International Solar Alliance Expert Training Course

In partnership with the Clean Energy Solutions Center

Dr. David Jacobs

Session 2: Introduction to Solar Policies

In partnership with the Clean Energy Solutions Center (CESC)

Dr. David Jacobs

Supporters of this Expert Training Series

International Energy Transition

INTERNATIONAL SOLAR ALLIANCE

CLEAN ENERGY SOLUTIONS CENTER

ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

IET – International Energy Transition GmbH

Dr. David Jacobs

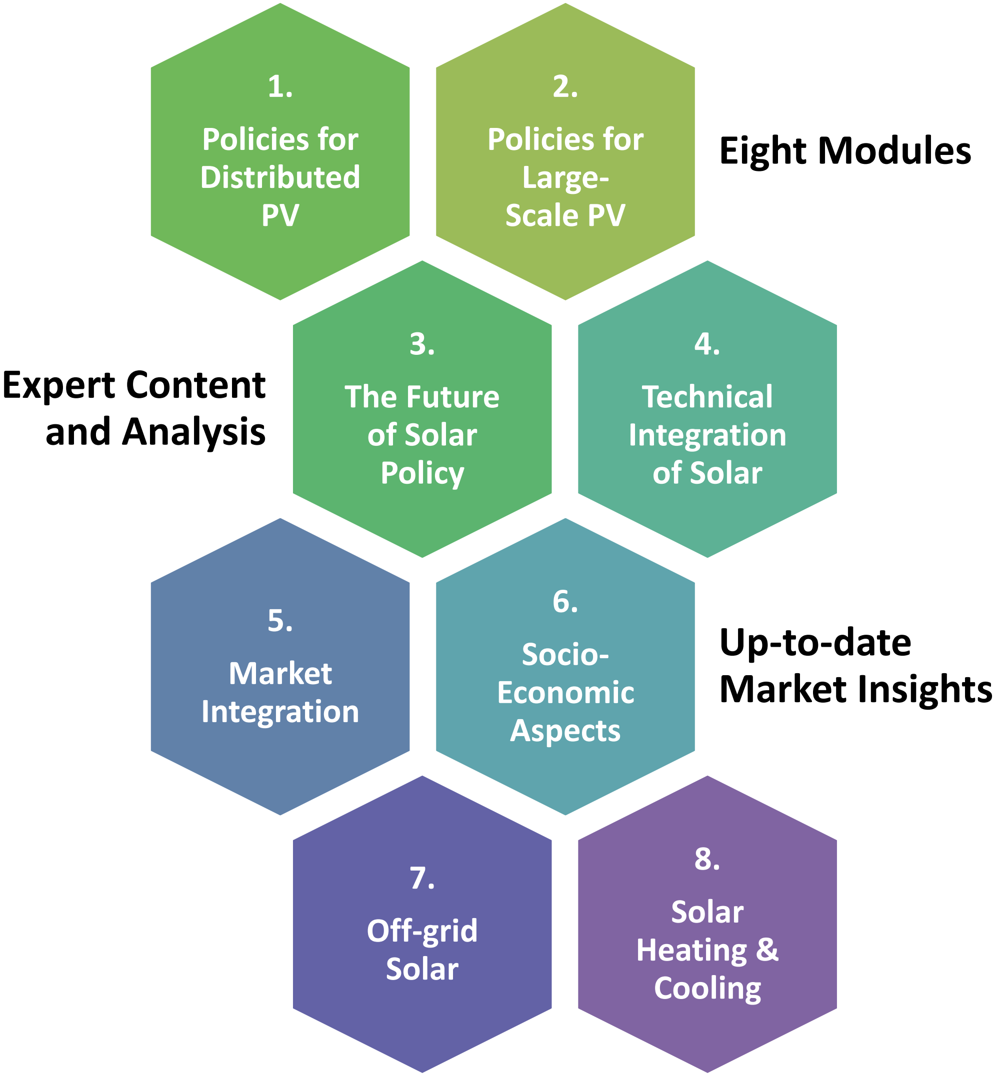
- Founder and director of IET
- Focus on sustainable energy policy and market design
- 14+ years experience in renewable energy policies
- 60+ publications on energy and climate
- 40+ countries work experience (consulting and presentations)

Training Course Material

This Training is part of Module 1, and focuses on support mechanisms (small+large)

<u>Related training units are:</u>

- ✓ Session 3-9 (distributed solar).
- ✓ Session 10-13 (large-scale solar)
- ✓ Session 14-18 (future policies)



Overview of the Training Session

1. Introduction: Learning Objective

2. Understanding the Basic Design of all Major Support Mechanisms for Solar PV

3. Further Reading

4. Knowledge Check: Multiple-Choice Questions

Introduction:

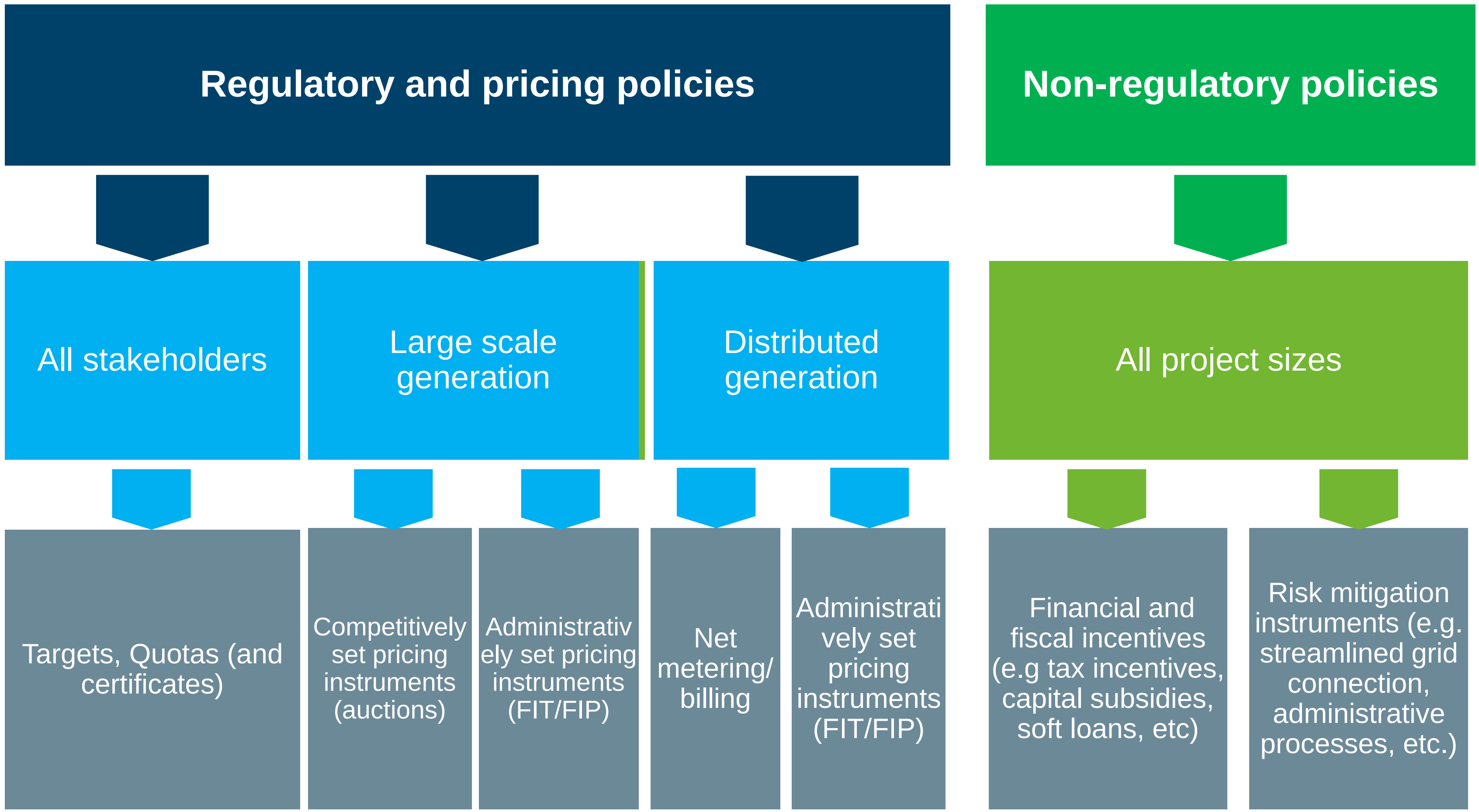
Learning Objective

Learning Objective (I)

- Understand different categories of support mechanisms
- Understand main support mechanisms: RPS, auctions, FITs, Net Metering
- Understand fiscal incentives
- Understand additional risk mitigation instruments

Overview of policies world-wide

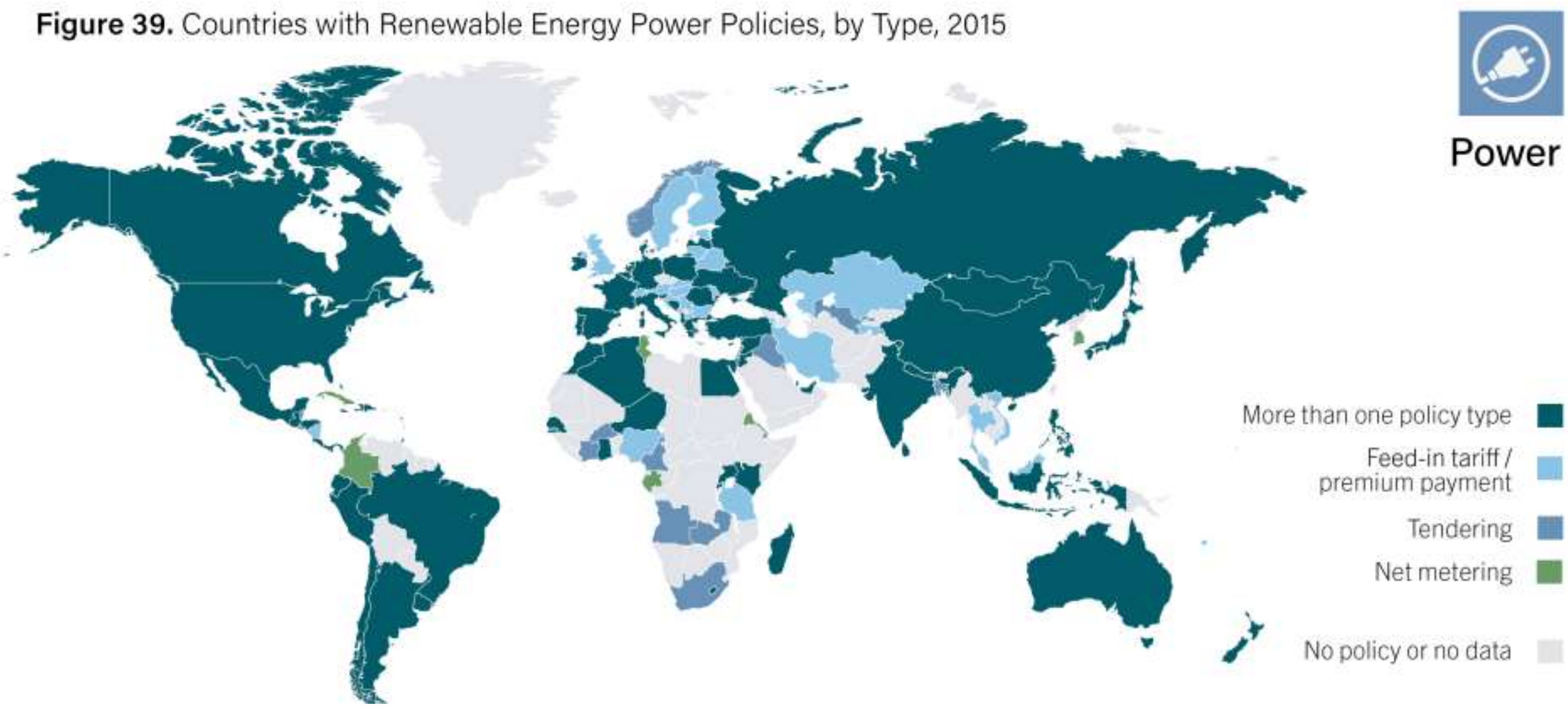
Categories of PV Policies



Note: FIT = feed-in tariff, FIP = Feed-in premium

Source: IET based on IRENA 2017

Most Countries Use More Than One Policy Instrument



Source: REN21 Global Status Report 2016

Policies - Key figures from latest GSR (REN21)

- At least **179 countrie**s had **renewable energy targets** by the end of 2017.
- More than 29 countries held **renewable energy auctions** in 2017 alone, bringing the total number of countries to have competitive renewable auctions to **84**.
- By the end of 2017, **113 countries had feed-in policies** in place to support small-scale installations.
- **33 countries** had **RPS/quota** policies in place in 2017.
- By end-2016, approximately **55 countries** had implemented **net-metering** policies either at a national subnational level.

Source: REN21 2018, REN21 2017

RE Targets

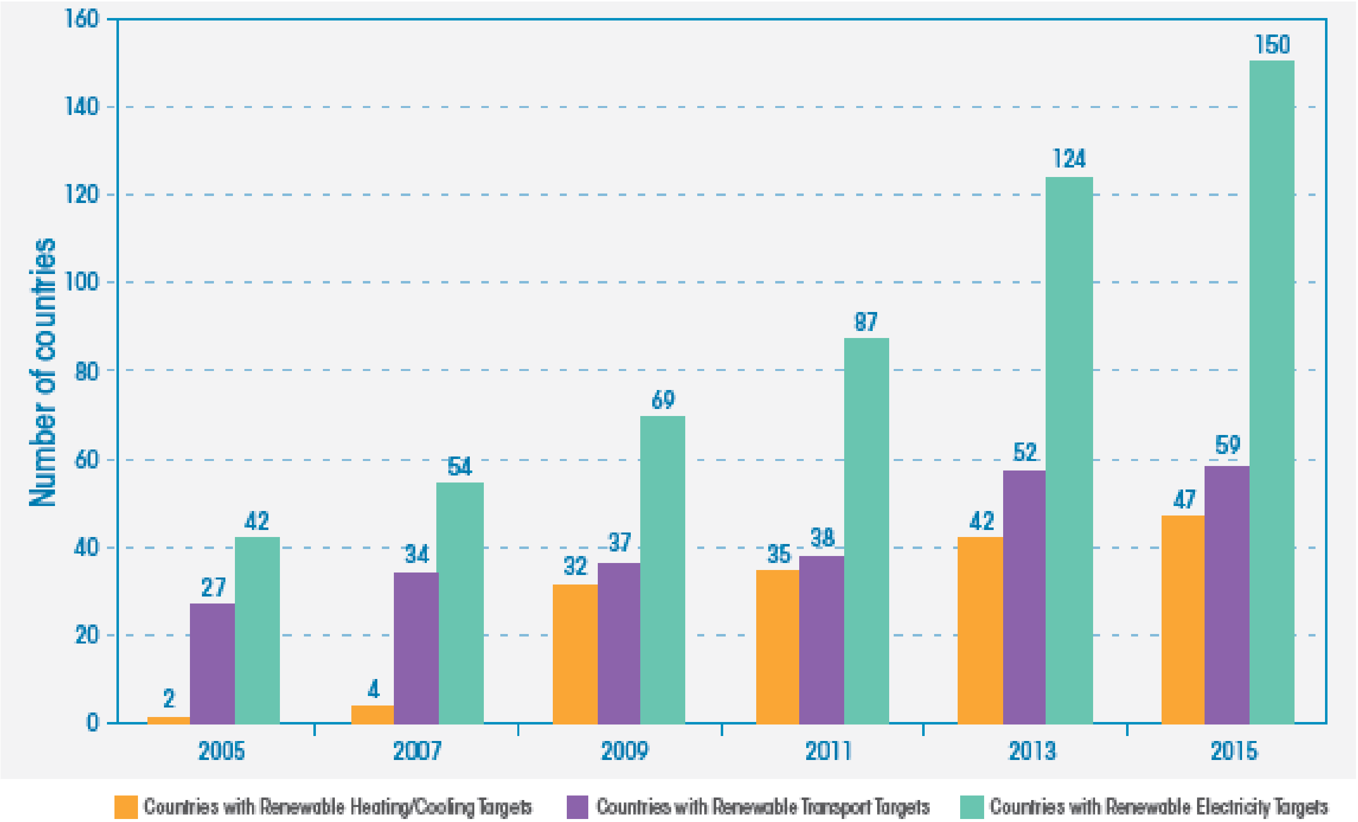
Designing RE targets

The design of RE targets varies widely:

- Technology-neutral vs. technology-specific
- Total final energy consumption (TFEC) vs. Total primary energy consumption (TPEC)
- Share of energy demand (%) or a fixed amount (e.g. ‘x’ GWh, PJs)
- By Sector: Electricity, Heating, Transport
- Long-term vs. Short-term
- Mandatory vs. Aspirational

Evolution of global RE targets by sector 2005-2017

- Today, **nearly 180 countries** have renewable energy targets (150 countries with targets for the power sector).



Source: IRENA based on REN21, 2005, 2007, 2009, 2011, 2013, 2014.

Quota based mechanisms (TGC/RPS)

RPS Policies: Basic Principles

- RPS policies are one way of establishing the long-term trajectory of the electricity system, and introducing a mandatory, legally-binding obligation to achieve it
- RPS Policies set a legally binding target: they are not a procurement mechanism. The target can be met with FITs, RFPs, net metering, etc.

RPS Policies: Basic Principles

- RPS establish, in law, a minimum requirement for RE procurement:

- This can be:
  - %-based (20% by 2020)
  - MW-based (1,000 MW by 2020)
  - or based on MWh of total generation (10 TWh per year by 2020)

- RPS policies can also differentiate by technology: e.g. 100MW of solar, 500MW of wind, etc.

RPS Policies: Advantages

- Set out a clear timetable for RE development
- Provide some degree of clarity over the future evolution of the electricity market
- Can be coordinated more easily with grid planning and expansion
- If legally binding, fines or penalties can be used to create discipline in the marketplace

RPS are Usually Combined with Other Support Mechanisms

- RPS are usually coupled with a procurement mechanism
  - FITs
  - Auctions
  - Net Metering
  - Quota obligation with certificate trading

REC Policies: Overview

- Renewable energy certificates (RECs) involve a separation of renewable energies and solar PV into two commodities:
  - 1. RE electricity (the value on the electricity market)
  - 2. ‘environmental attributes’ (the certificate value)

- In theory, they are designed to encourage more cost-efficient RE development, by allowing regions with lower quality RE resources to buy certificates from regions with higher quality RE resources

Quota Obligation: Advantages

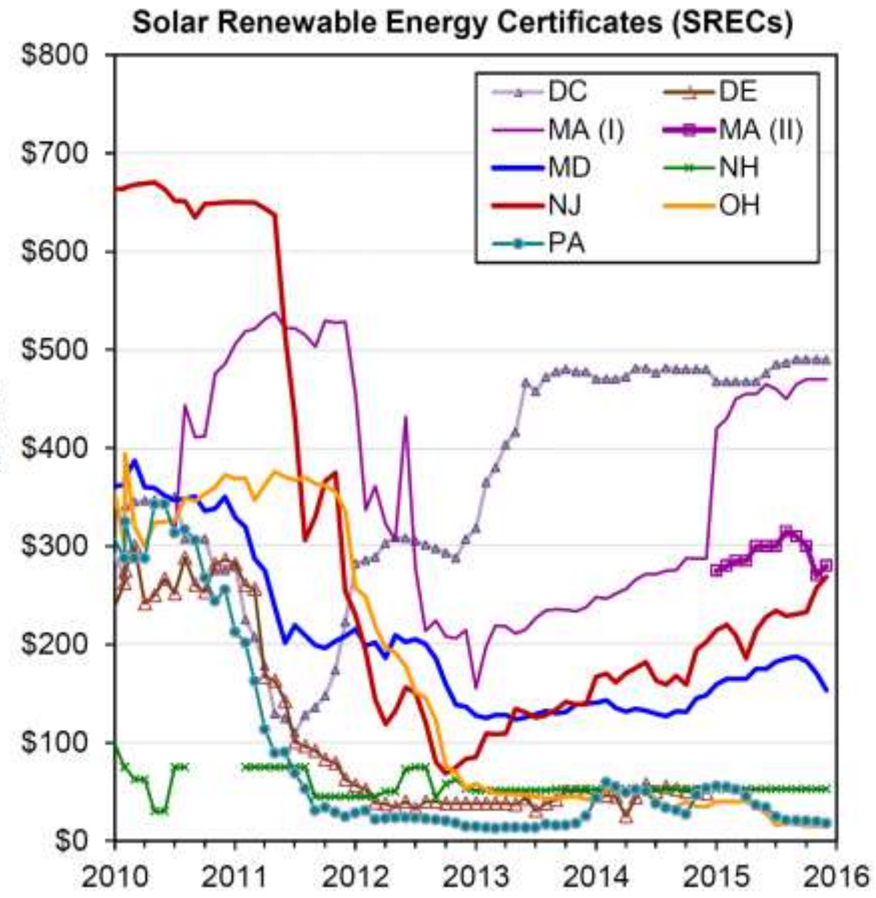
- Increase **compliance flexibility**: they allow utilities from different regions to meet their obligation by generating RE or buying certificates

- Can **lower total RE procurement** costs by allowing lowest cost resources to be procured first.

- Certificate trading can provide a **tracking mechanism** for RE generation.

Quota based support – volatile revenue streams

- Liquidity of market needed
- Price volatility of different certificate trading schemes in the US (2010-2016)



Source: Barbose 2016

Quota Obligation - Disadvantage

- Little investment security (volatile market and certificate price) requires risk premium for financing (increased capital costs)

- Exclusive support of least cost technologies

- Little dynamic efficiency (focus on mature technologies), de facto penalizing technological innovations

Quota obligation limitations

- Best applicable in fully liberalized electricity markets
  - Large number of independent renewable power producers (for liquidity on certificate market)
  - Large number of independent conventional power producers (for liquidity on the spot market)
- Countries with long-term tradition in liberalized energy markets

Auction mechanisms (tender/ competitive procurement)

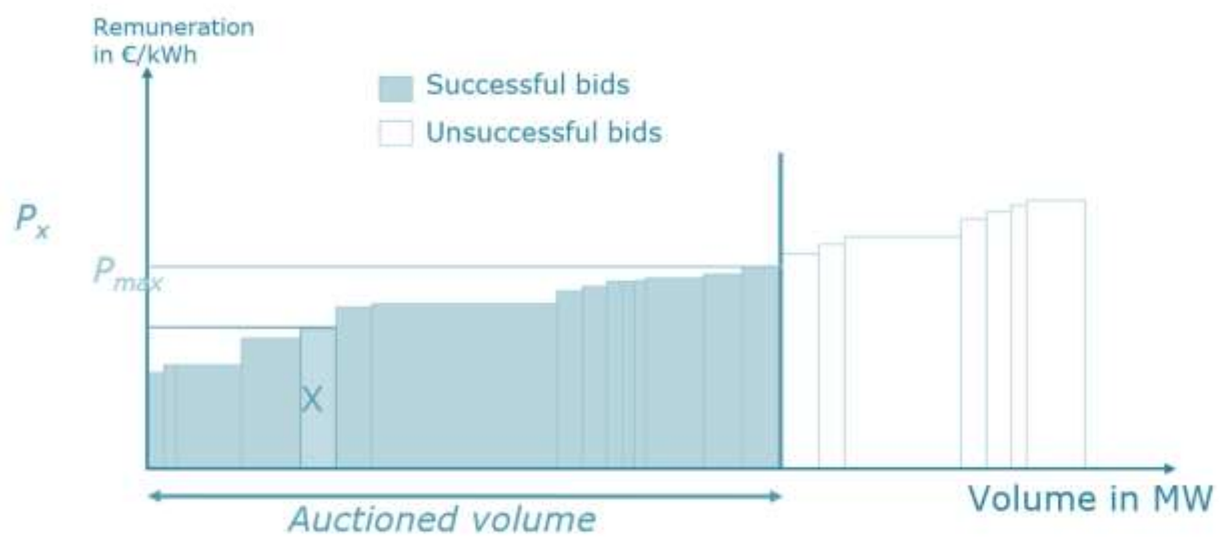
RE Auctions world-wide

RE auctions: from 7 countries in 2005 to 84 countries in 2017

Source: IRENA 2015, REN21 2005, REN21 2018

Tender / Auctioning Mechanism

- Generally: bids for cost per unit of electricity (generation focused)
- For example: 500 MW of total (accumulated) PV capacity
- Bidder with the lowest price “wins” contract and has the exclusive right for renewable electricity generation



Source: Ecofys (AURES project)

Key Questions for Auction Design

1. What is being auctioned and when? (**Procurement schedule**)
2. Who can participate in auctions? (**Pre-qualifications**)
3. On what basis are bid evaluated? (**selection criteria**)
4. What mechanisms is used for price determination? (**Price-finding mechanism**)
5. What payment will winners receive? (**payment modalities**)
6. How can I assure that projects will actually get built? (**Penalties for none-compliance**)

Advantages of auction mechanisms

- Cost efficiency and price competition (overcome challenge of information asymmetries)
- High investor security (PPA)
- Volume and budget control
- Predictability of RE-based electricity supply (sector growth)
- Combination with other policy objectives, e.g. local content, etc.

Disadvantages of auction mechanisms

- High administrative costs (complexity)
- Discontinuous market development (stop-and-go cycles)
- Risks of not winning project increases finance costs
- Risk of underbidding (lack of deployment and target achievement)
- Exclusion of small-scale actors

Feed-in tariffs

Application of FIT World-Wide

- 113 countries use FITs in 2017.
- Continues to be the most frequently used support mechanism world-wide.
- In the past years, many countries have switched from FIT to auctions for large-scale systems

Source: IET based on REN21 2018

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

Important FIT design features (continued)

- Technology-specific tariffs
- Size-specific tariffs
- Location-specific tariffs
- FIT degression
- Capacity caps

Advantages of Feed-in tariffs

- High level of investment security
- New actors are entering the power market (competition)
- PV price reduction and innovation triggered by degressive feed-in tariffs

  > Investments are not postponed
- Allows for technology specific support

Source: David Jacobs

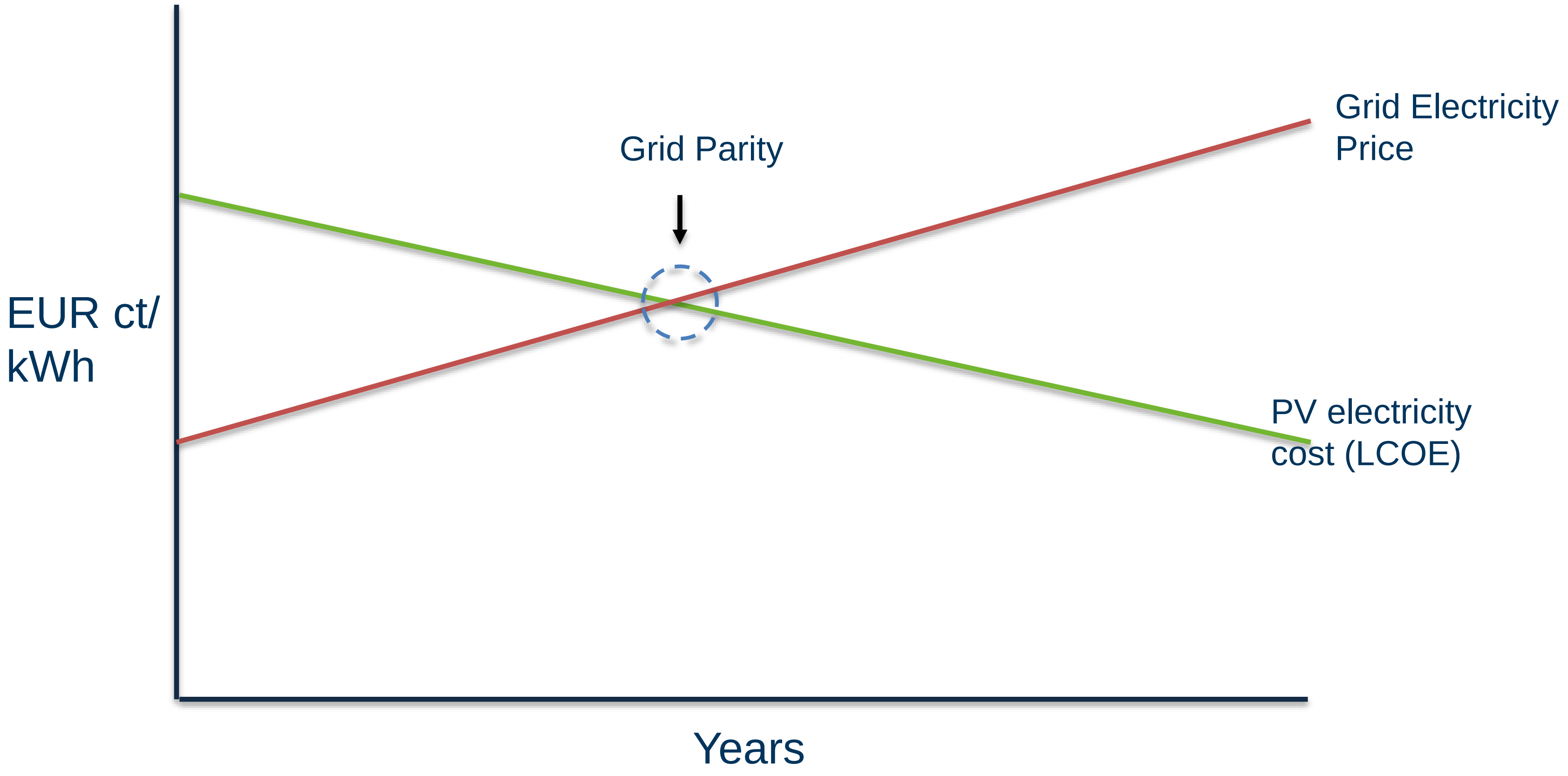
Disadvantages of Feed-in tariffs

- "Uncontrolled" market growth in case of tariffs that are too high (flexible degression)
- The costs are growing continuously until the payment period of the first plants ends
- Difficulty to anticipate technological development (progress reports and monitoring necessary)

Introduction:

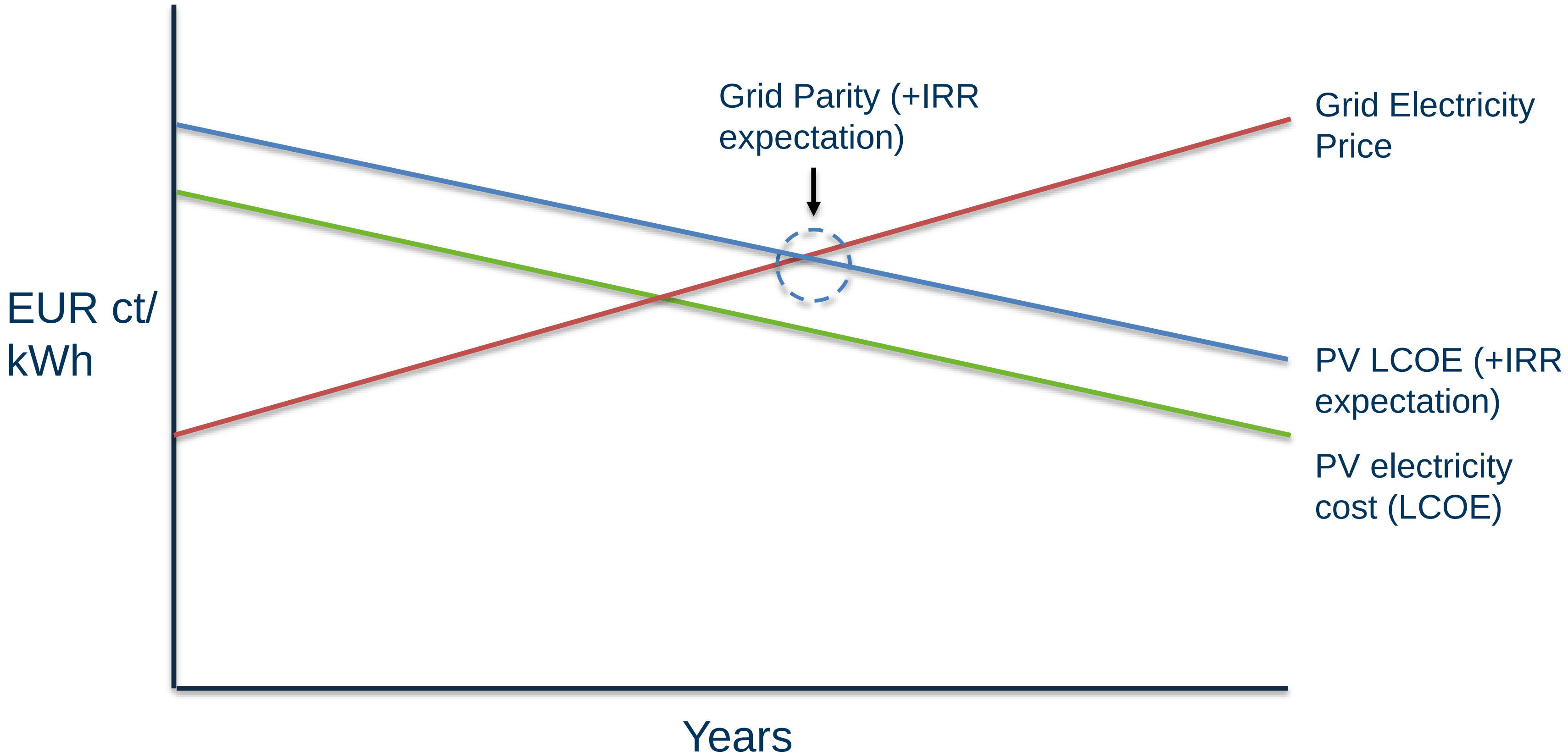
Net Metering Definition

Simplistic grid parity and "self-consumption"



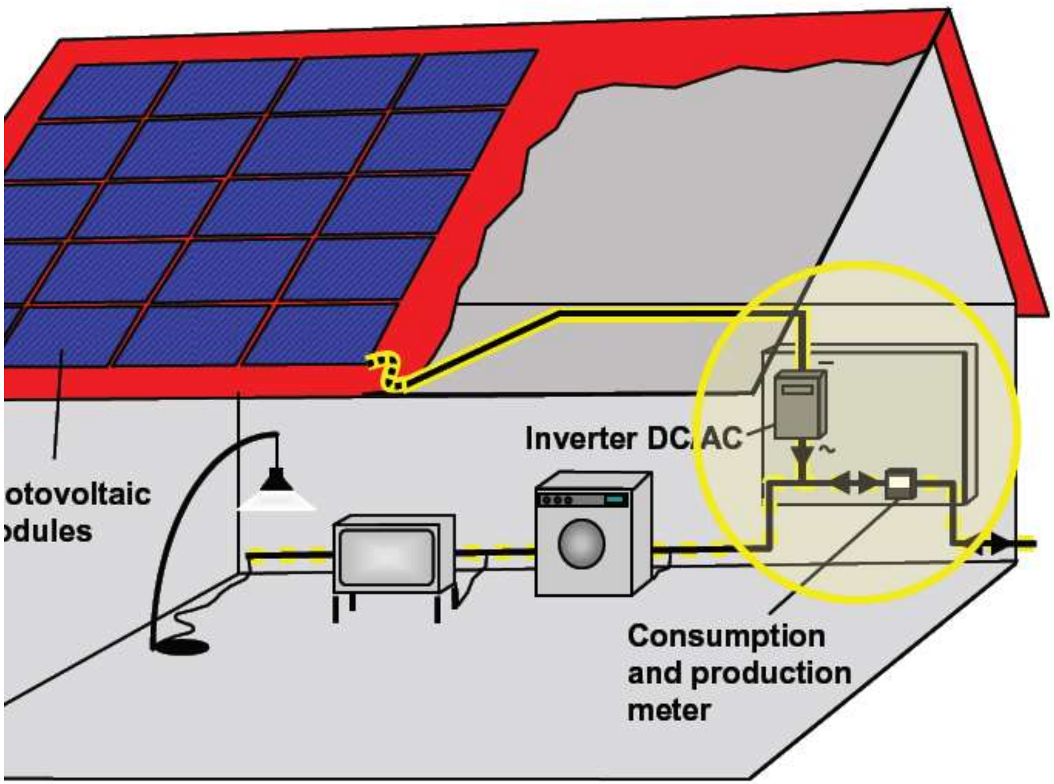
Source: Eclareon 2013

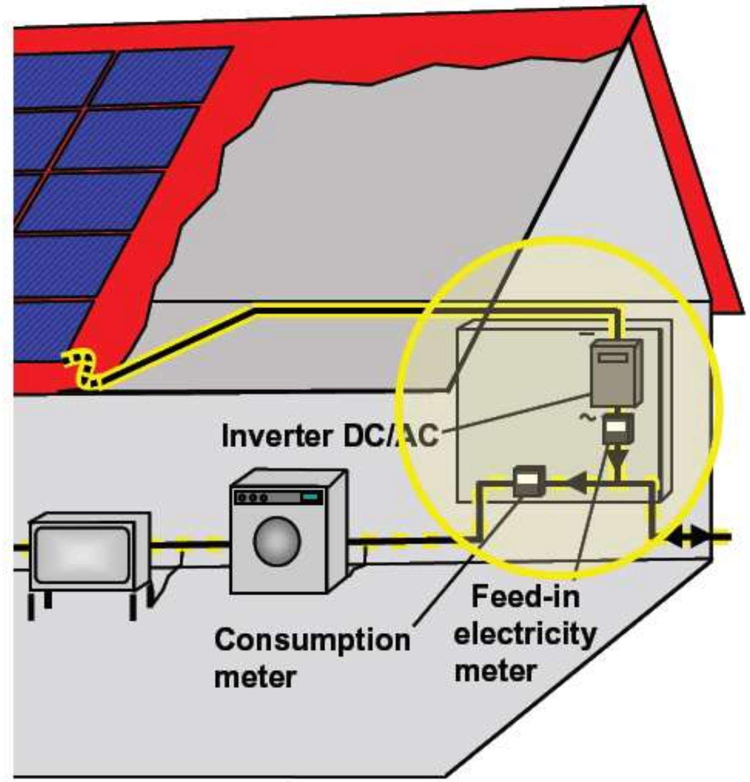
Simplistic grid parity and “self-consumption”



Source: Eclareon 2013

Net metering: Important differences to FITs





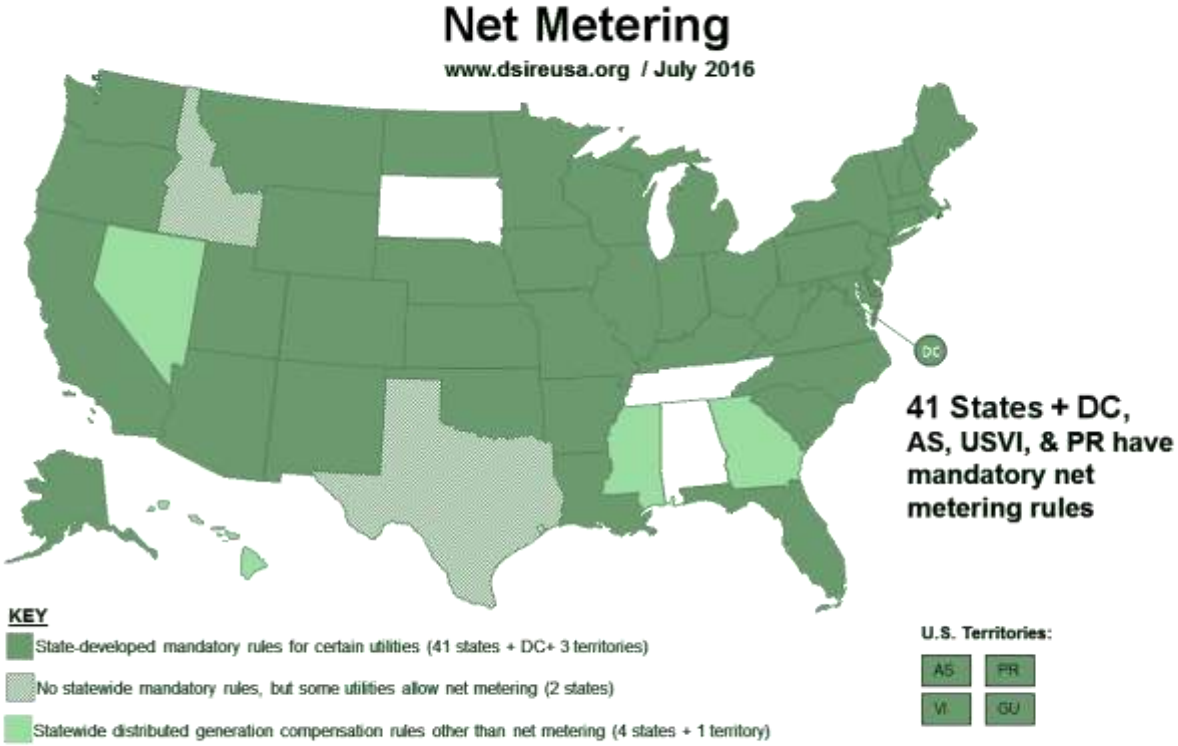
Net-metering
Electricity is used for consumption first, only excess electricity is fed into the grid

Feed-in tariff
Solar electricity is exclusively fed into the grid

Source: RENAC

Net Metering World-Wide

- Policy was first implemented in the US in early 1980s
- Up from 13 countries in 2010 to 52 countries in 2015



Source: http://www.dsireusa.org/resources/detailed-summary-maps/

Net-Metering Programs Worldwide

Europe	Europe (cont'd)	Americas	Americas	Asia - Pacific	Middle East	Africa
Albania	Switzerland	Barbados	Argentina	Japan	Bahrain	Tanzania
Belgium (regional)	Portugal	Chile	Canada	Korea	Israel	Tunisia
Cyprus	Spain	Guatemala	Chile	Malaysia	Jordan	Cap Verde
Czech Republic	Cyprus	Canada (regional)	Costa Rica	Philippines	Palestine	South Africa
Denmark	Slovenia	Mexico	Grenada	Singapore	Lebanon	Egypt
Greece	Netherlands	USA (42 States)	Jamaica	South Korea	Syria	Lesotho
Italy		Peru	St. Lucia	Thailand	Saudi Arabia	Mauritius
Malta		Dominican Republic	Micronesia	India		Namibia
Moldova		Panama	Honduras,	Pakistan		
Latvia		Uruguay	Guatemala	Sri Lanka		
Lithuania		Brazil		Vietnam		
Ukraine				Australia		
				New Zealand		
				Seychelles		

Source: REN21 2014, 2015, 2018

Design Options: Program or system-size caps?

Features	Design Options
Program size caps	• Defined as a percentage of total peak demand (e.g. 5% of peak demand) • Defined as a capacity limit (e.g. 500 MW) • Unlimited
System size caps	• Limit on installed capacity per unit (e.g. 10 kW) • Limitation in relation to the average, annual electricity demand in a region/country (e.g. average electricity demand of 300 kWh/a; 1% of 300 kWh = maximum size of 3 kw) • Caps on the maximum allowable level of distribution level penetration on a per-circuit basis (e.g. 15% of decentralized generation). • No direct caps (indirectly via role-over provisions)

Design option: Wide range of roll-over provisions

Features	Design Options
Roll-over period	• monthly • yearly • daily • hourly • cash compensation, credit rollover, payout at avoided cost • Overall Pricing Methodology (retail rate, time-of-use, below retail rate, bill credit vs. cash payment, etc.)

- The electricity grid serves as a “storage unit”
- Electricity can be banked (surplus electricity is carried forward and used to offset consumption in the future)
- Depends on the billing system (frequency) and climate conditions

The complexity of pricing methodologies: Important elements

Features	Design Options
Payment for rolled-over electricity	• FIT levels • Retail electricity • Value of solar • Avoided costs • Wholesale electricity • No compensation

Financial and Fiscal Incentives

Grant programs

- Grant for investment, usually covering a defined percentage of the system costs
- Generally these investment based – “buy down” initial cost for equipment (Germany until 2003: up to 60 percent for solar PV)
- Reduction of investment load and ease of purchase decision
- Usually taken from the state budget
  - usually capped
- Can be effective in creating demand in the first market phase of young RE technologies
- Problem: Disincentive to operate power plant optimally, especially in the case of high investment incentives (e.g. India)

Tax incentives

- Exemption for import tax for renewable energy equipment (mostly at an early stage of market development)
- Accelerated depreciation (e.g. write of total cost in first 5 years of operation)
- Tax reductions can also apply to direct taxes such as income tax or the corporate income tax.

Tax incentives

- Tax credits
  - Production tax credit: annual tax credit based on the amount of electricity generated
  - Investment tax credits: tax credits granted as a percentage of total investment costs (US: up to 35 percent)
- Generally they can give the same competitive edge as direct investments, however with a delay of one to two years.

Soft Loans

- Provide financing at below market rates to support investment.
  - Soft loans (or concessional loans) have been widely used to support RE market growth (e.g. Germany, China)
  - By offering a reliable credit provider, they can increase access to capital
  - Soft loans are also be leveraged to increase private participation in the market place
  - Lower cost debt can significantly improve the economics of RE projects

Soft Loans

- Soft loans can also offer longer tenor debt than would be available in the capital markets, or from private equity investors or banks

- However, if sustained over too long (e.g. > 5-10 years) private investors and banks may argue that public finance is ‘crowding out’ private finance.

Additional Risk Mitigation Instruments

Risks and PV Costs

International Energy Transition

Source: Couture and Jacobs (2018)

Price discovery mechanism:
FITs/Auctions

Contractual Factors:

Payment Duration, Off-taker, currency risk, inflation risk, exposure to market prices, etc.

Regulatory Factors:

Stable regulatory environment, Permitting, land access, streamlined administrative procedures, and grid access and connection

Market Factors:

Level of competition, size of targeted RE market, cost of capital, size of individual projects, economies of scale, etc.

Resource and Technology Factors:

Cost decline of RE components, a jurisdiction's resource quality, etc.

Risks and PV Costs: Regulatory factors

- Stable regulatory environment
- Streamlined permitting and administrative procedures
- Land access
- Grid interconnection procedures
- Other factor

Source: Couture and Jacobs (2018)

Risks and PV Costs: Market Factors

- Market size
- Project size
- Cost of capital
- Presence of a qualified workforce
- Presence of key supporting infrastructural

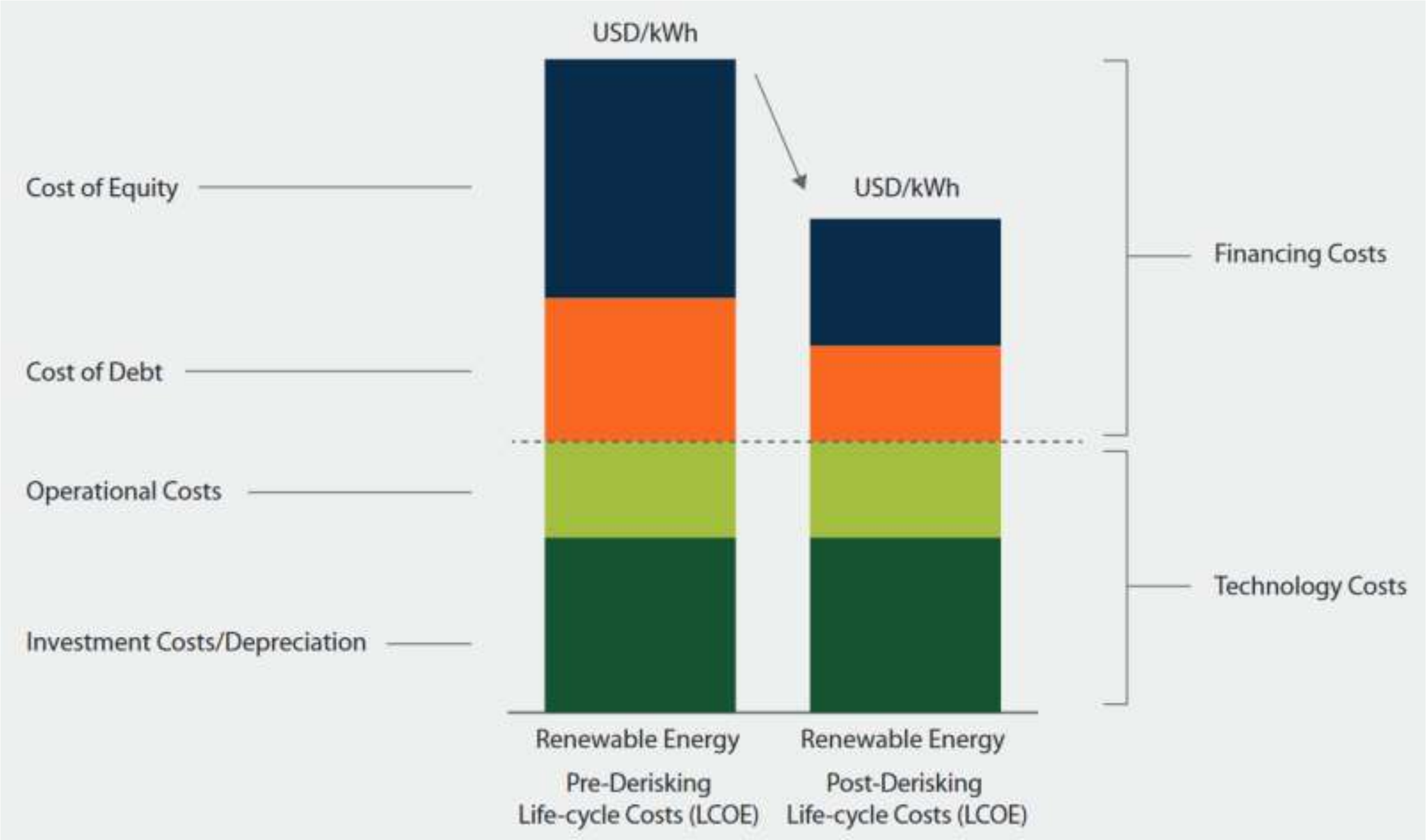
Source: Couture and Jacobs (2018)

Risks and PV Costs: Contractual Factors

- Solvent and reliable off-taker
- Contract duration
- Payment structure
- Inflation indexation
- Currency risk mitigation
- Dispatch and curtailment rule

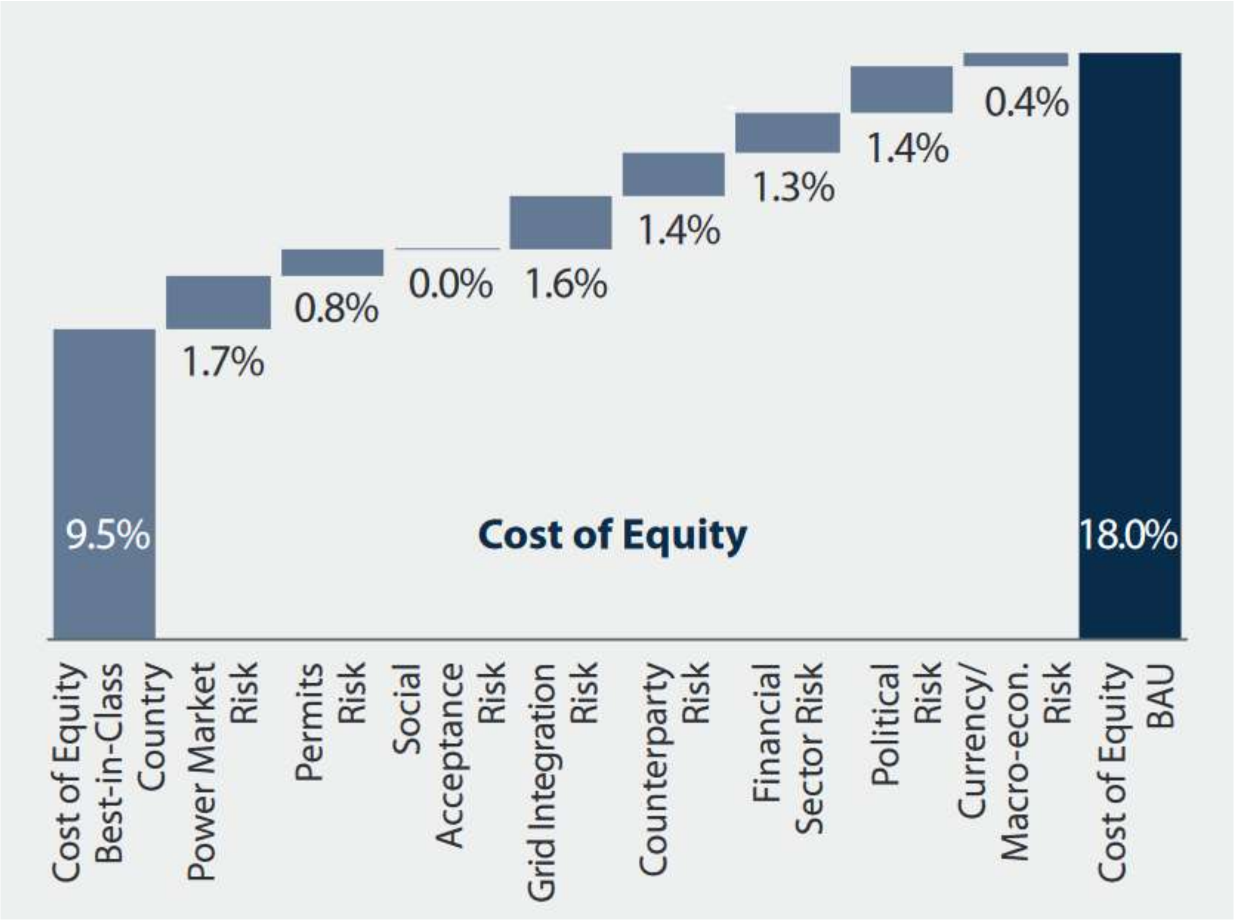
Source: Couture and Jacobs (2018)

Cost of Capital has a Signification Impact on LCOE



Source: Waissbein et al. (2013)

Risk and Impacts on Cost of Capital (Here: Equity in Kenya)



Source: Waissben et al. (2013)

Further Reading/List of References

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Thank you for your time!

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E3 ANALYTICS

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Factor Ideas for change

CLEAN ENERGY SOLUTIONS CENTER

ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

6. Knowledge Checkpoint: Multiple Choice Questions