



ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)
INSTITUTO DE INVESTIGACIÓN TECNOLÓGICA

Overview of costs and benefits and regulatory improvements needed for more DER integration in EU

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- DER integration in Electricity Networks
- DER support policies
- Regulatory changes
 - DER perspective
 - Network access
 - Market access
 - DSO perspective
 - Incremental OPEX and CAPEX
 - Impact on performance indicators
- Conclusions

DER integration in Electricity Networks

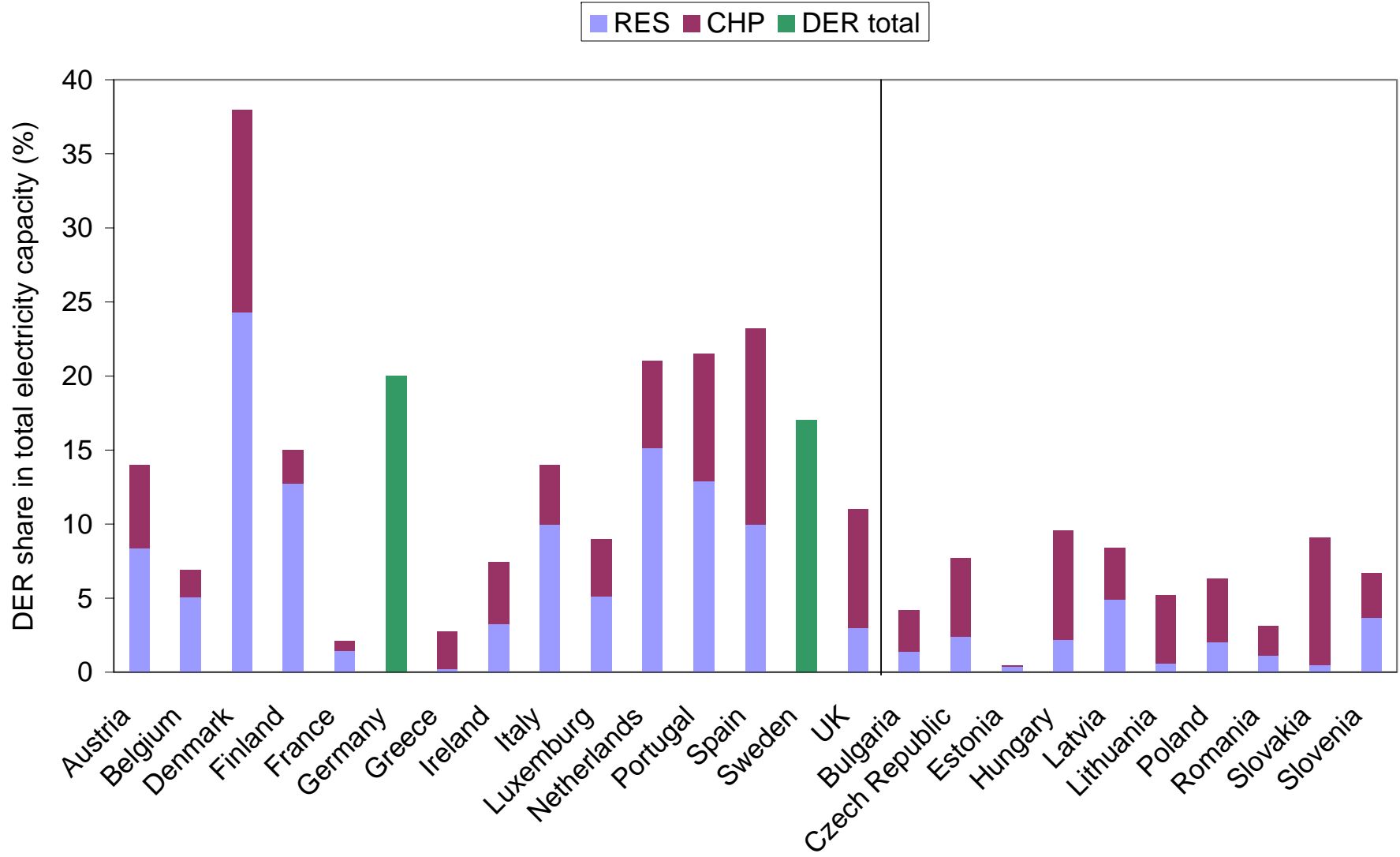
- Most RES and CHP are connected to distribution networks ➔ **DER**
- DER integration a **new challenge**:
 - Network ST< operation
 - DER impacts on DSO costs
- SOLID-DER **objectives** for enhancing the share of DER in distribution networks
 - **Review the current state** network in EU-25, especially in NMS
 - **Identify major topics** and constraints for DER integration
 - Propose specific **recommendations** for each topic



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DER share in EU



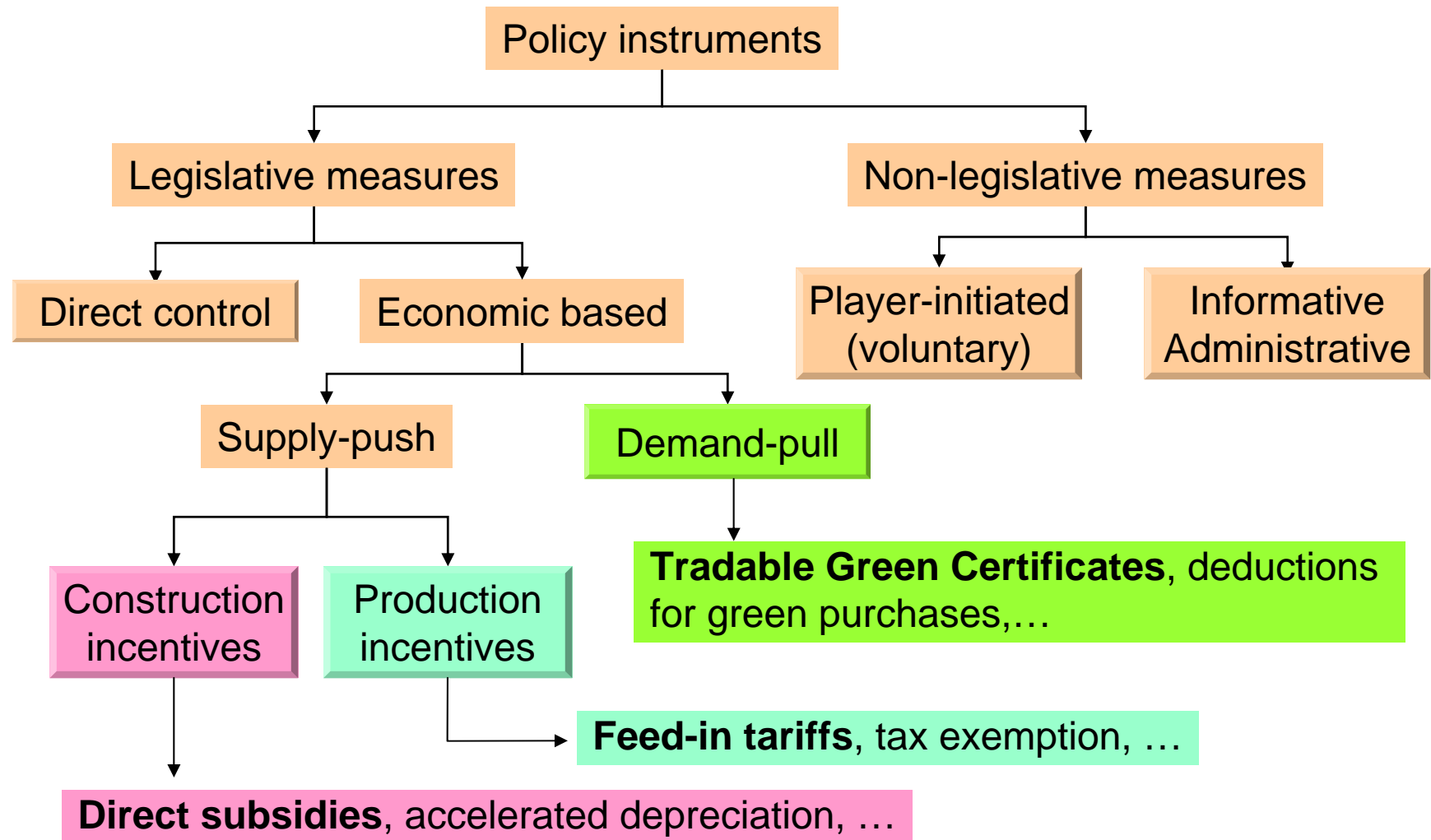
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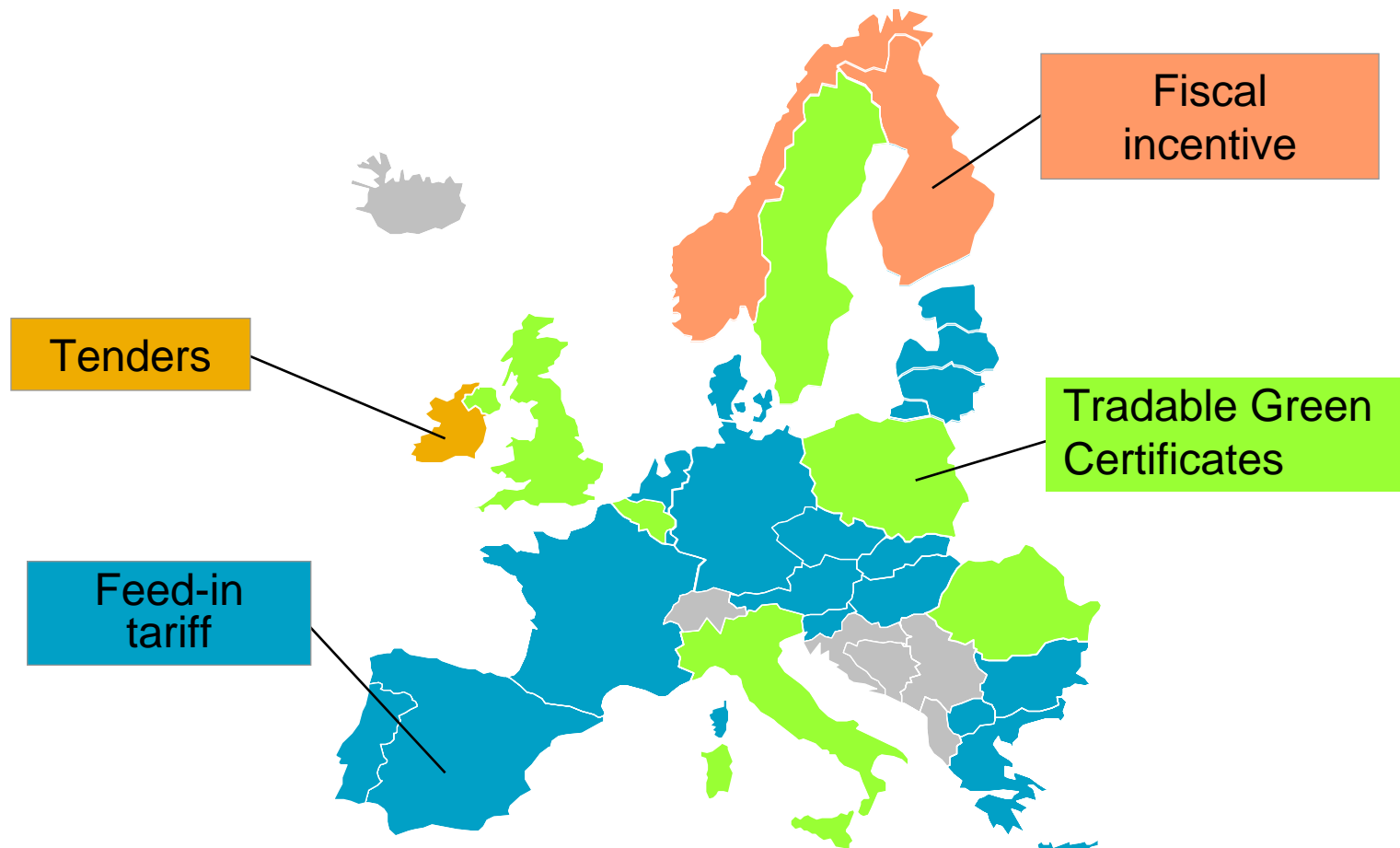
Support of DER: different perspectives & barriers

	Perspective	Current experiences and situation
Society	<ul style="list-style-type: none"> -Reach a sustainable energy system at as low costs -“Socially acceptable” energy prices 	<ul style="list-style-type: none"> -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)
Investor on DER	<ul style="list-style-type: none"> -(Long-term) stable environment -Clear and transparent rules 	<ul style="list-style-type: none"> -Frequently changing policies -Long & complicated procedures -Discriminatory prices (small) -Dominant position of DSOs
Network operator DSO	<ul style="list-style-type: none"> -Possibility to operate the network reliably and cost-efficiently -Willingness/possibility of DER to contribute to network management 	<ul style="list-style-type: none"> -Obligation to connect DER -DER is currently not contributing to stability, management -High cost to connect remote DER

Support of DER: main schemes (Enzesberber, 2002)



Support of DER: EU overview



Support of DER: EU overview

Country	Support category	Level of support (c€/kWh)*	% 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	<i>No limit</i>
Romania	TGC	Minimum 2.4 – 4.2		<i>No limit</i>
Slovakia	FIT	6 - 10	100 – 350	12 yrs*
Slovenia	FIT (fixed or premium)	6 - 9	140 – 200	10 yrs
Austria	FIT	5.5 - 14	130 – 300	10-13 yrs
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

DER support schemes: main features of the FIT

Country	Support category	Differentiation per time of day	Other differentiation
Bulgaria	Fixed tariff	No	Installed capacity, stepped tariffs for wind
Czech Republic	Fixed tariff or premium	Yes (small-hydro, CHP)	Choose green bonus and premium
Hungary	Fixed tariff	Yes* (no wind, solar)	IRR specific
Lithuania	Fixed tariff	No	-
Slovakia	Fixed tariff	No	-
Slovenia	Fixed tariff or premium	No	-
Austria	Fixed tariff	No	-
Denmark	Premium	No	Fixed tariff for old wind turbines
Netherlands	Premium	No	-
Spain	Fixed tariff or premium	Yes (CHP)	-

Elements of an optimal FIT scheme

- **Market** point of view: no distortion
 - DER production at **peak hours** should be stimulated
- **Network** point of view: little interference as possible or support to network management
 - Recommend to **differentiate feed-in tariffs** by time of use
 - Gaining support + mandatory reporting of expected power
- Creating **stable** investment environment
 - Being stable for a number of **years** or fixed regression rate
 - Making investments **attractive** (e.g. return period 10-15 years)
- **Overcompensation** should be avoided
 - Annual reduction for new plants & **Stepped** tariffs



Elements of an optimal RPS scheme (with TGC)

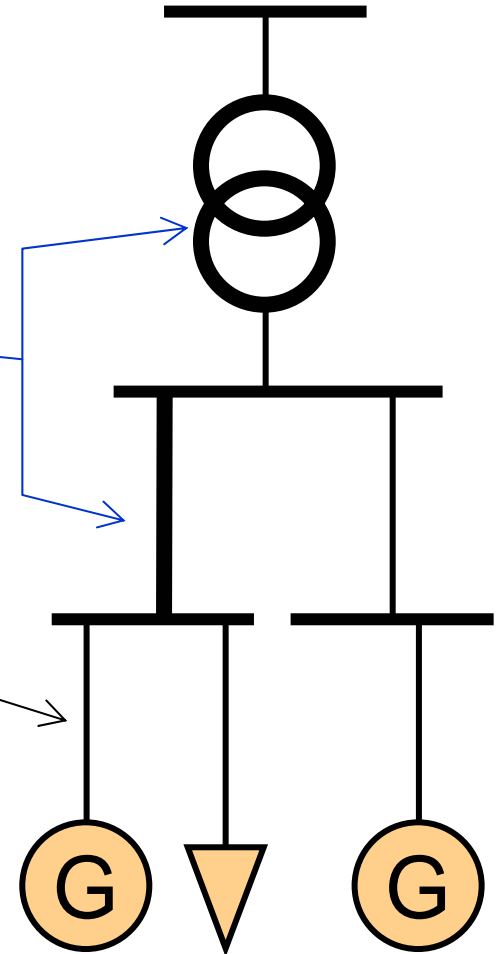
- Determine a long-term **quota tariff**
- Minimum & Maximum **limits** for the certificate price
- Keeping the **penalty** above the maximum price
- Technology specific quota obligation (**banding**)
- **Experiences** with RPS scheme (e.g. Poland, Sweden) show:
 - Increase of renewable electricity shares, but focused at cheapest options
 - Little support of new technologies

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DER network access

- 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



DER network access: connection charges

Connection charges DER	Countries	Structure of connection charges	Guidelines
Deep charges	Czech Republic, Slovakia, Romania, Lithuania Spain, The Netherlands*	Charges subjected to DSOs or TSOs intervention	Implement shallow charges
Shallow charges	Slovenia, Bulgaria, Poland, Hungary Austria, Germany	Total amount depends on DSOs calculations	Evolve to regulated charges
	The Netherlands*, Denmark	Published Charges	Evaluate

DER network access: use of system charges

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
Yes	Slovakia Austria, The Netherlands	Uniform charges	Structure of UoS charges: (1) voltage levels (2) DER size (3) time of use (4) location
	Romania	Dif. by voltage and location	

DER network access: unbundling

- **Directive 2003/54/EC:**

- Art 15 (1) **legal** unbundling required.

- Lack of unbundling at the distribution level may negatively impact DER access conditions & cross-subsidies may appear
- Lack of transparency

- **DER owned by DSOs**

- No conflicts have been found

- Art 15 (2) **exemption clause** for DSOs with <100.000 connections

- Assessed on a country basis rather than on a European level

DER network access: unbundling

Country	Unbundling situation	Can DSOs own DER?	Number of DSOs	DSOs with <100.000c
Czech Republic	Legal	No	3	None
Slovakia	Legal	Yes	3	0.5%c
Romania	Unbundled	No	8	None
Lithuania	Legal	If < 10000c	2	13%c
Slovenia	One public DSO	No	1	None
Bulgaria	Legal	No	-	0.1%c
Poland	Legal	Yes	14	1%c
Hungary	Legal	No	6	-
Spain	Functional	If < 10000c	308	3%c
The Netherlands	-Legal -Voluntary ownership unbundled*	No	11	3%c
Austria	Legal	Yes	138	119 (12%c)
Germany	Legal	Yes*	950	900
Denmark	Legal (to ownership)	If < 10000c	120	113 (43%c)

DER market access

- DER can **positively contribute** to network operation
 - Ancillary services (voltage support, islanding operation)
 - Balancing markets

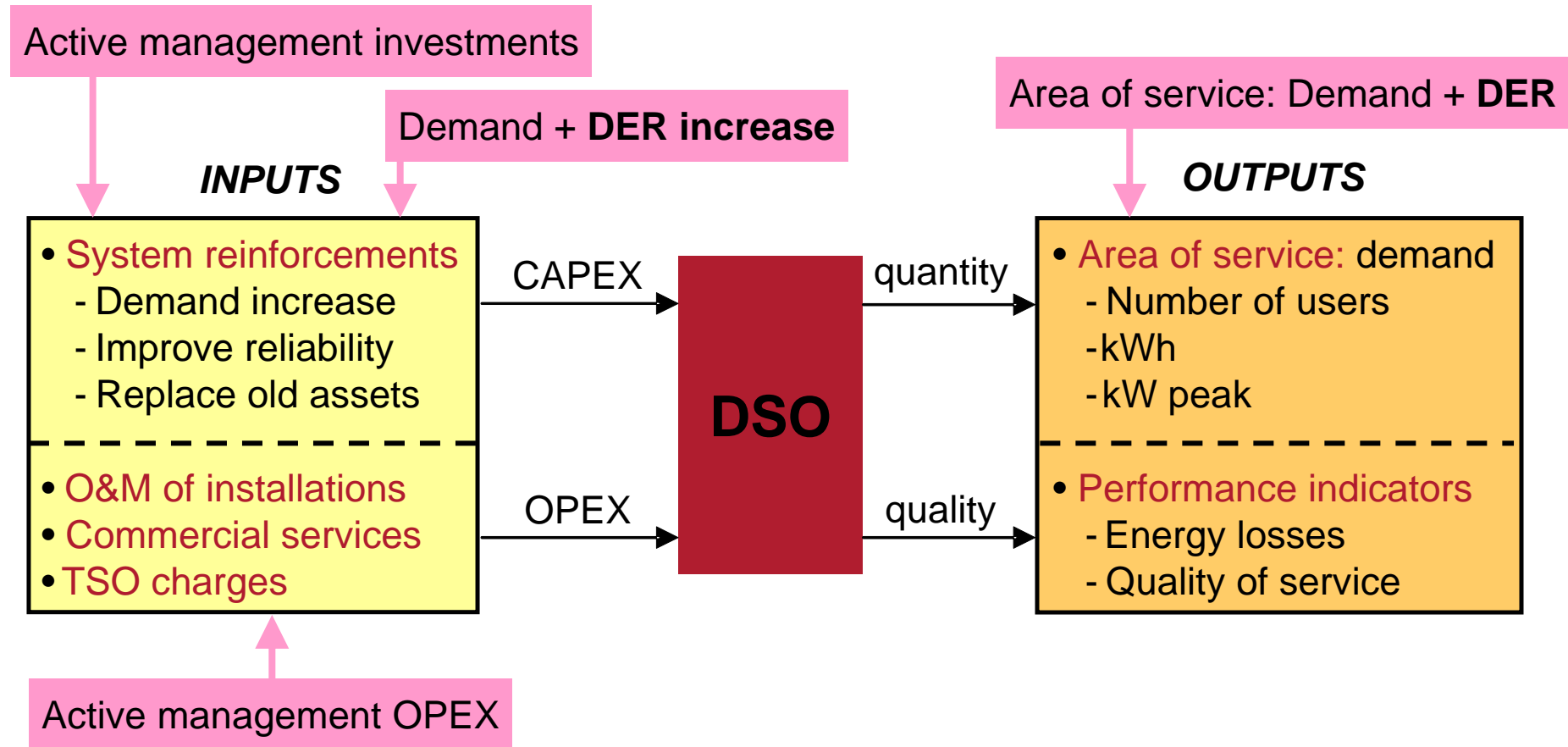
DER participation in AS	Countries	Services	Guidelines
NO	Lithuania, Poland, Bulgaria, Slovakia, Czech Republic Austria, Denmark	None	Include DG into AS
YES	Romania, Slovakia Germany, Netherlands, Spain, UK	Reactive power control, balancing market and reserves	Improve the contribution of DG to AS

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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

$$\updownarrow \text{Benefit}_t = \text{RAB}_t + \text{Quality_incentives} \uparrow - \text{OPEX} \updownarrow - \text{CAPEX} \updownarrow$$

$$\text{RAB}_t = (\text{RAB}_{t-1} + \text{Demand_increase}) \times (1 + \text{price_index})$$

– Impact of DER on DSO **capital expenditures**

- Short term: new network reinforcements, equipment
- Long term: production at peak load and permanence

– Impact of DER on DSO **operational expenditures**

- Increase transaction and data management costs
- Higher complexity of network operation
- Ancillary services can reduce OPEX

– Impact of DER on DSO **performance indicators**

- Energy losses: depends on the penetration level
- Quality of service: i.e. islanding operation, voltage control, ...

Compensating DSOs for CAPEX & OPEX

- DER impact depends on the **level of penetration**
- For levels > **20%** neutralize negative impact

Type of regulation	Countries	Incremental OPEX & 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, Netherlands*	NO	Explicit mechanisms to consider OPEX&CAPEX
	Lithuania, Bulgaria The Netherlands*	Incremental CAPEX considered	Consider OPEX
	Hungary, Czech Republic Denmark	Incremental CAPEX and OPEX considered	DER performance

Impact of DER on Pls: energy losses

- Energy losses are a main cost driver
- Depends on penetration levels
- Impact modulated with: UoS or revenue driver to DSOs

Incentives for losses reduction	Countries	Guidelines
Actual losses	Austria, Germany	Implement specific incentives
Upper limit	Lithuania, Slovenia	Incentives beyond the limit value
Buying losses at the market	The Netherlands	Compensate DSOs for incremental losses due to DER Share benefits with DER
Regulated targets	Czech Republic, Slovakia, Romania, Lithuania, Slovenia, Bulgaria, Poland, Hungary, Spain, Denmark	Compute targets including DER impact

Impact of DER on Pls: quality of service

- Quality of service i) continuity of supply, ii) voltage and power quality
- DER participation in AASS → Active networks

Incentive/penalties to meet quality of service	Countries	Guidelines
No	Lithuania, Poland, Czech Republic Austria, Germany	Implement incentives
Yes . Performance based regulation	Romania, Slovenia, Bulgaria, Hungary Denmark, Spain, Netherlands	Implement specific innovation actions
Yes . DSOs have non-regulated targets	Slovakia	Implement specific innovation actions

DSO incentives for innovation

- Current regulation lacks on mechanisms to promote network innovation
- Innovation is becoming a need
- DSOs only invest on mature technologies

Incentives for DSO innovation	Countries	Guidelines
No	Slovakia, Slovenia Austria, Germany, Spain	Implement incentives
Implicit	Czech Republic, Romania, Bulgaria, Lithuania Denmark, The Netherlands	Critical review of performance based regulation
Explicit	Poland, Hungary	Validate and tune current scheme



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Conclusions (i): DER support mechanisms

- **Support has created sufficient stability** for investors
- For **feed-in tariffs** this can be done through **differentiations** in feed-in price / premium: time-of-day, voltage level, location
 - Optimizing DER integration through support schemes or changes in **connection or UoS charges**
 - Give only **market-based signals** through feed-in tariffs?
- **Tradable green certificates** creates a market
 - Network signals should be given through the **network tariffs**
- **Choice between TGC and FIT** often determined by other factors, e.g. willingness to support renewable technology industry

Conclusions (ii): Network regulation

- **DER perspective:**

- **Connection charges** should ensure fair and non-discriminatory network access
- **UoS charges** should reflect real impact (costs/benefits)
- DER should be allowed to participate in the **ancillary services**
- **DSO unbundling** may negatively impact on DER network access

- **DSO perspective:**

- **Incremental costs** in CAPEX & OPEX due to DER should be compensated to DSOs
- DER can help DSOs to improve their **performance indicators**
- **DSO remuneration schemes** should introduce explicit incentives to network integration of consider DER
- Implement innovation programs to introduce **Active Network management**

Conclusions (iii): Network integration

- Most pan European regulations (both OMS & NMS) **have not developed specific mechanisms** to improve the integration of DER into networks
- Some **best practices** have been reported
 - OMS: UK, Denmark, Spain, 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



Co-ordination Action to consolidate RTD activities for large-scale integration of DER into the European electricity market



First Announcement and Invitation

Final International Conference SOLID-DER project

“Large scale integration of RES and DG into the European electricity supply for meeting the EU RES targets of 20% for 2020”

-An Overview of the progress in RTD, policy and stakeholders experiences for more DER integration in the EU-

**25 - 26 September 2008
Warsaw, Poland**

Thank you for your kind attention!



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