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Policy advice on low-carbon policies for Ukraine

Policy Briefing #5

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

Local curtailment charges for RES

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Implemented by

Berlin Economics

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Key Messages

1. The concentration of wind and solar power plants in high-yield regions will increase balancing needs and grid constraints

2. Most mechanisms to guide investors location selection, such as connection charges, are inflexible and leave room for discretionary power

3. We recommend introducing a transparently set curtailment charge mechanism for new RES installations

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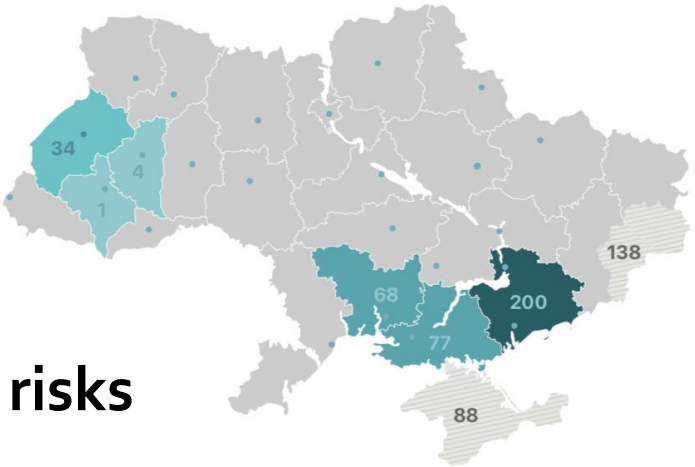
Motivation

- Without regulation, investors tend to choose the locations with the highest expected energy yields:
  - High wind speed
  - High solar radiation

Figure: Distribution of wind PP (in MW)



Source: Dixi (2018) Renewable energy in Ukraine

- This leads to a geographical concentration and hence **short-term risks** for the Ukrainian electricity system:
  - High utilization of grids in respective regions that may cause bottlenecks
  - Increasing balancing needs due to the regional correlation of energy yields

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Existing locational control methods face disadvantages

- Three types of locational control methods applied in other countries:
  - A) Locational differentiated network and/or connection charges
  - B) Regional RES development bans/limits
  - C) Regionally differentiated RES tariffs

- Potential disadvantages of these methods are:
  - Can give DSO/TSO/regulator substantial discretionary power, especially when calculated in an *ad hoc* non-transparent way
  - Risk of non-economic aspects dominating decisions

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We recommend alternative: Regional curtailment charges

- **Regional curtailment charges**
  - are based on a transparent & simple formula
  - are a penalty on the auctioning result in EUR / megawatt-hour
  - depend on actual curtailment losses in the respective region
- **Their price reflects the level of congestion at the time when a new installation is connected**
  - If the level of congestion changes, curtailment charges for **new** installations change but not for existing ones.
- **For simplification start with limited regional granularity (e.g. TSO regions or Oblasts)**
- **Revenues resulting from charges should be used for grid improvements**

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Regional curtailment charge: Formula for Wind

The curtailment charge (in EUR/MWh) for new installations is set depending on **curtailment losses** in the respective region based on the value of the previous year (in %) and the **latest auctioning results** (in EUR/MWh)

*curtailment charge = last year curtailment loss * latest auctioning result*

CC_t^r - curtailment charge in EUR/MWh, in year *t*, in region *r*

s_{t-1}^r - share of curtailment losses in regional wind generation, in previous year *t-1*, in region *r*

p_{t-1} - price base in EUR /MWh, in year *t-1;* latest auction result

$$CC_t^r = s_{t-1}^r \cdot p_{t-1}$$

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Regional curtailment charge: Example for Wind

- High wind yield in **region A** => low generation cost (46 EUR/MWh) => high deployment of wind generators
- This concentration resulted in high wind curtailment (10%)
- Lower wind yield in **region B** => higher generation cost (48 EUR/MWh) => lower deployment of wind generators => lower wind curtailment losses (2%)
- If RES-auction in Ukraine clears at 50 EUR/MWh
  - Most competitive projects from region A should be out
  - Most competitive projects from region B would be in

Region	Generation cost of new wind turbine	Curtailment losses for wind installations	Curtailment Charge	Maximum bidding price in auction
	(LCOE) EUR/MWh	%	EUR/MWh	EUR/MWh
A	46	10%	5 (10% x 50)	51 (5 + 46)
B	48	2%	1.0	49

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Advantages and disadvantages of curtailment charges

- ✚ Reflects regional challenges resulting from high share of renewables by considering curtailment losses
- ✚ Simple and transparent method without discretionary power of any market actor
- ✚ Terminable (e.g. for first five year of plant operation)
- ✚ Charges automatically decline if grid constraints disappear
- ▭ As each locational signal, does not reflect total system costs and might hinder RES development in most efficient regions

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Annex

Subsumption: Total energy system costs

In the **long-term**, renewable energy sources should be located such that the **total energy system cost** are minimized

- Total energy system costs = Sum of investments in
  - Power capacities
  - Networks
  - Storage capacities
  - And additionally variable costs for e.g. fuels and maintenance

In **short-term**, Ukraine has to avoid binding grid constraints and has to minimize balancing needs to limit system costs

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Internationally used typical location control solutions

- **A) Locational differentiated network and/or connection charges**

  To appropriately finance network expansion and guide the location of RES

- **B) Regional RES development bans/limits**

  Regulation, that either ban's new renewable energy projects in regions with insufficient transmission or defines capacity limits for each region

- **C) Regionally differentiated RES tariffs**

  Method that enables an adjustment of tariffs depending on the system value of the produced electricity

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A) Locational differentiated connection charges

- **Connection charges** are one-off payments for generators of RES
- Charges can apply for distribution and transmission grids

At the transmission level, differentiated charges can also present locational signals*

- ENTSO-E definitions classification
  - **Super-shallow**: All costs are socialized via the tariff, no costs are charged to the connecting entity;
  - **Shallow**: grid users pay for the infrastructure connecting its installation to the transmission grid (line/cable and other necessary equipment);
  - **Deep**: shallow + all other reinforcements/extensions in existing network, required in the transmission grid to enable the grid user to be connected

- Ukrainian DSO-connection charges reflect regional power load
- But connection charges in Ukraine do not send a location signal

** EWEA (2016) EWEA position paper on network tariffs and grid connection regimes*

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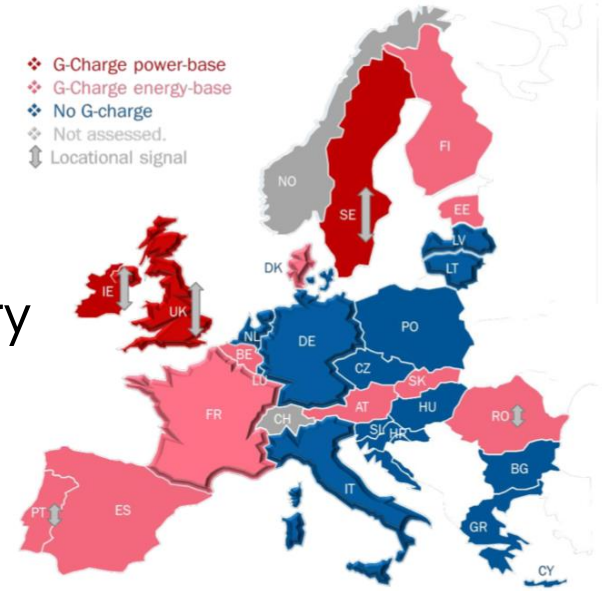
A) Locational differentiated network charges

- **Network charges for RES generators** can be defined:
  - Energy-based (per kWh)
  - Power based (per kW)
- Charges can be fixed for the whole territory or vary depending on the **location**
- **Five EU countries** apply location-based charges: Ireland, UK, Portugal, Sweden and Romania
- **No network-charges for RES generators** in Germany, Italy and Poland for example



Source: EWEA (2016) EWEA position paper on network tariffs and grid connection regimes

- Producers do not bear network charges in Ukraine

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B) Regional RES development bans

- Grid operators may prohibit the connection of new RES power facilities to the grid
- Bans **typically limited in time** till grid expansion takes place
- Often discretionary non-transparent decision of network operator

Example UK:

- The DSO (in UK DNO) for the Midlands, south-west England and Wales, has closed the grid to new large renewable projects in Cornwall, Devon, Somerset and Dorset for up to six years*

- In Ukraine, DSOs can block new installations to avoid grid constraints - and the corresponding rules are not transparent

** The Guardian (2015), UK electricity grid holds back renewable energy, solar trade body warns*

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B) Regional RES development limits

- Restrictions on the amount of (RES) capacities in each region
- Can be defined as
  - Total capacity limit in a given year and region (i.e., stock)
  - Limit for the annual construction in a given year and region (i.e., flow)

Example Turkey:

- Renewables projects in Turkey must be built in designated regions with identified transformers or sub-stations*

** BloombergNEF (2018), ClimateScope 2018*

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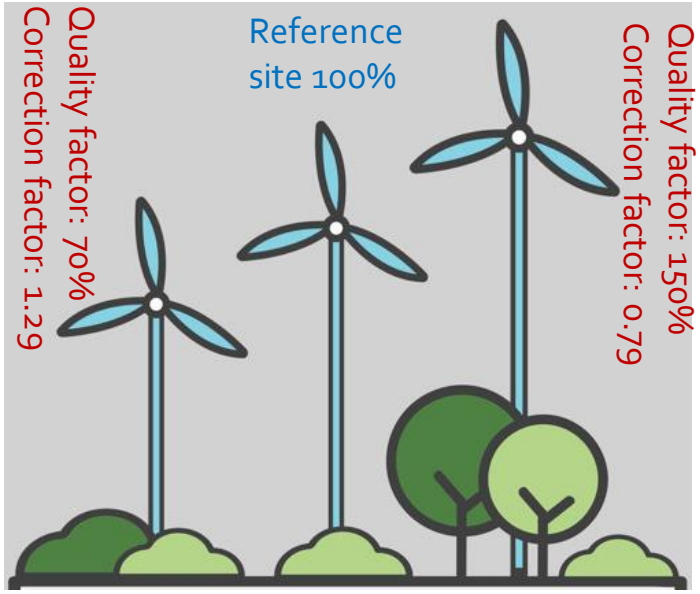
C) Regionally differentiated RES tariffs

- Instead of adjusting the network cost, countries can also directly adjust the tariffs for RES depending on their location or generation profile



Example Germany - The reference yield method

- A reference site (100%) is defined
- Sites with lower average yields than the reference site get proportionately higher tariffs
- Consideration of different plant types needed
- Investors are not incentivised to chose locations with the highest energy yield. This should reduce local concentration.

Assessment of methods

- **First-best** solution for defining regional RES and grid development would be based on a "**total system cost minimization approach**"
- Thus, all presented methods are only "**second-best**" compared to a "total system cost minimization"
- In contrast to the first-best approach they can be introduced relatively quickly and effectively avoid local RES concentrations

› For Ukraine a **quickly implementable** method is needed to avoid RES deployment being jeopardised by non-transparent discretionary measures by the system operators.

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All presented methods have advantages and disadvantages

A) Locational differentiated network and/or connection charges

- ✚ Price signals can provide granular incentives (good installations still being built in constraint areas)
- ✚ Network charge setting should follow a transparent process (proposed by DSO/TSO; approved by regulator)
- ▭ DSO/TSO still have substantial discretionary power

B) Regional RES development bans/limits

- ✚ Bans are very effective
- ▭ Bans might be set in a very non-transparent way by DSOs/TSOs
- ✚ Limits can be set by government in a politically transparent way
- ▭ But risk of non-economic aspects dominating decisions

C) Regionally differentiated RES tariffs

- ✚ Reference yield method is fully transparent and contains no discretionary element
- ▭ Reference yield method kills all incentives to built in high-yield locations

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Assessment criteria

- The presented methods have different advantages and disadvantages
- The choice of an suitable method for Ukraine has to consider:

Cost-efficiency: Is ensured if a measure is superior over alternative measures in respect of system costs

Effectiveness: Is ensured if a measure allows an achievement of specific targets

Simplicity: Is ensured if a regulations related to a measure are as simple as possible

Fairness: Is ensured if all affected investors are treated equally