Personal Energy Administration Kiosk Application

An ICT-ecosystem for Energy Savings

through Behavioural Change, Flexible Tariffs and Fun

Contract No 695945

Deliverable D5.3

Report on Regulatory Framework Issues

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V0.1	05/06/2019	First release	Initial analysis performed.
V1.0	26/06/2019	Second release	Completion of the analysis. Integration of comments from reviewers
V2.0	29/10/2019	Final version	Integration of comments from PO and monitors

Content

Description of work[1]

In this deliverable, the regulatory framework necessary to enable full exploitation of the ICT-to-Human ecosystem is analysed and developed. Current electricity market regulation does not sufficiently account for load situations and does not encourage an active role of consumers. However, fluctuating electricity provision and demand are detrimental to efficiency and GHG emissions reductions and thus, the prevalence of static grid tariffs is one roadblock for increased system efficiency, as it does not incentivise load shifting.

In order to exploit PEAKapp's full energy efficiency, energy savings and load shifting capacities and to enable the implementation of future ICT-based efficiency technologies, PEAKapp proposes amendments to the regulatory practise. Based on an overview of currently applied grid tariffs in the EU, some possible suggestions for potential adjustments to the grid tariff structure is provided. While the discussions about the required transformation of grid tariffs to more dynamic and flexible are supported by empirical results collected in the field tests of the PEAKapp project, a smooth transition to such tariffs, taking into account potential impact on the household, is challenging.

Further on, the legal team of PEAKapp provides an overview on new European legislation concerning internal electricity markets and its main actors, followed by a detailed analysis of the dynamic pricing from regulatory perspective. Based on the analysis of the Directive of the European Parliament and of the Council on common rules for the internal market in electricity (EU/2019/944), which now explicitly requires provisions for the possibility of dynamic prices, and the data protection provisions (analysed in task 5.1), there is no need to include a special clause (previously suggested in Del 5.1) in the supply contracts. Since these new rules on dynamic prices are an EU Directive, they must be transposed into national law by the Member States, which will facilitate the full exploitation of PEAKapp or similar ICT-to-Human ecosystems across member states.

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[1] Parts of the results presented in this Deliverable have been published in Azarova et al. (2018), where the funding through the H2020 programme is acknowledged as requested in the EC's publication rules.

1. Introduction and Motivation

Currently the world's electricity system is facing turbulent times with several challenges including continued growth in demand, integration of renewable energy sources and plug-in electric vehicles, the need to improve the security of supply and the need to lower carbon emissions. Residential electricity utilization patterns, which used to be rather homogenous in the past, are changing rapidly now especially with the rise of prosumers and electric vehicles. This situation requires high level of flexibility from the grid and provision of new services to customers, otherwise if no adjustment measures are taken, current challenges may even cause destabilization of the whole electricity system and blackouts.

The challenges of the electricity system also have a direct impact on current national and regional regulatory practices, such as, grid structure, legislative and regulatory policies and especially grid tariffs, which will require some major transformations in order to provide the best possible solution to the mentioned-above challenges. While no one-fits-all solution will emerge in this regard due to the heterogeneity among European countries, the empirical evidence collected from the PEAKapp field tests in four EU countries sheds some light on the potential solutions and possibilities for all participants of the system, including consumers and electricity providers, to adjust to changing circumstances of the electricity market.

With the introduction of European Union's Winter Package, the European Commission has highlighted the key role of the consumer in the current developments on European energy markets and in reaching the energy efficiency increase goals set by the EU for the upcoming years. Moreover, consumers according to the Commission should be "active and central players on the energy markets of the future" with "a better choice of supply, access to reliable energy price comparison tools and the possibility to produce and sell their own electricity"[2]. Yet, to promote and achieve these aims, existing regulatory frameworks and specifically currently applied grid tariffs need to be adapted to better allow consumers' involvement in the energy system and to give them the opportunity to respond to price signals[3], which is barely possible at the moment. Current network tariffs are still calculated based on the assumption of homogeneity of residential electricity consumption without taking into account the load shifting and peak production. Several studies suggest that such regulatory approach is not only getting obsolete, but also puts in danger the stability of the whole energy system (Rubin, 2015, Hledik, 2014). Currently applied grid tariffs, which usually are dominated by the total number of kWhs consumed by a household in the billing period, do not account for peak production and lack signals to encourage demand response. Grid tariffs can be used as a tool to incentivize consumers to adapt the timing (i.e. peak shifting) and level off their network use (i.e. peak shedding) to keep network

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[2] See https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

[3] See https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition for the whole statement.

utilisation within capacity constraints of the grid without further investments in the infrastructure (Neuteleers et al., 2017). In addition, looking at the results of PEAKapp field tests in Austria, we find evidence that if such incentives were included in the implemented tariffs, consumers would adjust their electricity consumption behaviour. For instance, we find that discounts implemented in PEAKapp will lead to a 0.96 – 2 % increase in electricity consumption during the discount periods of high renewable electricity production. As the financial gain in absolute terms is relatively small, we interpret the reason for the change in consumption happens mostly due to informational treatment – households were informed that discounts were caused by high share of energy produced from renewable sources like sun or wind. In the PEAKapp only manual reaction to the discounted prices was possible – meaning members of the households had either to be physically present at home during the discounted periods or program some of their appliances to start working in the discounted time. We assume that automation, although yet still challenging, will allow even higher reaction from consumer's side to dynamics prices. Moreover, PEAKapp field tests results show that there is a high interest in services providing easy-to-use and easy-to-understand information on household electricity consumption, because even after 69 weeks of the field tests in Austria the app was still used on a regular basis. Most importantly, PEAKapp demonstrates that there is an empirically proven readiness among consumers to actively react to price signals if these signals are clear and well communicated. Yet, in order for implementing PEAKapp ICT EU wide, there should be tariffs that allow consumers such flexibility and can incorporate price signaling.

When using PEAKapp the households that consumed electricity during discounted times could see their savings on daily basis, the monetary results of their behavioral change were clear to them, same should apply to potential new tariffs as clarity is one of the main principals of the tariff design (Neuteleers et al., 2017). In the Austrian case the savings were later deducted by the electricity provider from the annual electricity bill. While such a setting worked in a field test with 1,500 customers, this billing procedure is not efficient enough for a EU wide uptake, however it was the only possible option during the field test based on current regulation and practice of the utility partner in Austria.

Further on, conducted in the context of PEAKapp load-shifting experiment shows there is a potential to decrease system peaks by shifting demand from the peak times using monetary incentives and in this sense saving on infrastructural costs and increasing stability of the grid. We interpret this result as another proof that by adjusting the regulatory methodologies to include the possibility for consumers to embrace load shifting and to be able to react to dynamic prices significant economic and environmental benefits can be reached. Historically it was usually the grid that adjusted to peak demand by increasing its capacity to meet or even exceed the demand. However, such solution not only requires major investments in the infrastructure of the grid which is not even used most time, but also often involves increased consumption of electricity produced from carbon intense fossil fuels like coal, leading to both economic and environmental inefficiencies (Lacaine et al., 2015). Modern technologies supported by empirical research suggest better solutions to the described-above challenges. Such solutions involve high engagement on both sides of the grid, but also require a reform and transformation of currently applied regulatory practice and grid tariffs.

This deliverable describes these PEAKapp results, which demonstrate empirical evidence of potential solutions for current challenges of the electricity market regulation on the consumer side, followed by description of currently applied regulatory practice and grid tariffs. Further on, based on empirical research conducted in the framework of PEAKapp project an investigation of potential grid tariff reforms is provided. The derived amendments are then discussed, followed by a concluding section.

2. PEAKapp field tests results

The aim of the PEAKapp research project was to explore the behaviour of energy consumers especially in the context of dynamic prices as well as to determine energy saving- and load shifting potentials. In order to get robust insights, a field test was conducted in four European countries. About 1,500 participants from the Upper Austrian energy supplier ENAMO, 500 Estonian, 250 Latvian and 250 Swedish participants from the energy supplier 220E were targeted to take part in the field test. While PEAKapp offered consumers various functionalities from social comparison, to benchmarks to a serious game, the main focus in this deliverable is on the implemented price treatment and the induced load-shifting effect. Price treatment was implemented in form of discounts (in €/kWh) in Austria and in form of spot-market prices in Estonia, Latvia and Sweden. The results of the price treatments and the induced load-shifting effects are described in the following sections.

2.1 Consumers response to discounted prices in Austria

In order to assess the efficacy of the app, a field test took place in Austria in the years 2017 and 2018 and ran for 69 weeks (June 6th 2017 to October 15th 2018). The recruited 1,589 households were randomly assigned to one of three groups by using draws produced by a random number generator:

1) A treatment group that was given access to the app but received no discounted prices
2) A treatment group that was given access to the app and received discounted prices
3) A control group which did not have access to the app and also received no discounted prices. Customers in the control group agreed to the recording of their smart meter data and the use of this data in the PEAKapp project.

Approximately 500 households were assigned to each of the groups in Austria. Using smart meter data, the consumption of all the three groups was recorded in 15 minutes intervals during all 69 weeks of the field tests.

During the 69 weeks of the experiment, both treatment groups with access to PEAKapp used all the built-in functions of the app including household electricity consumption analysis, benchmark household comparison, and learning game. The discount treatment group also received push-messages on a regular basis informing the households about discounts on electricity. These push-messages were sent either day-head or one hour ahead of the discounted period. The discounted period duration was either 1 or 3 hours.

Further on, the messages included information about the reason of discount – economic (European market price situation) or environmental (high share of production of renewable energy from wind or sun). The discounts varied in size from 10 to 50% on kWh consumed during the respective timeslot. On average discounts were sent out two times per week. While a detailed analysis of consumers' reaction to discounted prices is provided in Deliverable 4.1, the key takeaway for the regulatory perspective is presented in Figure 1 , which shows total monthly consumption of the three PEAKapp groups in the discount periods. Looking at the figure we can see that the treatment group with a price signal reacted to the signal by increasing consumption during these periods between 0.96 and 2%. There is seasonal variation in the size of the effect and also variation depending on specific characteristics of the discount and the household (active users of PEAKapp vs non-active users, heavy energy users vs low energy users etc). Nevertheless, the overall conclusion of the PEAKapp field tests is rather straightforward: consumers are ready to adapt their electricity consumption patterns when provided with right price signals. Further, looking at Figure 1 we can assume that households in the group with discounts had higher consumption compared to both other groups throughout the whole field test during the discount time slots.

According to the results of PEAKapp price treatments we suggest that price signals that are transparent and clearly communicated to consumers – for instance lower per kWh prices when renewable energy is produced – induce a change in household electricity consumption. The analysis done with the data collected in PEAKapp provides empirical evidence that households will react to such signals by increasing their consumption in the given periods and in this way can contribute to increased flexibility of the overall system and the integration of renewables.

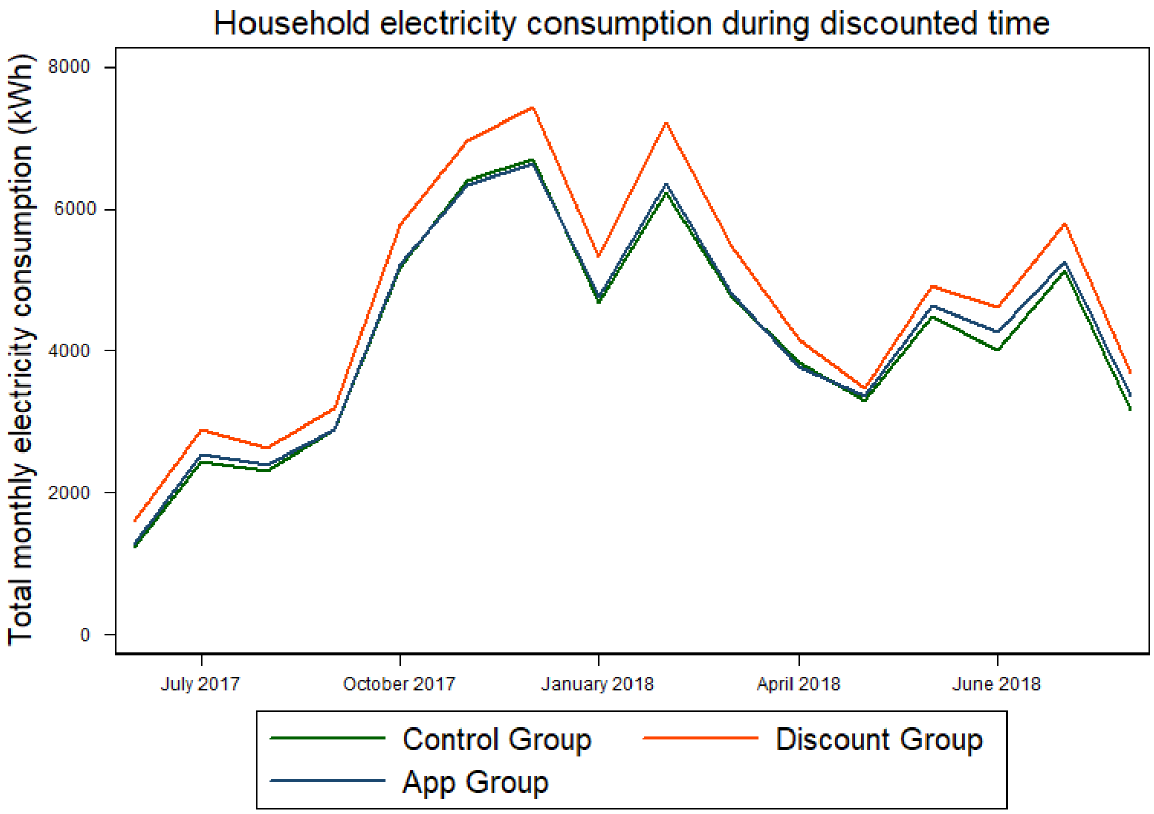

Figure 1. Consumers' response to discounted prices.

2.2 Peak-load-shifting experiment results

As load-shifting potentials will play a major role in future energy systems with increasing shares of volatile renewable power plants, we decided to test another possible direction of load-shifting in an experimental setting. The behavioural effect described in the previous section targeted an increase in household electricity consumption during times when renewable energy was produced through price signals and information provided via PEAKapp. We aimed to investigate whether there is a possibility to investigate the effect in the opposite direction, namely whether households can be incentivized to decrease household electricity consumption in order to avoid system peaks and thereby reduce infrastructure costs.

Peak consumption in Austria generally occurs during autumn/winter months on workdays from 6 p.m. to 7 p.m. During evening peak times households often consume the amount of electricity that accounts for approximately 35% of total electricity consumption as several major electricity consuming activities like cooking, washing or watching TV are usually performed by several members of the households in parallel in this time period (Andersen et al., 2017). In addition and due to the increasing number of electric vehicles and of installed heat pumps (Beaten et al.), household electricity consumption is expected to increase considerably, which, if demand is not flexible, is also expected to increase consumption during peak times. Peak electricity demand is the main factor driving the costs of the electricity infrastructure and therefore peak reduction or load-shifting are in the focus of many demand side management programs and studies. While there is a solid base of simulation studies like for instance, Dlamini and Cromieres (2012), who simulated the load reduction effectiveness by applying algorithms for load moving from high demand times to low demand times and show that peak load can be reduced of at least 6 %, the empirical research based on real data is rather scarce. To fill in this gap, we decided to use PEAKapp and conduct an experiment investigating peak reduction.

We asked approximately 1,000 PEAKapp users to decrease their electricity consumption to at least 50% of their average consumption during this time on Tuesday 25th of September 2018, from 6 p.m to 6.15 p.m. We tested monetary (7 days of free electricity) and altruistic (7 days of free electricity donated to a charity organization) incentives to reach this goal. Based on preliminary results 43% of households who received the monetary incentive and 41% with the altruistic incentive reached the goal of the experiment. Looking at the comparison of average electricity consumption on Tuesdays from 18:00 to 18:15 with the consumption during the experiment on Tuesday of the 25th of September (see

Figure 2), we see a high increase in number of households that consumed exactly zero kWhs compared to average. During the experiment the average savings of 0.02 kWh in the 15 minute window, thus a 13% reduction demand compared to average demand at this time slot, were observed. While this experiment was only executed once, based on the data collected on households' response to the suggested incentives to decrease their load, we can assume that there is a high potential to decrease system peak loads through such mobile applications as PEAKapp. Such applications do not require high investments in supplementary hardware and infrastructure and also increase consumers engagement in the energy market as a whole. In a survey after the end of the field test, we investigated what exactly the PEAKapp users changed in their electricity consumption behaviour during the experiment. According to this survey, 63% of the users who participated in this experiment turned off all the electronic appliances, roughly 30% postponed using their dishwasher, washing machine or dryer. Around 27% even postponed cooking.

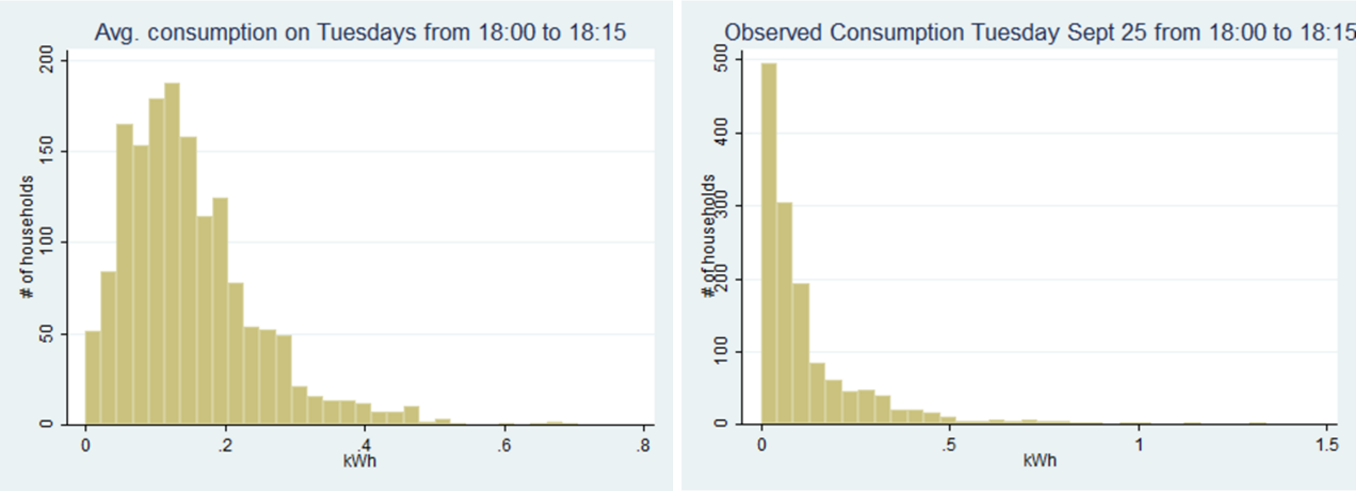

Figure 2. Peak load shifting experiment: average Tuesday consumption from 18:00 to 18:15 vs. consumption during the experiment.

Summing up, the results of the PEAKapp project provide deep insights in the energy using behaviour of households as well as empirical evidence for demand response and potential for peak load reductions through accurately designed price signals and information provision. These results can be directly incorporated in the regulatory practice. Namely by adjusting currently applied grid tariff and designing dynamic tariffs which can account for peak production, contribute to stabilizing the system and increase consumers active involvement in the energy transition.

3. Analysis of currently applied regulatory schemes in EU

Residential electricity prices are made up of a number of components, including grid tariffs, taxes and surcharges (renewables surcharge, usage surcharge, etc), and an energy charge. Grid tariffs in most European countries are defined by regulatory authorities (or a comparable bureaucratic entity) with the goal to recover the capital and operational expenditures of providing transmission and distribution of electricity and the investments needed to establish and maintain the required grid capacity. While there are various options to design a grid tariffs, usually the main components may be one or a combination of the following:

1) a volumetric component, reflecting the amount of consumed electricity (€/kWh),
2) a capacity or demand component, depending on the (measured or non-measured) demand (€/kW peak load), and
3) a component to recover fixed costs e.g. metering (€ per year/month).

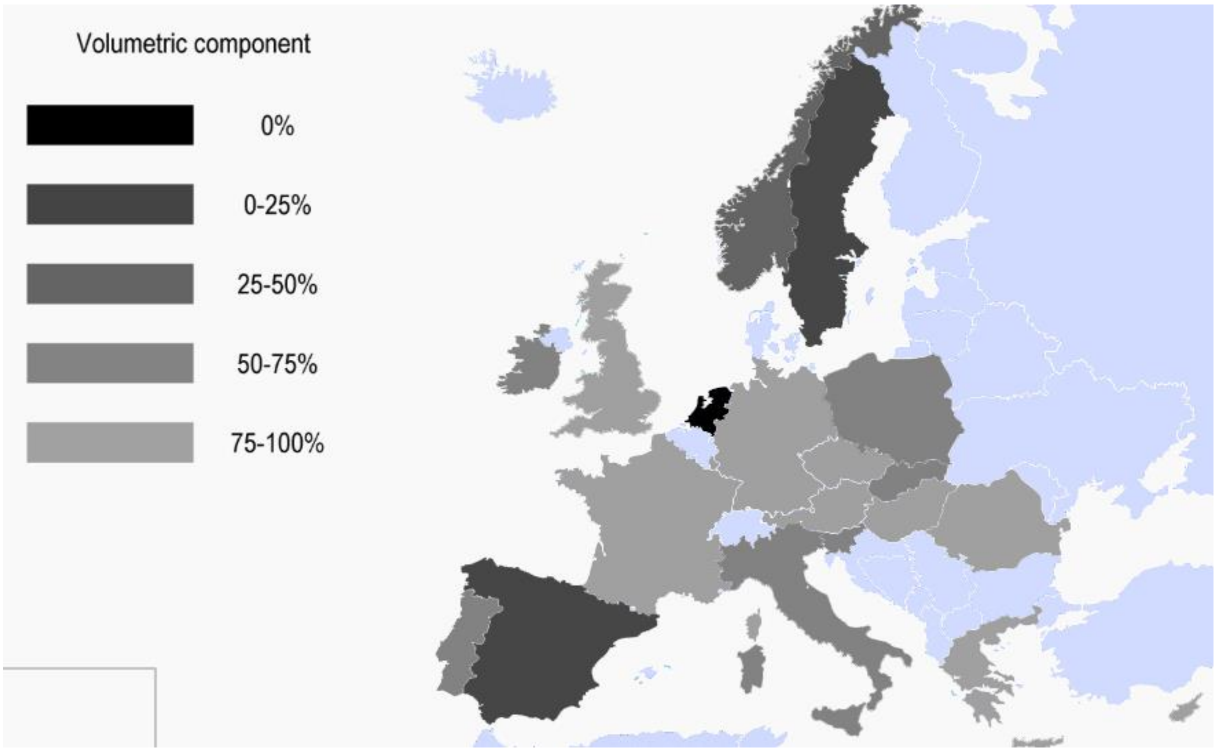

Figure 3. Share of volumetric tariffs in European regulatory schemes

As it can be seen from Figure 3, tariffs using a dominant volumetric component, which is based on the amount of consumed energy, are the most widely applied across the European countries. However, such a tariff structure does not send any signal to consumers to shift the load and decrease peak consumption, also the consumption of electricity during the times when renewable energy is produced is not incentivized in any form in this type of tariffs (Nijhuis et al., 2017). Another part of this challenge is the current promotion of renewable energy usage on the household level which contributes to increasing multi-directional operation modes of electricity grids, which means that there is an emerging and (presumably) growing share of consumers for whom the connection to the public grid will largely serve as a backup option, rather than being the primary source for their electricity acquisition (Simshauser, 2016). Consequently, for these consumers (aka prosumers) the volumes of electricity consumed from the grid will be subordinate (Hledik and Greenstein, 2016, Blank and Gegax, 2014). Depending on the tariff system in place, their contribution to the financing of the grid may decrease and a significant shift in the allocation of grid cost recovery may happen.

However, instead of sticking to emphasising the volumetric component, grid tariffs can be adjusted and used as a tool to incentivize consumers to adapt the timing (i.e. peak shifting) and level of their network use (i.e. peak shedding) to keep network utilisation within the capacity constraints of the grid without further investments in the infrastructure. Such incentives can be implemented through dynamic pricing and in particular through tariffs that are significantly higher during periods of high network usage, which is called peak or capacity pricing (Neuteleers et al, 2017).

In the past, capacity tariffs (if put in place) reflected contracted capacity, not actually measured loads. With the advent and current roll-out of smart meters, actual capacity demand becomes measurable (Felder, 2010). This development has triggered discussions about including capacity charges (also called demand or peak charges) in residential grid tariffs. While such charges have long been used in commercial and industrial network tariffs (Hledik, 2014), they are a novel development in the residential electricity market which raises fundamental questions about the effects of such a change in tariff setting for the individual household.

The costs of electricity networks are mainly determined by its capacity i.e. the maximum amount of energy that the grid is dimensioned to stand at any given point in time. Considering that consumers with on-side electricity producing technologies still require connection to the grid, the costs they induce for grid operation can not be well reflected through volumetric tariffs and have to be cross-subsidized by other consumers, who do not have access to such technologies and are still exclusively supplied via the grid. Considering that these innovations (own production, storage, EV) are more likely to happen first among a subgroup of the population owning single-family dwellings, a significant social imbalance from shifting the burdens of financing the grid towards lower income classes may by triggered. Moreover Severance (2011) even forecasted a possible "death spiral scenario" in the energy market, where higher network tariffs will be charged from poorer customers, which in the end threatens to collapse the whole electricity supply system.

While volumetric grid tariffs are the ones most widely applied in the EU, there are also tariffs with a dominant fixed component implemented for instance in the Netherlands. While such tariffs tackle the issue of over-subsidizing because in this regulatory approach, irrespective of household electricity consumption, all the households pay the same fixed price, and contribute equally to the financing of the grid. However, the ability to react to price signals and actively participate in the market, which is demanded by the European Commission, are not supported or incentivized in any way in this tariff structure.

To conclude this section, we find that the historic paradigm of unidirectional power grids is dissolving as the system needs to be more dynamic to be able to adapt to increasing levels of distributed generation but also other new technologies, like low-capacity storage, electro-mobility and house-to-house electricity trading (Schreiber et al. 2015). Currently applied grid tariffs are not designed to let consumers become more active players on the electricity market. With new technologies and smart-metering infrastructure, consumers can be the source of flexibility, which is required for transforming the electricity system. However, this requires a change in the regulatory approach and a reconsideration of currently applied grid tariffs.

4. Potential solutions: alternative grid tariff structures

According to the main PEAKapp results discussed in the previous sections, consumers are willing to change their electricity consumption when provided with price signals and there is also potential to reduce peak demand using the right incentives and communication technologies. As explained in the previous section currently implemented network tariffs are not designed to fulfil these tasks.

Several options have been proposed to deal with this issue, among others a switch to increased capacity or peak demand charges (see i.e. Hall et al., 2016, McLaren et al., 2015, Fenrick et al., 2014). With current roll-out of smart meters (meters with maximum (kW) demand reading capability), actual capacity demand becomes measurable. This development opens a possibility to include capacity charges in residential network tariffs. While such charges have long been used in commercial and industrial network tariffs (Hledik, 2014), they are a novel development in the residential electricity market. This potential reform of grid tariff raises questions about the effects that such a fundamental change in tariff setting may have on the individual households.

4.1. Austrian case-study: socio-economic effects

Reconsidering volumetric network tariffs for households and introducing capacity oriented schemes can indeed be one way of addressing the issues outlined above and re-establishing cost transparency and increasing consumers' active participation in the electricity market (Rubin, 2015, Faruqui, 2010).However, the impacts of these new tariff structures on the households' electricity bills are unknown while possibly significant.

In a recent study by Azarova et al. (2018) which was done in the framework of PEAKapp project, we analysed the effect of peak or capacity charges on households network expenditures. For this analysis, we used a unique real-world dataset of 765 Austrian households, whose electricity consumption was metered for a one-year period, and for whom we had detailed socio-demographic data at the individual level. Based on a literature review, we constructed 11 different grid tariffs with a variation in share of fixed, peak and volumetric components (see

Table 1 for details).

Table 1. The structure of 11 alternative grid tariffs

Scenario	**Description** (overall network costs are recovered through)	**Fixed charge** (per household per year)	**Energy charge** (per kWh)	**Peak/capacity charge** (per kW peak)
reference	tariff as applied in Austria in 2016	€24.60	€0.043	–
f100	100% flat tariff	€178.05	–	–
pa100	100% peak charge, based on the average of the 12 monthly measured peak loads	–	–	€39.07
pm100	100% peak charge, based on the one maximum load	–	–	€29.59
e100	100% energy charge, only based on consumed volume	–	€0.050	–
f50/e50	50% from fixed charges and 50% from consumed volume	€89.02	€0.025	–
f50/pa50	50% from fixed charges and 50% from peak charges (average of the 12 monthly peaks)	€89.02	–	€19.53
f50/pm50	50% from fixed charges and 50% from peak charges (one maximum load)	€89.02	–	€14.79
pa50/e50	50% from peak charges (average of the 12 monthly peaks) charge and 50% from consumed volume	–	€0.025	€19.53
pm50/e50	50% from peak charges (one maximum load) and 50% from consumed volume	–	€0.025	€14.79
f/pa/e*	14% from fixed charges, 43% from consumed volume and 43% from peak charges (average of the 12 monthly peaks)	€24.60	€0.022	€16.83
f/pm/e*	14% from fixed charge, 43% from consumed volume and 43% from peak charges (one maximum load)	€24.60	€0.022	€12.75

The goal of the analysis was to assess different network tariff schemes with respect to their effects on the budgets of individual households conditional on their socio-economic backgrounds. The analysis shows that alternative tariff schemes, in particular switching from a volume-based scheme that is currently the most widely applied to a scheme that recovers a substantial portion of network costs through measured peak-demand charges, may induce substantially increased electricity expenditures to a certain share of households.

Looking at Figure 4, we see that in extreme cases some households will pay up to 500% more if a tariff based only on a peak charge is applied. More over, the two extreme cases marked by triangles on Figure 4 represent rather small households with a total electricity consumption below the average of the sample, but with exceptionally high production of peaks. However, they are not the only ones: roughly 40% of the sample follow the same pattern, as they have no incentive to decrease their peak production or shift the load. Further analyses provide evidence that these increasing expenditures cannot sufficiently be explained by the possession of electric appliances, but are due to noticeable and systematic differences in the electricity consumption patterns along the politically critical dimensions of, among others, the households' income situation and number of children.

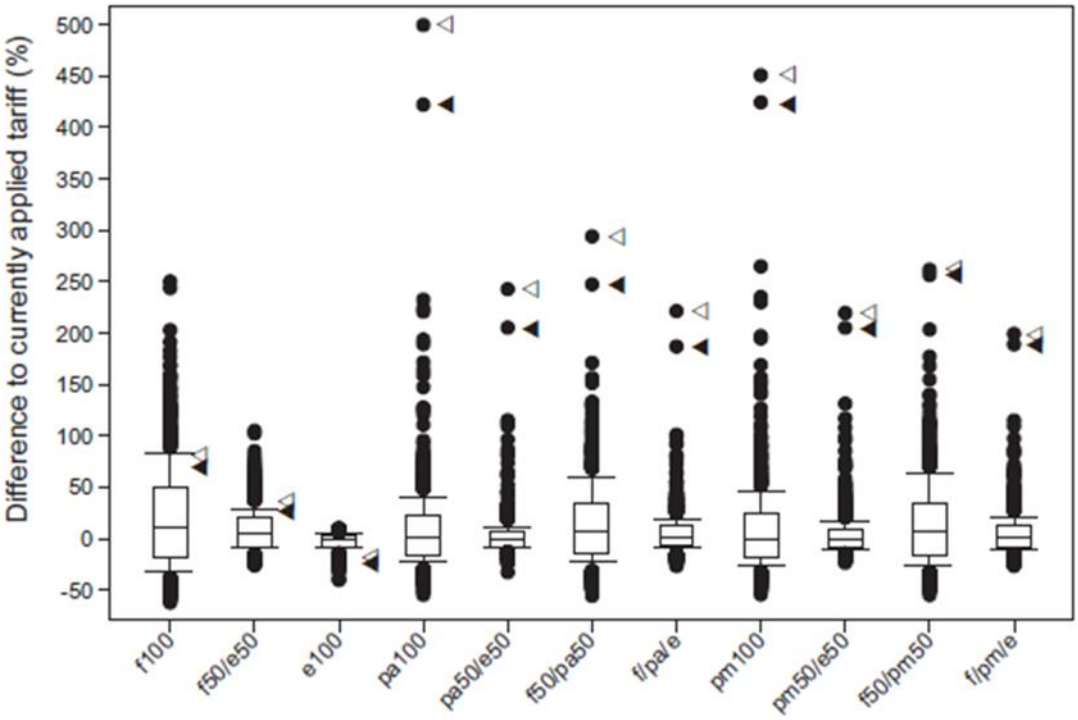

Figure 4: Change in the network expenditures under the 11 analysed grid tariffs.

In this study, no demand response or change in the electricity consumption patterns of the households is taken into account, however this research provides insights on potential effects of a transformation of the grid tariffs and can help to design tariffs that recover the costs needed for the sustainable operation of the grid. While the tariffs suggested in the study can not be implemented right away without additional preparations and research, the increasing share of renewables is being constantly promoted and supported on the governmental level also through incentives and subsidies, which increases the likelihood of further growth in the number of solar cells, electro vehicles, and in-home storage capacities in the nearest future and also means even more pressure and load differences in the grid. PEAKapp can enable a smoother transition to new tariffs as it allows an easy and fast communication, it gives consumers a clear understanding of the consumption and related costs. It can inform households about system peak times and incentives to decrease the consumption during these times, More ever PEAKapp can be upgraded to provide information to households in advance when their current consumption is reaching the peak value or is unusually high.

5. Regulatory support required for implementation of grid tariffs' adjustments

Although PEAKapp can support the transfer to more flexible, dynamic grid tariffs with price signals and incentives to reduce peak consumption, this is not possible without a proper regulatory support, which is presented in this section. First an overview of new EU legislation concerning internal electricity markets and its main actors is analysed, followed by a detailed analysis of the dynamic pricing from regulatory perspective. In the end a conclusion about the necessity of special clause in the supply contracts is given.

5.1 New EU legislation concerning internal market in electricity

The Directive of the European Parliament and of the Council on common rules for the internal market in electricity (EU/2019/944) strengthens the rights of consumers and their participation in the electricity market in Europe. For the first time, the new Electricity Market Directive also contains basic rules that facilitate the work of independent aggregators. These are suppliers that bundle small-scale capacities of several consumers and offer them on the market. The Directive must be transposed into national law by the Member States by 31 December 2020.

The aim of the Directive is to create integrated, competitive, consumer-centred, flexible, fair and transparent energy markets. More flexibility and decarbonisation will be sought and security of supply is crucial. The electricity market should be protected from state intervention, the role of consumers should be strengthened and the demand for electricity should be made more flexible. Another objective is increased cooperation between the Member States, regulatory authorities and grid operators to complete the EU-wide internal market.

The Directive brings new actors and regulates their rights and obligations: Aggregators, Active customers (Art 15) and Citizens energy associations (Art 16). Aggregators should bundle generation or load. Active customers may generate, store and sell electricity; they may make use of the aggregators. Aggregation is understood to mean an activity carried out by a natural or legal person in which several customers are bundled or generate electricity for purchase, sale or auction on an electricity market. Citizens' energy communities shall be free to generate, distribute, supply, consume, aggregate, store and, if Member States so permit in the context of implementation, operate networks. They may also provide energy efficiency services, energy services and charging services for electric vehicles to their members. Electricity sharing is also foreseen: permission to share within the Community the electricity generated by their own generation assets. Common electricity supply shall enable members to be supplied with electricity from generating installations in the Community which are not in their immediate vicinity or behind a common metering point; this should also be without prejudice to the levying of network charges taxes related to electricity flows. It is crucial that membership is open and transparent and that the citizens' energy community is effectively controlled by its shareholders or members. Participation is open to both natural persons and local authorities, including municipalities, as well as small and micro enterprises. They may not operate with the intention of making a profit, but should bring ecological, economic or social common advantages for members. Member States may provide for any legal form, such as an association, a cooperative, a partnership or even an SME.

The new Renewable Energy Directive (EU/2018/2001) acknowledges a similar definition the Renewable Energy Communities. However, its activities may only relate to the field of renewable energies; its powers are narrower than those of the Citizens' Energy Community, e.g. the operation of networks is not permitted. Reference should also be made to the possibility of self-supply with renewable electricity in accordance with Art 21 of the Renewable Energy Directive, where rights and obligations are defined for self-suppliers. Self-generated electricity from renewable sources used locally may only be included in levies or fees under certain conditions. Electricity drawn from or fed into the grid may be included in a cost-oriented levy and charging system. There is also the legal term "jointly acting self-sufficient suppliers" (Art. 2 No. 15): a group of at least two jointly acting RES self-sufficient suppliers located in the same building or apartment building. In principle, these must have the same rights as individual suppliers.

Final customers may consume, store, sell and participate in flexibility or energy efficiency systems electricity generated locally by them within certain limits. This without being subject to disproportionate or discriminatory barriers (e.g. non cost-oriented network charges). A maximum degree of freedom of choice for electricity customers should be made possible and consumer rights strengthened.

Network operators are encouraged to procure system services on a competitive basis and to make use of flexibility. They are only permitted to operate storage facilities and charging stations in exceptional cases.

5.2 Dynamic Electricity Pricing

According to Art 2 (15) of Directive EU/2019/944, a dynamic electricity price contract means “an electricity supply contract between a supplier and a final customer that reflects the price variation at the spot markets including day ahead and intraday markets, at intervals at least equal to the market settlement frequency”.

Electricity suppliers with more than 200,000 customers will have to offer flexible electricity tariffs in future according to Art 11. This new regulation is of particular interest to consumers who use an intelligent electricity meter ("smart meter"). Final customers who have a smart meter installed can request to conclude a dynamic electricity price contract from at least one supplier. They can choose a tariff with which they can purchase cheaper electricity at certain times and adjust their consumption patterns accordingly, for example charging their electric car when electricity costs the least. Every final customer shall always be required to give consent before being switched to a dynamic price contract.

According to recital 38, in order to maximise the benefits and effectiveness of dynamic electricity pricing, Member States should assess the potential for making more dynamic or reducing the share of fixed components in electricity bills, and where such potential exists, take appropriate action. Final customers must be fully informed by the suppliers of the opportunities, costs, and risks of such dynamic electricity price contract and that suppliers are required to provide information to the final customers accordingly, including the need to have an adequate electricity meter installed. Regulatory authorities shall monitor the market developments and assess the risks that the new products and services may entail and deal with abusive practices.

Also comparison tools have to include dynamic price contracts according to Art 14. Furthermore, Member States should ensure that all beneficiaries of regulated prices are able to fully benefit from the offers of the competitive market when they choose so. To this effect they need to be equipped with smart meters and have access to dynamic electricity price contracts, they should be directly and regularly informed of the offers and savings available on the competitive market, in particular dynamic electricity price contracts, and be provided with assistance to engage with and benefit from market based offers.

Since the new legislation now explicitly requires provisions for the possibility of dynamic prices and the data protection provisions (analysed in task 5.1) are also complied with by law anyway, in the author's opinion there is no need to include a special clause in the supply contracts. Since these new rules on dynamic prices are an EU Directive, they must be transposed into national law by the Member States. If in this context more specific rules are adopted which do not encourage dynamic pricing, the situation would have to be examined more closely in each individual Member State.

6. Conclusions

In this deliverable the main results of PEAKapp with respect to dynamic prices and load-shifting potentials of such an ICT based solution are analysed, further on an overview on current regulatory situation and specifically most widely implemented grid tariffs in European countries are given. Followed by an analysis of the new version of the Directive of the European Parliament and of the Council on common rules for the internal market in electricity (EU/2019/944) and its potential impact on the market uptake of PEAKapp and similar ICT-ecosystems.

Based on the main results of PEAKapp field test, price signals that are transparent and clearly communicated to consumers – for instance lower prices when renewable energy is produced – can cause a change in household electricity consumption. Data collected in PEAKapp provides empirical evidence that households will react to such signals by increasing their consumption in the given periods and in this way can start contributing to increased flexibility of the system and integration of renewables. However, this practice in order to be implemented EU wide should be supported in the regulatory level.

Based on the analysis of the EU-JKU legal team, the Directive of the European Parliament and of the Council on common rules for the internal market in electricity (EU/2019/944) explicitly requires provisions for the possibility of dynamic prices, and full information provision for the consumers. This means that the empirically proven consumer reaction to well-communicated price signals is also supported from the legal perspective. Further on, in the author's opinion based on this new legislation there is no need to include a special clause in supply contracts. Since these new rules on dynamic prices are an EU Directive, they must be transposed into national law by the Member States, which should allow for a fast and efficient uptake and full exploitation of PEAKapp or similar ICT-to-Human ecosystems across member states.

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