Case study: UK

	Capacity (MW)	Admin Strike price 2014 (£/MWh)	Lowest auction clearing price Jan 2015	Maximum % saving
Large solar PV	72	£120	**£79**	**34%**
Onshore Wind	1162	£95	**£79**	**17%**
Energy from Waste CHP	95	£80	**£80**	**0%**
Offshore Wind	750	£140	**£114**	**18%**
Advanced Conversion Technologies	62	£140	**£114**	**18%**

Source: Simplified from Newbery (2016a, Table 1).

Comparison between administrative prices and prices set through the 1st auction for new RES

Case study: Germany



FITs with floating premia

- It applies to all installations above 100kWs if they intend to obtain the premium
- Reference value: since 2017, set through an auction; fixed for 20 years
- Market Value (MV): technology specific weighted **monthly** average of market price
- One-way contract: if market price>reference price, investors do not pay back
- RES has balancing responsibilities

European Experience

- Aucion-based schemes tend to lead to lower prices more than administrative fees
- Auctions have shown a strong potential to drive price reductions in new RES
- In Europe, most auctions have been:
  - pay-as-bid format
  - for premia (ether fixed or floating)
  - technology specific
  - restricted to national players

Concluding remarks

- For a least-cost energy transition, it is paramount to design market mechanisms to:
  - encourage cost reductions
  - Pass such cost reductions to consumers
- Auctions for renewables, that reduce risk exposure (FiTs, CfDs or FiTs with floating premia)…
  - Reduce costs of capital
  - Promote greater participation and competition

….eventually transforming current market arrangements

Thank You for your Attention

More info and papers at
www.eco.uc3m.es/nfabra

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