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Regulatory improvements needed for increasing DER integration

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Outline of the presentation

- DER Objectives
- DER support mechanisms
  - DER costs and benefits
  - Support of DER in the EU MS (FIT & TGC)
  - Recommendations to improve DER support
- Smart grids
- DER network regulation
  - DER perspective
    - DER connection to the network
    - Network access
  - DSO perspective
    - DSO regulation
    - Incremental OPEX and CAPEX
    - Impact on performance indicators
- Conclusions

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Objective

Market and system integration of **Distributed Generation (DG)** or more broadly, **Distributed Energy Resources (DER;** = DG+storage+demand response**)**

- for **OPTIMAL** (???) share of DER in distribution networks - would require internalisation of external costs/benefits in the incentive system (AND remove barriers)

- **Environmental** benefits (climate, various pollutions)
- **Electricity system** benefits and costs of DER
- Mostly identified, but hardly measured and actually priced

- or as **policy drives** it (policy given ratios, etc)

Smart Grids – definition

European Technology Platform SmartGrids definition:

Electricity networks that can intelligently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

A natural appeal of smart vs dumb

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Smart Grids – technical features

Digital communication overlay and integration into the electric power network. More ICT, monitoring, control and protection. Self healing.

- Digital switching networks
- Remote sensing and monitoring in wires and in transformers
- Fault detection
- Devices for automated fault repair
- Intelligent end-use devices in homes, stores, office buildings, garages, and factories

distributed intelligence in the systems, incl. both technical devices and human agents

Smart Grids - functionalities

Technologies enable a variety of functionalities:

–• Transactive coordination of the system (many of the following functionalities contribute to this coordination)

–• Distributed resource interconnection, including renewable generation

–• The ability of a resource/agent to be either a producer or consumer of electricity, or both

–• Demand response to dynamic pricing

–• The ability of an agent to program end-use devices to respond autonomously to price signals

–• Distribution system automation by the wires company, leading to better service reliability

If also **good smart grid regulatory policy** added**:**

Not only an engineering, but a transactive network! (Lowers transaction costs – opens enormous perspectives)

Transition

- Integrating RES is not the only driving force

- Gradual or radical?
  - High fixed cost assets. Inertia – path dependency for a completely different lay out
  - But not necessarily completely new or more grid - smartness can be an added on
  - Also stochastic planning w regards to high penetration of DER

- Much innovation needed
  - innovative technical, regulatory, business solutions (aggregators!, virtual power plants of many DER)
  - Evolution of costs? Efficiency?

DER Research projects

- **RESPOND**: EU SPONSORED research project on dealing with intermittency - http://www.respond-project.eu/
- Includes links to further DER projects
- **SOLID-DER** http://www.solid-der.org
- **TradeWind**
- **SUSPLAN**
- **IRED**
- "Integration of Renewable Energy Sources and Distributed Generation into the European Electricity Grid" is a large European Cluster of RTD **Fenix**
- The objective of FENIX is to boost DER (Distributed Energy Resources) by maximizing their contribution to the electric power system, through aggregation into Large Scale Virtual Power Plants (LSVPP) and decentralized management.
- **EU-DEEP**
- Since January 2004, the R&D teams of eight European energy utilities have joined to develop transparent and efficient business models that will enable, from 2010 on, the operation of various types of Distributed Energy Resources (DER).
- **IMPROGRES**
- IMPROGRES - Improvement of the Social Optimal Outcome of Market Integration of DG/RES in European Electricity Markets
- **DG-Grid**
- Enhancement of Sustainable Electricity Supply through Improvements of the Regulatory Framework of the Distribution Network for Distributed Generatio.
- **DISPOWER**
- Contribution to the further development of technology as well as to the European exchange of experience in the field of integrating small and distributed generators into the electricity distribution grid.
- **GreenNet-Europe**
- A variety of different outputs: simulation software tools, empirical data bases, policy recommendations.
- **Green-X**
- The core objective of this project is to facilitate a significantly increased electricity generation from renewable energy sources (RES-E) in a liberalised electricity market with minimal costs.
- **WILMAR**
- WILMAR (Wind Power Integration in Liberalised Electricity Markets)

Main Policy Drivers

Greenhouse gas emission reduction

•**EU Kyoto target**: -8% reduction in 2008-2012 compared to 1990 emissions

•CO_2 emission reduction in 2020: -20%(or even 30% pending post-Kyoto outcome)

Renewable electricity

•2010 EU target: 21% electricity demand in EU from renewable sources

•**2020 EU target**: share of **RES 30-50% in electricity** and 20%in total primary energy supply

Energy efficiency

•EU directive for **Combined Heat and Power**(CHP)

•EU Action Plan for Energy efficiency: 20%energy saving by 2020 compared to baseline

Enhancing supply security/reducing fossil fuel dependency

Push: Support Schemes in Member States

But interaction with status and regulation of the electricity market and the grid!

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Support of DER: different perspectives & barriers

	Perspective	Current experiences and situation
DER Investor	-(Long-term) **stable environment** **-Clear and transparent** rules	-Frequently changing policies **-Long & complicated** procedures **-Discriminatory prices** **-Dominant position** of DSOs
Network operator DSO	-Possibility to operate the network **reliably and cost-efficiently** -Willingness/possibility of DER to **contribute to network management**	-**Obligation** to connect DER -DER is currently **not contributing** to stability, management -**High cost to connect** remote DER
Society	-Reach a **sustainable** energy system at low costs -"Socially acceptable" energy prices	-**Climate action and energy package of the EC**: 20%, 20%, 20% by 2020 -**Green Paper** on a European Strategy for Sustainable, Competitive, and Secure Energy (2006) -**Priority interconnection** Plan (2007)

SOLID-DER Project Objectives

SOLID-DER **objectives** for enhancing the share of DER in distribution networks

- **Review the current state** network in EU-25, especially in NMS
- **Identify major topics** and constraints for improved network integration
- Propose specific **recommendations** for each topic to improve DER network integration

Proposed **approach**:

- **DER** perspective: Assess additional revenue possibilities for DER operators to further integration of DER
- **DSO** perspective: Assess additional possibilities to lower costs for DSOs in furthering DER

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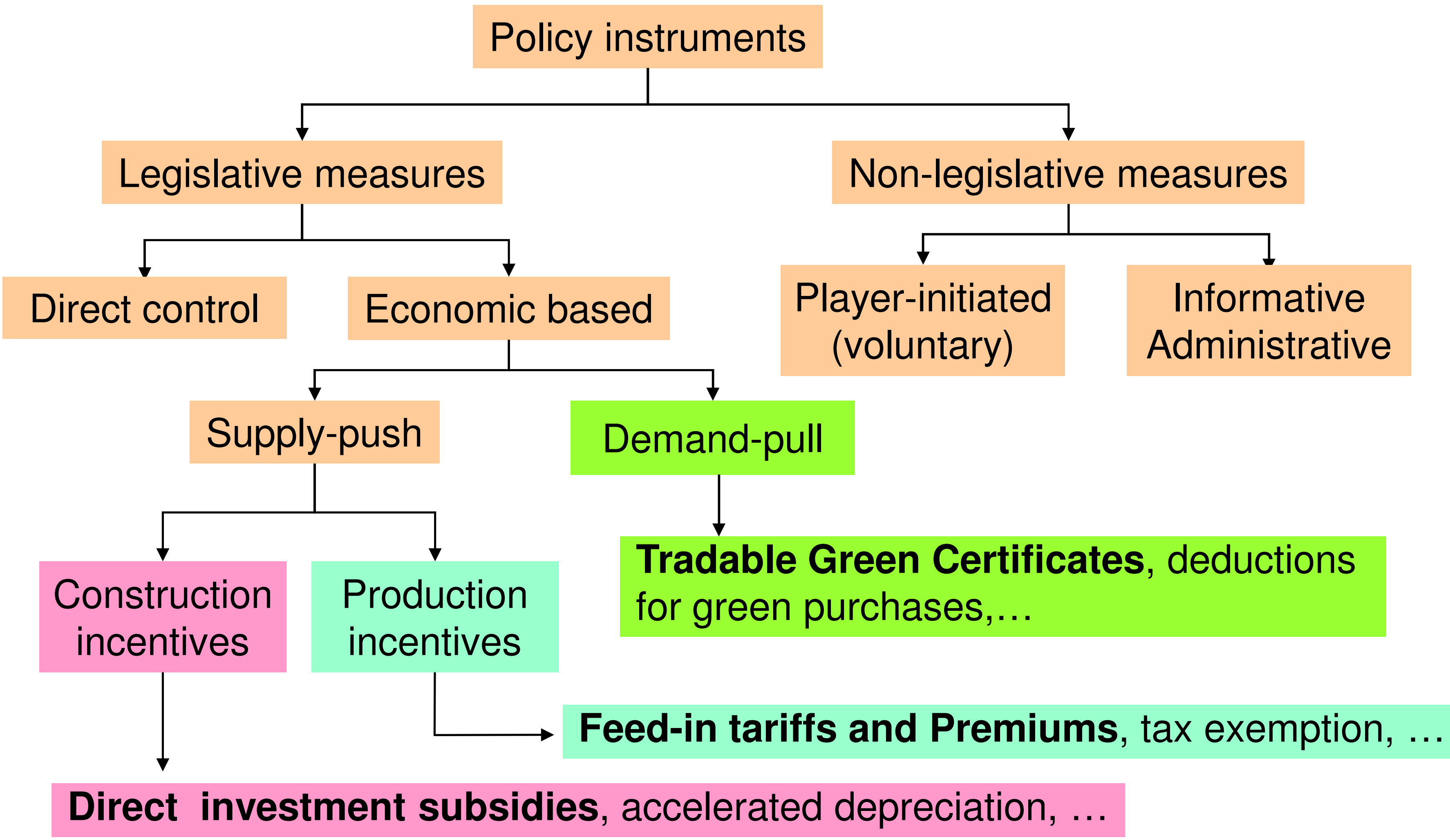
Support of DER: main schemes (Enzesberber, 2002)



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Support of DER: EU overview (2007)

Country	Support category	Level of support (€ct/kWh) – ex. solar	% of market price	Duration of support
Bulgaria	FIT	4 – 8.5	200 – 300	12 yrs
Czech Republic	FIT (fixed or premium)	6 – 10	200 – 300	15 yrs
Hungary	FIT	10.4	~ 200	Until return is yielded
Lithuania	FIT	5.8 – 7		Until 2020
Poland	TGC	Depending on market price	Up to 233	*No limit*
Romania	TGC	Minimum 2.4 – 4.2		*No limit*
Slovakia	FIT	6 - 10	100 – 350	12 yrs (not guaranteed)
Slovenia	FIT (fixed or premium)	6 - 9	140 – 200	10 yrs
Austria	FIT	5.5 - 14	130 – 300	10-13 years
Denmark	FIT (premium)	1.6 – 7 (wind) 5.4 – 8 (biomass)	115 – 160 140 – 180	20 yrs
Netherlands	FIT (premium)			12-15 yrs
Spain	FIT (fixed or premium)	7 - 12		15-20 yrs

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DER support schemes: main features of the FIT

Country	Support category	Differentiation per time of day	Other differentiation	Remarks
Bulgaria	Fixed tariff	No	Installed capacity, stepped tariffs for wind power	
Czech Republic	Fixed tariff or premium	For small-hydro and CHP	Possible to choose between green bonus and premium every year	- Mandatory reporting of exp. production for DER – except wind & solar) -Loss reduction rewarded
Hungary	Fixed tariff	Yes, except for wind and solar	Not technology-specific, but IRR specific	Tendering system for wind energy (from 2009)
Lithuania	Fixed tariff	No		
Slovakia	Fixed tariff	No		Support should cover payback of 12 yrs, but tariffs not guaranteed
Slovenia	Fixed tariff or premium	No		
Austria	Fixed tariff	No, but considered		
Denmark	**Premium**	No, but considered	Fixed tariff for old wind turbines	Compensation to wind turbines for their balancing costs
Netherlands	**Premium**	No		All producers responsible for day-ahead projections
Spain	Fixed tariff or premium	Yes, for RES-based CHP		DER units above 10 MW to be part of generation control centre

Elements of an optimal FIT scheme

- No distortion from the point of the market
  - DER production at peak hours should be stimulated
  - Match between supply and demand facilitated through premiums
- From the point of view of the network – little interference as possible or support to network management
  - Recommend to differentiate feed-in tariffs by time of use (e.g. Hungary, Slovenia)
  - Or use market price + FIT premium system
  - Gaining support combined with mandatory reporting of expected power
  - Balancing costs – extent imposed? within or outside the FIT scheme?
- Creating stable investment environment:
  - Being stable for a number of years or having a fixed regression rate
  - Making investments attractive (e.g. return period 10-15 years)
- Support is a costly option, so *overcompensation* should be avoided
  - Annual reduction for new plants (tariff reduction due to learning process)
- Stepped tariffs
  - (e.g. wind – lower tariffs after 2000 full load hours)
  - Or lower tariffs after 5/10 years

Elements of an optimal RPOS scheme (with TGC)

- Requires transparent, liquid electricity market and TGC market
- Determine a long-term quota tariff
  - Creates stability in the system (example of UK vs. Sweden)
- Maximum limits for the certificate price
  - Prevents making the system too costly (but: underperformance)
- Keeping the penalty above the maximum price
  - E.g. in Sweden 50% above the market price
- Minimum limits for the certificate price
  - Creating stability on the market
- Technology specific quota obligation
  - E.g. possibility to introduce quota for one type of RES or CHP and feed-in tariffs for the other
  - Older power plants can participate, but under other conditions
- Experiences with RPS scheme (e.g. Poland, Sweden) show:
  - Increase of renewable electricity shares, but focused at cheapest options
  - Little support of new technologies

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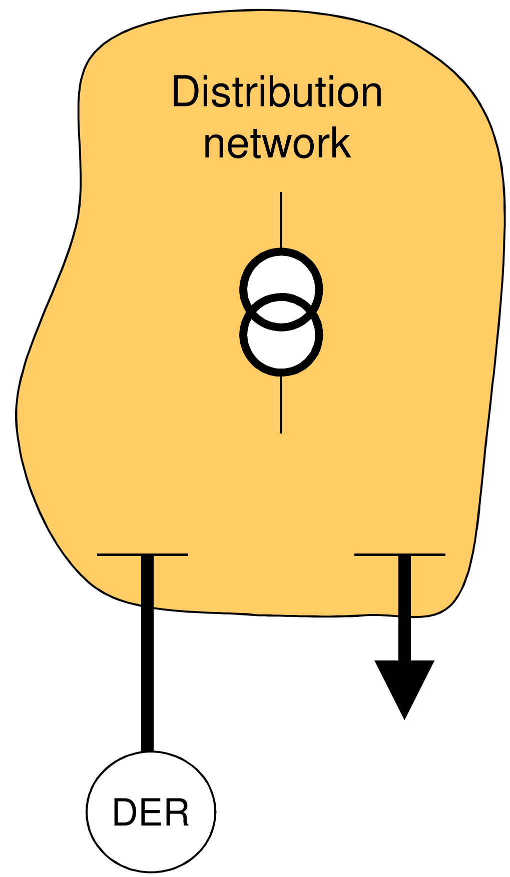
DER connection to the network

- Customers (DER or demand) must pay for the connection and use of the networks
  - **Connection charges**
    - **Shallow** connection charges: cost to the nearest point
    - **Deep** connection charges: shallow + additional network reinforcements
  - **Use of system charges** (DSO's allowed revenues)
    - Customer management costs (€/customer)
    - Capacity cost (€/kW)
    - Energy costs (€/kWh)
- **The design of UoS & connection charges**: key issue to ensure fair and non-discriminatory network access



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DER network access, connection charges: country questionnaire & recommendations

Connection charges for DER	Countries	Structure of connection charges	Guidelines
Deep charges	**Czech Republic, Slovakia, Romania, Lithuania** Spain, The Netherlands (>10MVA)	Rules for calculation are set, but charges are subjected to DSOs or TSOs intervention	**Implement shallow charges (?)**
Shallow charges	**Slovenia, Bulgaria, Poland, Hungary** The Netherlands (<10MVA), Austria, Germany, Denmark	-Rules exist, but total amount depends on DSOs calculations -Connection charges are published in The Netherlands and Denmark	**Evolve to regulated charges**

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DER network access, UoS charges: country questionnaire & recommendations

UoS charges for DER	Countries	Structure of UoS charges	Guidelines
No	**Czech Republic, Slovenia, Bulgaria, Poland, Lithuania, Hungary** Denmark, Germany and Spain		**Implement UoS charging mechanisms.**
Yes	**Slovakia** Austria, The Netherlands	Uniform charges	**Structure UoS charges, according to voltage levels, DER size, time of use and location**
	Romania	Differentiated by voltage level and area	**-Implement time of use and DER size differentiation** **-Evaluate the efficiency of this cost mechanism**

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DER network access: unbundling

- Legal unbundling is required.
  - Lack of unbundling at the distribution level may negatively impact independent DER access conditions & cross-subsidies may appear
  - Unbundling might negatively impact DER as an alternative to distribution capacity investment (under improper DSO framwork regulation)
- DER owned by DSOs (in some countries not allowed)
  - may negatively impact independent DER access conditions & cross-subsidies may appear

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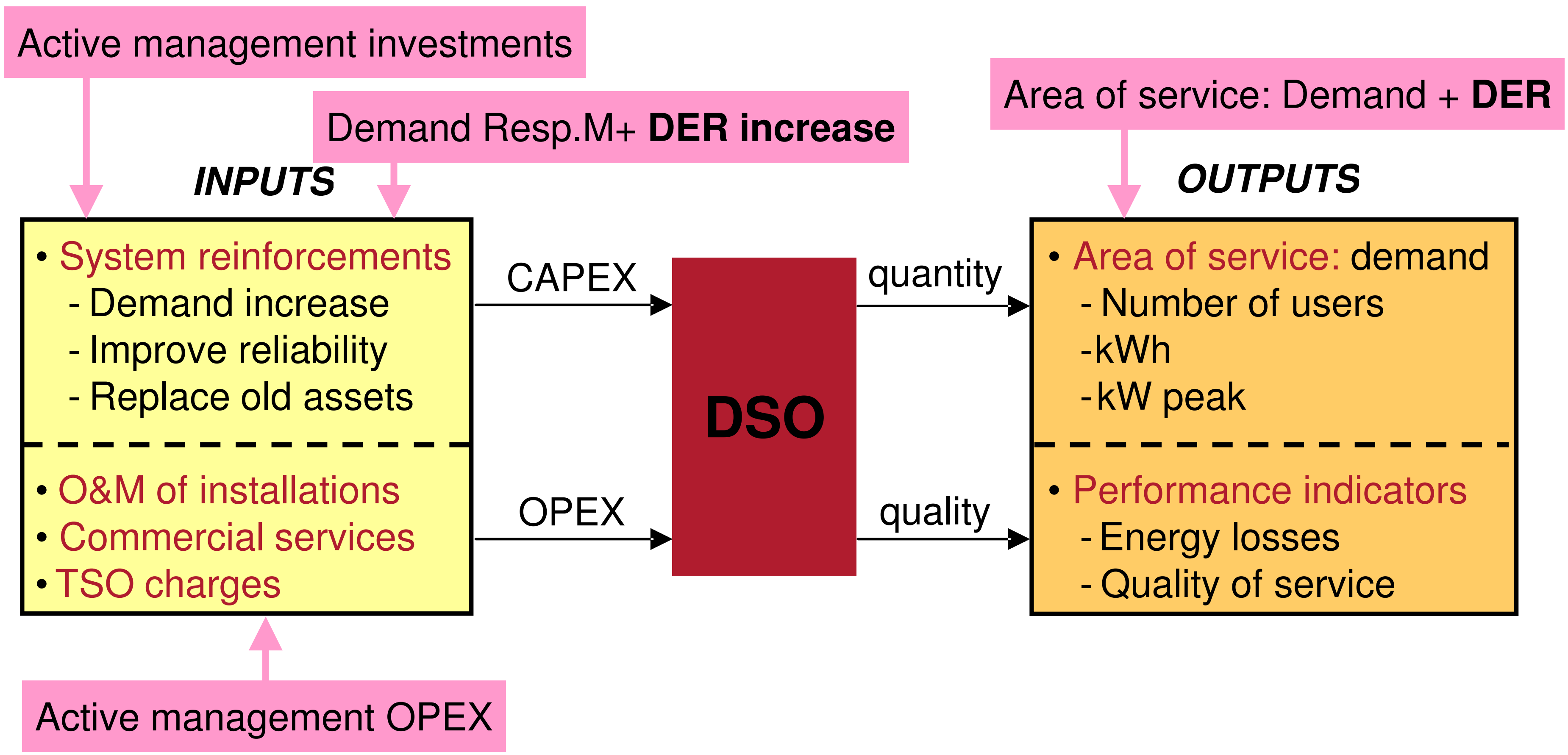
DSO regulation

- DSO is a **regulated** wire business
- Nowadays based on **passive** network management



Impact of DER on DSO regulatory model

- **DSOs remuneration** based on incentive regulation
  - costs, performance, efficiency improvement factor
- Impact of DER on DSO **capital expenditures**
  - Short term: new network reinforcements, equipment
  - Depends on voltage level and production at peak load.

- Impact of DER on DSO **operational expenditures**
  - Increase transaction and data management costs
  - Higher complexity of network operation – bi-directional flows?
  - With active management of the network the purchase of ancillary services from the TSO can be reduced (reactive power with DER)
- Impact of DER on DSO **performance indicators**
  - Energy losses: depends on the penetration level
  - Quality of service: i.e. islanding operation, voltage control,…
- TSO can include DER in ancillary (mainly tertiary reserves) services …

Compensating DSOs for CAPEX & OPEX increase (2007)

- DER impact on DSOs depending on the level of penetration
- For levels > c. 20% → neutralize negative impact
- Revenue cap vs price cap in the long term?

Type of regulation	Countries	Incremental OPEX and CAPEX due to DER	Guidelines
Cost of Service	Germany	**YES** No specific mechanisms	**Migrate to incentive regulation**
Incentive regulation: Price or revenue cap	**Poland, Romania, Slovakia, Slovenia** Denmark, Austria, Spain, The Netherlands (>10MVA)	**NO** Incremental CAPEX and OPEX are not considered	**Implement explicit mechanissms to take into account incremental costs due to DER**
Incentive regulation plus incremental CAPEX	**Lithuania, Bulgaria** The Netherlands (<10MVA)	**Only CAPEX** Investments necessary to connect DER not covered by connection charges are remunerated as any other CAPEX	**Include specific treatment of incremental OPEX**
Incentive regulation plus explicit mechanisms for OPEX and CAPEX	**Hungary, Czech Republic** Denmark	**YES** Incremental costs are remunerated after approval of the regulatoty authority	**Implement mechanisms that consider DER performance and give incentives for the connection of more DER**

Impact of DER on performance indicators: energy losses

- Energy losses are a main cost driver for DSOs due to DER connection & Depends on penetration levels
- Impact modulated with: UoS tariffs or revenue driver to DSOs
- (also reward DER for loss reduction)

Incentives for losses reduction	Countries	Guidelines
DSOs are compensated for **actual losses**. No incentives to reduce them	Austria, Germany	**Implement some kind of incentive for losses reduction**
An **upper limit** on compensated losses is established. DSOs have no incentives to reduce losses further	**Lithuania, Slovenia**	**-Give incentives to DSOs for reducing losses beyond the limit value** **-Take into account the influence of DER over energy losses**
DSOs have to compensate energy losses by **buying them in the market** Losses are regarded as a controllable cost	The Netherlands	**-Compensate DSOs for incremental losses due to DER** **-If losses reduce thanks to DER, these generators should benefit from that**
DSOs have **incentives** to reduce losses below specific **regulated targets**	**Czech Republic, Slovakia, Romania, Lithuania, Slovenia, Bulgaria, Poland, Hungary** Spain, Denmark	**Include the impact of DER on energy losses to compute the losses targets**

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Impact of DER on performance indicators: quality of service

- Quality of service consist of: i) continuity of supply, ii) voltage and power quality
- DER can improve DSO performance indicators by participating in different ancillary services -> Active network management
- Currently, DER mainly seen as a source of problems rather than an opportunity

Incentive/penalties to meet quality of service requirements	Countries	Guidelines
DSOs have no incentives or penalties	**Lithuania, Poland, Czech Republic** Austria, Germany	**Implement incentives for quality of service improvements**
Performance based regulation for quality of service	**Romania, Slovenia, Bulgaria, Hungary** Denmark, Spain, The Netherlands,	**Implement specific innovation actions to integrate DER as a control source to improve quality of service**
DSOs have non-regulated targets for quality of service	**Slovakia**	**Implement specific innovation actions to integrate DER as a control source to improve quality of service**

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DSO incentives for innovation

- Current regulation mostly lacks mechanisms to promote network innovation (main exception: UK, eg. Registered power zones – higher IRR allowed for higher tech risk)
- Innovation is becoming a need for the adequate system operation
- DSOs only invest in mature technologies → new incentives

Incentives for DSO innovation	Countries	Guidelines
No incentives	**Slovakia, Slovenia** Austria, Germany, Spain	**Implement incentives aimed at improving DSO performance**
Implicit incentives associated with incentive regulation	**Czech Republic, Romania, Bulgaria, Lithuania** Denmark, The Netherlands	**Critical review of current situation to asses wheter performance based regulation is enough to bring DSO innovation**
Explicit incentives	**Poland, (Hungary not in system regulation but innovation tax incentive)**	**Validate and tune current scheme**

MAKK Conclusions (i): DER support mechanisms

- **DER support** schemes, **network regulation** and **power market** (commodity and reserves) interact in penetration of DER
- **Support has created sufficient incentives** for investors in most EU MS (recently also NMS) so that modifying the system by market or network incentives has to be considered.
- For **feed-in tariffs** this can be done either through **differentiations** in feed-in price / premium: time-of-day, voltage level, location
- Or Optimizing DER integration through changes in **connection or UoS charges**
- For transparency, better to separate out RES/CHP incentives and power system incentives- rely on market responsive FIT (or TGC) schemes and include differentiated Generator UoS charges and rewards for avoiding losses etc
- **Tradable green certificates** create a market, so in principle, they give sufficient market signals – other signals may distort
- In this case, network signals should be given through **network tariffs**
- **Choice between TGC and FIT** often determined by other factors, e.g. willingness to support renewable technology industry

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Conclusions (ii): Network regulation

DER perspective:

- Connection charges should ensure fair and non-discriminatory network access
- G UoS charges should reflect real impact (costs/benefits) of DER on the Distribution Networks – but admin costs?
- DER should be allowed and incentivised to participate in the ancillary services market (e.g. via aggregators/virtual power plant of several DER)
- DSO unbundling may positively and negatively impact on DER
- International standardisation of connection device requirements

DSO perspective:

- Incremental costs in CAPEX & OPEX due to DER should be compensated to DSOs (investments, energy losses, higher complexity in operation, …) – but not without limits
- DER can help DSOs to improve their performance indicators (but also worsen)
- DSO remuneration schemes should introduce explicit incentives to network integration of DER
- From price cap to revenue cap?
- Implement innovation programs to introduce Active Network management

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Conclusions (iii): Network integration

- Most pan European regulations (both OMS & NMS) have broadly similar treatment of DER in the sense that there is much to do yet
- Some best practices have been reported
  - OMS: UK, Spain, Denmark etc.
  - NMS: Czech Republic, Poland, etc.
- Future increase of DER penetration in Distribution networks will require Electricity Regulators to introduce some of the proposed recommendations
- Innovative solutions are required on all three sides: DER business models, network business models and technology development and regulatory improvements

Thank you !

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