# USING TIME-OF-USE TARIFFS TO ENGAGE CUSTOMERS AND BENEFIT THE POWER SYSTEM

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|---|---|
| **Country/region** | **Europe** |
| **Type of E1st approach** | A – In front / General<br>1 – Allowing E1st<br>(Energy market regulation) |
| **Energy carrier(s) targeted** | Electricity |
| **Sector(s) / energy system(s) or end-uses targeted** | Residential |
| **Implementing bodies** | Regulatory authorities |
| **Decision makers involved** | Suppliers, consumers |
| **Main objective(s)** | System integration of renewable energy sources, lower energy bills, reduced supply-side infrastructure |
| **Implementation period** | 1960s – ongoing |

Demand response is key for a renewable-powered future, paving the way for an ongoing integration of variable renewable energies as well as for limiting investments in grid reinforcements and in peak capacity. Time-of-Use (ToU) tariffs are an important enabler of demand response by incentivising customers to shift their electricity use from high- to low-demand periods, allowing them to save on energy expenses while benefitting the power system.

## 1. Background

Demand response is a key flexibility resource in power systems with increasing shares of variable renewable energy (VRE) generation. An important element of demand response is ToU tariffs that incentivise customers to adjust their electricity use voluntarily – either through automation or manually – to reduce their expenses. As the name suggests, the price signals are time-varying, reflecting the marginal network costs and/or

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generation costs of energy in the wholesale market.[1] The price signal can be static or dynamic, or a combination of the two (ACER/CEER, 2016; IRENA, 2019), as illustrated in Figure 1.

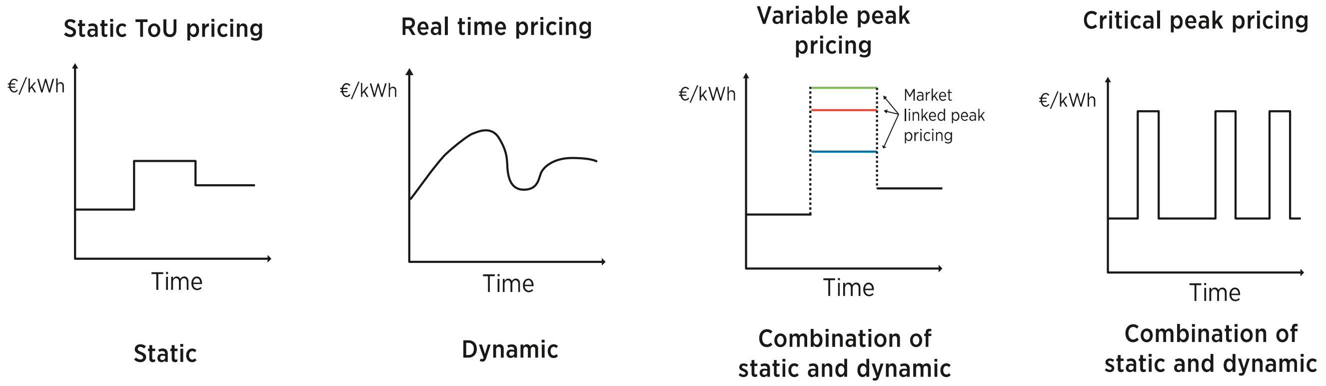



**Figure 1 – Forms of Time-of-Use signals**

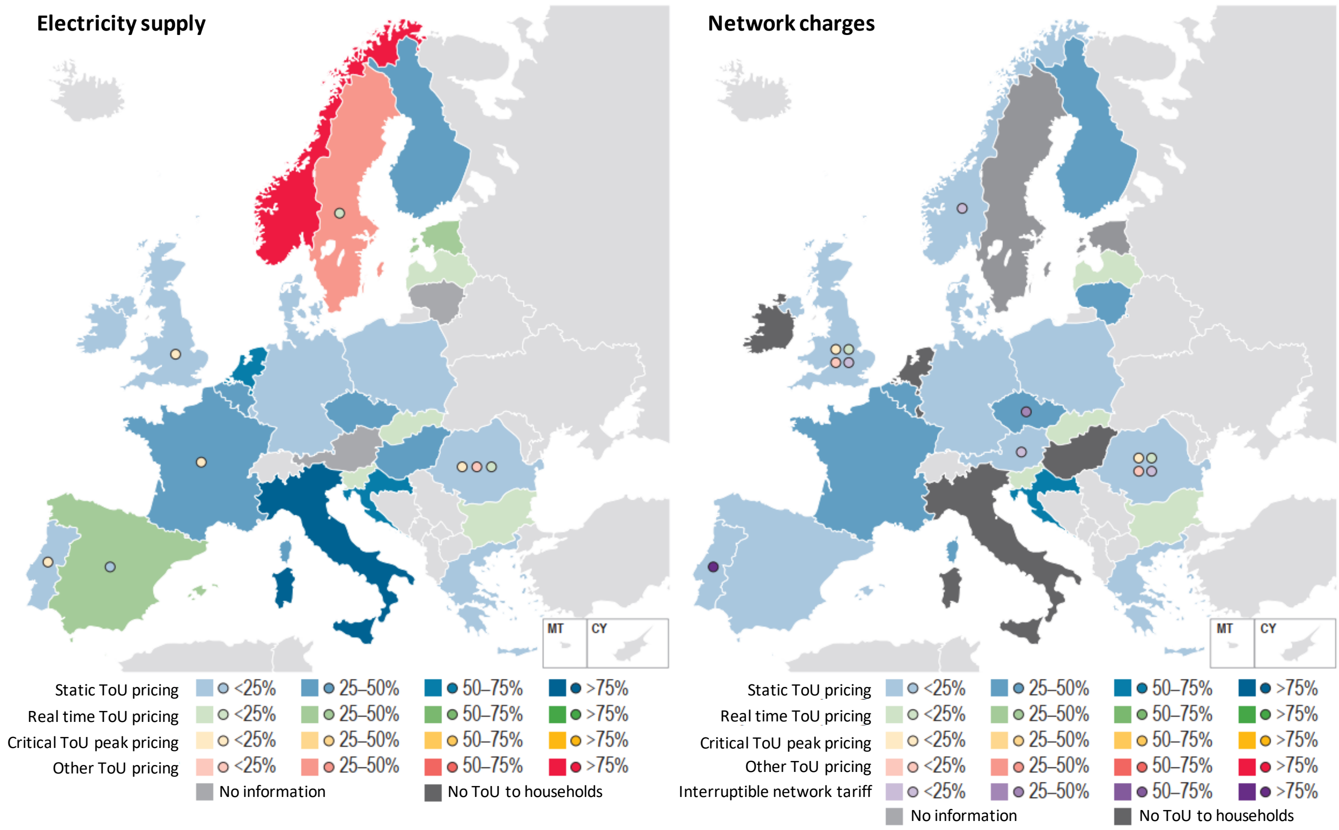
**(Source: IRENA 2019)**

A *static signal* is determined in advance, typically applied to usage over time blocks of several hours for which the price remains constant. This can be simple day- and night-pricing to reflect on-peak and off-peak hours. *Dynamic signals* are determined in "real-time," based on actual system conditions. Prices in a dynamic setting are calculated based on at least hourly metering of electricity use, or within even higher granularity (e.g., 15 minutes). Combinations of static and dynamic signals include *variable peak pricing* (different periods for pricing defined in advance, but price for on-peak period varies by market conditions), and *critical peak pricing* (e.g., the French Tempo tariff[2] in which electricity prices increase substantially only a few days in a year).

## 2. How has the E1st principle (or similar concept) been implemented?

Providing ToU tariffs to customers requires advanced metering devices to track the consumption of individual consumers. If investments in such cost-effective ToU equipment, as well as setting up and operating the overall demand response programmes, is preferred over investments in reserve capacities, network upgrades and other supply-side infrastructure, the Efficiency First principle is met. In terms of actual implementation, many EU Member States (MS) already have wide experience with the different forms of ToU tariffs. Figure 2 illustrates the share of households per country that are supplied under different ToU pricing for electricity and network charges, as of 2015.

[1] Demand response programmes based on ToU tariffs are also referred to as *implicit demand response*. In turn, trading committed and dispatchable flexibility in power markets (single consumers or through "aggregators") is referred to as *explicit demand response* (SEDC 2016).
[2] https://particulier.edf.fr/en/home/energy-and-services/electricity/tarif-bleu.html




*Note: Countries are coloured according to the ToU method that is the most representative. The coloured dots represent additional ToU pricing methods which also appear in a country.*

**Figure 2 – Share of household consumers supplied under Time-of-Use pricing for electricity supply and network charges in European countries**

**(Source: ACER/CEER 2016)**

It is apparent that ToU tariffs are typically applied in the supply of energy rather than in network charges. The most commonly applied type of ToU for electricity supply is static pricing with a day/night differentiation, which has a particularly large share in Italy. Hourly real-time pricing is used predominantly in six European countries: Estonia, Latvia, Spain, Slovakia, Slovenia and Bulgaria. Critical peak pricing is used to a minor extent in different countries, such as in France where the "Tempo" tariff has been chosen by 1.2% of households (Rosenow et al., 2016). Other dynamic pricing methods apply to a large electricity household base in two countries, Norway and Sweden. There, electricity consumers typically incur spot-market-based pricing through the monthly average wholesale price. For example, in Denmark consumers pay for electricity upfront on a monthly basis and face subsequent corrections to reflect the real price paid by suppliers on the spot market as opposed to the forecast price. Similar to electricity tariffs, static pricing is the most common type of ToU pricing for electricity networks, applied in 15 out of 22 countries for which information is available. Overall, electricity tariffs are changing rapidly across Europe with, for example, tariffs favouring residential on-site PV (photovoltaic) for self-consumption becoming more widespread and adding complexity to the system (ACER/CEER, 2016; IRENA, 2019).

## 3. Effects / impacts

ToU tariffs facilitate demand response as, to varying degrees, they reflect marginal generation costs of energy and/or network costs. As such, consumers have an incentive to change their consumption in response to time-based price signals, which can benefit the whole power system (ACER/CEER, 2016). On one hand, demand response programmes based on ToU tariffs have the potential to become one of the most cost-effective flexibility resources in the power system, key to enabling the integration of high shares of variable renewable energy (VRE) generation from wind power and photovoltaics (IRENA, 2019). By shifting demand towards periods of abundant VRE generation and decreasing demand in times of high residual load, demand response can substantially reduce the curtailment of VRE resources and improve the system's reliability. On the other hand, the increasing responsiveness of customers to ToU tariffs enables system operators to save on investments in generation reserve capacities by shifting demand to off-peak or lower-price time intervals. Also, by reducing peak demand, investments in network upgrades can be deferred or reduced (IRENA, 2019).[3]

According to the American Council for an Energy-Efficient Economy (ACEEE), in the U.S. during 2015, about 200 TWh of electricity, or more than 5% of retail sales, were saved due to demand response programmes. This also substantially reduces peak demand. On a median basis, for each 1% reduction in electric sales for a utility, peak demand reductions from demand response programmes are 0.66% of peak demand for the utility. If these trends hold for future years, it would mean that for a utility that reduces retail sales by 15%, peak demand savings will be around 10% (ACEEE, 2017). For the EU, the aggregated theoretical demand response potential at present is estimated to at least a 61 GW for load reduction and to 68 GW for load increase, available in every hour of the year (Gils, 2014). With regard to consumer responsiveness to ToU tariffs, a pilot programme was conducted in Gotland, Sweden. During its initial stage, 23% of total electricity use occurred during the five most expensive hours of the day. In response to the newly integrated price signals, this dropped to 19% and 20% in the first and second year of the programme (World Economic Forum, 2017). The French Tempo tariff – a critical peak pricing tariff launched in the 1990s – has reduced national peak load by about 4%, with households shifting about 6 GW of load daily (Rosenow et al., 2016). Overall, by enabling demand response, ToU tariffs are key for efficient power system operation.

## 4. Changes over time, if any

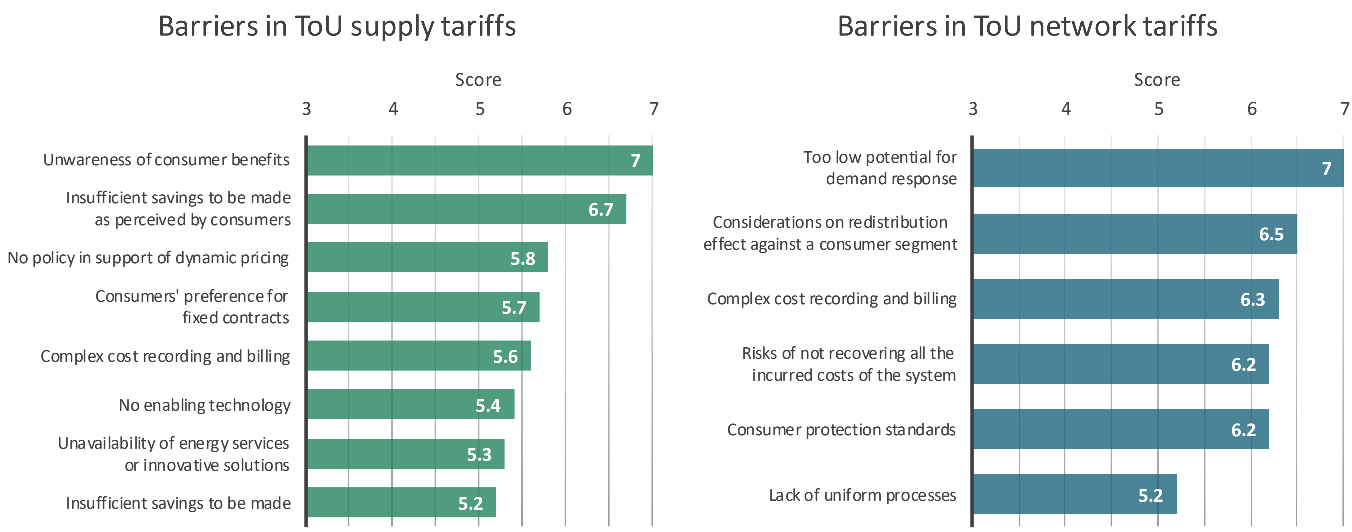
The implementation of ToU tariffs started in Europe in the 1960s when electrical heating became more popular. Static day/night ToU tariffs were used to shift the heating demand to the night when power demand was generally low and affordable. Over time, additional and more complex dynamic tariffs entered the market. The EU policy framework for the development of demand response and associated ToU tariffs in the EU has essentially been provided through the 3rd Internal Electricity Market Directive (2009/72/EC) as well as the Energy Efficiency Directive (2012/27/EU). These required enabling demand response to participate in retail

[3] Note that network dynamics are different from supply dynamics, but they can interact, which makes it challenging to expose consumers to the correct cost-reflective price signals. Under specific conditions, wholesale market and network signals might even be contradictory, sending mixed messages to consumers to reduce their consumption based on the local distribution network congestion, but to increase consumption due to low supply prices. These coordination challenges are a matter of increasing practical experience and ongoing research (ACER/CEER, 2016).

and wholesale markets according to its technical possibilities. As part of the recent 'Clean Energy for All Europeans' package (European Commission 2016), the recast Internal Electricity Market Directive ([EU] 2019/944) and Electricity Regulation ([EU] 2019/943) add provisions that improve the status of demand response. This includes the standing of demand response in capacity markets as well as the role of aggregators in bundling the flexibility of numerous customers (Pató et al., 2019). Yet, considerable barriers facing demand response and associated ToU tariffs persist.

## 5. Barriers and success factors

The adoption of ToU tariffs by consumers is subject to various barriers. Figure 3 provides a ranking of these barriers for electricity supply tariffs (left) and for network tariffs (right). These barriers were identified by National Regulatory Authorities (NRA), several of which have experience in the field with introducing ToU tariffs in their Member States (ACER/CEER, 2016). In electricity supply, a lack of awareness and consumer motivation are the key reasons why ToU pricing in electricity is not applied in many MS. To address this, consumer engagement can be encouraged through consumer information efforts and by designing easily usable dynamic pricing (IRENA, 2019).




*Note: The respondents (NRAs) were asked to rank the barriers on a scale from 1 ('Existence of a barrier which is not at all important') to 10 ('Existence of a barrier which is very important'). The average of the rankings is presented per identified barrier.*

**Figure 3 – Underlying barriers to dynamic pricing in electricity supply and network tariffs to household consumers in a selection of EU Member States**

**(Source: ACER/CEER, 2016)**

However, consumers' monetary savings might still be limited because of weak price signals. These can be explained by the structure of electricity bills. Typically, only one third of the bill consists of the actual energy price; the remaining two thirds represent network costs, taxes and levies. By reducing the tariff components, policy frameworks could significantly support the uptake of ToU tariffs (EURELECTRIC, 2017). Another important barrier to dynamic ToU pricing is the limited availability and the associated costs of enabling technologies. This includes smart meters, controlling devices for household appliances and electricity price communicators, which provide accurate information and allow customers to shift loads without having to follow price signals and manually operate electrical appliances. Given the high initial costs for such automation devices, financial models that combine ToU tariffs with smart home utility leasing could be beneficial for an increasing interest in ToU tariffs (EURELECTRIC 2017; IRENA 2019; ACER/CEER 2016).[4]

## 6. Replicability and scalability potential

Demand response programmes using ToU tariffs can be implemented for various consumer types (residential, tertiary, industry), if hardware, software and market requirements are met. Most important is an advanced metering infrastructure for two-way communication between supplier and consumer. Scaling effects significantly depend on the success of consumer recruitment and the consumers' engagement (IRENA, 2019).

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[4] According to a British survey (Fell et al., 2015), 25% of respondents somewhat or strongly agree to sign up if they were offered a dynamic ToU tariff. This share increases to 29% for dynamic ToU tariffs if a high degree of automation is included. The arrangement most preferred by respondents is direct load control (37% somewhat or strongly agreeing to sign up if offered).

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# ABOUT ENEFIRST

ENEFIRST is a 3-year project funded under the Horizon2020 programme, which gathers a consortium of partners from across sectors and regions: IEECP, BPIE, Fraunhofer ISI, CEU, RAP, IREES, TU Wien.

From definition to implementation, ENEFIRST aims at making the “Efficiency First” (E1st) principle more concrete and operational, better understand its relevance for decision processes related to energy demand and supply, its broader impacts across sectors and markets, focusing on the building sector and related energy systems in EU Member States.

> ***E1st gives priority to demand-side resources whenever they are more cost-effective from a societal perspective than investments in energy infrastructure in meeting policy objectives. It is a decision principle that is applied systematically at any level to energy-related investment planning and enabled by an “equal opportunity” policy design.***

ENEFIRST combines policy analysis and quantitative assessments of E1st impacts to develop policy guidelines and recommendations, following a process with continuous exchanges with stakeholders.

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