Day 2:
From scenarios to policy and market development

IRENA Global Atlas
Spatial planning techniques
2-day seminar

Dr. David Jacobs – IET (International Energy Transition)

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Scenarios

Strategies:

1. Target setting
2. The availability of flexibility in the power sector?
3. The availability of grid infrastructure?
4. The availability of space (spatial planning)?

Instruments:

5. Designing finance mechanisms for different market segments
6. Financing support mechanisms
7. Reducing administrative barriers

Project development:

8. Resource mapping for investors and project developers
9. Monitoring and reviewing (target achievement)

RE Market

Establishing political and financial instruments:

Designing finance mechanisms for different market segments

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Overview of support mechanisms for RES-e

SUPPORT MECHANISMS	Price-based support	Quantity based support
Investment focussed	Investment subsidies Tax incentives	
Generation focused	Feed-in tariffs Net metering Tax incentives	Tender scheme Quota obligation (TGC / RPS)

Custom taxes

- Are there custom taxes for renewable energy equipment?
- If yes, what is the rational?

Pilot projects

- In emerging RE markets:
  - Have you started with pilot projects in order to make actors familiar with renewables (fluctuations, permitting, grid access, etc.)?

Local content requirement

- Several countries have introduced local content requirements in national support mechanisms, i.e. obligations to produce a certain share of renewable energy equipment locally/nationally (e.g. Spain, China, India, Argentina - Chubut, Ontario - Canada, Malaysia, Italy)
- These requirements can be implemented in national feed-in tariff mechanisms
  - Establish a national renewable energy industry
  - Take advantage of positive macro-economic effects

- Problem: potential confliction with international trade rules (WTO)
- Malaysia: Adder for nationally produced equipment:

Source: Mendonca et al. 2009

From scenarios to instruments:

FIT design and locational signals

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Basic feed-in tariff design

- Purchase obligation
  - "Independent" from power demand
- Fixed tariff payment based on the actual power generation costs
  - Price setting will be discussed later
- Long duration of tariff payment

Tariff calculation methodology

- Tariff calculation based on technology specific generation costs + “reasonable” rates of return
- Don’t use “avoided costs” as point of reference
- Cost factors:
  - Investment costs (material and capital costs); Grid-related and administrative costs (including grid connection, costs for licensing procedure; Operation and maintenance costs; Fuels costs (biomass and biogas)

Tariff calculation methodology

- Targeted IRR (Internal rate of return)
  - In the EU, feed-in tariffs target at an internal rate of return of 5-9 percent (certain jurisdictions use return on equity)
  - In developing countries, the targeted IRR usually needs to be higher (10-20 percent)
  - Public investment (monopolist, often without profit interest); or private IPPs (profitability important)?
  - Similar profitability for renewable energy projects needed as for convention energy market

Figure 4: Equity IRR expectation in developing countries:

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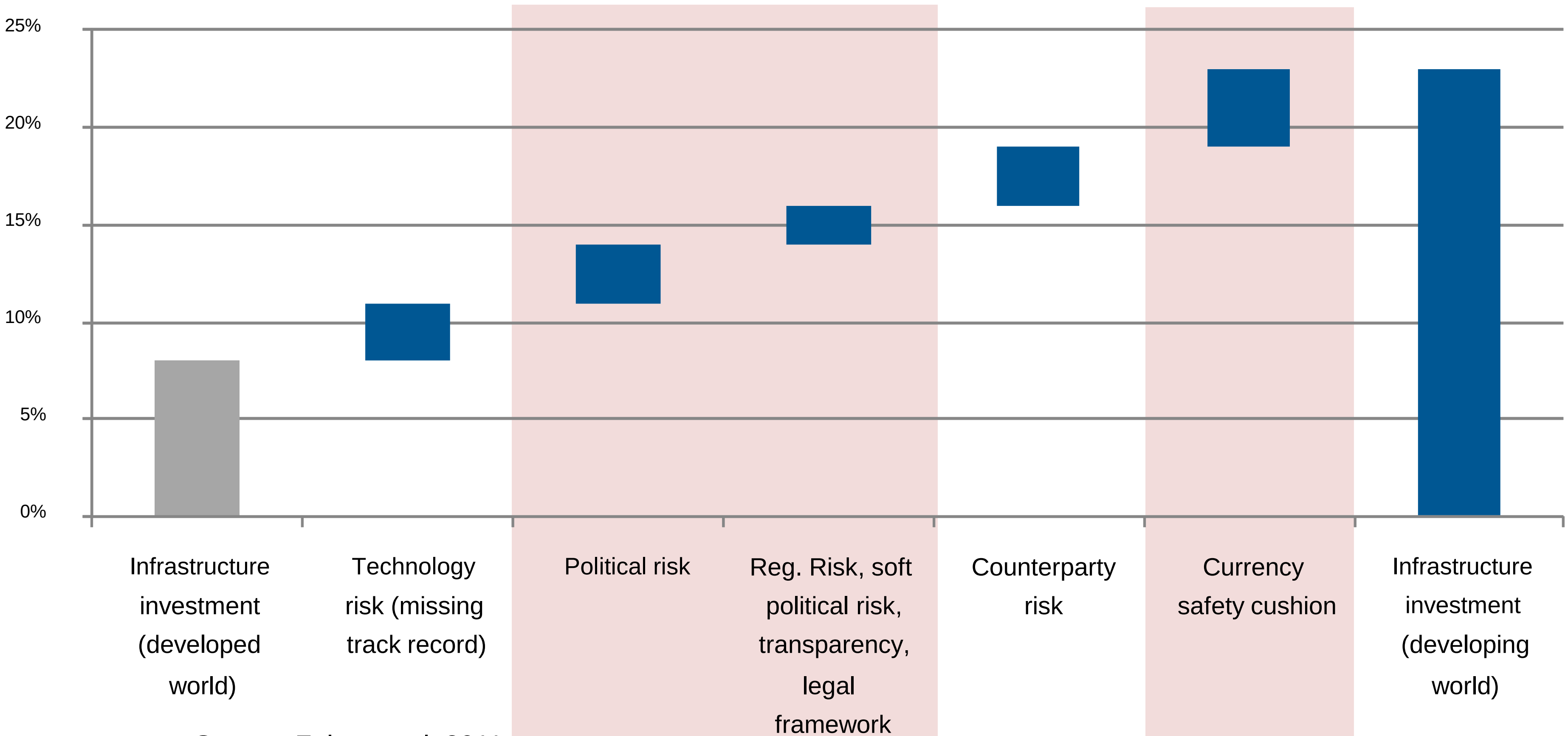
Equity IRR expectation in developing countries



Source. Fulton et al. 2011

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Debt-equity ratio:

- **International benchmarking**
  - **South Africa, Nersa: 70:30**
  - **Ruanda FIT: 75:25**
  - **Nigeria: 60:40**
  - **Germany: 90:10; 70:30**
  - **Netherlands: 80:20 (biomass); 90:10 wind**

Hands-on exercise: How to calculate FIT levels for your country?

Pro Forma Financials PV Project	

User Inputs	Calculated Inputs	Output fields

Project data	
Location	
Module technology	

Technical Parameters	
System Size (DC) [kWp]	200
Specific Yield [kWh/kWp]	1.600
Degradation Factor [%]	0,70%
System lifetime / PPA Term [years]	20
Inverter lifetime [years]	10
Inverter warranty [years]	2

Economic Aspects	
FIT/PPA price period 1 [$/MWh]	146,70
End year period 1	20
FIT/PPA price period 2 [$/MWh]	0,00
Annual FIT/PPA price escalator [%]	0,0%
Inflation Rate Increase [%]	0,0%

Investment Costs	[T$/kWp]	[T$]
Modules [T$]	1,00	200
Inverter [T$]	0,15	30
Civil BOS [T$]	0,00	0
Electrical BOS [T$]	0,00	0
Connection to Grid	0,10	20
Direct Project Costs		250,00
Project Mgmt&Eng. [T$]	16,20%	41
Contingencies [T$]	5,00%	13
Construction Insurance [T$]		0
Basic Project Costs		303
IDC [T$]	0,00%	0
Up-front Fees [T$]	0,00%	0
Total Investment Costs [T$]		303
Spec. Investment Costs [$/kW]		1.515
Annual Operation and Maintenance Costs		
O&M (in % of Direct Proj. Costs)	2,00%	5,0
Land Lease [T$/MWp*a]	1,00	0,20

Levelised Cost of Electricity	
LCOE [$/MWh]	$ 143,08

FIT / PPA Price Determination	
Investor's expected equity-IRR	12,0%
Calculate FIT/ PPA Price [$/MWh]	**$ 146,70**

Read note on FIT/Bidding Price Determination

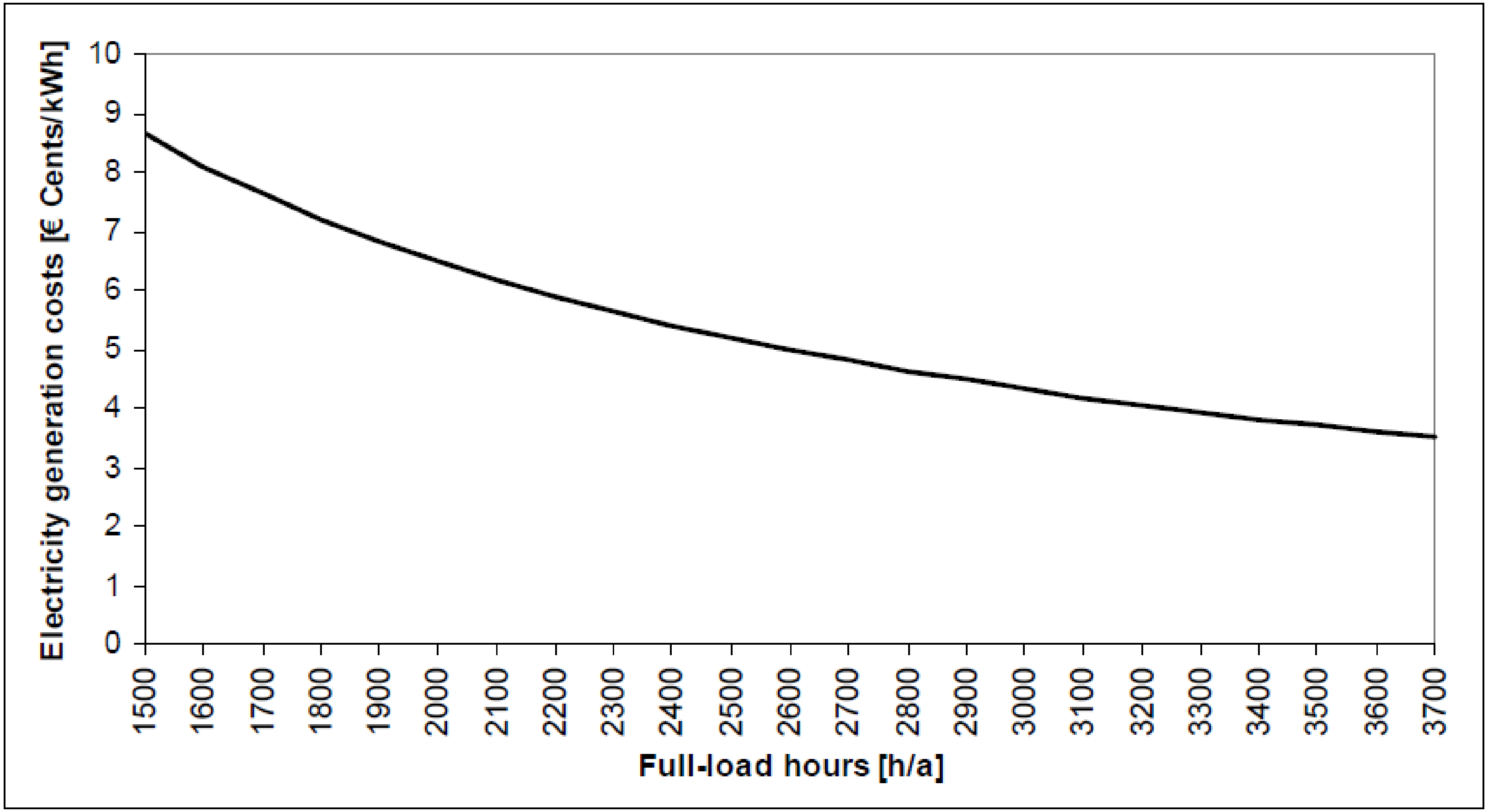
Important FIT design features (continued)

- Payment duration
- Eligibility
- Technology-specific tariffs
- Feed-in tariff calculation
- FIT degression
- Capacity caps

Locational signals for new power generation - Location-specific tariff payment

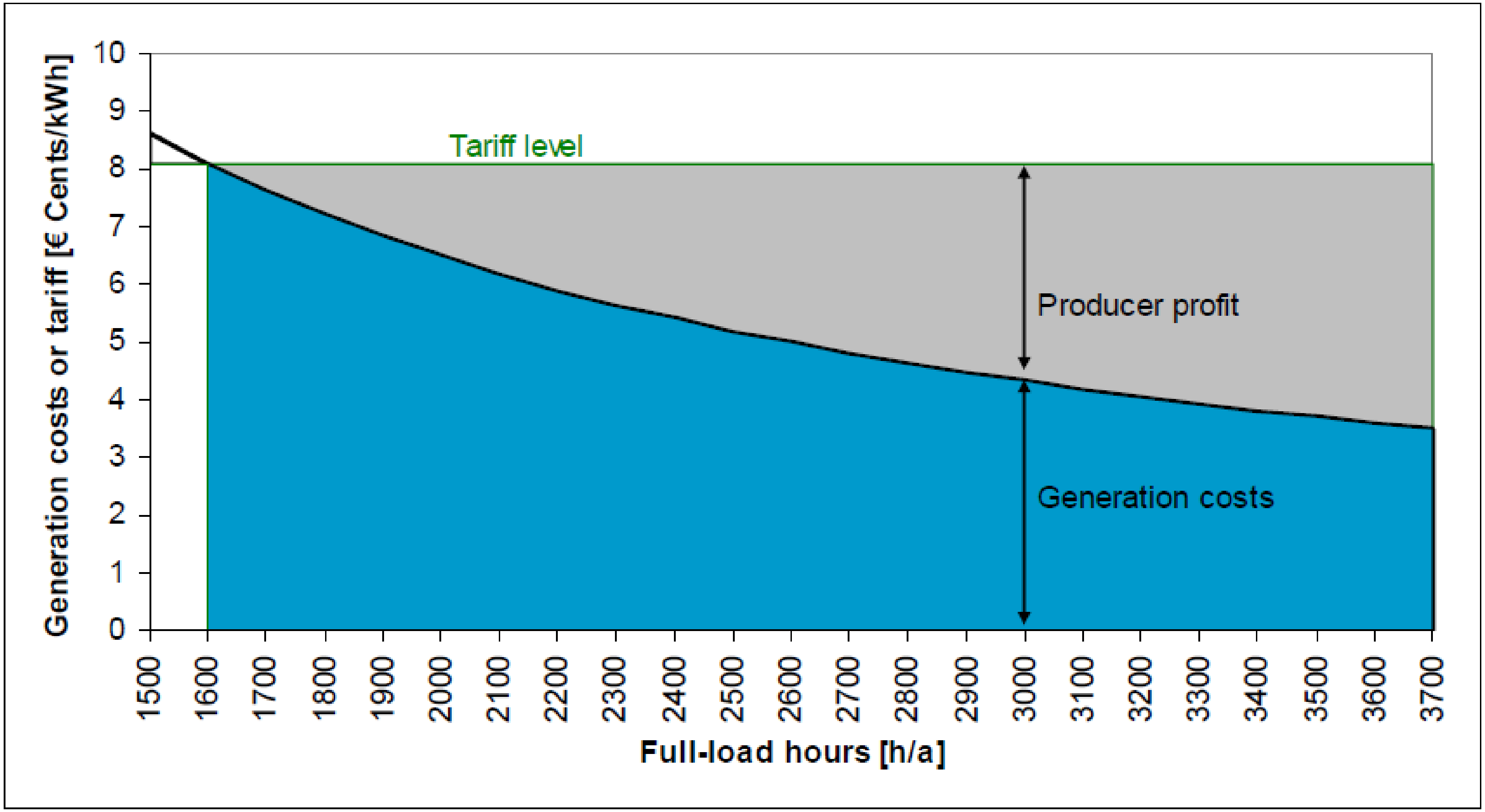
- Mostly applied for wind energy (Germany and France)
- Reduce accumulation of wind power plants in coastal areas (increases public acceptance); visual impact; grid integration
- Location specific tariffs in Germany depend on wind speed at a given location (measured during the first 10 years of operation)
- First 10 years: flat rate
- Final 5 years: depending on “quality” of site

Location specific tariffs - Germany



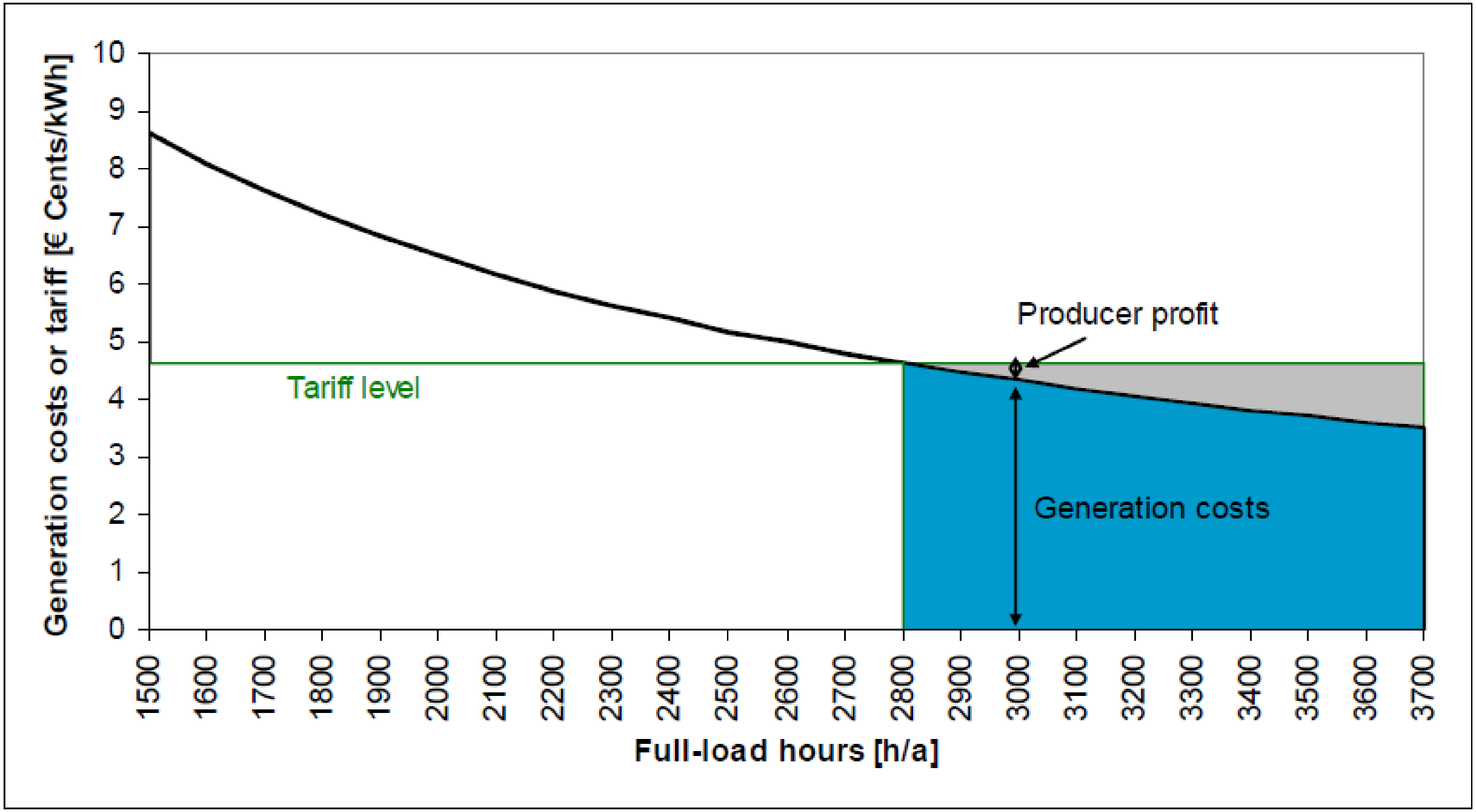
Source: Klein et al. 2008

Location specific tariffs - Germany



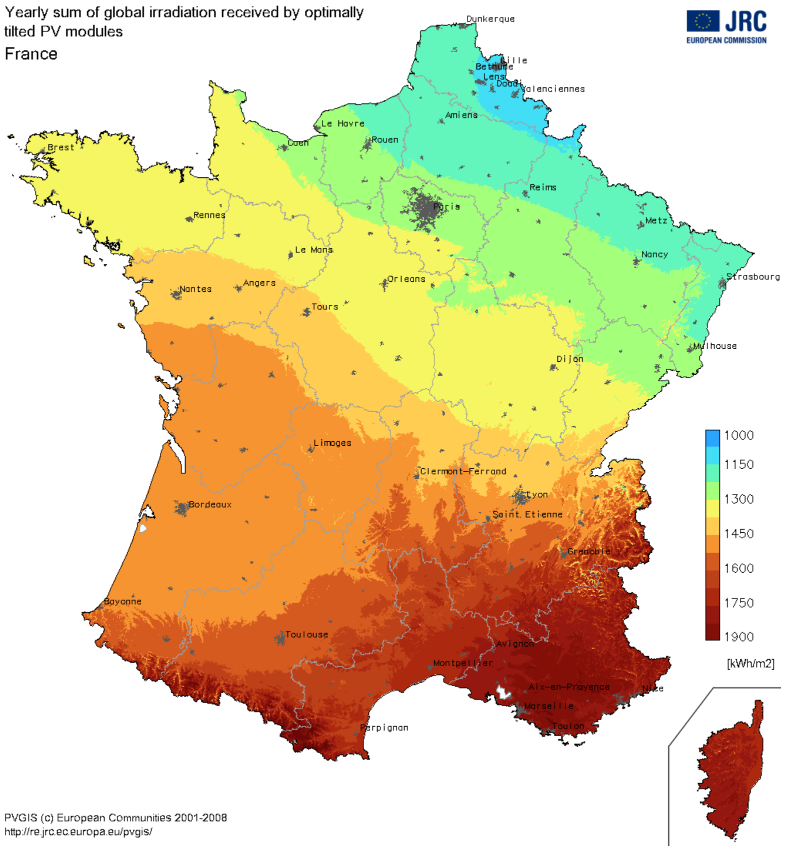
Source: Klein et al. 2008

Location specific tariffs - Germany



Location specific tariffs

- French FIT for solar also includes location specific tariffs



DÉPARTEMENT	NUMÉRO DE DÉPARTEMENT	RÉGION	COEFFICIENT R
Allier	3	Auvergne	1,09
Alpes-de-Haute-Provence	4	Provence-Alpes-Côte d'Azur	1,00
Hautes-Alpes	5	Provence-Alpes-Côte d'Azur	1,00
Alpes-Maritimes	6	Provence-Alpes-Côte d'Azur	1,00
Ardèche	7	Rhône-Alpes	1,03
Ardennes	8	Champagne-Ardenne	1,16
Ariège	9	Midi-Pyrénées	1,05
Aube	10	Champagne-Ardenne	1,13

Source:
http://re.jrc.ec.europa.eu/pvgis/countries/europe.htm

Additional measures for locational incentives

- Nodal pricing
- Using differentiated grid-usage fees
- Define areas with good, medium and no grid connection capability

From scenarios to instruments:

Auction design and spatial planning

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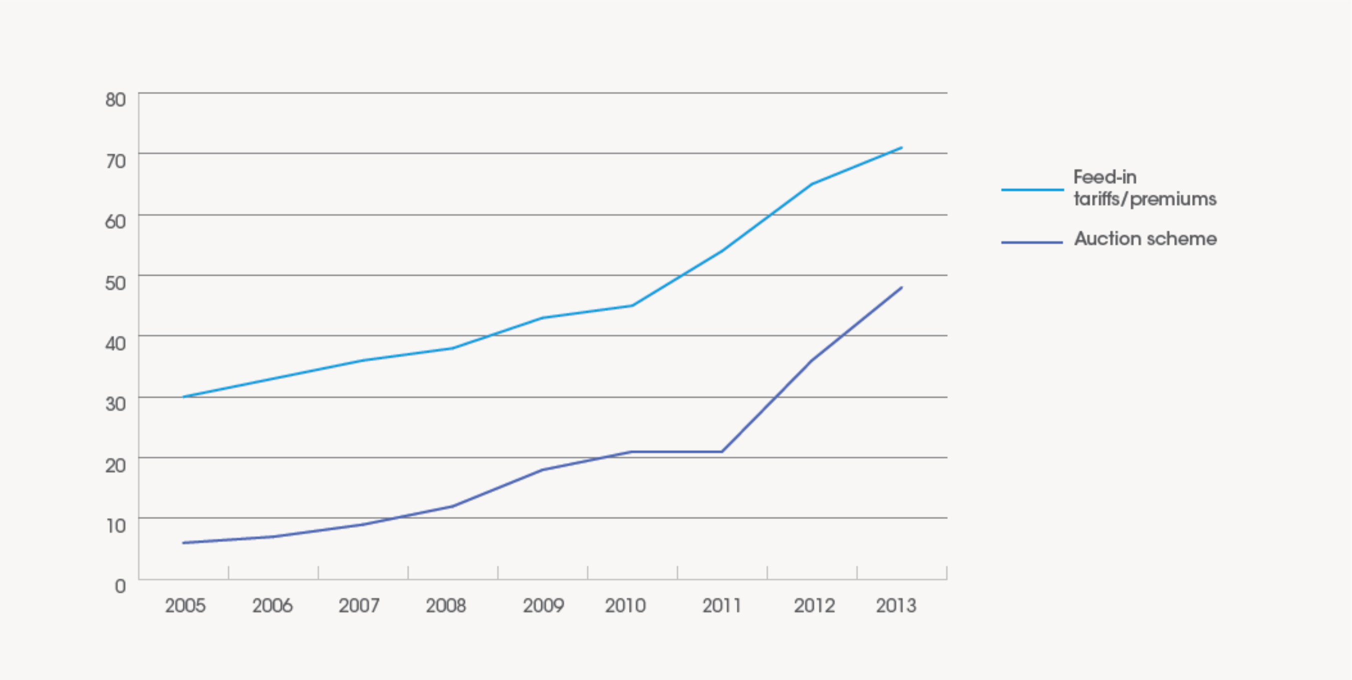
Increasing use of auctions in emerging markets

FIGURE 1 TRENDS IN NUMBER OF COUNTRIES ADOPTING AUCTION SCHEMES AND OTHER TARIFF-BASED MECHANISMS (2005 –2013)



Source: REN21, 2005; REN21, 2007; REN21, 2010; REN21, 2011; REN21, 2012; REN21, 2013.
Notes: Figures for the years 2006, 2008 and 2009 are based on estimations.

Source: IRENA 2013

Tender/auctioning mechanism

- Government issues call for tender
  - Generally: bids for cost per unit of electricity (generation focused)
  - Sometimes: bids for upfront investment cost of one project (investment focused)
  - For example: 100 MW wind energy onshore
  - Bidder with the lowest price "wins" contract and has the exclusive right for renewable electricity generation

Auctions design: How to determine prices?

- Basic price finding mechanism:
  - **English (or Ascending)**
    - Price for item is increased until only one bidder if left and the item is sold to that bidder
  - **Dutch (or Descending clock)** Multi-round bid
    - Auctioner starts with a high price and then calls out successively lower prices until quantity offered and quantity required match!

Auctions design: How to determine prices?

- Sealed-bid auction
  - Each bidder writes down a single bid which is not disclosed to other bidders and the most competitive bidders win ("pay as bid").
- **Other selection criteria than the price?**
  - **Local content**
  - **job creation**
  - **ownership**
  - **socioeconomic development**
  - **Resource securitization in the case of biomass**
  - **Locational incentives**

Auction design: Who can participate? (Prequalification)

- Prequalification requirements for auctions – important for project realization rate!
  - Material pre-qualifications
    - Project development experience
    - Securitization of land, grid access
    - Contracts for equipment
    - Etc.
  - Financial prequalification
    - Bid bonds
    - Etc.

Auction design and site determination

- Option 1: Allow project developers to freely select sites (within the existing spatial planning arrangement)

- Option 2: Package pre-selected sites in order to have better control over land use (and help to shorten bidding process).

Auction design: Other important design decisions

- Which authority should be in charge of procurement?
- Technology neutral versus technology-specific auctions?
- How often will procurement take place (frequency)?
- Size of each procurement round? Technology-specific?
- Upper or lower limit on project size?
- Upper or lower limit on prices?

Pros and cons of auction mechanisms

Advantages	Disadvantages
Cost efficiency and price competition in emerging markets	High administrative costs (complexity)
High investor security (PPA)	Discontinuous market development (stop-and-go cycles)
Volume and budget control	risks of not winning project increases finance costs
Predictability of RE-based electricity supply (sector growth)	Risk of underbidding (lack of deployment and target achievement)
Combination with local content, etc.	

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Experience from emerging markets:

Case study South Africa

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South Africa: Moving from FITs to auctions

- In 2009, the government began exploring feed-in tariffs (FITs)
- later rejected in favor of competitive tenders:
  - Insecurity about "right tariff levels" (2009, 2011)
  - FITs prohibited by the government's public finance and procurement regulations?

	REFIT (ZAR / kWh)		REIPPPP (ZAR/kWh)	
Technology	2009 Tariff	2011 Tariff	Bid Cap	Round 1
Wind	1.25	0.94	1.15	1.14
Photovoltaic	3.94	2.31	2.85	2.76
Concentrated solar trough with storage	3.14	1.84	2.85	2.69

Source: Eberhard et al. 2014

South Africa: First bidding round in 2011

- **Auction design and results:**
  - **Department of Energy in charge of auction (not Eskom!)**
  - **Strict pre-qualification (EIA; resource measurement)**
    - **Bids needed to be fully underwritten with debt and equity (avoid under-bidding)**
  - **Selection of 28 projects with 1416 MW (investment of US$6 billion)**

- **Reasons for high prices:**
  - **Most bids close to the maximum price (previously calculated FITs) - Lack of competition**
  - **significant upfront administrative requirements**
  - **high bid costs**

Source: Eberhard et al. 2014

South Africa: Second and third round in 2011 and 2013

- Second round in November 2011
  - Tighter procurement process and increase competition
  - Seventy-nine bids for 3233 MW – 19 projects selected

- Third round started in May 2013
  - 93 bids for 6023 MW – 73 projects with 1456 MW selected
  - Prices fell further in round three
  - Increased local content
  - wide variety of domestic and international project developers, sponsors and equity shareholders

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South Africa: Successful auctions?

- Decline of submitted bids over time:

Table 3: REIPPPP Average Bid Prices, 2011 values (SAc/kW)

	Round 1	Round 2	Round 3
Wind	114.3	89.7	65.6
Reduction from previous round		-21.5%	-26.9%
Total reduction from round 1			-42.6%
Solar PV	275.8	164.5	88.1
Reduction from previous round		-40.4%	-46.4%
Total reduction from round 1			-68.1%

- **Lack of competition in the 1st round – right benchmark?**
- **General cost decline of PV and wind in the past 3 years!**
- **How many projects will eventually be realized?**

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Experience from emerging markets:

Case study China

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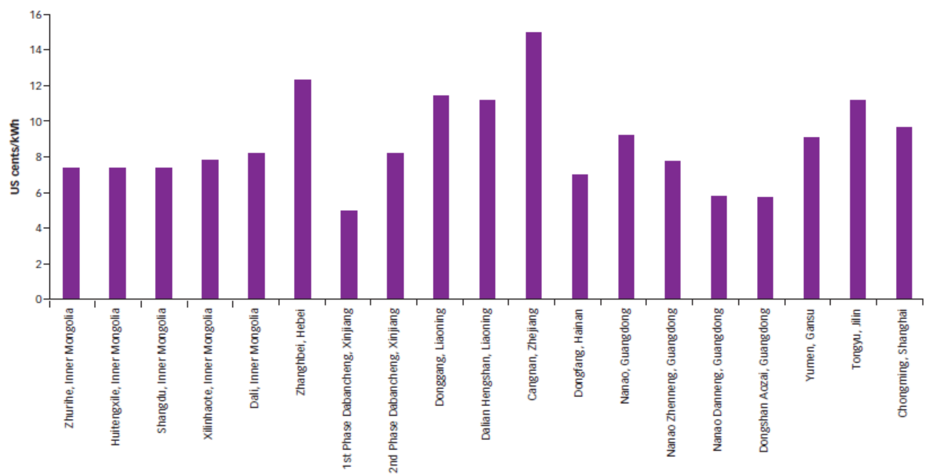
China: Moving from auctions to FITs

- **Policy framework:**
  - **2005 Renewable Energy Law – clear roadmap and targets (15 percent of primary energy supply by 2020)**
  - **Initially passed to support FITs but no consensus of tariff level based on experience with previous concession loans**

Figure 1. Mean electricity prices for wind power generation projects operational at the end of 2006 (before the auctioning of concessions)



Source: Junfeng, Pengfei, and Hu 2010.

https://openknowledge.worldbank.org/handle/10986/18676

China: Auction design features and effects

- Policy framework:
  - First auction for onshore wind started in 2003
  - Sealed bid, single round determined prices
  - Early auction rounds: bids below cost of production – projects were not completed
    - Loose prequalification requirements
    - Large state-owned enterprises wanted to enter the market and could cross subsidize their low bids with coal-generation business
- Effects:
  - slow expansion of wind power sector
  - insecurity for investors

China: Auction design adjustments

- Adjustment of auction design:
  - Minimum price
  - Stricter pre-qualifications
  - Local content requirement
- Further adjustment in 2007:
  - Winner was no longer the lowest price but the bidder that was closest to the average price resulting from all bids, after excluding the highest and lowest bids
- Further adjustment:
  - Move back to “lowest bid” design

China: Successful auctions?

- **China used auction round as a price-discovery mechanism for FIT program (attract international investors)**
- **2009: Establishment of location-differentiated feed-in tariffs for wind energy**
- **2011: FITs for solar PV**
- **2014: Offshore wind tariffs**
- **Emerging technologies such as CSP and offshore wind energy continue to use bidding for contracts**

Experience from emerging markets:

Combining FITs and auctions?

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Auctions or FITs: No easy answer…

- Do you have experience in setting prices administratively?
- Is there sufficient interest in investing in renewables in your country (competition in Least Developed Countries)?
- Is the market big enough to create competition (size of auction)?
- Which type of actors should invest (small vs. big)?

Auctions and FITs?

- Use auctions to determine FIT prices (China)?
- Use auctions for emerging technologies and FITs for mature technologies (Denmark, China)?
- Use auctions for large projects and FITs for small projects (France, Taiwan)?

Financing support mechanisms:

Design options and international experience

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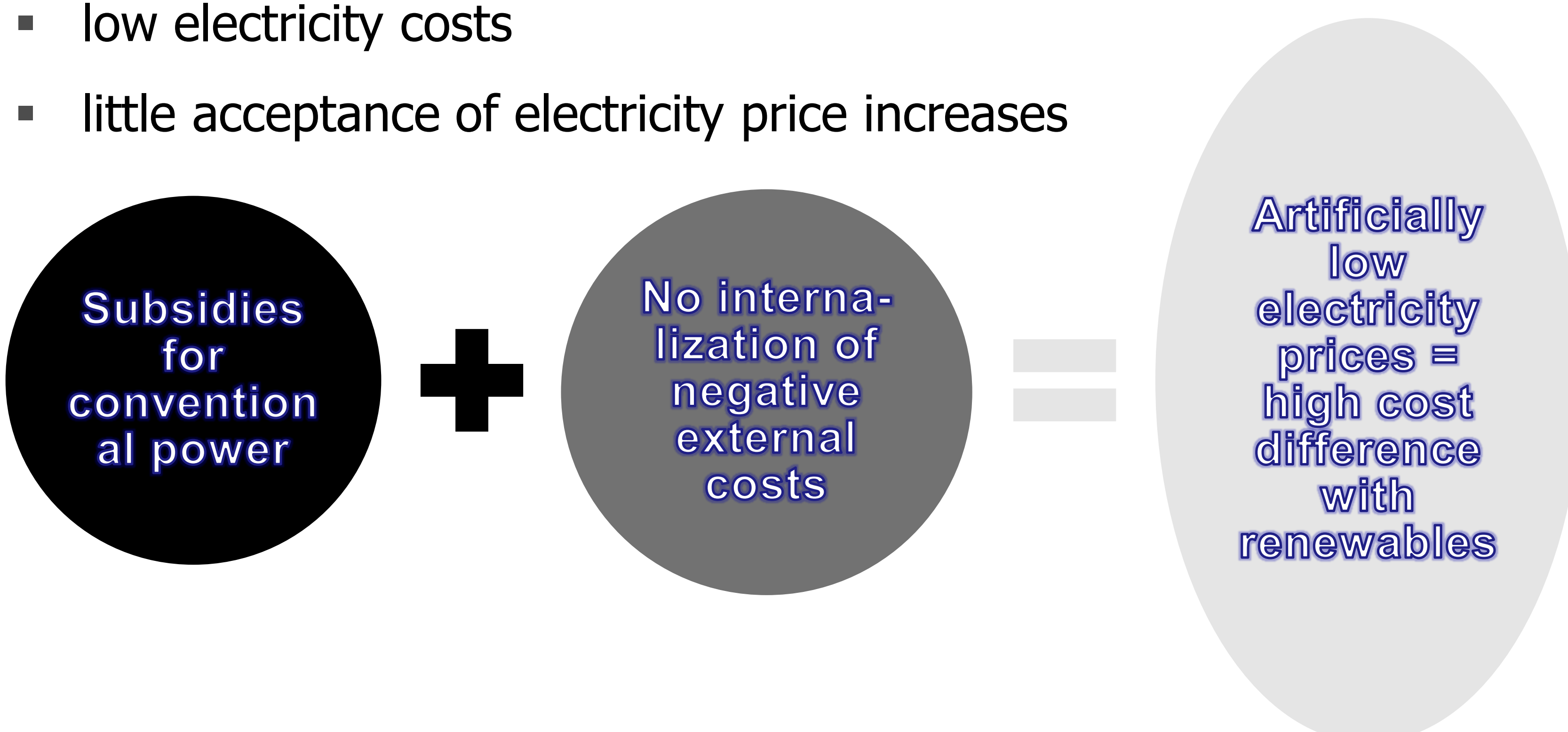
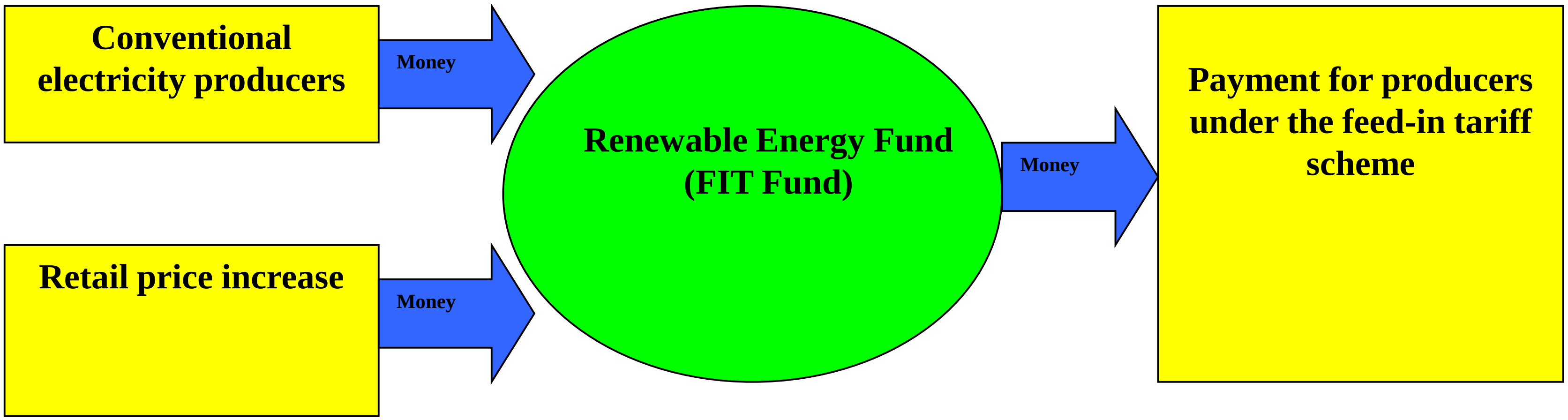
Financing support programs in developing countries

- low electricity costs
- little acceptance of electricity price increases



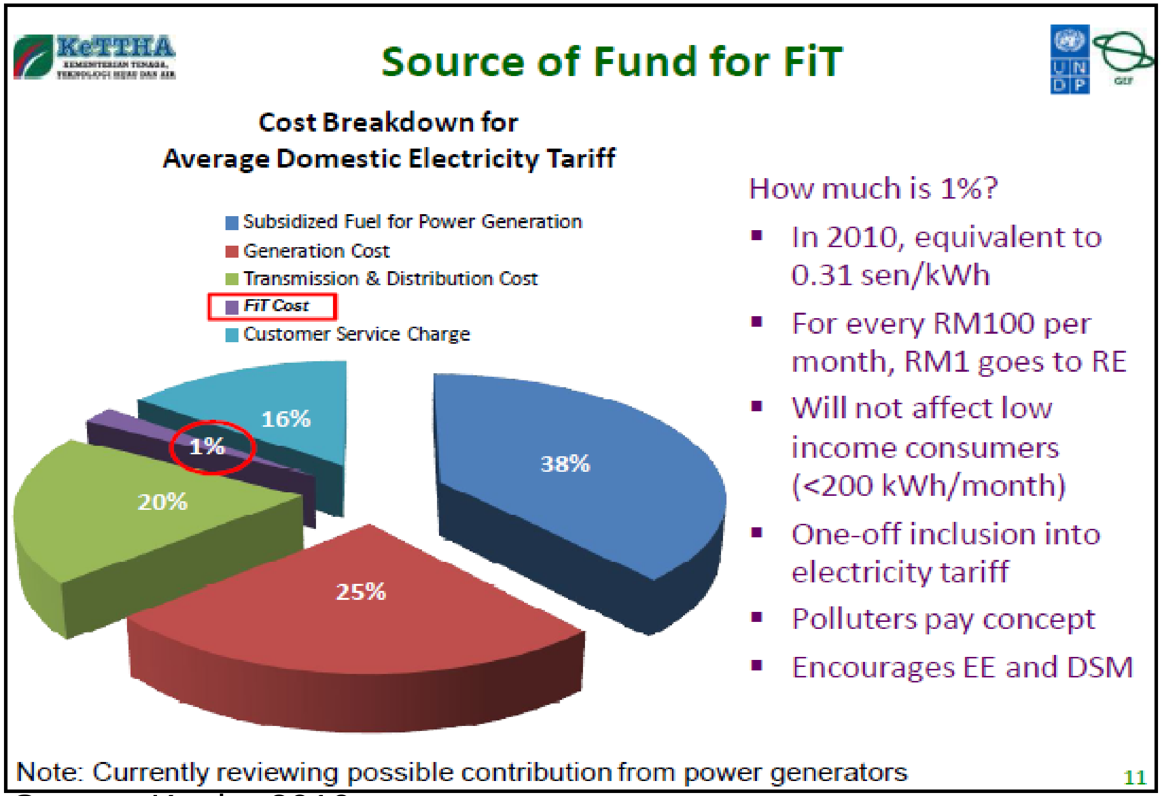
Combined financing – Taiwan

- Add additional financing to the national RES fund (levy on producers from conventional electricity)
- Increase the retail electricity price by a certain share (after general elections next year)



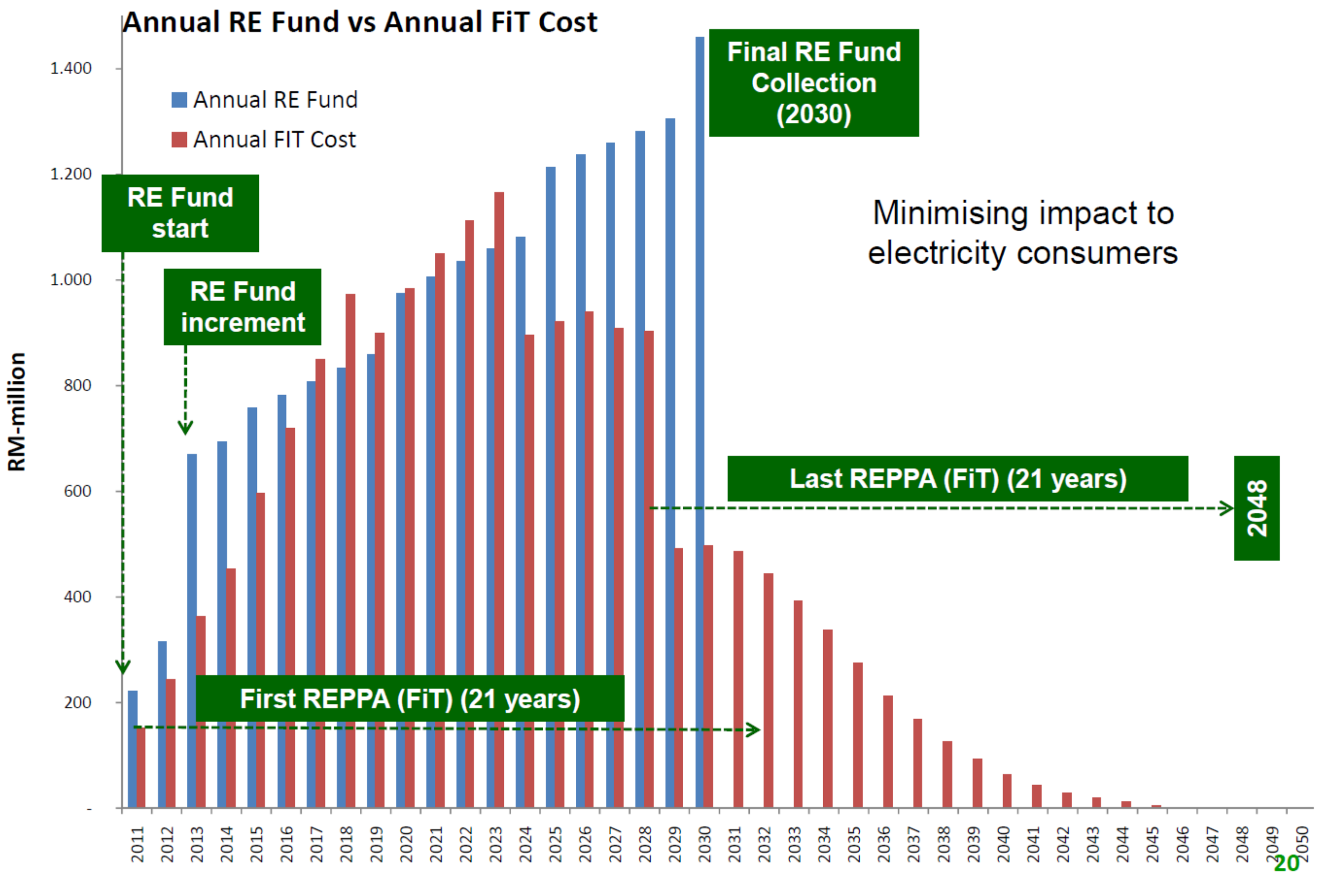
Source: David Jacobs

RES financing in Malaysia – limited electricity price increase (limited scope of FIT program)



Source: Kettha 2010

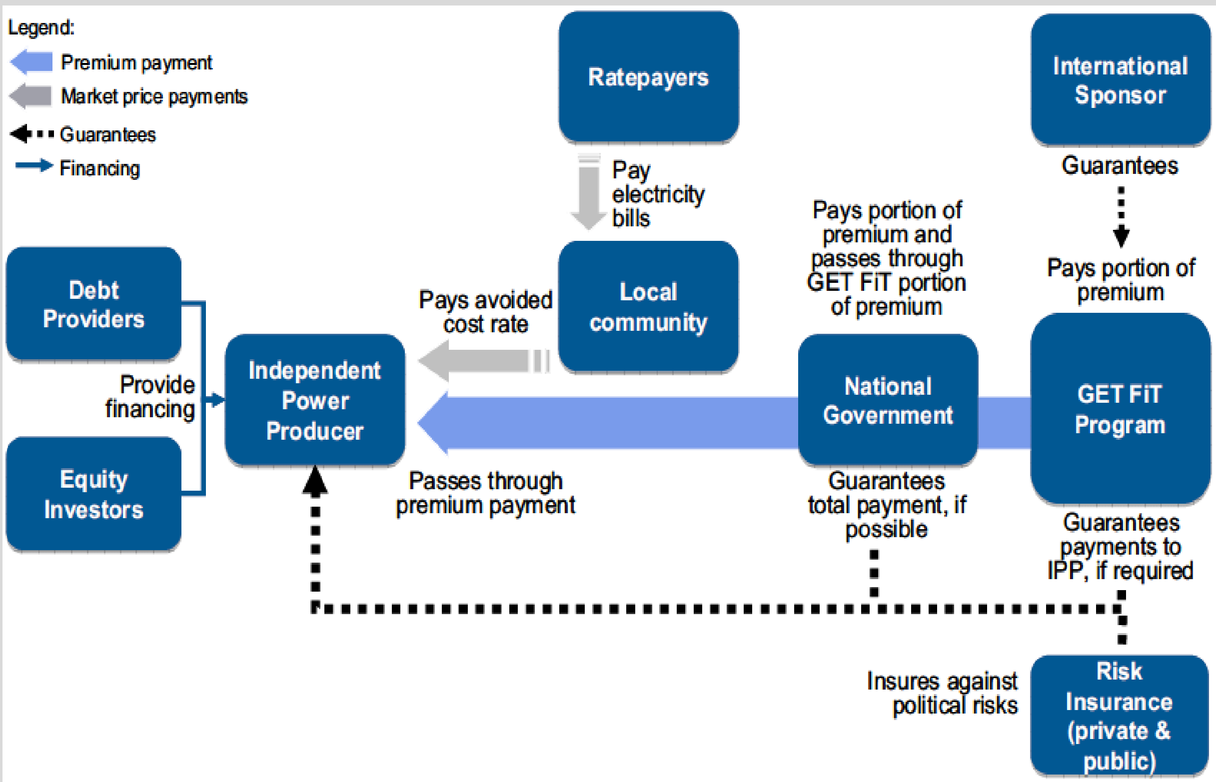
RES Fund in Malaysia



Minimising impact to electricity consumers

International RES financing? – The future of international climate talks?

GET FiT financing flows



Source: DBCCA, "GET FiT", April 2010

From scenarios to instruments:

Reducing administrative barriers

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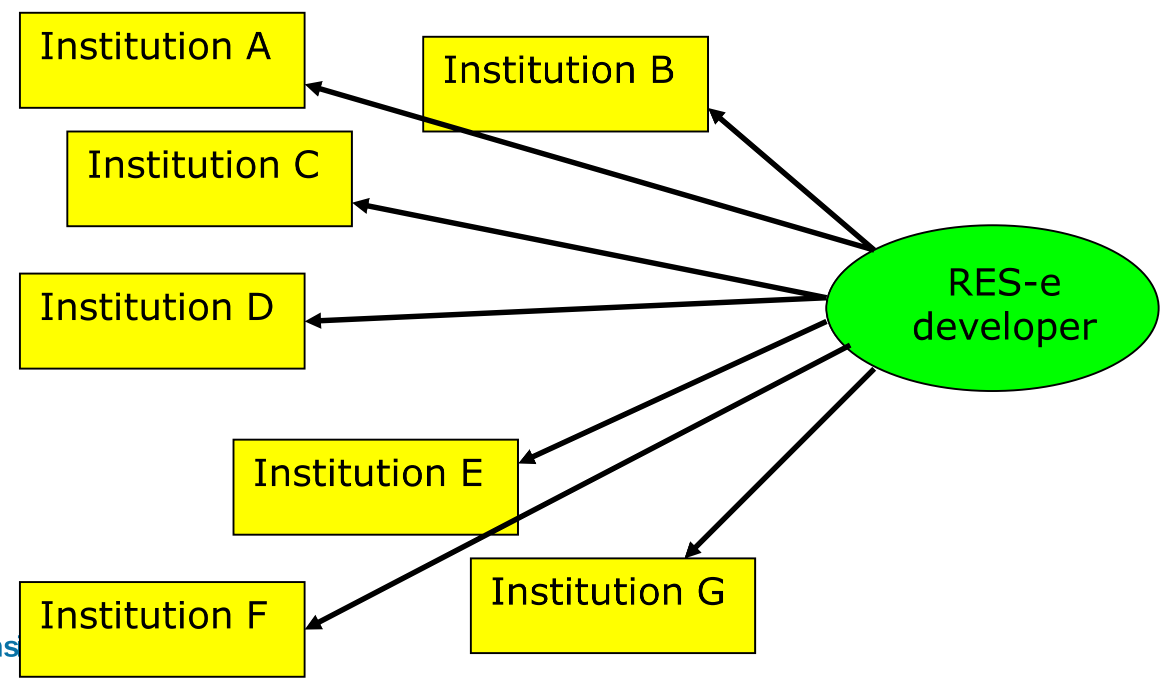
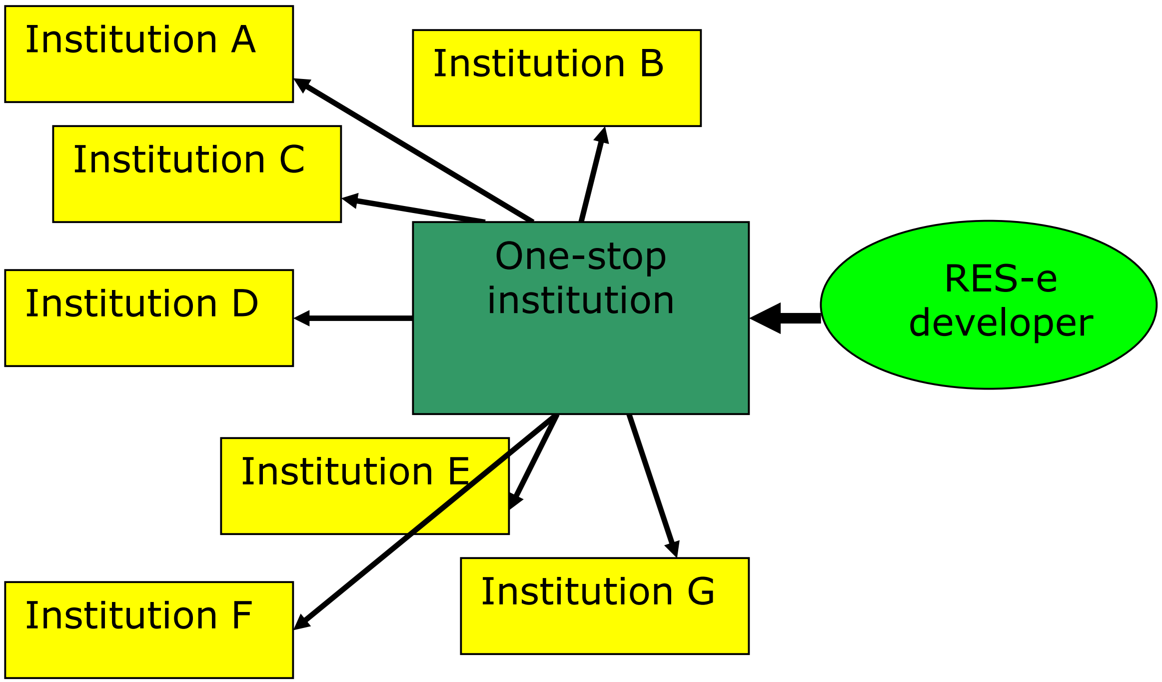
High number of institutions involved in planning and permitting process

- Lengthy and complicated application process
- High number of rejections
- High administrative costs



High number of institutions involved in planning and permitting process

- Solution: One-stop-shop institution



Long lead times

- Long lead times to obtain necessary permits
- Spain and Portugal: 12 year for small hydro
- France: 5 years for wind energy
- Approval rates (France - wind energy) = less than 30%

Long lead times

- Exact length of procedure not known up-front: clear guidelines and obligatory response periods for authorities needed
- Clear attribution of responsibilities
- Especially spatial planning related permits can take many years (wind, biomass)

From instruments to market deployment:

The importance of resource mapping for investors and project developers

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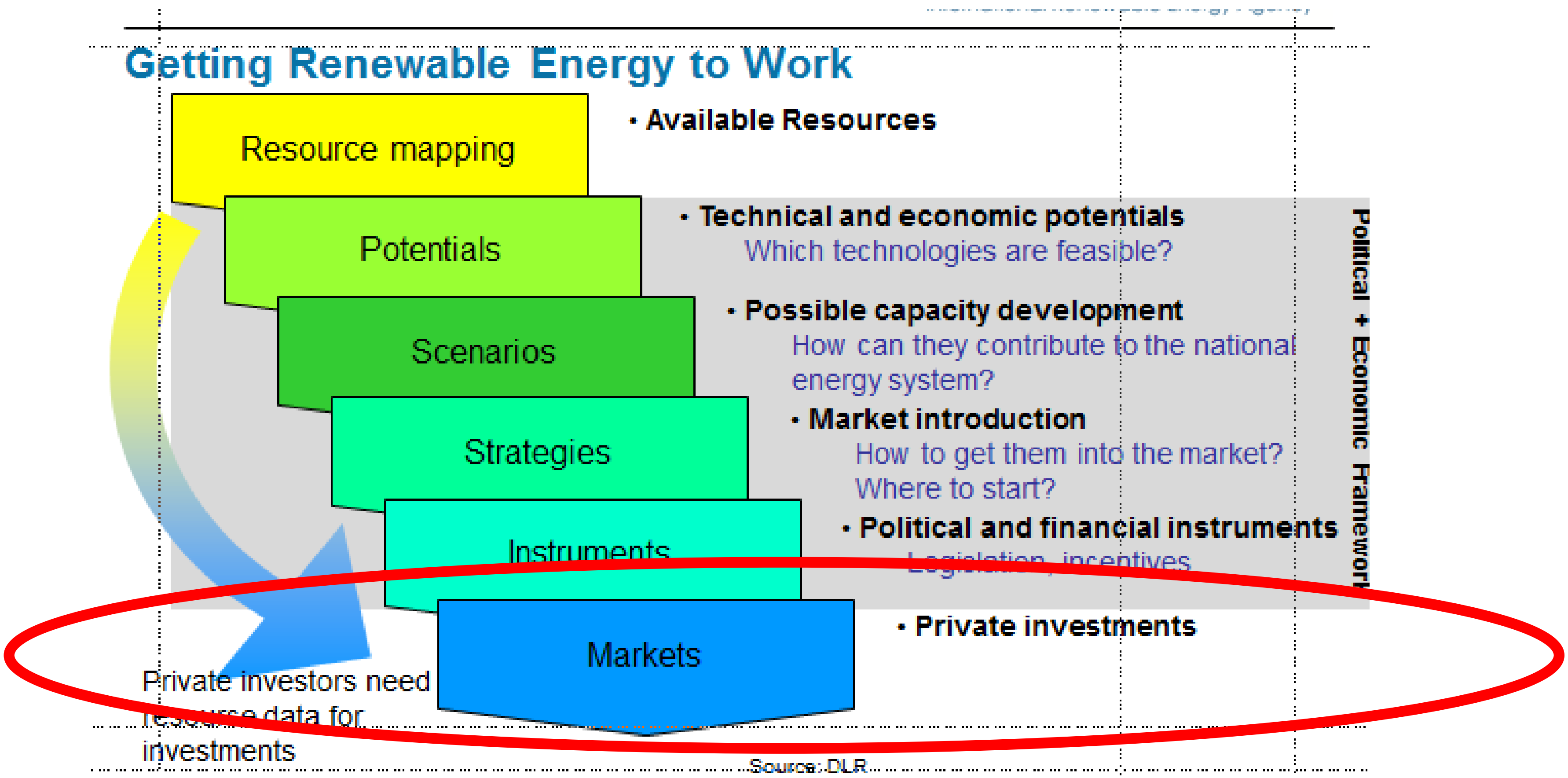
From resource mapping to the actual deployment of renewables

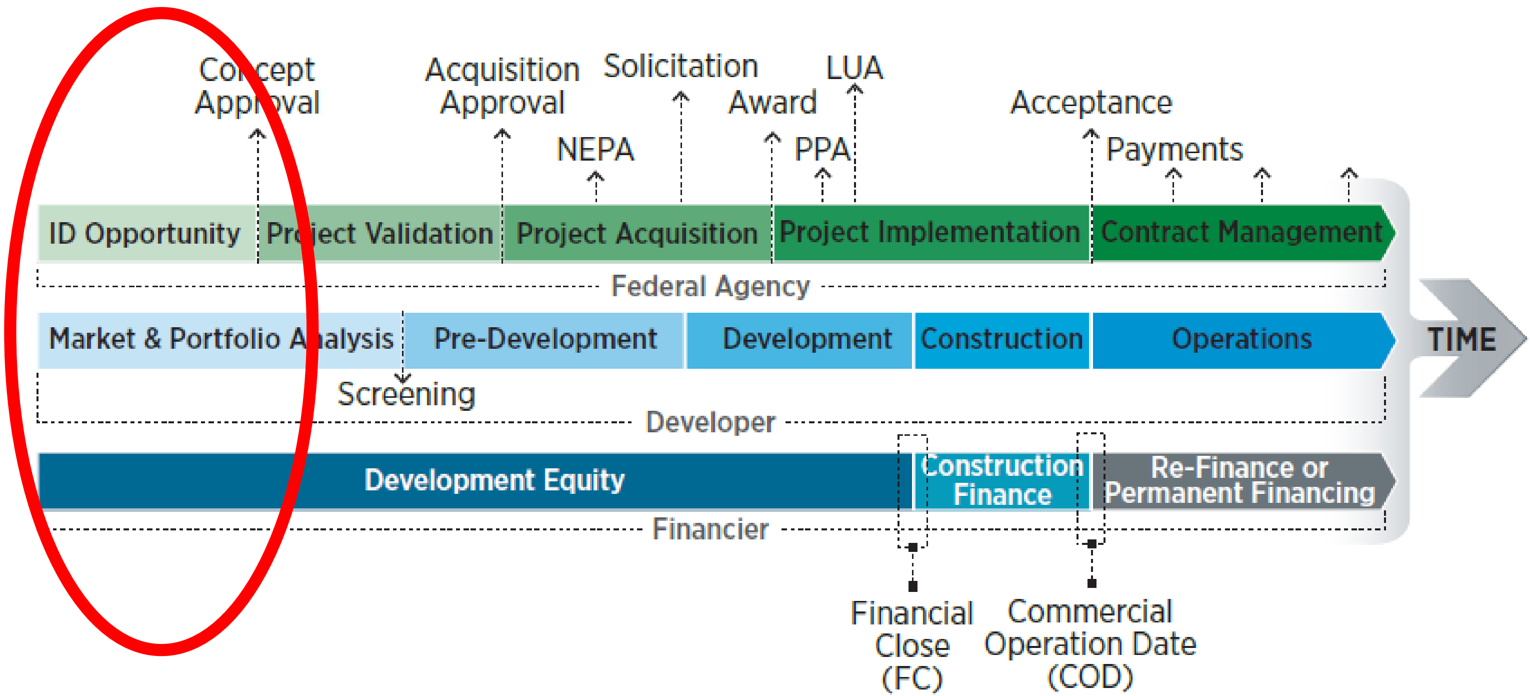


Resource mapping and project development

- Purpose of resource mapping:
  - Helping governments and utilities plan and guide investment through improved understanding of resource availability and constraints
  - **Providing commercial developers with information on resource location**
  - Shortening project development times and access to finance by providing ground-based datasets for resource validation purposes

Resource mapping and project development

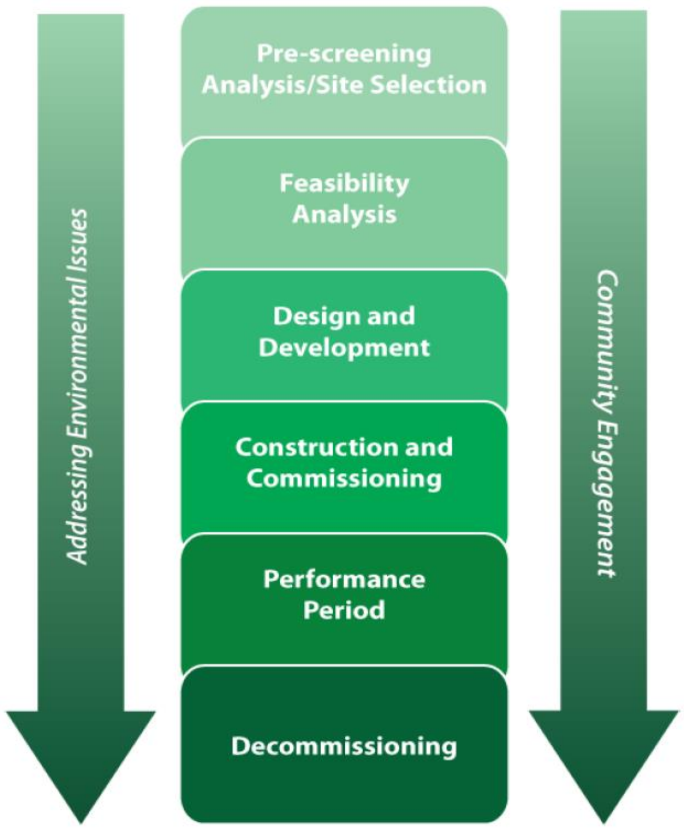
- The first step on a long process until project operation



Source: http://www1.eere.energy.gov/femp/pdfs/large-scalereguide.pdf

Renewable energy project planning

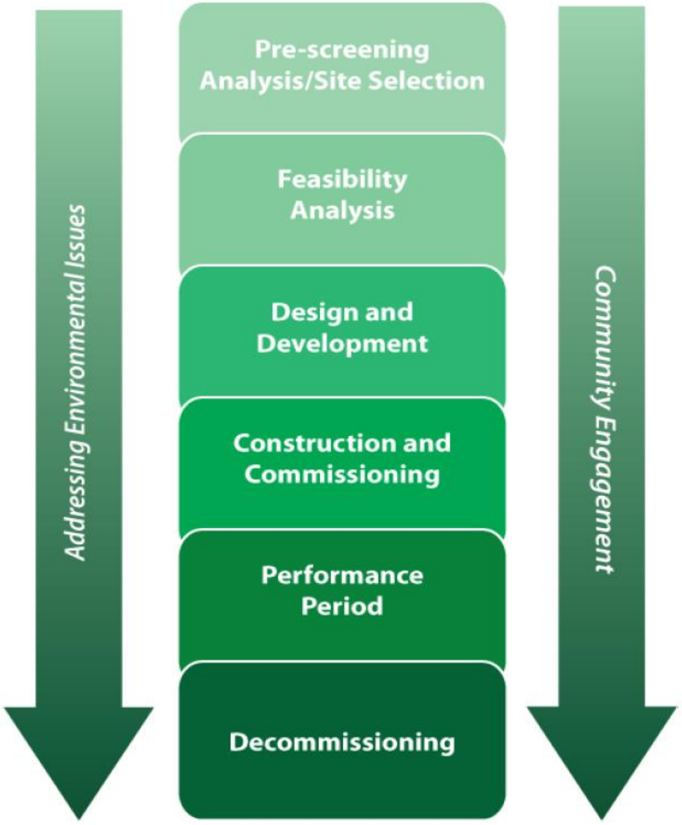
- Site selection based on:
  - Resource availability (maps)
  - Grid availability
  - Planning and support framework
- Feasibility Analysis (Site-specific assessment)
  - identify physical and spatial issues
  - determine technical performance potential (onsite measurement) and economic viability
  - identify environmental, social or other constraints



Source: http://www.epa.gov/oswercpa/docs/handbook_siting_repowering_projects.pdf

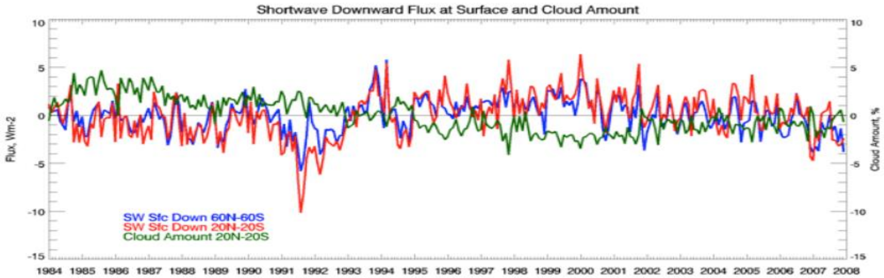
Renewable energy project planning

- Design and development
  - Design and planning of the physical aspects of the project (negotiation of financial, regulatory, contractual, and other nonphysical aspects)
- Construction and Commissioning
- Performance Period
  - Operation and Maintenance
- Decommissioning
  - equipment replacement, permit revision, and new financing; negotiating a new lease agreement



Source: http://www.epa.gov/oswercpa/docs/handbook_siting_repowering_projects.pdf

Longer term weather trends?

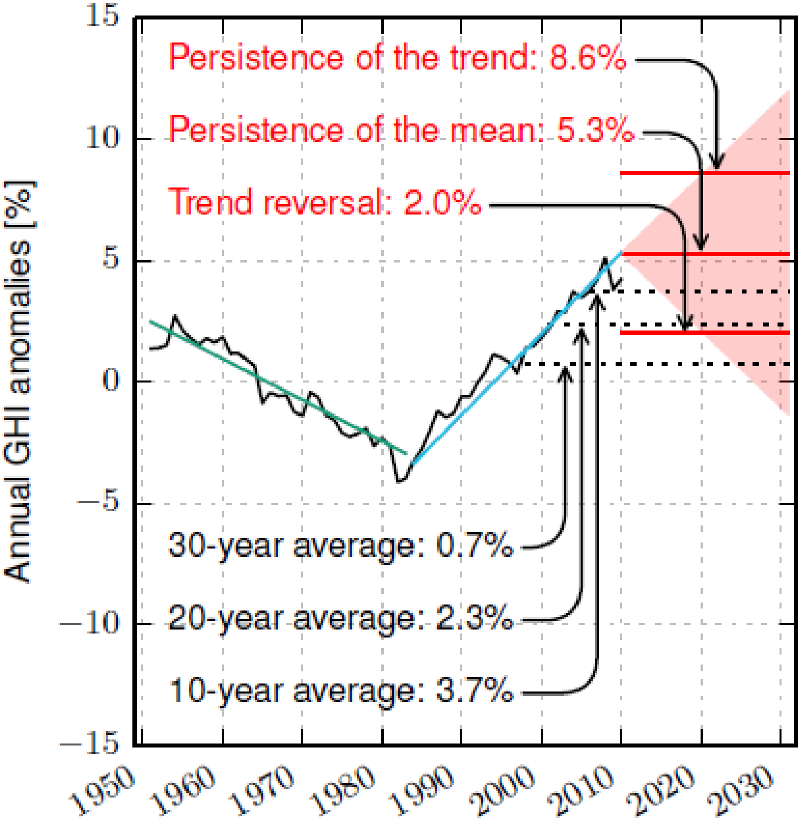


- Measurements usually have to take place for a longer period of time in order to convince investors of the quality of the site:
  - Wind projects may require 12-18 months of direct readings from a mounted met mast on each potential site. 12 months is possible but requires correlation with geographically close meteorological information from an airport or other measuring stations
  - Because CSP projects tend to be very large scale and depend on direct versus diffused irradiation, 12 months of data appears to be a minimum for CSP if correlated with 15 years of satellite data
  - Solar PV usually required one year of measurements

Source: David Renne, NREL

Longer term weather trends?

- Long-term fluctuations?
  - Effects from climate change and other environmental impacts
  - German average solar radiation 5% higher than expected (increase since mid-80s)
  - Opposite development in Chinese cities due to smog
  - “global dimming and brightening” - only the 10 most recent years as benchmark!



Source: Fraunhofer ISE (Müller et al. 2014)

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Short term variability due to whether events

- Not crucial for project finance
- However, crucial for predictability of electricity output and therefore for system (and market) integration
- Important improvements in
- Example: cloud shading for solar PV

Source: Windlogics/FPL (Adam Kankiewicz)

Assessment and revising of existing policies and frameworks?

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Review and assessment

- Assess target achievement (annually, bi-annually)
- Identify bottle-necks and barriers (finance, grid access, administrative barriers, etc.).
- Adjust policies and framework conditions

Thank you very much for your attention!

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