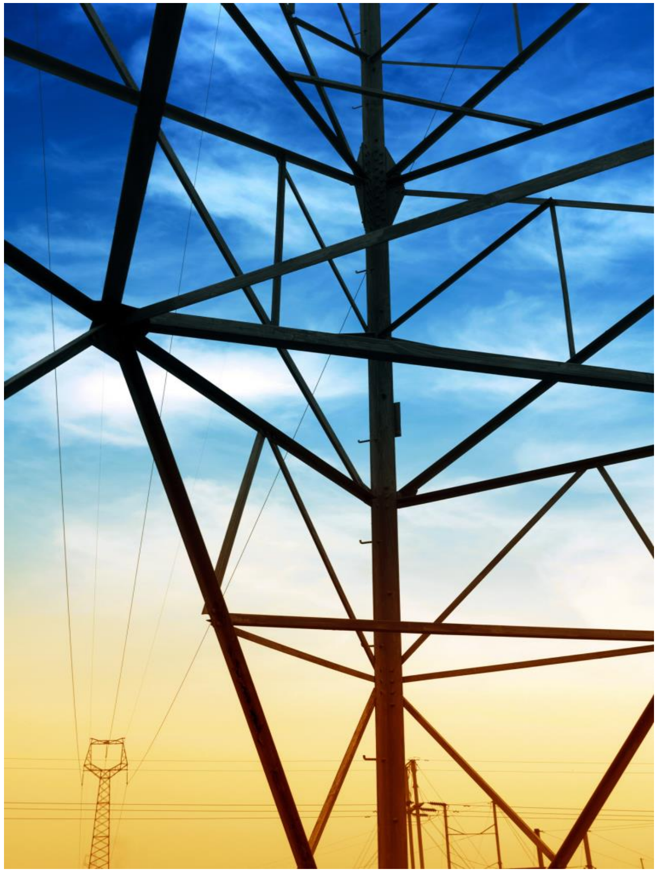

DSO Tariffs:
one size *does not* fit all?

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Paris January 2016

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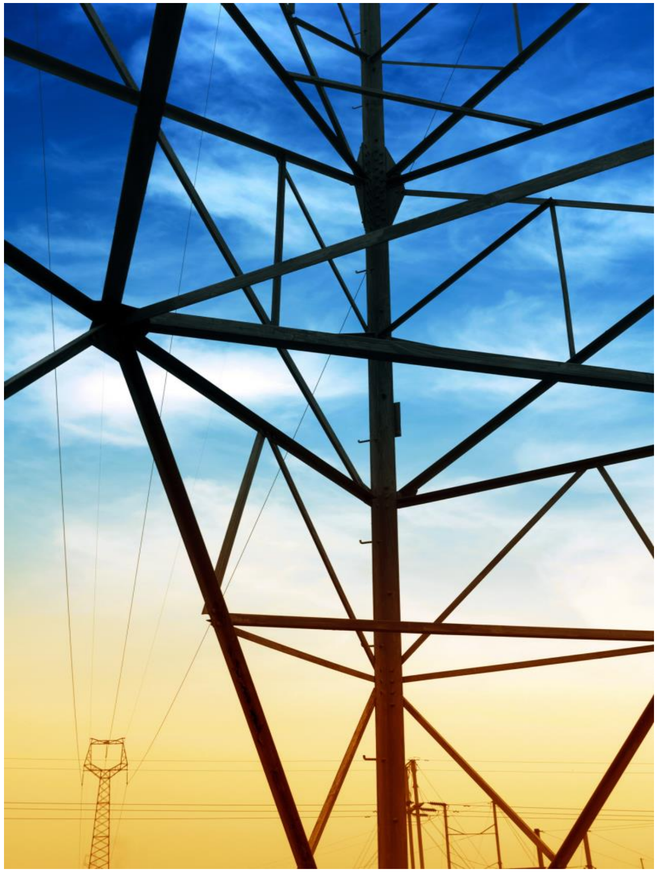
Outline

- From theory to practice: main implementation issues in DSO tariff design
  - A theoretical example of incentive for investments in PV with locational pricing
- « Case study » of the one size does not fit all: distributed generation and tariff design
- Concluding remarks



From theory to practice: main implementation issues in DSO tariff design

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DSO Tariffs

Context

- Traditionally the regulation of DSO activities has focused on the attainment of operational cost efficiency together with an adequate level of quality of services and coverage

- The additional objectives in the context of EU energy markets, climate policies and security of supply are: encouraging energy efficiency and the development of distributed generation; contributing to system flexibility and the well functioning of markets; allocating network costs along network users in an efficient manner; selecting the right sets of investments…

- According to the ACER-CEER “Bridge to 2025” vision, DSO must remain network facilitators, while being able to manage new tasks (congestion, counterflows, ancillary service management)

DSO Tariffs

Theory: natural monopoly

- According to the economic theory, marginal cost based pricing maximises the social welfare also in networks, despite them being considered natural monopolies. The "first best optimum" of any distribution or transmission company), from the social welfare point of view, is setting the price (tariff) equal to the marginal costs.

- However, if prices are equal to marginal costs, revenues of a producer fall short of total costs implicating financial losses.

DSO Tariffs

Theoretical Solutions

- Ramsey-pricing: maximises the total surplus of producers and consumers *subject to the breakeven constraint*

- *Optimal two-part tariffs:* usage charge equal to the regulated firm's marginal costs and a fixed entry fee at a level sufficient to cover the firm's total costs

- *Fully distributed costs:* allocate common costs according to a predefined criterion
  - *Axiomatic criteria can also be used*

- So called *rolled-in pricing methods are currently widely used.* All costs related to transmission are summed up in a single number, and the sum of costs is allocated between different users according to a chosen criterion. Examples of this criterion include *postage stamp, contract path and Mwmile methodologies. (Krause 2003)*

- *Locational marginal pricing or nodal pricing* can be used (Sotkiewicz & Vignolo (2005)

Locational pricing vs time ageraged consumption: incentives in PV investment

- Let us suppose the the local consumtion tariff is Pb; the production of the PV installation is a random variable δ and the local nodal price is P (a random variable too); the variable cost of PV production is zero

- The local nodal price is above zero, so it is efficient to produce as much solar output is possible $Pb = -$

- If the consumers installs a capacity K of solar generation at a fixed cost F:
  - its expected profit under time-averaged pricing is

$$PbE(\delta)K\text{-}F$$

  - its expected profit under nodalpricing is

$$E(\delta P)K\text{-}F$$

Locational pricing vs time ageraged consumption: incentives in PV investment

- Efficient investment incentives requires the local consumption tariff equal to a weighted-average nodal price, with the weights determined by solar output:

$$Pb=E(\delta P)/E(\delta)$$

- If the total solar production is very small and/or uncorrelated with the local nodal price, the local consumtion tariff is equal to the average local nodal price and will provide efficient incentives

- If solar generation is negatively correlated with nodal price of time-averaged consumtion tariff is above the local nodal prices, over-incentive in PV investment evenf without feed in tariffs

DSO Tariff design

- A variety of option is available in implementing tariffs. These options includes for example:
  - Time resolution
  - Division of tariff between fixed and varying parts
  - Tariff differentiation between customer types or companies
  - The cost basis of tariffs and innovation
  - Regulation model

DSO tariffs
Components to mix-and-match

Different tariffs configuration depend on the combination of several elements

Geography	Time-of-use	Fixed and variable elements	Payment liability	Type of service	Type of customer
Uniform charges	*Peak load pricing*	*Energy, demand charge*	*Generation - load split*	*Charges for connection, network, meter etc.*	*Household, commercial, industrial*
Locational charge		*Two-/multi-part tariffs*			
Voltage level					

Adapted from Petrov and Keller (2009)

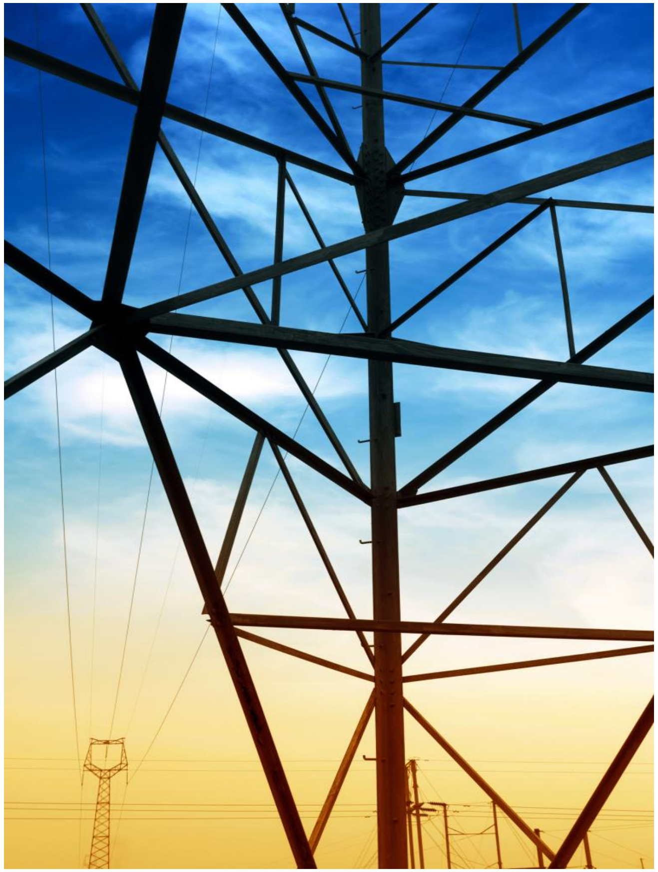
DSO Tariffs Design

- The combination of these elements depends on three main principles:
  - System sustainability
  - Economic Efficiency
  - Protection principles
- Trade-offs:
  - Cost reflectivity vs simplicity and/or stability
  - Allocative efficiency vs cost recovery
  - Ramsey principles vs non –discrimination

Rodriquez Ortega et al. (2008) : "*the fulfillment of all these principles may be quite complex, as some conflicts may arise: equity may limit efficiency, which cannot be achieved easily. Even if there were no conflicts, some steps of the tariff design methodology are very complex— especially, allocating network cost between all the customers.*"

DSO Tariffs

- Synergies:
  - Economic efficiency and innovation promotion.
    - Example: while within an incentive-based system DSOs get to keep all the savings from cost reductions, the regulatory framework can also include additional elements that recognize the different risk profile and cost drivers of innovative technologies and operating procedures in order to stimulate their deployment by DSOs.
  - Intertwined nature of the productive efficiency, allocative efficiency and cost causality principles
    - Example: substitution effect of OPEX and CAPEX and the coordination between them. The ‘deferred investment value’ of distributed generation can be defined as the value of postponing the need to reinforce the system in case of load growth or reducing the investment required in case of equipment replacement.



DSO tariff design and distributed generation

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Distributed generation/tariffs

- The heterogeneity of DSO governance and tariffs across European countries, renewable integration share and support schemes do not ease a coherent transformation

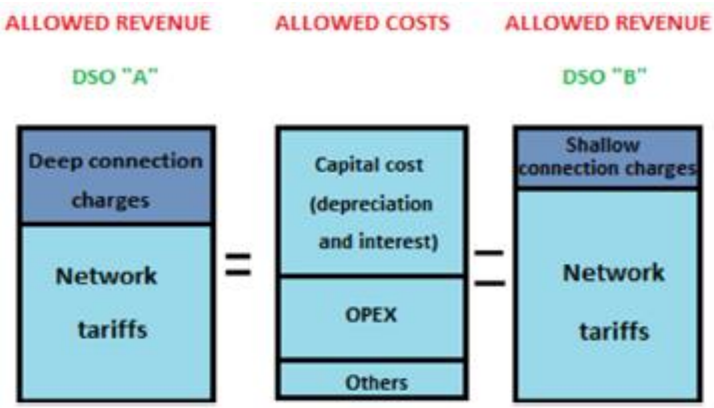
Examples of connection and grid access for DG

Country	Connection method			Use of system charges		Connection to the grid		Use of grid	
	deep	shallowish	shallow	Yes	No	Priority	Non-discriminatory	Priority	Non-discriminatory
Germany			X		X	X		X	
Denmark			X		X		X	X	
Sweden	X			X			X		X

Source: Anaya, K. L., & Pollitt, M. G. (2015). Integrating Distributed Generation: Regulation and Trends in three leading countries. *Energy Policy*.

Deep and Shallow

- Connection charges are defined
  - "deep" when they cover both consumer specific costs and part of the cost of infrastructures shared among multiple network users.
  - "shallow" when they cover only (and sometimes not entirely) the cost of infrastructures that are not shared among multiple network users



Who pays for DG connection?

- According to the Anaya and Pollitt (2015), there is a lot of socialisation of connection costs, especially in Germany and Denmark
  - the shallow approach is the connection methodology and the grid operator or DSO is obligated to reinforce the network and transfer the related costs to demand customers, with an increase of electricity cost for consumers

- In terms of subsidies, again Denmark and Germany are the ones with the most sophisticated methodologies.
  - However, this sophistication remains in the subsidies and it is not evident in the business model for the connection of more DG in a cost and efficient way.

Tariffs and DG: different regimes

Overview of DG distribution tariffs in different countries (2011).

	DG share (% of total gross energy production)	Any DG charge in place?	DG charge options	Net metering applied	Proposals in the pipeline
Germany	19.9%	No	Remuneration for avoided charges at higher voltage levels	No	–
Spain	21.2%	Yes	Flat tariff (0.5 €/MWh)	No	Convenience fee
UK	6.9%	Yes	CDCM applied	No	–
Portugal	21.7%	Yes	Only for DG on HV and MV	No (ongoing discussion)	Net injections remuneration
Italy	16.1%	No	Only conventional loss factors applied to DG energy	Yes	DUoS charges for prosumers
Norway	0.3%	Yes	DG coverage of gerenration-specific network assets	No	–
Sweden	10.7%	Yes	Tariff for units > 1500 kW only	No	–
Arizona	0.4%	No	Fees only for industrial customers	Yes	Bill credit
Texas	8.3%	No	–	Yes	VOST

Source: Picciariello, A., Reneses, J., Frias, P., & Söder, L. (2015) *Electric Power Systems Research*, *119*, 370-376.

Note: CDCM Common Distribution Connection Methodology: fully distributed costs; DUoS: distribution of use of System

Tariff design

- Transparent and cost-reflective network tariffs facilitate appropriate network investments
- Regulation drives cost reductions, but must also take innovation into account (e.g. *more ICT – less copper)*

Open questions

- Complexity issues for retail competition: Time of Use (ToU) pricing can be used to reflect the value of energy consumed at different times more accurately: ToU dependency for only energy prices or also for distribution tariffs?

- How to recover DSOs costs with energy-based tariffs in a world with a different balance in distributed energy (*prosumers, net metering, energy efficiency)?*

DG and tariffs: tackling open questions

- General tariff structure
  - Fixed charge (€/period)
  - Volumetric charge (€/kWh/period)
  - Capacity charge (€/kW/period)

- New costs arising from DG integration
  - Initial network investments
  - Changes in operation and maintenance costs
  - Changes in the long term network planning

- ***Main DG related challenges***

  - DG exemption from distribution tariffs
  - Load- tailored schemes applied to DG (e.g. combination of net metering and volumetric tariffs)

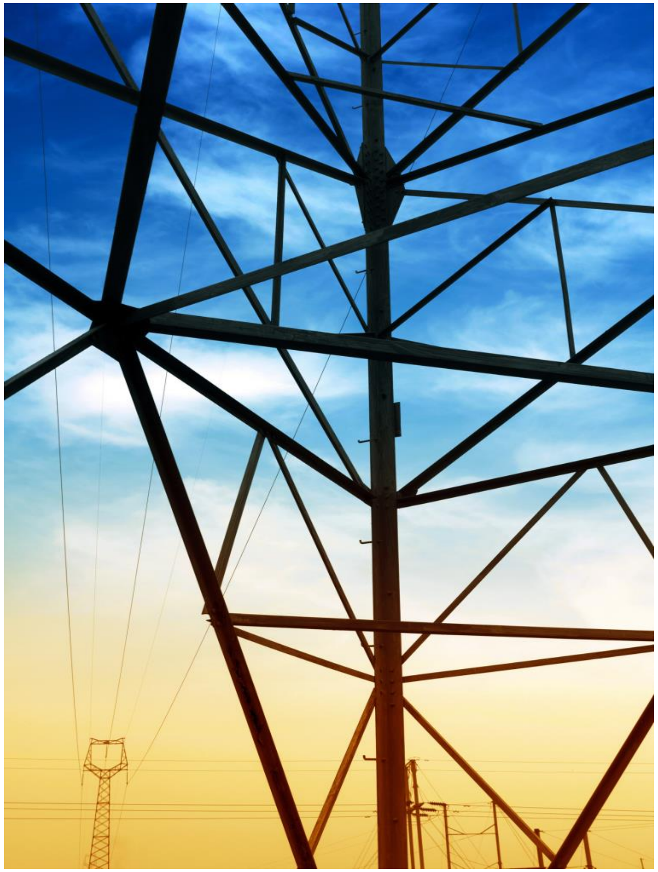
Tariffs and DG: towards new tariff principles?

- Depending on the DG penetration and concentration levels, network characteristics and dynamics of the distribution networks, the type of network management and DG generation technology/profile.

- An increasingly urgent question is: who is going to pay for those additional DG-driven costs/benefits?

- One of the risks that exists is the cross-subsidization of some consumers, especially with increasing DG penetration

- Several case studies/simulations show that
  - on one hand, when net metering is adopted and volumetric tariffs utilized, cross subsidization of customers with self generation by the customers without it is likely to arise;
  - on the other hand, separate volumetric tariffs to be applied to producers and consumers allocated network costs on a cost-causality basis and, in this way, neutralize such risk for cross subsidization.



Concluding remarks

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Concluding remarks

- Increasing complexity in tariff design
  - Increasing differentiation?

- Need to define clear business and regulation models
  - Need of benchmarking