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Inštitut za elektrogospodarstvo in elektroindustrijo
Ljubljana

Dissemination activity

Reform of the Slovenian network charging methodology

Instituto de Investigación Tecnológica - IIT

April 22th, 2021

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Introduction Clean Energy Package

The objective of this Project is to develop a **network tariff methodology** aligned with the EU Clean Energy Package

Directive (EU) 2019/944

- Article 15 (2e): "*__active customers__ are subject to __cost-reflective__, transparent and non-discriminatory network charges that account separately for the __electricity fed__ into the grid and the __electricity consumed__ from the grid"*

- Article 16 (1): *"__citizen energy communities__ are subject to non-discriminatory, fair, proportionate and transparent procedures and charges, including transparent, non-discriminatory and __cost- reflective network charges__"*

Regulation (EU) 2019/943

- Article 18 "*__Distribution tariffs__ shall be __cost-reflective__ taking into account the use of the distribution network by system users including __active customers__, may contain network connection capacity elements and may be differentiated based on __system users' consumption or generation profiles__. With __smart metering__ systems, regulatory authorities shall consider __time differentiated network tariffs__, and where appropriate, may be introduced to reflect the use of the network, in a transparent, cost efficient and foreseeable way for the final customer"*

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Introduction
International Experience

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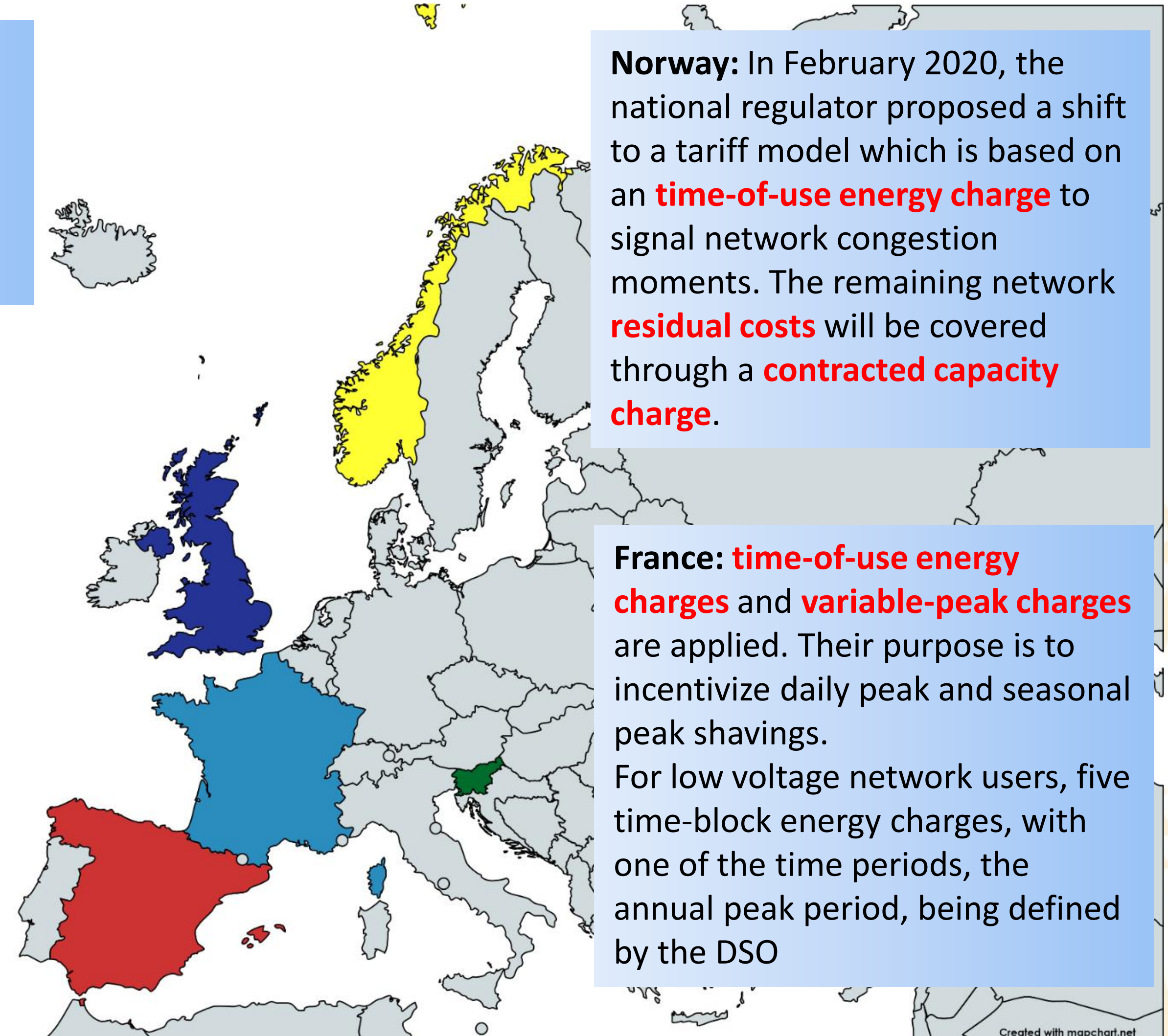
United Kingdom: is currently reviewing the tariff design in order to make tariffs more cost reflective, reviewing their methodology which segments **network costs among forward-looking and residual**.

Norway: In February 2020, the national regulator proposed a shift to a tariff model which is based on an **time-of-use energy charge** to signal network congestion moments. The remaining network **residual costs** will be covered through a **contracted capacity charge**.



Spain: tariff design with **high temporal granularity** for all customers thanks to the **smart-meters** roll out for all customers a few years ago.
Customers connected to HV, and MV face energy and capacity charges with 6 time-blocks per year.
For small customers, network costs are recovered through a contracted capacity charge and a ToU energy-charge

France: time-of-use energy charges and **variable-peak charges** are applied. Their purpose is to incentivize daily peak and seasonal peak shavings.
For low voltage network users, five time-block energy charges, with one of the time periods, the annual peak period, being defined by the DSO

Introduction

Some comparisons from ACER review on D-tariff

Tariffs for injection

Transmission injection charges to recover transmission costs	Transmission injection charges to recover both transmission and distribution costs	Distribution injection tariffs to recover only distribution costs
DK, IE, PT, RO	AT, BE, FI, FR, SK, SE	EE, LT, LU

Basis for withdrawal tariffs (all MS)

Energy based	Energy + lump sum	Power + lump sum	Energy + Power	Energy + Power+ lump sum
CY, LT, RO for all, BE(Fl), BG, CZ, EE, IE, IT for some	DK for all, AT, BE (Br), EE, FI, DE, HU, IE, LU, SE for some	IT: for most users	HR, CZ, GR, LV, PT, SK, SI, ES, BE (Wa) for all AT, BE(Br, Fl), BG, EE, DE, LU for some	FR, MT, NL, PL for all EE, FI, HU, IE, SE: for some

Basis for power-based withdrawal charges

Actual maximum power	Actual power at specified time (e.g. peak periods)	Contracted or rated power	Others
BE, DK, MT, SE	HR, GR (for MV only)	CZ, FR, GR (for LV only), LV, PL, SK	NL, PT, ES

Slovenian current network tariffs

1. Cost allocation to customer groups according to estimated contribution to system peak

2. Allocation to energy and capacity charges

3. Allocation to day-night charges

Customer group			Tariffs*			
Voltage level	Type of connection	Load factor	Capacity (EUR/kW/month	Consumed energy (EUR/kWh)		
				VT	MT	ET
HV (VN)		T ≥ 6,000 hr				
		6,000 > T ≥ 2,500 hr				
		T < 2,500 hr				
MV (SN)	Busbar MV	T ≥ 2,500 hr				
		T < 2,500 hr				
		T ≥ 2,500 hr				
		T < 2,500 hr				
LV (NN)	Busbar LV	T ≥ 2,500 hr				
		T < 2,500 hr				
		T ≥ 2,500 hr				
		T < 2,500 hr				
		charging EV				
		Without power measurement				
		household				

Principles for network charging assuming cost recovery

Economic efficiency

- Cost reflectivity: electricity tariffs reflect the costs of delivering the service, recognizing that electricity costs may vary by time, location, and supplied quality
- Predictability: consumers can estimate ex-ante the amount they will be charged
- Technology neutral: should be indifferent to the particular activities for which electricity is used by network users or to the technology used to withdraw or inject energy into the grid
- Minimization of cross subsidies: one consumer's actions should not negatively impact other consumers' charges.

Equity

- Allocative equity: Identical network usages are charged equally. Identical network usage refers to comparable location and consumption patterns
- Distributional equity: charges should be proportional to the economic capability of each user
- Transitional equity: a transition from an old to a new tariff scheme should be gradually implemented

Methodology for network charging

COST RECOGNITION & SEGMENTATION

Network costs (T&D)

- Investment costs
- O&M costs

Energy losses costs

Ancillary services costs

PRINCIPLES

Cost recovery

Economic efficiency

Equity

Transparency

AVAILABLE CHARGES FOR EACH CUSTOMER GROUP

- Generators
- Customers
- Final customer
- Active customer
- Member of EC

- Energy charges
- Capacity charges
- Fixed charges

GRANULARITY

- Locational granularity

- Temporal granularity

Introduction to proposed methodologies

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First alternative: Methodology 1

- The first methodology will be focused on **improvements of the current methodology** to become more **cost reflective**
- based on available data and searching **cost drivers,**
- implementing **capacity and energy charges**
- with **time-of-use differentiation.**

Second alternative: Methodology 2

- The second methodology will be focused on a **long-term** perspective,
- which could require a large amount of currently **unavailable data** and computational burden.
- implementation of forward looking **peak-coincident charges** based on more **dynamic** time of use discrimination
- and the use of **fixed charges** for allocating **residual network costs**

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10-min break

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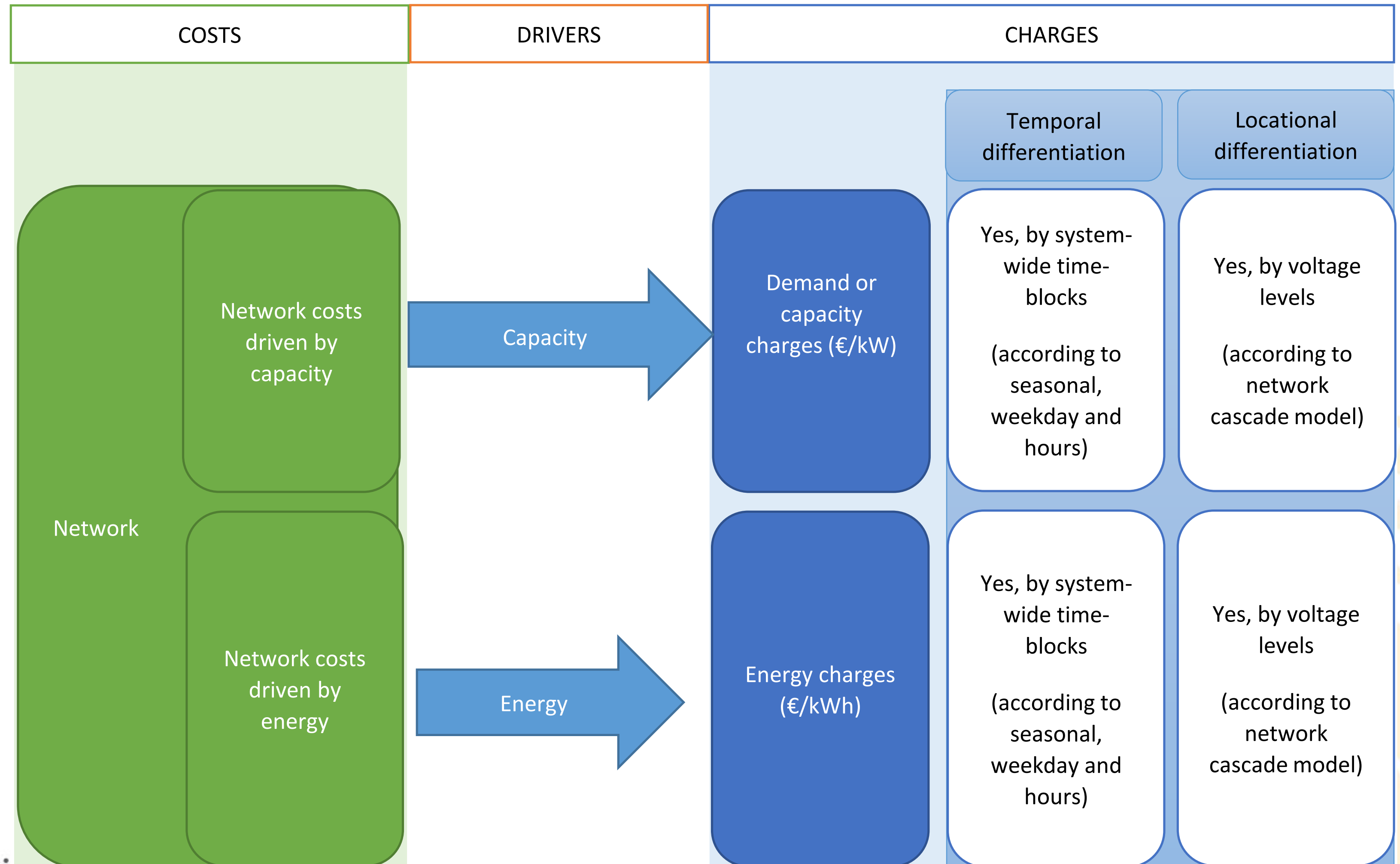
Methodology 1:

Energy and capacity charges for withdrawal (generators and injections do not pay charges)



Resulting tariff under methodology 1

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Time-blocks: B1 (peak),…,B4 (off-peak)

Customer groups	Capacity (€/kW)				Energy (€/kWh)			
	B1	B2	B3	B4	B1	B2	B3	B4
HV customers								
MV customers connected at HV/MV substation								
MV customers								
LV customers connected at MV/LV transformer								
LV customers								

Example of time-blocks

	B1	B2	B3	B4
High season weekday	From 9 to 14h, and from 18 to 22h	From 8 to 9 h, from 14 to 18 h, and from 22 to 0 h		From 0 to 8h
Low season weekday		From 9 to 14h, and from 18 to 22h	From 8 to 9h, from 14 to 18h, and from 22 to 0h	From 0 to 8h
Weekends and holidays				All hours

Determination of Time-blocks

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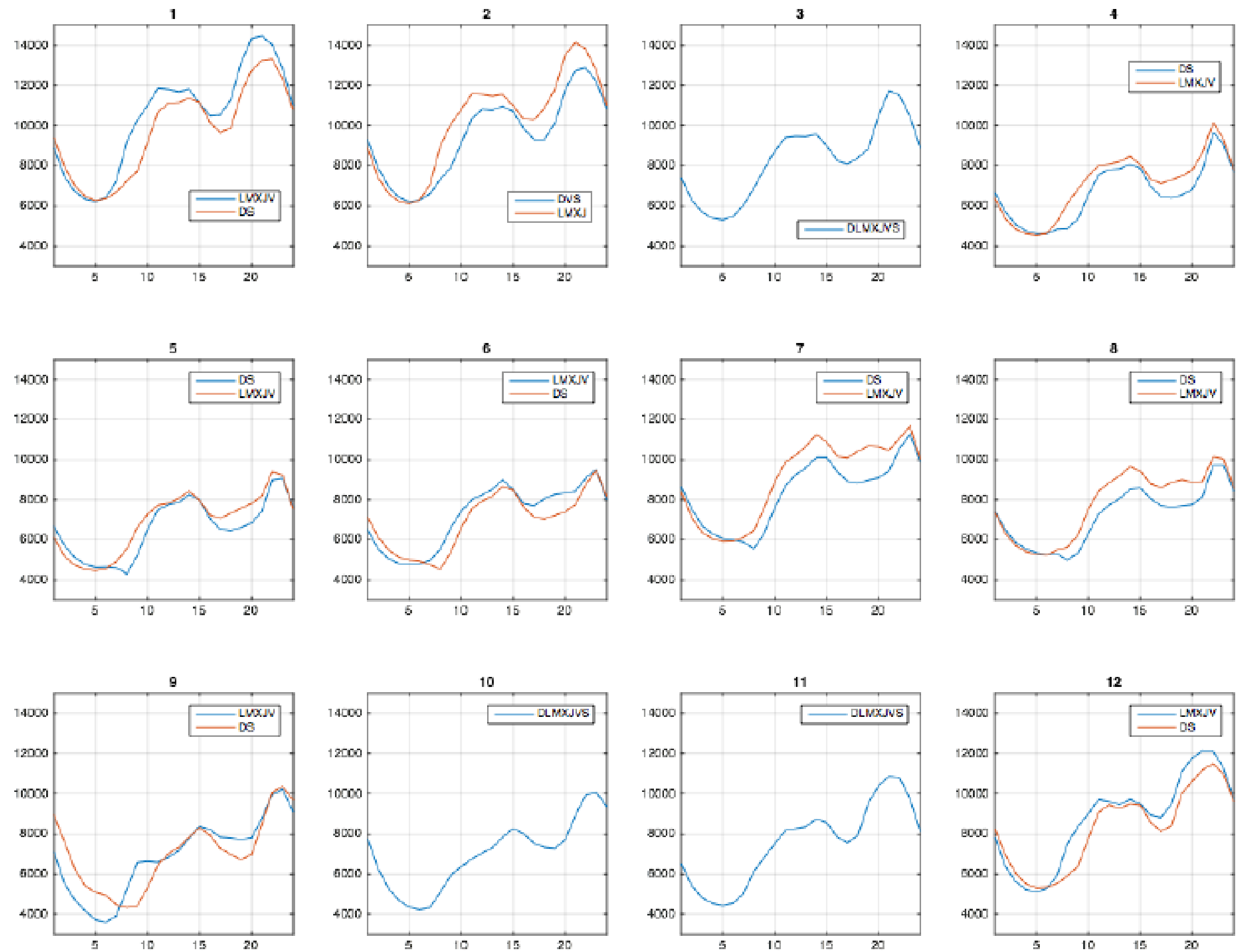
Example of clustering for network usage in Spain

Clustering techniques are able to classify network usage under different time periods, and therefore can identify different time blocks per seasons, days, hours, 15-min within a day. This can be applied for whole network, or for voltage levels.



Active customers and energy communities under methodology 1

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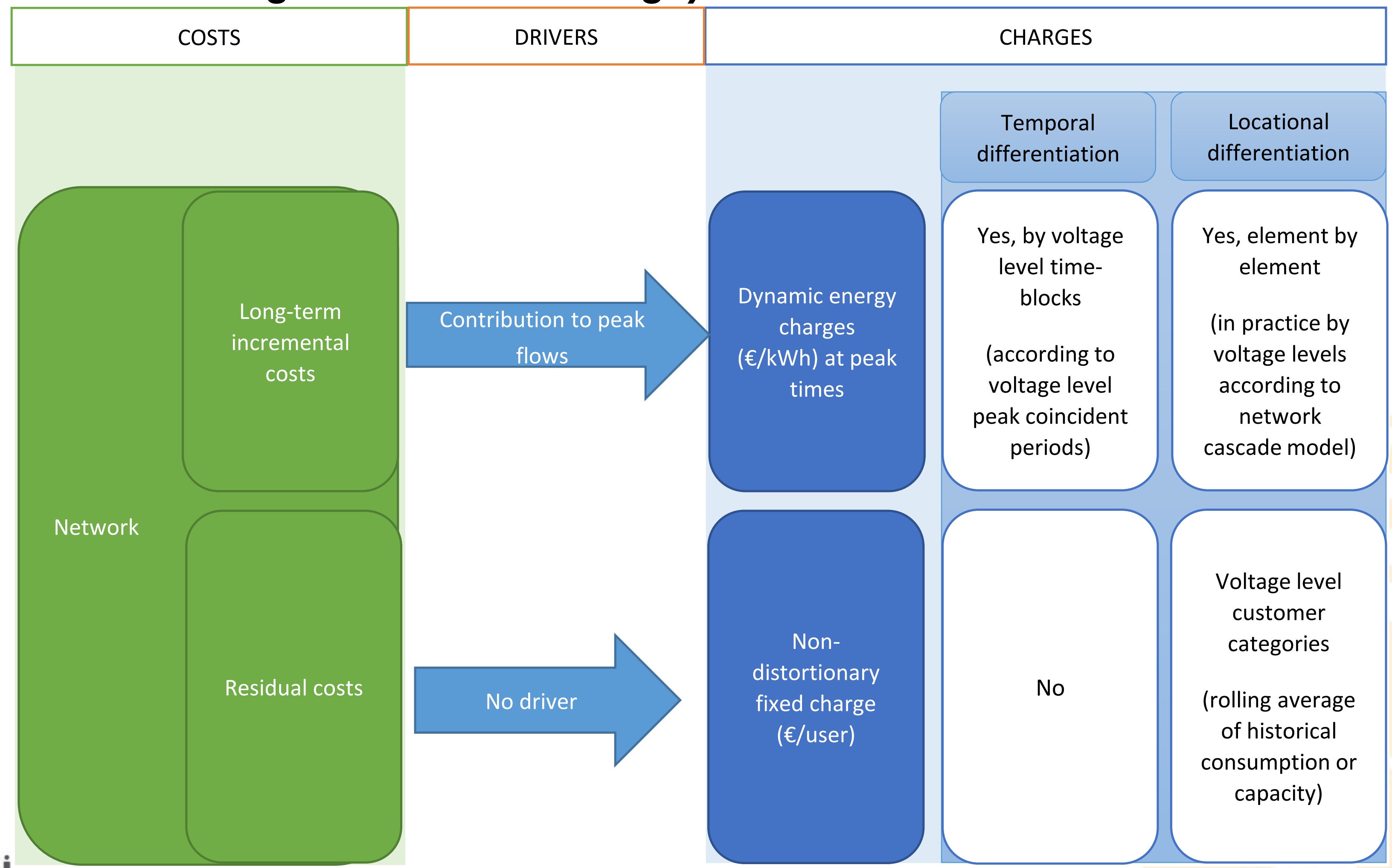
- **Active customers with own self-generation behind the meter.** These are treated as **consumers**, only face their corresponding **energy and capacity charges** according to the **net metered withdrawal (15 min samples).**

- **Active customers as part of an energy community with shared generation units connected at the same local network (voltage level).** It is assumed that the network is not owned by the energy community. The energy produced is shared among energy community customers as if they were self-consuming. These customers face in each time-block an energy network charge composed of
  1. the **regular energy charge** applied to the net consumption (**total consumption less assigned self-generation in 15 min samples**),
  2. the **reduced energy charge applied to the assigned self-generation**. This reduced energy charge accounts only for the network usage made by the connection between the generation units and the consumers within the energy community (at the same voltage level and ignoring the costs of transmission from upper voltage levels).
  3. The **corresponding contracted capacity charge** associated to the net consumption

Methodology 2:

Forward-looking peak coincident (symmetric for withdrawal and injection) and fixed residual charges (to customers, no to generators or storage)



Resulting tariff under methodology 2

Customer groups	Residual (€/kW contracted, or €/kWh of historical consumption)	Peak-coincident + Energy losses + Ancillary services (€/kWh)				
		Type of day d				
		H1	H2	H3	…	H24
HV customers						
MV generation connected to HV/MV substation	-					
MV customers connected to HV/MV substation						
MV generation	-					
MV customers						
LV generation connected to MV/LV transformers	-					
LV customers connected to MV/LV transformers						
LV generation	-					
LV customers						

Active customers and energy communities under methodology 2

Customers with self-generation or **forming an energy community** are treated according to **their interaction with the network** in their **own supply points**

- For the **energy withdrawn** from the network in their respective supply points (active consumers with self-generation, or consumers belonging to an energy community), they are **charged/rewarded the applicable peak-coincident charge**

- For the **energy injected** into the network in their respective supply points (active consumers with self-generation, or production units belonging to an energy community), they are **charged/rewarded the applicable peak-coincident charge**

- **Residual charges** are applied to **active customers** according to the proposed methodology, based on their **contracted capacity**, their **historical consumption**, or income level.

Alternatives for allocation of network asset costs

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Current

Customer allocation: Costs are allocated to customer groups according to **estimated contribution to system peak** (cascade model) ✓

All costs are treated as peak-driven costs

Cost segmentation: Allocation to energy and capacity charges

This should be first step, following drivers

Time-block allocation: Allocation to day-night charges

Alternative 1

Cost segmentation: Costs separation according to **drivers** (peak power and energy)

Cost reflectivity searching cost drivers

Time-block allocation: Allocation to **predefined** time blocks according to their contribution to **system peak periods**

Cost reflectivity according to time blocks

Customer allocation: Allocation to customer categories (voltage levels) according to cascade network model ✓

Alternative 2

Cost separation according to forward looking **incremental and residual** costs

Cost reflectivity on long-term costs

Allocation to **dynamic** time blocks according to their contribution to **voltage level peak periods**

Cost reflectivity according to dynamic prices

Allocation to customer categories (voltage levels) according to cascade network model ✓

Alignment of methodologies and principles

Principles	Current	Alternative 1	Alternative 2
Cost-reflectivity	According to system peak	According to cost drivers	According to forward-looking costs ✓
Equity			✓
Simplicity and implementation barriers	✓	✓	
Transparent methodology	✓	✓	✓
Active customers efficiently integrated		✓	✓
Energy communities efficiently integrated		✓	✓

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Thank you very much

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Questions?

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Dissemination activity

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Back-up slides

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Methodology 1:
Contracted capacity and excess demand over contracted capacity

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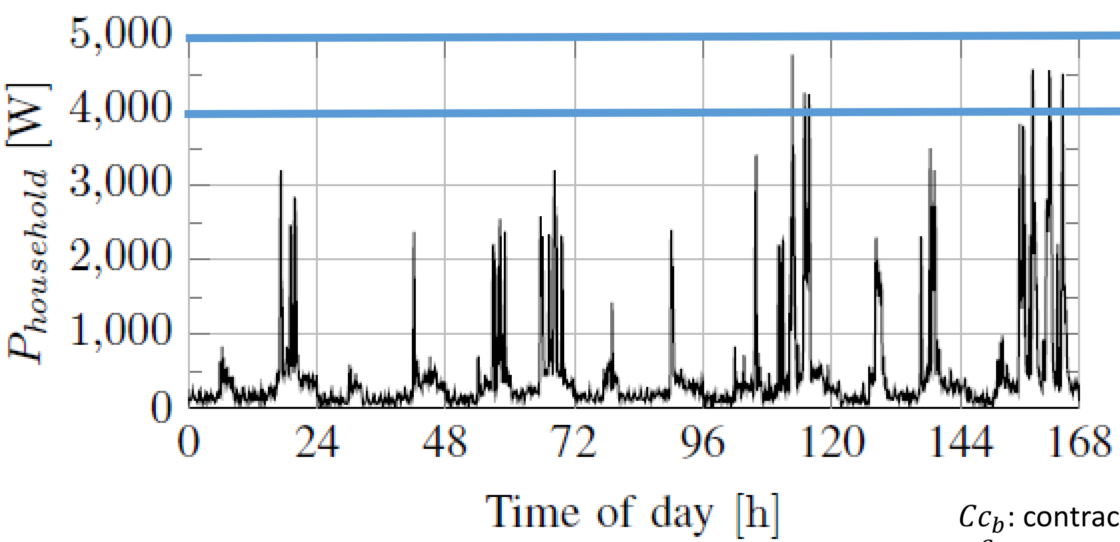
Contracted Capacity payment for time block b

$$Cc_b * T^C_{i,b}$$

Contracted Capacity= 5kW



Contracted Capacity= 4kW and excess demand = 1.21 kW

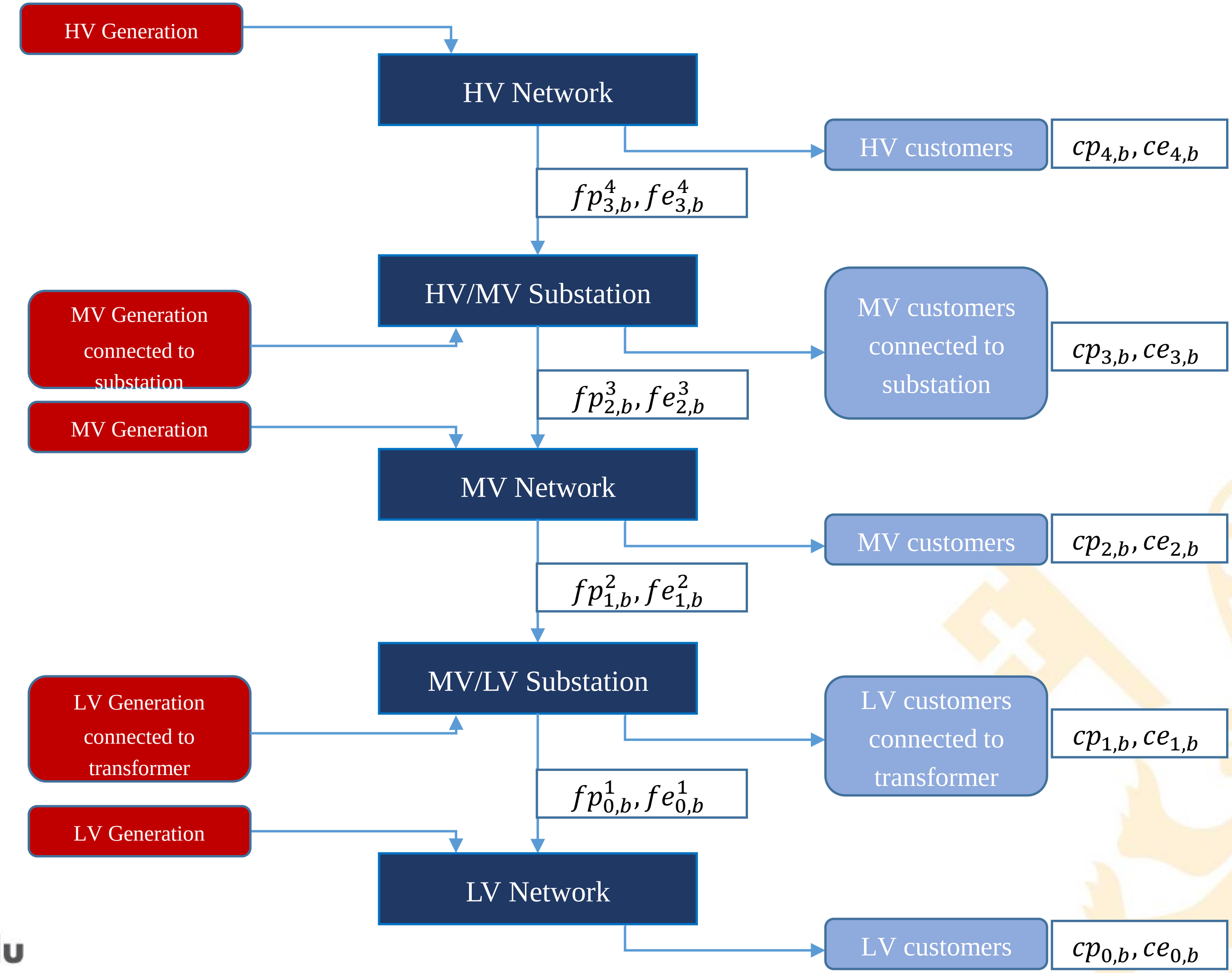
$$T^C_{Ex,b} * \sqrt{\sum_{j=1}^{n}(Cd_{j,b} - Cc_b)^2}$$

$$\textit{Capacity payment} = \textit{contracted capacity payment} + \textit{excess capacity payment}$$

Excess demand = sqrt(0.8^2+2*0.2^2+3*0.5^2)=1.21 kW

Cc_b: contracted capacity for the customer at time-block b, in kW
$T^C_{i,b}$: contracted capacity tariff (€/kW) for voltage level i, and time-block b
$T^C_{Ex,b}$: cumulative excess demand charge at time-block b (€/kW), which is equal to the capacity charge for time block b and voltage level i, multiplied by an additional factor, for instance 1.2.
$Cd_{j,b}$: maximum demand consumed by the customer, in kW, for each 15-min sample when contracted capacity is exceeded in time-block b
n: total number of 15-min samples when contracted capacity is exceeded

Cascade model for Methodology 1



Methodology 1. Model for network cost allocation to capacity & energy

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- Conceptual Model
  - Allocation of network costs TOTEX as CAPEX (return on investment + annual depreciation of network installations) + OPEX (operation & maintenance costs of network installations)
  - Allocation to capacity & energy based on network design criteria following the cost causality principle

Methodology 1. Model for network cost allocation to capacity & energy

- Conceptual Model
  - Allocation to capacity
    - Cost of the optimal adapted network to supply instantaneous peak demand, i.e. minimum size conductors and radial topology in LV and MV networks
  - Allocation to energy
    - Incremental cost resulting from the optimal adapted network to supply the instantaneous peak demand plus the associated energy along 8760h. Two effects:
      - Due to energy losses, the optimal size of conductors is thicker than the one to supply the peak demand
      - Reliability investment and expenses (network loops, switching equipment, maintenance crews) are associated to energy due that supply interruptions happen along the whole year
  - The obtained results for optimal adapted networks are applied in the same proportion to the cost of the existing networks
  - References

Rodríguez MP, Pérez-Arriaga JI, Rivier J, Peco J (2008) Distribution network tariffs: a closed question? Energy Policy 36:1712–1725

J. Reneses, M. Rodríguez, I.J. Pérez-Arriaga, **Electricity tariffs**, in *Regulation of the power sector. Power systems, 61*. Editors Pérez-Arriaga, I.J.. Ed. Springer. London, United Kingdom, 2013.

Definition of peak hours in methodology 2

- Peak hours are defined as the ones in which the expected load growth would overload the system beyond its security limits = estimated as the number of hours in which the existing load overpass a specific threshold (set according to the level of current network utilization)