TIME OF USE TARIFFS MANDATE

A Report to the Commission for Energy Regulation

December 2012
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EXECUTIVE SUMMARY

CER Scope of work

Time of Use (ToU) electricity tariffs are an integral part of the National Smart Metering Programme in Ireland. Decision Paper CER/12/008 specifies the CER’s intent to mandate electricity time of use tariffs for consumers with smart meters.

To this end the CER commissioned Pöyry Management Consulting to complete an Information Paper that would cover the following:

- An overview of relevant international experience and lessons learned from electricity time of use tariff deployments/mandates.
- Potential options for implementing the mandate of electricity time of use tariffs in Ireland including:
  - scope and nature of the time of use tariff mandate – time of use network tariffs and time of use retail tariffs;
  - time of use tariff implementation strategy – approach and timing options;
  - impact assessment of time of use tariff mandate options on current electricity retail market;
  - consumer engagement strategy for a successful time of use tariff mandate implementation that addresses any potential consumer concerns; and
  - advice to the CER in forming its initial position relating to the time of use tariff mandate policy.
- A high level overview of the potential for new gas tariffs arising from a smart metering implementation, including relevant international references.

The final Pöyry Information Paper on ‘Time of Use Tariffs Mandate’ is appended (Appendix B) and this will now be used to inform the CER-led Tariffs work stream during the High Level Design Stage 2 scheduled for 2013.

Introduction

The Commission for Energy Regulation (CER) mandated Time of Use (ToU) tariffs for electricity residential and small business customers as part of its smart metering roll out in its decision paper of 4 July 2012. The CER commissioned Pöyry Management Consulting to provide interim consultancy advice to the CER in relation to the options and issues which need to be investigated in order for the ToU tariffs mandate to be implemented.

The ToU tariffs to be mandated in Ireland have the potential to create a behavioural shift by putting the cost consequences of choices on when electricity is consumed firmly in the hands of the consumer.

2  Other deliverables from Pöyry Management Consulting include prepayment options paper and information paper outlining changes to customer codes and procedures required in the future
The implementation of ToU tariffs could be an evolution. To succeed, it must achieve changes in consumer behaviour, so consumer acceptance is a pre-requisite for the necessary positive engagement. The degree of acceptance has the potential to improve over time as consumers become more familiar with the concept and the products on offer.

Ensuring the buy-in of various parts of the value chain (DSO, TSO and suppliers) is also essential for the mandate to work in practice.

**ToU tariff options**

**What are the choices?**

We have outlined a series of ‘building blocks’ which represent the major choices available to both industry and the CER in defining how this mandate will work in the future.

The building blocks are the overarching considerations which drive the trade-offs which the CER and the industry have to make in order to successfully deliver ToU tariffs in Ireland. These choices include:

- the temporal separation of the tariffs: the number of time bands which the tariff has could be between 2 and 17,520 in a year;
- the choice of time bands available to the supplier, which includes:
  - *fixed*, meaning the supplier has no freedom in the choice of time bands;
  - *pre-determined*, where the supplier has a limited choice of sets of time bands; or
  - *variable*, where the supplier has the freedom to define their time bands as they choose.
- whether the tariff is dynamic, implying an ability to change prices or time bands at relatively short notice (subject to minimum notice periods);
- whether the TSO and/or DSO are able to influence the behaviour of customers (whether through charges or other signals);
- the use of interval metered data in the settlement process; and
- the means of communication with the customer, whether through the In-Home Display (IHD), web portal or other means of communication.

**‘Straw men’**

We have combined the building blocks in plausible ways to produce five ‘straw men’ alternatives for ToU tariffs that can be evaluated for their efficacy in meeting the objectives of the smart metering programme. The options are described in more detail in section 3. The five ‘straw men’ include:

- **Option 1** – The *classical* ToU tariff which has a similar form to those employed in the RoI smart metering trials. Its features include four fixed time bands that reflect the anticipated variation in wholesale costs. The classic ToU tariff is likely to be more applicable to the residential customer than to small businesses.
- **Option 2** – a limited choice of *Fixed time bands* (pre-determined by the regulator of DSO); which in concept is similar to Option 1 but in which the supplier can choose to offer customers a tariff which has time bands selected from a menu of regimes. Time regimes are available that could show up to five intra-day periods, with further
variation possible between business days, Saturdays and Sundays, and with the seasons (or months). Fixed time bands could be applicable to both residential and small businesses.

- **Option 3 – Critical day or peak pricing** uses the pre-determined time bands as per option 2 but introduces a dynamic feature in that the supplier or the TSO can declare a number of days (or hours) to be ‘critical’ when pre-determined premium prices would apply. The communications channel would be used to communicate the critical periods (with some notice) and would show the prices. This type of tariff could be used to cater for wind lull periods in Ireland (periods, typically during the winter, with low wind output). As an example, the “tempo tariff” (Annex A, international experience) in France enables EDF to declare a limited number of days when premium prices apply. This option could be applicable to both residential and small businesses.

- **Option 4 – Shifting peak** is a time of use tariff where the supplier has flexibility to change both time bands and prices. A peak pricing period can be declared within day subject to a notice period (perhaps 4 hours). There would be limits on the number of peak period calls that could be made, their duration within a day (say 6 hours), and their overall duration within a year (say a total of 200 hours). Network charges that incorporated a similar feature for the purpose of managing local congestion or times of network stress would constitute a variation of this option. The TSO could also provide a signal or message to the end consumer to provide ramping up capabilities via the IHD or other device. Shifting peaks would be applicable to both residential and small businesses.

- **Option 5 – Modified SEM pass-through** exposes the customer directly to price movements in the SEM. The pre-determined part of the tariff structure would now relate mainly to the recovery of network costs, whilst the energy component of the tariff would link directly to the supplier’s liability in the SEM (by assumption at the day-ahead stage, on the understanding that with the implementation of the Target Model a day-ahead market will be introduced). To be truly effective, this option would require a degree of home automation\(^3\). The energy costs would be directly linked to (day-ahead) SEM prices, grossed up for system losses, capacity and imperfection charges (and any imbalance exposure), and effectively displaying the supplier margin transparently to the consumer. The same variant on network charges and TSO possibilities would apply as in Option 4. The modified pass through would be applicable to both residential and small businesses.

**Evaluation**

An evaluation of the different straw man options was carried out which teases out the trade-offs between the different alternatives. The full evaluation can be found in Section 3. An example of the evaluation results is shown here. It should be noted that this is a non-quantitative evaluation and the results are (by design) rather subjective, but the intention is to identify strengths, weaknesses and trade-offs and not to select the ‘best’ option.

\(^3\) Costs of automation were not included in the smart metering CBA – it is assumed here by Pöyry that this type of option will only be viable if automation is cost competitive.
We first assessed the cost savings which can be associated with specific changes in behaviour triggered by different types of tariffs. Figure 1 illustrates how effective each type of option would be at delivering cost savings to the wider electricity system through generating certain patterns of customer behaviour; for example, increasing consumption off-peak can reduce the level of wind curtailment required in the future and therefore generate savings in operational expenditure.

The relative merits of the options are discussed below. Each option is assessed against each criterion.

### Figure 1 – Customer system savings

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Reduce total consumption</th>
<th>Reduce absolute peak demand</th>
<th>Reduce system effective peak demand</th>
<th>Increase the effective off-peak demand</th>
<th>Demand provision of system reserve to TSO</th>
<th>Reduce localised distribution system peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Option #2 - Fixed time bands</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Key

-4 -3 -2 -1 0 1 2 3 4

High savings  High costs
Some insights from evaluating the alternative options in terms of their effectiveness of achieving system cost savings include:

- Reducing total consumption: the alternative time of use options are anticipated to influence the patterns of consumption but not the overall total consumption; however (as found in the trials) increased awareness on the part of the consumer (reinforced by the in-home display) can reduce total demand.

- Reducing absolute peak demand: the more dynamic options (3, 4 and 5) are assumed to be more effective at reducing absolute consumption as the peaks will be targeted to those specific peak hours in the year. Options 1 and 2 will display more averaged peak prices which will be less effective at reducing absolute peak demand.

- Reducing effective system peak: the static tariffs (options 1 and 2) will be able to reduce the system effective peak (peak net of wind) to a certain extent because of the correlation between the absolute peak demand and the effective peak. Dynamic tariffs will be more successful in reducing the effective peak than the static ones, as they are able to change in response to wind forecast. Prices for options 3, 4 and 5 will change to reflect the unpredictability and variability of the system over the year. These changes in prices will be transferred to the end consumer.

Another set of evaluation criteria used was the degree of consumer acceptance which we have separated into a number of issues. Figure 2 provides an overview of the results.
## Figure 2 – Consumer acceptance

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Consumer acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simplicity of tariffs &amp; ease of interpretation</td>
</tr>
<tr>
<td>Option #1 - Classic ToU</td>
<td>2</td>
</tr>
<tr>
<td>Option #2 - Fixed time bands</td>
<td>1</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>1</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>-1</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>-3</td>
</tr>
</tbody>
</table>

**Key**

-4, -3, -2, -1, 0, 1, 2, 3, 4

Easy to accept | Significant consumer resistance
Some insights from the assessment of consumer acceptance include:

- All the options could offer some protection to customers in financial hardship depending on the construction of the tariffs. It is however more difficult if these customers wish to be on the more dynamic propositions as they will be directly exposed to system volatility, especially with critical day or pass-through prices.

- From a behavioural change perspective, we are assuming that options 4 and 5 would require a degree of home automation (and more electrification of heating, hot water and ultimately transport) to be effective, whereas options 1 and 2 would deliver the most proactive behavioural change immediately after roll-out. Option 5 could also include providing signals to the end consumer rather than relying on prices.

- Consumers would be less likely to rebel against fixed ToU tariffs as there is a pattern which can be easily adopted. Consumers in such countries as France and California, where time bands have been fixed, have adjusted to a routine of reacting to the changes in prices. The more dynamic options, 4 and 5, would be complicated to deploy at the start of the mandate as customers might not be able to react fast enough and therefore be ‘penalised’ for consuming at certain times. A degree of home automation is needed for the more dynamic options to be successfully implemented.

The detailed evaluation can be found in Section 3.

The options outlined above represent a number of formats which can be implemented. These forms are, however, by no means exhaustive. The building blocks on the other hand, outlined in Section 2, provide the overarching choices in the implementation of the mandate to successfully deliver ToU tariffs in Ireland.

We therefore use the building blocks outlined in section 2 to provide a view of how this ToU mandate could be implemented in practice.

**Prospective scenarios**

An evolutionary approach could provide time for systems to develop to accommodate more sophisticated tariffs. However, while the DSO would be upgrading the system to allow for half-hourly (HH) settlement; it is by no means a certainty that the data will be available to all parties.

We therefore consider a number of pathways for the implementation of ToU tariffs as shown in Figure 3.
The scenarios all start with fixed or pre-determined time bands in 2015, to raise customer awareness.

**Step 1 – Raising customer awareness**

Raising customer awareness of the time of use cost variation of electricity supply requires smart meters and communications devices to be in place to ensure that the prices are visible to the end consumer. We anticipate this step to involve tariff designs likely to be based on relatively few fixed time periods. Engagement programmes would be required in parallel to educate the customer in relation to the reasons for and opportunities which the ToU tariffs represent for them. The IHD and other communications devices will help to facilitate this awareness.

There would be a licence obligation on suppliers to provide ToU tariffs to customers. The format of this obligation needs to be defined in Phase II.

Whilst the classic fixed ToU tariff would be applicable to the residential customers, it would be difficult to impose a universal tariff on all small businesses. Whether the tariff could be an opt-out or whether the mandate might start at a later stage for small businesses (when a greater variety of ToU tariffs is available) still needs to be defined.

There are a significant number of segments within the small businesses categories. It would be difficult to impose a classic ToU tariff as per the smart metering trial in Ireland on all small and medium sized customers. There are a number of options available to the CER with regards to small businesses:

- skip Step 1 and move to Step 3 where a greater variety of ToU tariffs will be available, therefore delaying the implementation of the mandate on small businesses to 2018; or
allow for an opt-in mechanism for small businesses rather than the mandate.

**Step 2 – Separation of network charges**

Network charges would be separately billed to the customer. There is prospect for the introduction of more sophisticated time of day network charges if appropriate. Customers would therefore see more granularity in all their charges.

**Step 3 – Half-hourly aggregation**

A significant breakthrough is anticipated in 2017/2018.

The extant systems, and any short term development of them to facilitate steps 1 to 2, are predicated on the use of artificial settlement profiles to convert meter advances to a half-hourly allocation of wholesale costs. In the meantime, smart meters have been collecting interval (i.e. half-hourly) data for all customers.

The development of a platform for wholesale market settlement using half-hourly interval data is assumed to become available. Its introduction would need to be in conjunction with developments in supplier and wholesale settlement systems, although both currently handle quarter-hourly (QH) data albeit it in smaller volumes.

Once these systems were installed interval data could be used directly by the:

- supplier for billing;
- DSO or TSO for formulating DUoS or TUoS charges respectively; and/or
- SEMO for settlement (aggregated for each supplier).

This would break through the constraints on the systems. Interval data could now become the bedrock for all activity in the industry. Implementation of this step would be dependent on data confidentiality issues being overcome.

If permitted by the DPC and/or by the customer, access to the data will be available to suppliers and other parties to deliver innovative products and new propositions to customers.

**Scenario α – Customer responds to set bands**

This scenario implies that we stay in a world where fixed or pre-determined time bands are available to customers. Customers know when prices will change. They are used to a fixed routine. If there are a significant number of pre-determined buckets, HH data would be required for settlement purposes. This scenario would apply to both small businesses (pre-determined) and residential customers (fixed and/or pre-determined).

**Scenario β – Customer responds to differentials**

Customers would be able to choose amongst a variety of propositions, some more dynamic than others. They would effectively be responding to differentials between peaks and troughs. How this is implemented in practice would have to be defined.

This scenario allows the TSO, albeit perhaps through other parties, to access a demand side response for the purposes of better managing the security of the system. Electric vehicles and heat pumps could be better integrated. Customers would be using electricity off-peak when charging their electric vehicles for example, leading to a
reduction in the curtailment of wind generation capacity. This pathway would apply to both residential customers and small businesses.

**Scenario y – Customer is a proxy market participant (based on D-1 prices)**

Customers would have access to the day-ahead wholesale prices, assuming that the SEM was amended to include day-ahead trading in accordance with the European Target Model. (Note that this would still expose the supplier to within-day or imbalance prices to the extent that the total consumption in each half hour does not match their expectations).

Consumers are now a participant of the value chain. There is no regulation with regards to the propositions which are available to them. Customers are (semi-)active participants in the value chain, automating their homes, determining when to consume electricity, e.g. charge their electric vehicles, based on (day-ahead) prices. They may help to reduce the overall requirement for peak generation capacity by providing demand response. They are also able to contribute to the reduction in wind curtailment by consuming electricity off-peak at high wind periods in response to market prices.

We have provided an implementation vision as part of Section 4, implementation strategy, which shows that the CER will probably have to regulate the first few years of the ToU tariff implementation to ensure customer confidence but that the market should prevail and suppliers should be able to offer new and innovative products to customers once the systems and the technology are in place.

**International experiences and consumer engagement**

**Consumer engagement**

The consumer engagement aspect is of significant importance to the successful delivery of ToU tariffs. The success of the pilot schemes does not necessarily imply that the overall roll-out will be successful, especially as ToU tariffs will be mandated. Consumer engagement will therefore be crucial.

In the Irish context, communications campaigns should be carried out ahead of the introduction of the mandate to ensure that customers understand the concepts and understand how it could impact on their lives. A successful campaign will contribute towards consumer acceptance.

**Consumer acceptance is key**

Ontario Canada has mandated ToU tariffs for residential and small business consumers. The customers moved from a tiered tariff to ToU pricing. The tariffs form part of a regional end-to-end energy efficiency action plan. This strategic plan has been successfully communicated to the public over the course of 3 years ahead of the implementation of the tariffs. Specific goals were set to bolster customer awareness and understanding which included amongst others:

- how many consumers should sign onto their interactive website (10% of customers);
- the level of consumer awareness of the tariffs (80% of customers); and
- the number of neutral media stories (10 neutral (neither positive or negative) stories on ToU).

The success rate for the objectives was measured. This represents an excellent way to keep track of the needs of the customer and incorporate their feedback and views in the schemes being deployed.
Successful rates provide a clear signal

In a national ToU rollout, pricing signals must be clear and consistent to ensure adequate impact. In California, France, Arizona and others markets where Critical Peak Pricing (CPP) is offered, the time bands have been consistent and consumers have related well to those routines.

In the Irish context, we note the challenge which wind generation will bring in terms of making the timing of the critical periods less predictable. This will need to be overcome, perhaps through a combination of education and automation.

Dynamic tariffs, (including TSO signals) have not been trialled to date and we recommend that a trial be carried out using available automation technology to better understand the impact of dynamic prices on the end consumer.

Feedback and ToU

Feedback is an integral part of a successful ToU programme. In fact consumers in pricing programmes which do not include feedback and education, will sometimes increase their total consumption (when electricity is cheaper) while still lowering consumption during peak hours.

Multiple communication and engagement channels

Our research indicates that ‘more is more’ at every stage of the roll out process. For example, marketing programmes using consumer segmentation to create targeted messages for a range of consumer groups increase consumer uptake and results. Feedback and pricing together achieve better long-term overall results than any programme type alone. Education improves dynamic pricing schemes and informative billing programmes. Different types of information on an IHD or a bill tends to achieve better results than a simple display or one message on a bill.

Successful feedback and pricing programmes begin an important cycle of learning for consumers providing them with tools to better understand the connection between behavioural choices, consumption and cost. The feedback experience is outlined in Annex A.

Gas ToU tariff options

A number of high level gas ToU options have been outlined using the same building blocks as for electricity ToU tariffs. Gas ToU tariffs contributed to the positive smart metering cost benefit assessment by reducing overall consumption of gas. The possibility of gas ToU tariffs will be considered further during Phase II of the smart metering roll out.

- Option 1 – Classic ToU is similar to the one used in the smart metering trial and includes six or twelve fixed monthly time bands and shippers are able to choose one or the other. The tariffs would be fixed and pre-determined for the length of the contract with the customer.
- Option 2 – Variable gas tariff has twelve monthly time bands which would reflect a price for every month. The tariffs would be more variable in that the contract between the shipper and the customer would specify a particular goal with regards to

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4 Bi-monthly tariffs were used in the trial
a maximum level of consumption for the month (block tariff). Any gas consumed above the specified level would be charged at a different (higher) price.

- Option 3 – Daily pass through which would be a daily pass through of the gas price to the end consumer. The tariff includes 365 time bands which would reflect a price for every day which would match the daily settlement in line with the gas wholesale market.

A variant on this option would include customers being incentivised to target a particular threshold with regards to their consumption of gas. Above a certain level of daily consumption, they would be charged a different price which would be the daily price plus a premium.
1. INTRODUCTION

1.1 Background

The Smart Metering Programme Phase 1 was established in late 2007 with the objective of setting up and running smart metering trials and assessing their costs and benefits, as part of this process the National Smart Metering Programme (NSMP) was launched. The key deliverables from Phase 1 were the electricity and gas smart metering trials findings reports and cost-benefit analyses reports which were published by the CER during 2011.

Following the completion of Stage 1 the CER launched Stage 2 of the NSMP. Phase 2 of the smart metering roll out relates to planning, requirements, definition, procurement and selection. The CER has been working with stakeholders to formally mobilise and initiate Phase 2 of the NSMP, which is intended to last two years as shown in Figure 4 and will require numerous consultations with key stakeholders.

Time of Use (ToU) electricity tariffs are an integral part of the National Smart Metering Programme in Ireland. Decision Paper CER/12/008 specifies the CER’s intent to mandate electricity time of use tariffs for consumers with smart meters.

To this end the CER commissioned Pöyry Management Consulting to complete an Information Paper that would cover the following:

- An overview of relevant international experience and lessons learned from electricity time of use tariff deployments/mandates.
- Potential options for implementing the mandate of electricity time of use tariffs in Ireland including:

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- scope and nature of the time of use tariff mandate – time of use network tariffs and time of use retail tariffs;
- time of use tariff implementation strategy – approach and timing options;
- impact assessment of time of use tariff mandate options on current electricity retail market;
- consumer engagement strategy for a successful time of use tariff mandate implementation that addresses any potential consumer concerns; and
- advice to the CER in forming its initial position relating to the time of use tariff mandate policy.

- A high level overview of the potential for new gas tariffs arising from a smart metering implementation, including relevant international references.

The final Pöyry Information Paper on ‘Time of Use Tariffs Mandate’ is appended (Appendix B) and this will now be used to inform the CER-led Tariffs work stream during the High Level Design Stage 2 scheduled for 2013.

The work carried out has generated a number of insights and will provide the industry and the CER with a framework to develop their arguments and the models to be implemented in the future. This particular paper looks at options for ToU tariffs.

1.2 Context

ToU tariffs are intended to provide public benefits by eliciting changes in customer behaviour that reduce consumption and encourage more efficient (and effective) use of energy. These goals have an impact on the different entities in the supply chain as they pursue their own commercial objectives:

- Generators could see a reduction in the usage of their thermal plants resulting in reduced investment in peaking plants. There could also be a reduction in the curtailment of wind generated output as the system is managed more efficiently.
- The system operator could see merit in marshalling a demand side response as a source of reserve, and more efficient balancing of electricity production with consumption.
- The transmission owner might see benefit from reduced demand leading to a deferral or avoidance of network reinforcement otherwise required.
- The distribution owner could see features in ToU tariffs as beneficial if they reduce their system losses, permitted a more constant use of assets, and reduce the need for investment in distribution network reinforcement.
- Suppliers might find advantage in a ToU tariff framework in order to better hedge their exposure to wholesale electricity prices. There could also be competitive advantage through delivering more innovative propositions to the end consumer, including a variety of pricing propositions.

From a customer’s perspective, more sophisticated pricing signals and information for the customer should encourage greater efficiency in energy use, an effective reduction in electricity demand, a switch towards patterns of consumption which are cheaper to serve and have lower carbon emissions.

With ToU tariffs, customers will have access to more information on the cost of their electricity. They should be able to see a change in their patterns of consumption with the more transparent prices resulting in lower bills.
1.3 **Objective of report**

The Commission for Energy Regulation (CER) has mandated Time of Use (ToU) tariffs as part of its smart metering roll out in its decision paper of the 4 July 2012.

The CER has commissioned Pöyry Management Consulting to provide interim consultancy advice to the CER in relation to how this mandate could be implemented. The advice includes providing the CER with an understanding of:

- the choices which need to be taken into account when considering the implementation of the mandate;
- the options for ToU tariffs which could be considered in delivering this mandate;
- the pros and cons of the different types of options;
- the challenges which will be faced by different parties with the implementation of the mandate; and
- the consumer engagement strategy which would need to be carried out for the implementation of ToU tariffs to be successful.

1.4 **Structure of the report**

The report is structured as follows:

- Section 2 examines the various building blocks that could be used to construct a ToU tariff. This section also looks at the systems and in home displays (IHD) or customer communications that would be needed to make the tariffs real to the consumer.

- Section 3 suggests ways in which the building blocks could be combined into five ‘straw man’ options for ToU tariffs. These representations have the purpose of illustrating how specific features in a ToU tariff would function in a practical application. They are not intended to be taken as concrete proposals for the mandate. This section also evaluates these options against their ability to meet the objectives of the smart metering programme. This evaluation is qualitative but provides an insight into the effectiveness of the features in each of the formats and the constraints on different formulations.

- Section 4 outlines an implementation strategy, building a pathway for a possible mandate that recognises the capability of the existing systems, but also proposes specific developments that would be required for the pathway to be effective. This section of the paper provides an overview of some of the regulatory issues that will need to be addressed in the implementation of a ToU tariff mandate as well as an understanding of the consumer engagement strategy which will need to be carried out in order for the mandate to be successful.

1.4.1 **Sources**

Unless otherwise attributed the source for all tables, figures and charts is Pöyry Management Consulting.
2. TIME OF USE TARIFF BUILDING BLOCKS

2.1 General principles

Electricity is a complex commodity. The costs of its supply can vary both temporally and with other parameters, such as location and the voltage of delivery. Customers do not see the full cost of electricity at any one point in time as they have access to averaged prices.

The costs to be recovered from the customer comprise the following:

- Energy purchased by the supplier in the **wholesale electricity market** for the purpose of meeting customer demand. This cost is incurred on a half hourly basis and can show considerable variation both diurnally, with day of the week, and seasonally. It is driven by the structure of the Single Electricity Market (SEM) where prices are derived from the costs of the marginal generation needed to meet demand in any settlement period. In addition, the SEM adds an administered capacity cost which varies by half hour, the demand charge being based on demand forecast\(^6\).

- In addition to these SEM costs the supplier may incur **hedging costs** that stabilise the volatility of the SEM prices.

- The costs of the **transmission and distribution networks** that transport energy are of a different nature. They comprise the capital costs of reinforcing and renewing transmission and distribution assets, and the costs of operating and maintaining these networks.

- The **cost of balancing** the system is met by the Transmission System Operator, EirGrid, which has responsibility for ensuring that the supply of electricity meets demand at all times. An imperfection charge by the system operator covers the costs of stabilising the physical imbalances between consumption and production and provides for a reserve of generation (or demand response) to secure the system and resolve transmission constraints.

- In addition to the above, there are other costs of electricity supply which include the **costs of administering supplies**, the measurement and **billing** of energy and any **levies** and impost that fund specific low carbon or energy efficiency policies.

2.1.1 Electricity tariffs and their construction

Traditionally, residential retail tariffs have been simple in their construction. Such an approach masks the true cost of the energy from customers (especially at peak times) who are then likely to make sub optimal economic decisions in the manner in which they use electricity. A simple tariff also leads to inequitable treatment between customers,

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\(^6\) Capacity payments are made to generators based on their outturn availability in each half hour (with adjustment for transmission losses). Capacity charges are levied on suppliers based on their metered consumption in each half hour. Although there is a balance between the total capacity payment sum paid to generators and received from suppliers in each month, the ‘capacity prices’ for generation and demand within each half hour in the month will follow different patterns.

The calculations for capacity charges to suppliers are more straightforward, and are singularly dependent on the ‘fixed’ element. These values are determined by the market operator in advance of the capacity period in each year and are therefore far more predictable (and less responsive to system conditions) than the generator capacity payments.
since some will be subsidising others at times that are unbeknown to both. Customers are therefore not able to see and experience the actual cost of electricity, preventing them from making informed choices.

A simple tariff also precludes opportunities for the supplier and others to make use of customer demand to manage the system more efficiently.

ToU tariffs provide a potential platform for addressing these shortcomings. The effectiveness of a tariff in these respects is weighed against its complexity and lucidity to the customer.

ToU tariffs will provide customers with exposure to the actual cost of electricity. They will be able to make informed decisions on the basis of the prices they see, deciding whether and how much to consume. This ability will shift the balance of power to the end consumer, ensuring they become participants in the value chain instead of a passive link in the process.

The CER decision on the functionality for a smart meter specifies that it should be capable of facilitating a minimum of three types of tariff: energy import tariffs, energy export tariffs and network tariffs.

Separating energy from network tariffs is a useful step given the different nature of the costs. The present recovery of network costs has tended to be straight jacketed by the mechanisms for energy cost recovery in the tariff.

There are a number of choices or building blocks which need to be taken into account when creating ToU tariffs.

### 2.2 Building blocks

Pöyry has defined six building blocks that can be employed in the construction of a ToU tariff. These are illustrated in Figure 5 and described below.

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7 Decision on National Rollout of Electricity and Gas Smart Metering; CER 12/008, page 67
2.2.1  **Time Resolution**

The first building block is the temporal separation that would be incorporated. The number of time bands could be anything between 2 and 17,520 half hourly bands for each tariff in a year depending on the construction and type of tariff.

An electricity tariff could average the expected half hourly energy costs of the SEM together with any hedging costs into longer time periods, although the availability of hedging products may constrain the choice of time periods and their duration.

In deciding the appropriate duration of the time block across which costs would be averaged, consideration needs to be given to the likely customer response to the price signal. This in turn is likely to depend upon the nature of customer use at different times of the day as customers might want to see more or less granularity in their time bands.

2.2.2  **Fixed, pre-determined or variable building block**

This building block is concerned with how fixed, pre-determined or flexible the time intervals of the ToU tariff are and therefore with how much freedom the supplier has in defining the time bands:

- **Fixed** implies that suppliers do not define the time bands at which they will sell peak and off peak electricity to their customers. The time bands will be defined in advance.
- **Pre-determined** relates to a choice of time bands. Suppliers cannot move the time bands themselves but are able to choose from a selection which has already been fixed in advance.
- **Flexible** means that suppliers have the freedom to determine their own time bands and are therefore able to sell unique products to their consumers.
With fixed or pre-determined time bands, customers will learn when prices change as the time bands remain constant. With more variable time bands, customers experience more unpredictability in their tariffs.

### 2.2.3 Dynamic features in tariffs

To make the tariff more responsive to market and system conditions, a ToU tariff could incorporate more flexible features designed to encourage a demand response at times of system stress. Dynamic features mean that suppliers are able to change the tariffs at different points in time, subject to giving customers enough notice. The notice period and the frequency with which tariffs change will be agreed between the suppliers and the customers in advance.

### 2.2.4 TSO/DSO charges and influences

Our fourth building block is concerned with the use of system network charges and the prospect for interventions by the system operator. Network charges typically represent around one third of the overall cost for non-interval metered customers. Thus whilst not as dominant as the energy component of the tariff it is desirable that these costs are reflected separately so that the representation of one does not subvert the other. Furthermore a significant part of network costs are either invariant with time, or reflect the recovery of sunk investment which might better utilise a non-ToU charging base.

Separating network and energy charges would also allow the avoidable costs of energy to be readily distinguished and facilitate the formulation of tariffs for the purchase of energy from generators embedded in the distribution system.

The two way communication capability of a smart meter creates opportunities for the system operator or supplier to intervene more directly in the ToU charging arrangement in a more direct fashion. This may be as a result of a supplier acting as an aggregator of load for demand management purposes, offering a reserve service to the system operator, or mitigating local congestion for the DSO. Whilst this paper does not offer any definitive ideas in this respect, the separation of network charges would create a platform for these possibilities. In principle the network charges could also have greater or lesser time resolution, and could employ dynamic features.

Customers will be provided with a message or alert which will trigger a response. Whether this response is automated or manual will depend on the consumer, on their tariffs and on the equipment available within their homes. Customers will be financially rewarded (could be through a rebate) for reducing or increasing demand when required.

### 2.2.5 Use of interval metered data in settlement

At present, a supplier’s liability for the wholesale costs of its customers that have non-interval metering is determined by applying an average profile of demand that allocates the metered consumption over a specified period into half hours. Artificial settlement profiles are sampled from urban and rural residential customers, and small businesses for unrestricted and day/night tariff groups. The relevant artificial settlement profile is then applied to all customer meter reads to allocate their consumption into the SEM half-hourly settlement periods.

A difficulty with suppliers encouraging their customers to reduce or shift their consumption of electricity by way of a ToU tariff is that the reduction in revenue from the transfer of use to off-peak times, assuming the tariff is successful in this respect, will not be offset by a reduction in the wholesale cost if the artificial profile is then applied. Therefore, suppliers
will face a net cost, if they are successful in modifying their customers' behaviour more than the average. To avoid this issue, and for the tariff to remain reflective of the underlying costs, a new assumed settlement profile would need to be described for each ToU tariff formulation that would represent the change in consumption behaviour the tariff had elicited. These profiles can only be created once the tariff has been implemented using a sample of customer actual ex-post data.

ToU tariffs that embodied dynamic features such as critical days or shifting peak prices would need to make use of profiles derived on an ex-post basis to reflect the change in the pattern of consumption that the dynamic feature had caused. Finding a methodology for this and applying it in settlement timescales is likely to be particularly onerous. This leads to the conclusion that the direct use of half hourly metered data in settlement would be needed for these forms of tariff to be effective. The more variation there is between the tariff offerings of the individual suppliers, the greater the need to use half-hourly metered data in settlement in order to avoid giving perverse incentives to suppliers.

2.2.6 Visibility to customer: IHD and energy statements

The smart metering trials have demonstrated that for a ToU tariff to be effective in changing customer behaviour it is necessary for the customer to be continually aware of the price being paid at any time. Only then can there be a direct engagement by the customer with the tariff features. Furthermore there could then be a direct linkage between a ToU tariff and the functioning of appliances without recourse to the customer as home communication and control systems (HAN) are implemented.

The smart metering trials used various devices for the purpose of informing the customer of the ToU tariff prices. These included stickers and fridge magnets to remind the customer of the rate applying at any time. The decision following the trial was that an IHD should be a part of the mandate for an interim period on the grounds that the NPV of the cost benefit analysis for providing this equipment was positive.

It would appear that the design of the IHD initially mandated will be relatively simple and the device will be temporary (maintained for two years). Other means of communication, e.g., web portals or other communications equipment (which could include IHDs) will be used to communicate with the customer after the first two years. At present, apart from the IHD, there are no plans to mandate additional communications channels.

Suppliers who offer more sophisticated ToU tariff formulations (e.g. dynamic prices) would need the IHD and/or other means of communication for the tariff information to be visible to their end consumers and to inform the customers of any changes in prices. If significant investment is required for this purpose it implies there would need to be a more enduring contract between supplier and customer than is currently the case.

Communications channels and equipment are essential to ensuring changes in consumer behaviour. Consumers will see the prices they are exposed to at different points in time, triggering changes in their behaviour. The more flexibility and variety there is with regards to the channels of communication, the more customers are able to respond to the needs of the system.

Customer engagement is also to be won by the provision of an energy statement. The chosen channel for this is as yet undecided but it would appear that there are a number of electronic possibilities that would allow a customer to see the history of its energy consumption and correlate this to price, weather and other parameters.
2.3 Combining the building blocks

When producing our ToU tariff options that can be evaluated for its efficacy in meeting the objectives of the smart metering programme, we have combined these building blocks with regard to a number of considerations. These are set out below.

2.3.1 System constraints – IT viewpoint

It is assumed that all meters will be capable of recording half-hourly consumption. It is recognised that access to these records may not be available to all parties straight away. If consent is not granted by the DPC and/or the customer, the data will not be available at all.

There are therefore options which can only be considered once the half hourly data can be confidently passed on to numerous parties. The systems need upgrading for the transfer of metered data for wholesale aggregation in relation to settlement and billing purposes and the provision of data in any consumption report to which the customer has access.

At the start of the ToU mandate, dynamic tariffs which require half hourly settlement would be an unlikely possibility until the systems have been upgraded.

2.3.2 Customer behaviour – a learning process

The success in engaging customers will need to have regard for the likely learning required to gain familiarity with the ToU concept, and how any information necessary for the functioning of the tariff can be communicated. The IHD or other communicating device will help this engagement with the customer.

The concept of ToU tariffs is a learning curve for the customer and adapting to a simpler tariff at the outset may be a good prelude to the introduction of more complicated tariffs.

2.3.3 Smart automation – dynamic pricing

In a world where tariffs are being continuously updated, it is anticipated that reflecting the SEM half hourly prices in ToU tariffs would facilitate the introduction of automatic switching of some home applications (and local storage, e.g. of hot water). Therefore a degree of home automation is expected before more dynamic tariffs can be introduced effectively. The basis for this assumption is that customers will not necessarily be glued to their communications channels, responding to prices on a half hourly basis.

2.3.4 Regulation viewpoint

The smart metering roll out introduces a number of changes as far as the customer is concerned and the ToU mandate needs to be carefully crafted to safeguard the best interests of the end consumer and to minimise the risk of a consumer backlash.

Once consumers are comfortable with the concept, suppliers could be provided with more flexibility to innovate and provide new products and services (dynamic tariffs).
3. **TARIFF POSSIBILITIES AND EVALUATION**

3.1 **Tariff Options**

The following five ‘straw man’ tariff formats are presented for the purpose of exploring the practicality of their features and effectiveness in delivering the objectives of the programme. It is important to stress that these forms are illustrative rather than definitive. The five formats use the building blocks outlined above in their construction.

### 3.1.1 Option 1 – *Classic ToU tariff*

The “classic” ToU tariff has a similar form to those employed in the RoI smart metering trials. Its features include:

- Four time bands that reflect the anticipated variation in wholesale costs. These would be designated as peak, day, shoulder, and off-peak and apply across the year.
- Mandated time bands that are fixed and would apply to all suppliers. All customers would see one tariff structure.
- Network charges would be shown separately from energy rates and could provide an option for intervention by the DSO/TSO.
- Three separate settlement profiles would be derived for Urban Domestic, Rural Domestic and Small Business customers (if applicable) and used to determine the wholesale market liability in settlement. They would reflect the changed customer consumption pattern that resulted from the tariffs features.
- The IHD would simply display the variable tariff rate that applied at any point in time.
- Customers could change their supplier with the same frequency as at present.

This tariff would apply to residential customers. Whether it can be equally applied to all Small and Medium Sized enterprises (SMEs) is to be debated. There is a wide variety of SME types in Ireland and a ‘one size fits all’ approach might not be appropriate for SME customers.

This tariff is illustrated in Figure 6.

**Figure 6 – Classic Time of Use tariff**

The Irish load curve displays a pronounced evening peak in demand that coincides with the onset of the lighting load – typically between 17.00-19.00 on a winter weekday. This peak is at its earliest in December and January but drifts later in February and March.
This daily peak demand is illustrated in Figure 7 which shows the average demand in MW for each hour of every day (24 hours) in the months of January and July for both 2011 and 2012. The chart shows that the demand peaks between 17.00 and 19.00 in winter.

Figure 7 – Peak times occurring between 17.00 and 19.00

In the RoI smart metering trial\(^8\) a three rate structure was employed with the peak confined to just two hours (17.00 to 19.00) as illustrated in Figure 8.

The trial investigated a number of tariffs in which the peak rate was a multiple of between 1½ and 3 times the day rate. Whilst the peak price created a significant reduction in demand the response between these multiples was not statistically significant suggesting that it was the customer’s awareness of the charges rather than the magnitude of the price differential that elicited the demand reduction.

Elsewhere ToU tariff rates offered to customers have tended to be designed to address specific aspects of the load curve. The Ontario Hydro ToU tariff extends for 6 hours and is more diffused than the Irish trials, having a premium of just 17% over the adjacent

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\(^8\) Electricity Smart Metering Customer Behaviour Trials Findings Report; CER 11/080a
rates. It applies during summer months and reflects the dominance of air conditioning in the load curve at those times.

### 3.1.2 Option 2 – Fixed time bands

In concept the second option is similar to Option 1 but now the supplier can choose to offer customers a tariff which has time bands selected from a menu of regimes. The multiplicity of sub-options in this category would be greater than in Option 1. The time bands would be fixed in advance by the regulator or the DSO. The features of this option are:

- A choice by supplier of time bands from a mandated and predetermined menu. Customers would have access to propositions constructed from the time bands chosen by their preferred supplier.
- Time regimes that could show up to five intra-day periods, with further variation between business days, Saturdays and Sundays, and with the seasons.
- Network charges would be applied separately from energy rates.
- Settlement profiles would now be required for each menu selection and would reflect the average consumption pattern for customers with that tariff formulation. The profile of metered consumption by customers would not be used in wholesale settlement.
- An IHD or other communication device that would maintain customer awareness of the tariff rate at any time.
- Customers would be able to change supplier with the same frequency as at present.

This tariff could apply to both SMEs and residential customers. A number of buckets of pre-determined prices will be available which might suit some types of small businesses. This tariff is illustrated in Figure 9.

### Figure 9 – Fixed time bands

![Fixed time bands diagram](image)

### 3.1.3 Option 3 – Critical day or peak pricing

This tariff framework introduces a dynamic feature that is intended to introduce a measure of demand side management. Under this arrangement the supplier can declare a number of days or a number of peak hours to be “critical” when premium prices will apply. This
type of tariff could be used to cater for wind lull periods in Ireland (periods, typically during the winter when the wind is not blowing). With increasing wind penetration, wind lull periods will result in higher prices as less efficient generation capacity will be needed on the system to cater for these infrequent events.

These critical days would be designed by either the supplier or the TSO. The arrangement would include:

- Disaggregated fixed time bands as in Option 2.
- A limited call, say 20 in the year, of the number of “critical days” which must be advised day-ahead; OR
- A limited number of hours based on the fixed time bands in Option 2 when peak pricing could occur.
- Separate network charges as in Option 1.
- With appropriate commercial arrangements in place, the TSO might have the ability to call the critical peaks.
- The aggregation of half-hourly metered data would be used in wholesale settlement.
- An IHD or other communications devices would relay critical day messages as well as informing customer of the relevant rates at any time.
- Customer contracts would now have a fixed term (possibly 1 year) to ensure that there could be full compliance with the tariff features as there would be a maximum number of critical days which would be called on in the year.

Again, this type of tariff could apply to both SMEs and residential customers.

Critical day pricing is illustrated in Figure 10.

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**Figure 10 – Critical day or peak pricing**

By way of illustration the “tempo tariff” in France enables EDF to declare a limited number of days when premium prices apply. The objective of this arrangement is to curtail demand on days when it is expected that cold weather will cause a surge in electric heating load that could prejudice the security of the system. The tariff requires notice to be given of these days, usually through an In Home Display (IHD) the evening before the expected period of system stress. Customers understand the tempo tariff and have reacted well to the signals over the years.
An alternative to this approach would be a ToU tariff that offered rebates to customers who could reduce demand when such periods were anticipated. A call for load reduction would be needed for the price discount to apply. Typically the call would be limited to a maximum number of hours in the year.

By encouraging a demand side response these forms of ToU tariff could be useful in providing a source of reserve for the system operator, hence reducing the cost of the system to the end consumer.

### 3.1.4 Option 4 – Shifting peak

The approach in this ToU tariff is similar to the critical day format of Option 3 in that it incorporates a dynamic feature that can engage customer participation in a demand side response. However, in this case the tariff format permits the supplier to designate a period within the day as a peak period. The supplier would use this feature to back reserve arrangement with the TSO, or for its own energy hedging purposes. The features of this arrangement are:

- A basic framework of time of use periods as in Options 2 and 3.
- A peak pricing period that can be declared within day subject to a notice period (perhaps 4 hours).
- Limits on the number of peak period calls that could be made, their duration within a day (say 6 hours), and their overall duration within a year (say a total of 200 hours).
- As in Option 3 settlement profiles for customers covered by this arrangement would be determined ex-post, or more likely half-hour aggregation of metered data would be needed for settling wholesale costs.
- The IHD or other forms of communication equipment in this arrangement would be needed for both alerting the customer to a forthcoming peak period as well as indicating the relevant and forthcoming tariff rates at any time.
- As in Option 3 this form of ToU tariff would need to be incorporated in a term contract that committed the customer to be supplied under the arrangement for a minimum period, perhaps 1 year.
- Network charges incorporating a dynamic feature for the purpose of managing local congestion at times of network stress would constitute a variation of this option. The TSO could provide a signal or message to the end consumer to provide reserve at times of demand ramping or when generation faces forced outages.

SMEs and residential customers could both benefit from this type of tariffs. This type of variable and dynamic tariffs might suit some types of small businesses which are more flexible by virtue of their activities. If they were able to follow the wind patterns, whether through storing heat or electricity at various points during the day; this type of tariffs could deliver a competitive advantage to some parties.

A shifting peak option is illustrated in Figure 11.
3.1.5 **Option 5 – Modified SEM pass-through**

The fifth option considered here steps back from the traditional features of an electricity tariff in that it provides an opportunity to expose the customer directly to price movements in the SEM. The pre-determined part of the tariff structure would now relate mainly to the recovery of network costs, whilst the energy component of the tariff would link directly to the supplier’s liability in the SEM (by assumption at the day-ahead stage, on the understanding that with the implementation of the Target Model a day-ahead market will be introduced).

The approach may have increasing relevance when customers gain familiarity with the ToU principles, and if and when ‘HAN automation’, local storage and microgeneration become prevalent. The features of this arrangement are:

- An assumption that wholesale prices will be available from day ahead trading rather than solely at D+4 as at present as per the requirements of the Target Model.
- Energy costs that are directly linked to (day-ahead) SEM prices, grossed up for system losses, capacity and imperfection charges (and any imbalance exposure), and effectively displaying the supplier margin transparently.
- Network charges are now the major part of the predetermined proportion of the tariff and could incorporate dynamic features if appropriate (for example, a signal/message sent by the TSO to provide a ramping reserve capability).
- Changes in behaviour could occur through a signal or message sent directly to the end consumer as opposed to price changes (as the customer will become an active participant of the value chain).
- Aggregation of half-hourly metered data would be required for wholesale market settlement.
- Suppliers could offer hedged prices in place of the pass-through day-ahead SEM prices but would need to indicate the hedging cost in the offering.
- The IHD or other communications device would be needed to relay the day-ahead prices to the customer, and link to any HAN applications that are responsive to price.

SMEs and residential customers might be interested in taking on the wholesale market risk with the pass-through. SMEs would be less likely than domestic customers to have automated processes which can be switched on and off. However, the reduction in hedging costs might make this type of offering competitive for small businesses.
The modified SEM pass-through option is illustrated in Figure 12.

Figure 12 – Modified SEM pass through

Source: Pöyry Management Consulting, SEMO

3.2 Evaluating the options

Pöyry has evaluated each of the options outlined above using a set of evaluation criteria. The detailed description of the evaluation criteria is outlined in Annex B.

The evaluation carried out is qualitative and addresses the trade-offs between the different choices in defining how to implement this mandate. By definition, the analysis is subjective; the intention is to draw out differences, not to present scores. The analysis does not constitute an indication of which ToU tariff options should be implemented by the CER.

As outlined in Annex B, we have used two sets of evaluation criteria to assess the ToU tariff options:

- The first set of criteria relates to the customer system savings which can be achieved by providing an incentive for different customer behaviour. These criteria are:
  - reducing total consumption at all times;
  - reducing absolute peak demand;
  - reducing system effective peak demand;
  - increasing the effective off-peak demand;
  - the provision of demand for reserve purposes to the TSO; and
  - the reduction in the localised distribution system peak.

These system savings will feed through to the end consumer as the total cost of the system would likely be lower.

The assessment is discussed in Section 3.2.1.

- The second set of criteria relates to the costs, risk and scale of change and consumer acceptance which might constrain the full delivery of the benefits outlined in Section 3.2.1. These criteria are:
  - The cost of deployment from the perspective of the suppliers, the DSO and the TSO/SEMO.
  - The ongoing costs from the perspective of the suppliers, the DSO and the TSO/SEMO.
The risks and scale of change which includes amongst other factors the overall scale of change compared to existing systems, technical reliability of the end to end system, robustness to data transfer failure (accidental or malicious) and future proofing and scalability.

The consumer acceptance issues which includes simplicity of tariffs and ease of interpretation, alignment of ToU and prepayment regimes, data protection and confidentiality and consumer acceptance both from a behavioural change perspective and the acceptance of the mandate.

Supplier issues and competition which relate to incentives for suppliers to participate, prospects for supplier competition, competition in other services and furthering competition in generation.

These are discussed and analysed in section 3.2.2.

### 3.2.1 Customer system savings

ToU tariffs could improve security of supply (or reduce the cost of delivering a given level of security of supply) while also reducing output from the most inefficient (carbon-emitting) peak generation. This type of system savings leads to lower consumer bills.

We have first assessed the cost savings which can be associated with specific changes in consumer behaviour triggered by different types of tariffs. Figure 13 illustrates how effective each type of option would be at delivering certain cost savings by generating certain types of behaviour, for example, increasing consumption off-peak can reduce the level of wind curtailment required in the future and therefore generate savings in operational expenditure. The consumer behaviour which triggers each saving is described in our evaluation criteria section in Annex B.

The relative merits of the options are discussed below. Each option is assessed against each criterion.
### Figure 13 – System cost savings

The table below shows the effectiveness of different options in delivering system savings:

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Reduce total consumption</th>
<th>Reduce absolute peak demand</th>
<th>Reduce system effective peak demand</th>
<th>Increase the effective off-peak demand</th>
<th>Demand provision of system reserve to TSO</th>
<th>Reduce localised distribution system peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Option #2 - Fixed time bands</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Key**

-4 3 2 1 0 -1 -2 -3 -4

High savings High costs
3.2.1.1 Reduction in total consumption

The alternative time of use options are anticipated to influence the patterns of consumption but not the overall total consumption; however (as found in the trials) increased awareness on the part of the consumer (reinforced by the in-home display) can reduce total demand.

A reduction in total consumption leads to less generation capacity being required on the system. This reduced cost of the overall system constitutes a customer saving.

3.2.1.2 Reduction in absolute peak demand

Broadly, a reduction in absolute peak demand can be achieved under all options, subject to each option showing a differential between the peak prices and the off-peak prices to ensure that consumption is moved away from peak times into other time periods.

The reduction in peak demand will occur if the prices are displayed to the end consumer and if the customer is made aware of when the peak prices will occur. This will depend on the IHD or any other means of communication displaying the prices to the customer.

The more dynamic options (3, 4 and 5) are assumed to be more effective at reducing absolute consumption as the peaks will be targeted to those specific peak hours in the year. Options 1 and 2 will display more averaged peak prices which will be less effective at reducing absolute peak demand.

Reduction in absolute consumption will lead to a reduction in the number of peak plants required on the system. The avoidance cost of the peak plants will reduce the overall cost of the system to the customer.

3.2.1.3 Reduction in effective system peak

In the future, we anticipate peak prices rising significantly with increased penetration of wind as illustrated in the capacity margin curve below. The chart in Figure 14 shows the capacity margins which we anticipate in a world of increasing wind penetration. This analysis was carried out as part of Pöyry’s multi-client intermittency study which was published in 2009. The system capacity margin evolves such that the system is tight for fewer periods in the year in the future (when demand is high which often coincides with low wind generation). This tightness should result in high peak prices. On the other hand, the capacity margin is anticipated to be very high at other times which would result in very low prices. The second diagram in Figure 14 shows the timing of peak demand (dark blue blocks) which is clustered around the evening peak as well the demand net of wind (light blue blocks) which exhibits more within-day variance. The timing of those peaks show how volatile the system will be in the future. The unpredictability will lead to more volatile prices than in the present system.

The charts show that the timing of the effective system peak will become more unpredictable, and (depending on the precise nature of the trading arrangements) we anticipate the SEM prices becoming peakier and less predictable than currently.

This price differential, if reflected in actual prices, should provide an incentive for the end consumer to reduce their consumption at effective peak times and shifting consumption to effective off-peak times. We anticipate this price differential to become more significant with increased wind penetration.

All options outlined have the potential to reduce the effective system peak. The static tariffs (options 1 and 2) will only be able to generate this cost saving to a certain extent.
because of the correlation between the absolute peak demand and the effective peak (net of wind). Option 2 will be more effective than Option 1 as the variability which comes with seasonal prices will contribute towards reducing the effective peak.

Wind generation results in a loss of correlation between prices and absolute peak demand. Dynamic tariffs, which can be changed closer to real time, will therefore be more successful in reducing the effective peak than the static ones, as they are able to change in response to wind forecast. Prices for options 3, 4 and 5 will change to reflect the unpredictability and variability of the system over the year. These changes in prices will be transferred to the end consumer. Changes in consumer behaviour will therefore contribute to reducing the system effective peak to the extent that the dynamic nature of the tariffs does not confuse customers and/or put them off responding. This is expected to be most effective in future with home automation of critical loads such as electric heating, hot water and even transport.

Customers benefit from reduced system costs through reducing the effective peak demand, ensuring that less generation capacity is required as back up plants to cater for wind intermittency issues.

**Figure 14 – SEM capacity margin changes from Pöyry Intermittency analysis**

3.2.1.4 Increase effective off-peak demand

Figure 14 suggests that the off peak prices will be very low. When the wind is blowing, the capacity margin could rise to more than 30%. Prices in a market dominated by baseload and intermittent generation will frequently drop to low levels overnight as thermal plants are pushed off the system and plants with very low or negative marginal costs set prices.

Whilst static tariffs will show lower prices for certain time bands, these will not necessarily reflect the very low prices anticipated at certain times (on windy nights), especially in a world with high wind generation capacity.

Option 3 will show high prices on peak days but might not provide the right incentives of lower off-peak prices at other times to produce this particular behaviour. Dynamic tariffs (Options 4 and 5) are better able to reflect lower prices to the end consumer which would lead to a more effective increase in consumption off-peak. Again this is subject to the ability of consumers to accept and respond to dynamic tariffs, which will increase in future with automation.
Increasing off-peak consumption at times of high wind output leads to an increase in the usage of wind generation. This leads to a reduced cost of wind curtailment benefiting the customer as the system saving trickles down to the customer bill.

### 3.2.1.5 Demand provision of system reserve

An increase in system reserve capacity will be needed in a world of high wind penetration due to the unpredictability and variability of wind generation. Wind forecast and demand forecast errors increase the requirement for reserve capacity to be held on the system. Customers can contribute to the provision of reserve through demand response. This is dependent on appropriate price signals being sent to the end consumer.

Static systems are not able to provide reserve capacity to the system as the tariffs do not change over time and do not therefore reflect the hourly variations which are key to reserve requirements. Option 3 will not necessarily be able to provide reserve capacity as the customer needs to be advised of a critical day approximately 7 to 8 hours in advance. Option 3 can mitigate the prolonged loss of generation capacity by enabling the system operator to hold less reserve than would otherwise been needed.

On the other hand, Options 4 and 5 are able to provide the necessary price signals for customers to reduce demand and contribute to the provision of reserve requirements. Aggregators or suppliers, through targeted customer propositions, could bundle the demand reduction close to real time and offer this capacity to the TSO for reserve purposes. Option 4 is less effective than option 5 as the consumer will be given 4 hours advance notice. Option 5, on the other hand, will be more effective at contributing to price driven reserve requirements closer to real time subject to automation of technologies in the home.

### 3.2.1.6 Reduce localised distribution system peak

The DSO view is that ToU tariffs should bring some benefit for DSO systems in the sub-transmission networks, but the impact on investment in lower voltage networks would diminish with the lack of diversity between individual loads.

The more disaggregated tariffs (option 5), which exposes the end consumer to the full volatility of the system, will have a greater impact on the networks than the more averaged peaks which can be found under the other options.

A reduction in network reinforcement requirements would lead to a reduction in system costs, benefiting the end consumer.

### 3.2.2 Other evaluation criteria

There are a number of constraints which will affect the full delivery of the benefits outlined in section 3.2.1. The evaluation below aims to understand how these constraints and these criteria affect the implementation of the various forms of ToU tariffs.
3.2.2.1 Cost of deployment

Figure 15 – Cost of deployment

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Supplier perspective</th>
<th>DSO</th>
<th>TS/O/SEMO</th>
<th>Similarities with EU countries</th>
<th>Deal with DUoS tariffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Option #2 - Fixed time bands</td>
<td>-2</td>
<td>-2</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>-3</td>
<td>-4</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>-3</td>
<td>-4</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>-4</td>
<td>-4</td>
<td>-1</td>
<td>2</td>
<td>-1</td>
</tr>
</tbody>
</table>

Main insights:

- From a supplier’s perspective, offering ToU tariffs with varying degrees of complexity to the end consumer is not necessarily an issue since tariffs are already designed from a prediction of the wholesale costs in a 17,520 cell matrix. However, we understand that this will create significant IT costs both in terms of amendments to the billing systems and data storage for the purposes of servicing consumer energy reports. As can be seen from Figure 15, the more complicated the ToU tariffs, the more expensive the solution becomes (although dealing with the raw half-hourly data perhaps is simpler than building complex rules dealing with aggregation into changeable time periods).

- It is generally expected from a DSO perspective that there are no major metering issues with the Option 1 tariff framework, as seen in Figure 15, although it would be necessary to create a new profile for customers who were supplied under this arrangement. Data management, on the other hand, is likely to be a significant challenge under the more complex options. The SAP systems currently in use would be incapable of handling the volumes of data if aggregation of customer demand for wholesale settlement were to be half hourly and new systems would therefore be required. A significant increase in costs would therefore be anticipated in order to have more complicated tariff structures.

- From a TSO perspective, the main impact of the choice of ToU tariff design is likely to manifest itself in the systems used for billing suppliers and data mining (for the purposes of reporting). As the TUoS costs represent only approximately 5% of the customer’s bill, the TSO will not necessarily benefit from the ToU format.

- In terms of similarities with other countries, it can be noted that the collection of half hourly reads for settlement is carried out in other countries across the EU. Larger industrial and commercial customers are already on half hourly reads in Ireland but the smart metering roll out requires all 1.8m residential and small businesses to be on half hourly reads and this is a significant challenge for the systems.

- The separation of DUoS, or even all network charges and energy prices might not be as easily managed as envisaged within the tariff options. Apparently the GB meter architecture does not permit the meter to specify separately an energy and DUoS tariff, although this is a requirement of the CER decision on the smart metering roll out. If the GB procurement programme is to be leveraged for the purpose of...
supplying smart meters to the RoI market, then, this objective could be compromised. DUoS charges could be separately devised by considering half-hourly profile data but this may again run up against data protection issues.

3.2.2.2 Ongoing costs

**Figure 16 – Ongoing costs**

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Suppliers</th>
<th>DSO</th>
<th>TSO/SEMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Option #2 - Fixed time bands</td>
<td>-2</td>
<td>-4</td>
<td>-2</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>-3</td>
<td>-3</td>
<td>-1</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>-3</td>
<td>-3</td>
<td>-1</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>-3</td>
<td>-3</td>
<td>-1</td>
</tr>
</tbody>
</table>

Key

-4  -3  -2  -1  0  1  2  3  4
High savings  High costs

**Main insights:**

- From a supplier’s perspective, processing the data for billing and settlement purposes for increasingly complex ToU tariffs will lead to an increase in ongoing operating costs as seen in Figure 16. Dual billing arrangements would be needed for any period that the mandated ToU tariffs for customers were applied in parallel with extant tariffs.

- From a DSO perspective, ongoing costs are anticipated to increase with increasing number of ToU Tariffs. Any specific formulation of the static tariff would create a new Meter Configuration Code (MCC). It has been suggested that the extant systems can only handle in the region of 10 MCCs thus severely restraining the proliferation of tariff formulations envisaged in the Option 2 example. A new MCC would spawn three additional Settlement Profiles applying to small business, urban residential and rural residential premises, which would be used to translate a meter advance into the half-hourly wholesale energy liability. Creation of new class settlement profiles would need to be on a provisional basis until interval metered data could be sampled and the profile validated or adjusted. Should Option 2 be implemented with a variety of pre-determined tariffs, the ongoing costs from a DSO perspective would be significant.

- The TSO would be concerned with the instability of its charging base that a ToU tariff design might introduce. The TSO believes it might be necessary to reassess its charging methodology so as to ensure revenue recovery was still secure. A review of the forecasting methodology might also be needed if the ToU tariff design elicited a particular behavioural change. If the TSO were to lose accuracy of its forecasts of customer behaviour, security of supply would be compromised or (more likely) the cost of reserve provision would increase. This could increase the costs as shown in Figure 16. Option 2 would be the riskiest from a TSO perspective as the other options are either predictable or the dynamic nature of the tariff is generally helping the TSO in balancing and unlikely to be reacted to as reliably. By the time option 5 is available, we assume that the TSO would have significantly updated their forecasting methodology.
### 3.2.2.3 Risks and scale of change

#### Figure 17 – Risks and scale of change

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Overall scale of change compared to existing systems</th>
<th>Technical reliability of end to end system</th>
<th>Robustness to data transfer failure (accidental or malicious)</th>
<th>Data security issues</th>
<th>Modular development</th>
<th>Realisation of benefits from 2016 onwards</th>
<th>Speed of deployment</th>
<th>Future proofing/scalability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Option #2 - Fixed time bands</td>
<td>-2</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>-4</td>
<td>-3</td>
<td>-2</td>
<td>-2</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>-4</td>
<td>-3</td>
<td>-2</td>
<td>-2</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>-4</td>
<td>-4</td>
<td>-2</td>
<td>-2</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

**Key**
-4, -3, -2, -1, 0, 1, 2, 3, 4

-4 = Significant negative change or high risk
-3 = Large negative change or high risk
-2 = Major negative change or high risk
-1 = Small negative change or high risk
0 = No change or low risk
1 = Small positive change or low risk
2 = Major positive change or low risk
3 = Large positive change or low risk
4 = Significant positive change or low risk
Main insights:

- The overall scale of change required is more significant the more complex the ToU tariffs.

- Options 4 and 5 require the use of automation and might therefore be less technically reliable than options 1 and 2.

- As the IT system which the DSO is currently trialling to handle the smart metering data requirements is a proof of concept, we can reasonably argue that robustness of the system with regards to technical reliability, data security and data transfer failure still needs to be ascertained as shown in Figure 17.

- Option 1 is the only option which can be readily implemented with little change to the systems and which could be proposed to customers from day one of the smart metering roll out, thus contributing to realising the benefits from 2016 onwards. Option 1 can also be speedily deployed, while option 5 will require an overhaul of the DSO and suppliers’ systems.

- Option 5 is the most modular of the options as it provides maximum flexibility for suppliers to construct other tariffs and can be used to build options 2, 3 and 4. Option 1 can also be built on to deliver more complex classic ToU tariffs.

- Option 1 is easy to deploy but hard to scale. Option 5 on the other hand, is the most scalable and the most flexible of all options.
3.2.2.4 Consumer acceptance

Figure 18 – Consumer acceptance

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Simplicity of tariffs &amp; ease of interpretation</th>
<th>Data protection and confidentiality</th>
<th>Showstoppers - overall perception of increase in cost to end consumer</th>
<th>Showstoppers - too much complexity resulting in delays in communication</th>
<th>Protection for customers on financial hardship</th>
<th>Customer acceptance - Manual behavioural change</th>
<th>Customer acceptance mandate - possibility of outright rebellion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option #1 - Classic ToU</td>
<td>2</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>2</td>
<td>-1</td>
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<tr>
<td>Option #2 - Fixed time bands</td>
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<td>-2</td>
<td>-2</td>
<td>0</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>Option #3 - Critical day</td>
<td>1</td>
<td>-2</td>
<td>-2</td>
<td>-2</td>
<td>-2</td>
<td>1</td>
<td>-3</td>
</tr>
<tr>
<td>Option #4 - Shifting peak</td>
<td>-1</td>
<td>-2</td>
<td>-2</td>
<td>-3</td>
<td>-2</td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>Option #5 - Modified pass through</td>
<td>-3</td>
<td>-2</td>
<td>-1</td>
<td>-4</td>
<td>-2</td>
<td>0</td>
<td>-4</td>
</tr>
</tbody>
</table>

Key

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
<th>-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to accept</td>
<td>Significant consumer resistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Main insights:

- Option 1 is easy to understand from a customer perspective. The other options are more complex in terms of how their impact on consumption can be understood by the end consumer. Option 5 is simple enough to understand but complex for the customer, unless some or full automation is available within the home.

- Options 3, 4 and 5 carry the most risk with regards to data confidentiality as the half hourly data provides third parties with a view of actual customers’ habits. Data protection considerations could present constraints on the ability of a supplier to deploy effectively some formulations of ToU tariffs. The view has been expressed that half-hourly data must be either billed or consented to by the customer in accordance with EU data protection legislation. The regulatory assumption is that the supplier will receive half-hourly data but this may not always be possible for practical reasons.

- There could be an overall perception of increase in costs with ToU tariffs from the customer perspective which might make overall acceptance harder. However, subject to automation, consumers would probably find that option 5 allows them to reduce costs with the least change in behaviour.

- The more granular and complex the proposition and tariff, the greater the risk of communication delays as seen in Figure 18.

- All the options could offer some protection to customers on financial hardship depending on the construction of the tariffs. It is however more difficult if those customers wish to be on the more dynamic propositions as they will be directly exposed to system volatility, especially with critical day prices.

- From a behavioural change perspective, we are assuming that options 4 and 5 would require a degree of home automation (and more electrification of heating, hot water and ultimately transport) to be effective, whereas options 1 and 2 would deliver the most proactive behavioural change immediately after roll-out. Option 5 could also include providing signals to the end consumer rather than relying on prices.

- Consumers would be more likely to accept fixed ToU tariffs as there is a pattern which can be easily adopted. Consumers in such countries as France and California, where time bands have been fixed, have adjusted to a routine of reacting to the changes in prices. The more dynamic options, 4 and 5, would be complicated to deploy at the start of the mandate as customers might not be able to react fast enough and therefore be ‘penalised’ for consuming at certain times. A degree of home automation is needed for the more dynamic options to be successfully implemented.
3.2.2.5 Supplier issues and competition

Main insights:

- Dynamic tariffs such as option 5 will increase competition in the retail market as:
  - the need for hedging is removed; and
  - suppliers have to compete on innovative propositions.
- There are more incentives for suppliers to participate in the market when there is more flexibility to construct the tariffs as shown in Figure 19.
- Suppliers appear eager to embrace competition in the nature of the ToU offerings they could make, and it has been emphasised by suppliers that they should have a choice in choosing the time bands for a ToU tariff. Suppliers believe that a simple ToU tariff mandate would limit the functioning of the retail market.
- In terms of promoting competition in other services, it is noted that the Licence Conditions for suppliers preclude the use of digressive features in tariffs that encourage consumption at certain times. Clarification would be needed so that off-peak prices were not seen as a form of predatory pricing. More dynamic tariffs will provide more opportunities for suppliers to offer creative propositions to their customers.
4. IMPLEMENTATION STRATEGY

The ToU tariffs mandate in Ireland has the objective of creating a behavioural shift by putting the cost consequence of when electricity is consumed firmly in the hands of the consumer. This represents a radical departure from other smart metering programmes.

The implementation of ToU tariffs is likely to be an evolution. To succeed, it must achieve changes in consumer behaviour, so consumer acceptance is a pre-requisite. The degree of acceptance should improve over time as consumers become more familiar with the concept and the products on offer.

Ensuring the buy-in of various parts of the value chain (DSO, TSO and suppliers) is also essential for the mandate to work in practice.

The options outlined above represent a number of formats which can be implemented. These forms are, however, by no means exhaustive. The building blocks on the other hand, outlined in section 2, provide the overarching considerations in the implementation of the mandate, by driving the choices and trade-offs which the CER and the industry have to make in order to successfully deliver ToU tariffs in Ireland.

In this section, we therefore use the building blocks outlined in section 2 to provide a view of how this ToU mandate could be implemented in practice.

4.1 Prospective scenarios

An evolutionary approach could provide time for systems to develop to accommodate more sophisticated tariffs. However, while the DSO would be upgrading the system to allow for half-hourly (HH) settlement; it is by no means a certainty that the data will be available to all parties.

We therefore consider a number of pathways for the implementation of ToU tariffs as shown in Figure 20.
The scenarios all start with fixed or pre-determined time bands in 2015, to raise customer awareness.

**Step 1 – Raising customer awareness**

Raising customer awareness of the time of use cost variation of electricity supply requires smart meters and communications devices to be in place to ensure that the prices are visible to the end consumer. We anticipate this step to involve tariff designs likely to be based on relatively few fixed time periods. Engagement programmes would be required in parallel to educate the customer in relation to the reasons for and opportunities which the ToU tariffs represent for them. The IHD and other communications devices will help to facilitate this awareness.

There would be a licence obligation on suppliers to provide ToU tariffs to customers. The format of this obligation needs to be defined in Phase II.

Whilst the classic fixed ToU tariff would be applicable to the residential customers, it would be difficult to impose a universal tariff on all small businesses. Whether the tariff could be an opt-out or whether the mandate might start at a later stage for small businesses (when a greater variety of ToU tariffs is available) still needs to be defined.

There are a significant number of segments within the small businesses categories. It would be difficult to impose a classic ToU tariff as per the smart metering trial in Ireland on all small and medium sized customers. There are a number of options available to the CER with regards to small businesses:

- skip Step 1 and move to Step 3 where a greater variety of ToU tariffs will be available, therefore delaying the implementation of the mandate on small businesses to 2018; or
allow for an opt-in mechanism for small businesses rather than the mandate.

**Step 2 – Separation of network charges**

Network charges would be separately billed to the customer. There is prospect for the introduction of more sophisticated time of day network charges if appropriate. Customers would therefore see more granularity in all their charges.

**Step 3 – Half-hourly aggregation**

A significant breakthrough is anticipated in 2017/2018.

The extant systems, and any short term development of them to facilitate steps 1 to 2, are predicated on the use of artificial settlement profiles to convert meter advances to a half-hourly allocation of wholesale costs. In the meantime, smart meters have been collecting interval (i.e. half-hourly) data for all customers.

The development of a platform for wholesale market settlement using half-hourly interval data is assumed to become available. Its introduction would need to be in conjunction with developments in supplier and wholesale settlement systems, although both currently handle quarter-hourly (QH) data albeit it in smaller volumes.

Once these systems were installed interval data could be used directly by the:
- supplier for billing;
- DSO or TSO for formulating DUoS or TUoS charges respectively; and/or
- SEMO for settlement (aggregated for each supplier).

This would break through the constraints on the systems. Interval data could now become the bedrock for all activity in the industry. Implementation of this step would be dependent on data confidentiality issues being overcome.

If permitted by the DPC and/or by the customer, access to the data will be available to suppliers and other parties to deliver innovative products and new propositions to customers.

**Scenario α – Customer responds to set bands**

This scenario implies that we stay in a world where fixed or pre-determined time bands are available to customers. Customers know when prices will change. They are used to a fixed routine. If there are a significant number of pre-determined buckets, HH data would be required for settlement purposes. This scenario would apply to both small businesses (pre-determined) and residential customers (fixed and/or pre-determined).

**Scenario β – Customer responds to differentials**

Customers would be able to choose amongst a variety of propositions, some more dynamic than others. They would effectively be responding to differentials between peaks and troughs. How this is implemented in practice would have to be defined.

This scenario allows the TSO, albeit perhaps through other parties, to access a demand side response for the purposes of better managing the security of the system. Electric vehicles and heat pumps could be better integrated. Customers would be using electricity off-peak when charging their electric vehicles for example, leading to a reduction in the
curtailment of wind generation capacity. This pathway would apply to both residential customers and small businesses.

**Scenario y – Customer is a proxy market participant (based on D-1 prices)**

Customers would have access to the day-ahead wholesale prices, assuming that the SEM was amended to include day-ahead trading in accordance with the European Target Model. (Note that this would still expose the supplier to within-day or imbalance prices to the extent that the total consumption in each half hour does not match their expectations).

Consumers are now a participant of the value chain. There is no regulation with regards to the propositions which are available to them. Customers are (semi-)active participants in the value chain, automating their homes, determining when to consume electricity, e.g. charge their electric vehicles, based on (day-ahead) prices. They may help to reduce the overall requirement for peak generation capacity by providing demand response. They are also able to contribute to the reduction in wind curtailment by consuming electricity off-peak at high wind periods in response to market prices.

### 4.1.1 System constraints

This project has so far identified a number of constraints that could restrict the adoption of various forms of ToU tariffs. These have already been discussed in the previous sections but are summarised here:

- the capability of the smart meter to be configured to accept complex tariff formulations, and separate DUoS charges;
- changes to the market design to accommodate additional meter configuration codes (MCC);
- the alignment between DUoS and energy rate periods;
- the creation of settlement profiles for any new tariff definition;
- the acceptance of new Profiles by the SEMO;
- the capability of the IHD or other communications means to display or accept certain types of data transmissions;
- the ability of existing supplier billing systems to process complex ToU tariff structures; and
- the replacement of settlement profiles by interval data in market settlement.

These constraints feed into our perspectives of the different parts of the value chain outlined below, creating a framework for a vision and its implementation.
4.2 Implementation vision

Figure 21 – Stakeholders’ perspectives

The implementation of a mandate for ToU tariffs requires buy-in from all stakeholders.

4.2.1 Customer perspective, rise of the active consumer

A mandated ToU tariff is a change as far as the customer is concerned. For the first time, customers will have access to prices which reflect the within day movement of electricity costs. From 2015 onwards, a number of more averaged tariffs (classic ToU) will help customers to understand how this new world operates.

From 2018 onwards, assuming HH data can be used in wholesale settlement customers will have access to more innovative pricing schemes offering opportunities to directly affect the system price through for example, dynamic and sharper peak prices or be able to offer a demand reduction to the system operator, either through their supplier or through an aggregator.

The ability to compare propositions, to automate their homes and the prospect of being rewarded for their changed behaviour will drive them to demand more from suppliers leading to a wider variety of propositions in the market.

4.2.2 Supplier perspective, driving innovation

Suppliers will have an incentive to deliver innovative products to the end consumer.

The mandate will probably drive the implementation of simple ToU tariffs in the first few years to ensure consumers become accustomed to the new framework. Pöyry believes that soon after the infrastructure constraints (DSO and supplier systems), have been removed, assuming use of data is possible; suppliers should have the freedom to innovate and provide new products and services to their customers.
Suppliers will have an incentive through increased volatility and variability in the wholesale market to push through new pricing schemes which would reduce their hedging costs.

Once half hourly data can be readily used for settlement purposes, suppliers can offer dynamic pricing schemes or classic ToU tariff schemes depending on their customer preferences or simply provide half hourly prices for use within home automation systems.

4.2.3 **DSO and TSO perspective, providing the framework to the industry**

ESBN will be constrained by their current systems until 2018. In the meantime, new MCCs and associated settlement profiles will need to be established to ensure the retail tariffs can be settled in the wholesale market. Once the systems have been upgraded, the DSO will be able to facilitate all data transfer requirements.

The TSO will be keen to leverage on the demand response available for reserve purposes. We anticipate a market where suppliers and/or aggregators are offering dynamic products to their customers to reduce their consumption and offer load reduction into the ancillary services market alongside other generator providers.

4.2.4 **CER perspective, regulatory oversight**

The involvement of the CER in the framing of retail tariffs for the first few years is probably a necessity for moving the market to a position where customers can engage with confidence with the pricing message in the ToU tariff.

This would release the subsequent steps where supplier competition and innovation would have a positive impact on sustainability and system security, as well as placing a downward pressure on costs. Aligning the mandated framework of step 1 with the prepayment tariff structure could also assist customers in financial hardship.

Step 2 would enhance the development of the regulatory framework required for the distribution and transmission networks.

The regulatory activity in introducing a ToU tariff mandate would need, inter alia, to embrace:

- specifying the time bands for a ubiquitous ToU tariff structure in line with the Option 1 design that would apply during the initial phase of the mandate;
- (potentially) mandating a minimum price differential between time bands which could allow for more flexibility in the implementation of the mandate, especially from the perspective of constructing ToU tariff propositions for small businesses;
- directing the separation of network and energy charges, and developing the price control for DUoS to take advantage of the new charging freedoms that were available;
- providing protection for customers in financial hardship by ensuring the availability of a prepayment tariff by each supplier that has a structure that was consistent with the mandated ToU tariff structure;
- ensuring comparison algorithms were available to customers so that supplier offerings, which would be on a common basis could be readily assessed by any customer;
- providing guidance on how to best exploit the ToU tariff pricing messages in the context of energy efficiency; and
- updating the vision for any subsequent phases of the evolution of ToU tariffs when the universal use of interval data created the freedom for suppliers to devise whatever ToU tariff frameworks they believed competitive.

4.3 International experiences and consumer engagement strategy

A well-crafted consumer engagement strategy and plan will ensure an economically successful rollout of Smart Metering and ToU tariffs.

In the case of Ireland, the cost benefit analysis for the smart meter rollout is based in part on results from the opt-in CER pilot. The take up rate for this pilot was 35%. However, to achieve similar results during the actual rollout, it will be essential to create a communication campaign, which engages the population as a whole. We provide a high level overview of consumer engagement and acceptance factors for ToU tariffs, in the context of a national regulatory mandate.

**Consumer acceptance is key**

Ontario Canada has mandated ToU tariffs for residential and small business consumers. The customers moved from a tiered tariff to ToU pricing. The tariffs form part of a regional end-to-end energy efficiency action plan. This strategic plan has been successfully communicated to the public over the course of 3 years ahead of the implementation of the tariffs. Specific goals were set to bolster customer awareness and understanding which included amongst others:

- how many consumers should sign onto their interactive website (10% of customers);
- the level of consumer awareness of the tariffs (80% of customers); and
- the number of neutral media stories (10 neutral (neither positive nor negative) stories on ToU).

The success rate for the objectives was measured. This represents an excellent way to keep track of the needs of the customer and incorporate their feedback and views in the schemes being deployed.

**Successful rates provide a clear signal**

In a national ToU rollout, pricing signals must be clear and consistent to ensure adequate impact. In California, France, Arizona and others markets where Critical Peak Pricing (CPP) is offered, the time bands have been consistent and consumers have related well to those routines.

In the Irish context, we note the challenge which wind generation will bring in terms of making the timing of the critical periods less predictable. This will need to be overcome, perhaps through a combination of education and automation.

Dynamic tariffs, (including TSO signals) have not been trialled to date and we recommend that a trial be carried out using available automation technology to better understand the impact of dynamic prices on the end consumer.

**Feedback and ToU**

Feedback is an integral part of a successful ToU programme. In fact consumers in pricing programmes which do not include feedback and education, will sometimes increase their total consumption (when electricity is cheaper) while still lowering consumption during peak hours.
Multiple communication and engagement channels

Our research indicates that ‘more is more’ at every stage of the roll out process. For example, marketing programmes using consumer segmentation to create targeted messages for a range of consumer groups increase consumer uptake and results. Feedback and pricing together achieve better long-term overall results than any programme type alone. Education improves dynamic pricing schemes and informative billing programmes. Different types of information on an IHD or a bill tends to achieve better results than a simple display or one message on a bill.

Successful feedback and pricing programmes begin an important cycle of learning for consumers providing them with tools to better understand the connection between behavioural choices, consumption and cost.
ANNEX A – INTERNATIONAL EXPERIENCE

Annex A describes the residential and small commercial dynamic tariffs in six regional markets. This includes Ontario Canada, Victoria Australia, Italy, France, California and Maryland (USA). The descriptions cover, wherever possible, dynamic pricing rollouts rather than dynamic pricing pilots. The markets were also chosen for the variation in tariffs that they are launching. These cover classical Time of Use (ToU), Critical Peak Pricing (CPP), Critical Peak Rebates (CPR) and hourly wholesale market prices.

Each market description provides information as available on the following items:

- historical development of the tariff;
- tariff description;
- the level of peak shift and/or energy savings achieved; and
- a description of customer experience

It should be noted that the most successful tariff rollouts are supported with full feedback programmes.

A.1 Ontario, Canada

Between 2007 and 2025 Ontario will be obliged to rebuild almost its entire energy system, including 80% of its generation assets and most of its distribution grid. This is a key driver for the development of improved energy efficiency measures and peak load reductions. In 2005 the Ontario regulator mandated a full smart meter rollout to be completed by 2010 – one of the main justifications was lowering peak demand and increasing systems efficiency.

A.1.1 A description of the ToU tariff

Toronto Hydro is a DSO in the Ontario region in Canada and has launched an ambitious dynamic pricing programmes. The ToU rates are on an opt-out rather than opt-in principle and have been introduced in coordination with smart metering. In August of 2010, the Ontario Energy Board (OEB) issued a final determination to mandate ToU pricing for Regulated Price Plan (“RPP”) customers by June 2011. It is to support the Government’s expectation for 3.6 million RPP consumers to be on ToU pricing by June 2011, and to ensure that smart meters funded at ratepayer expense are being used for their intended purpose.

Below information is provided, concerning the RPP ToU rate which is the opt-out dynamic tariff offered by Ontario One and the PeakSaver Plus programme, an opt-in home automation programme which does not include a dedicated dynamic tariff.

Table 1 describes the results of the ToU Tariff.
Table 1 – Toronto Hydro Regulated ToU Tariff

<table>
<thead>
<tr>
<th>Utility</th>
<th>Toronto Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Canada</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>The Regulated Price Plan ToU rate</td>
</tr>
<tr>
<td>Launch date</td>
<td>2009</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-out</td>
</tr>
<tr>
<td>Number of participants</td>
<td>622 613 (end of 2011)</td>
</tr>
<tr>
<td>Peak shifting per event</td>
<td>The specific savings generated through Toronto Hydro’s ToU rates are not as yet been published. However Toronto Hydro representatives calculate the peak shifting is 4-5%</td>
</tr>
<tr>
<td>Energy savings</td>
<td>Total energy savings are still undergoing calculation. However, Toronto Hydro representatives calculate the total savings at 8%</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>Representatives of Toronto Hydro state that 60 percent of customers saw a bill increase during summertime. During winter, when there are two peak periods, morning and evening, about 80 percent saw higher bills. With increases, the average bill went up about Can$ 1.50 (€ 1.2) per month (2010). This is apparently due to the overall higher rates within the ToU tariffs compared to the previous tiered tariffs.</td>
</tr>
</tbody>
</table>

Toronto Hydro is the DSO for Ontario Canada and has launched the most ambitious dynamic pricing programme of all the markets reviewed here. The ToU rates are opt-out rather than opt-in and have been rolled out in coordination with smart metering. In August of 2010, the OEB issued a final determination to mandate ToU pricing for Regulated Price Plan (“RPP”) customers by June 2011, in order to support the Government’s expectation for 3.6 million RPP consumers to be on ToU pricing by June 2011, and to ensure that smart meters funded at ratepayer expense are being used for their intended purpose. Previously consumers had only a tiered pricing program.

Below information is provided concerning the RPP ToU rate which is the opt-out dynamic tariff offered by Ontario One and the PeakSaver Plus programme, an opt-in home automation programme which does not include a dedicated dynamic tariff.

The Regulated Price Plan (RPP) ToU is a 3-band ToU rate. The time-bands shift from summer to winter however the price differentials remain the same.

The summer daily peak is in the middle of the day – to counter balance air-conditioning. The winter tariff covers the morning and evening peaks. The pricing and time variables can be viewed in Figure 22 and Figure 23.
4.3.1.1 Regulated Price Plan ToU Pricing (Winter):

Figure 22 shows a graphical representation of tariff changes for winter (winter being defined as the period between 1st November and 30th April). Tariffs are split according to the following periods:

- **On-peak:** 7 a.m. – 11 a.m. and 5 p.m. – 7 p.m.;
- **Mid-peak:** 11 a.m. – 5 p.m.; and
- **Off-peak:** 7 p.m. - 7 a.m.
- Highest Price (On-Peak) 11.8 cents/kWh
- Mid Price (Mid-Peak) 9.9 cents/kWh
- Lowest Price (Off-Peak) 6.3 cents/kWh

4.3.1.2 Summer ToU Pricing (1st May – 31st October):

- **On-peak:** 11 a.m. – 5 p.m.;
- **Mid-peak:** 7 a.m. – 11 a.m. and 5 p.m. – 7 p.m.; and
- **Off-peak:** 7 p.m. to 7 a.m.
- Highest Price (On-Peak) 11.7 cents/kWh
- Mid Price (Mid-Peak) 10.0 cents/kWh
- Lowest Price (Off-Peak) 6.5 cents/kWh
A.1.2 How was the product rolled out

A great deal of consumer communication and education was done for the promotion of Time of Use tariffs including:

- direct mail – ToU Tool Kit with discount coupons; reminder email/letters;
- event outreach at community events;
- on bill messaging / ‘Guide to first ToU’ bill inserts;
- statement messaging website promoting use of ToU portal;
- social media – Facebook, Twitter;
- multilingual advertising campaign; ethnic television vignettes;
- public relations – media releases (prior to statutory holidays for off-peak);
- councillor outreach; and
- ToU portal – 115,000 customers registered (as of the end of 2011).

Consumer preparation and education campaign for the full ToU tariffs spanned 3 years.

Smart metering and ToU rates are part of a much larger energy efficiency programme, which impacts every segment of society and is wide ranging, from coupons for energy efficient lighting to commercial industrial demand response programmes. The ToU rate therefore must be seen in this larger context to be fully understood.

4.3.2 A view of the quality of consumer experience

The quality of consumer experience with ToU tariffs and the surrounding interaction campaign has been high. Consumer satisfaction with the communication and education efforts is reported to be 70%. Toronto Hydro also counted over 30 positive media stories related to the tariffs.
However, customer bills seem to have increased rather than decreased for over 60% of the population, adding on average $48 (Canadian Dollars), corresponding to around 37 Euros to the bill. This indicates a lack of engagement on the part of consumers and may be reflected in lowered peak reductions for Toronto Hydro.

The utility has indicated their wish to simplify the tariff to one peak period per day and increase the rate differentials. They state that “the changing peak times, between summer and winter, are too confusing for consumers and the differences in peak and base price are too low to engage interest.”

A.1.2.1 Description of PeakSaver Plus

PeakSaver Plus is a home automation and feedback programme designed to lower peak during summer critical peak days. However, consumers remain on their standard ToU tariff and do not participate in a critical peak rate.

Toronto Hydro offers to install a programmable thermostat (value € 192) for free. As of 2012, they also provide a free IHD to allow for a better overview of total household consumption. It should be noted as well that consumers can receive a free optional IHD without taking part in the Peak Saver programme. The programmable thermostat can be remotely controlled by the consumer and will work with both air-conditioners and electric heating but only those with central air-conditioning can participate in the program.

In return for providing the free technology the utility will:
- lower the AC thermostat by up to 2 degrees for a maximum of 4 hours 10 times a summer;
- ensure activations take place only during weekdays from 2:00 p.m. to 6:00 p.m.; and
- ensure the fan continues to run during this period and most consumers to not notice the activation.

Consumers are able to opt-out if they call the utility the day before.

The offer is marketed with the following message:
- Get a FREE, professionally installed programmable thermostat valued at Can$ 250 (€ 192).
- Save on your heating and cooling energy consumption year-round.
- Enjoy the convenience of managing your home temperature from anywhere.
- Earn up to 100 AIR MILES® reward miles.
- Preserve energy for Ontario’s future generations.”

Residential consumers can receive a Can$ 25 (€ 19) gift for enrolling in the program. Business consumers can receive Can$ 75 (€ 58).

Table 2 describes the Toronto Hydro PeakSaver Plus program.

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9 This information was provided through interviews with Toronto Hydro representatives.
Table 2 – Toronto Hydro PeakSaver Plus

<table>
<thead>
<tr>
<th>Utility</th>
<th>Toronto Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Canada</td>
</tr>
<tr>
<td>Time of use</td>
<td>PeakSaver Plus</td>
</tr>
<tr>
<td>programme</td>
<td></td>
</tr>
<tr>
<td>Launch date</td>
<td>2007</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-in</td>
</tr>
<tr>
<td>Number of</td>
<td>67 000 (9% of total</td>
</tr>
<tr>
<td>participants</td>
<td>customers, as of 2012)</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>Approximately 60MW</td>
</tr>
<tr>
<td>per event</td>
<td></td>
</tr>
<tr>
<td>Energy savings</td>
<td>None measured, although</td>
</tr>
<tr>
<td></td>
<td>the introduction of the</td>
</tr>
<tr>
<td></td>
<td>IHD in 2012.</td>
</tr>
<tr>
<td>Savings on the</td>
<td>The programme alone</td>
</tr>
<tr>
<td>bill</td>
<td>does not create bill</td>
</tr>
<tr>
<td></td>
<td>savings. However, the</td>
</tr>
<tr>
<td></td>
<td>technology provides</td>
</tr>
<tr>
<td></td>
<td>the consumers with</td>
</tr>
<tr>
<td></td>
<td>tools to lower their</td>
</tr>
<tr>
<td></td>
<td>own bills if they</td>
</tr>
<tr>
<td></td>
<td>decide to engage.</td>
</tr>
<tr>
<td></td>
<td>These savings have</td>
</tr>
<tr>
<td></td>
<td>not been measured by</td>
</tr>
<tr>
<td></td>
<td>the utility.</td>
</tr>
<tr>
<td>Customer</td>
<td>Both residential and</td>
</tr>
<tr>
<td>segmentation</td>
<td>small businesses can</td>
</tr>
<tr>
<td></td>
<td>enroll; however there</td>
</tr>
<tr>
<td></td>
<td>is no segmentation</td>
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<td></td>
<td>within the programme</td>
</tr>
<tr>
<td></td>
<td>beside the level of</td>
</tr>
<tr>
<td></td>
<td>the financial reward.</td>
</tr>
<tr>
<td></td>
<td>(Residential consumers</td>
</tr>
<tr>
<td></td>
<td>can receive a Can$ 25</td>
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<td></td>
<td>(€ 19) gift for</td>
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<td>enrolling in the</td>
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<td></td>
<td>programme while</td>
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<tr>
<td></td>
<td>business consumers can</td>
</tr>
<tr>
<td></td>
<td>receive Can$ 75 (€ 58).</td>
</tr>
<tr>
<td>Notification of</td>
<td>Website announcement</td>
</tr>
<tr>
<td>event</td>
<td></td>
</tr>
</tbody>
</table>

**Segmentation**: Both residential and small businesses can enrol however there is no segmentation within the programme beside the level of the financial reward described above.

**Information provided**: PeakSaver began in 2007 with written and website support. However, in 2012, Toronto Hydro also began to provide an IHD and called it PeakSaver Plus. The IHD provides numerical real-time information, including how much the residence or business is currently paying per hour, how many KW, and monthly total cost and total consumption. Consumer Experience PeakSaver Plus

Consumers are positive toward the programme and the introduction of the IHD seems to have increased consumer interest. They appreciate that they can receive Can$ 25 (€ 19), gain free technology and feel they are supporting their community (without needing to change their behaviour) unless they want to.

There have been a few technical issues; for example, not all air-conditioner thermostats are compatible and there have been instances where consumers are left with a hole in the wall after a failed installation attempt. Many interoperability issues however have been solved during installation and overall consumer reactions are positive.
A.2 Victoria, Australia

Smart Meter rollout was mandated in Victoria Australia to help deal with specific capacity and infrastructure challenges caused by periodic extreme weather conditions. South Australia and Victoria have among the world’s peakiest electricity load shapes – the last 10% of maximum demand occurs for less than 20 hours per year. This means that those creating the peak are imposing significant costs on those with flatter load profiles. The cross subsidies between domestic customers that do not have air conditioning and those that do could be as much as Au$ 200 (€ 162) per customer per annum.

Studies for EnergyAustralia and for Integral in New South Wales found that there are significant differences between calculating the cost of supply based on load profiles or interval metered half-hourly costs. A study in Victoria found that the residential customers whose consumption is 50% greater than the average user are paying a margin of Au$ 75 (€ 61) p.a., which is 50% more than they ‘should’; while customers whose consumption is 100% greater than the average user are paying a margin of Au$ 100 (€ 81) p.a., double what they ‘should’.

In 2006, the government mandated Smart Meter rollout, which will result in 2.4 million meters being installed from 2009 to 2013.

The rollout was to enable the introduction of mandated ToU tariffs, designed to lower peak consumption. As the introduction of dynamic tariffs was to be after the completion of the meter rollout, the authorities did not think it was necessary to launch a comprehensive public information campaign prior to the start of rollout. Consumers knew the meters would help them control their energy costs through some form of feedback but they did not understand how this was to take place and there was little public awareness about the introduction of ToU tariffs.

Between 2009 and 2010, four complications occurred which turned public opinion from neutral to negative:

- A few individual customers rejected the meters or raised concerns about their safety. As no extensive public education campaign was underway at the time, the rumours of inaccurate meter readings, health issues, exploding meters etc. spread and dominated the public discussion, without a timely and well-informed response from the utilities or government.
- The Supplier “Origin Energy” experienced technical issues with the WiMax communication technology supporting the meters. The system had to be changed to mesh-radio and the total budget for the rollout increased.
- The meters were discussed in public as devices which would provide consumption feedback and would help customers control their increasing energy costs. However after the rollout was underway, it became clear that no feedback technologies would be provided with the meters for free. If households wished to be able to access their own consumption data, they would have to purchase an IHD. This was seen as false advertising on the part of the utilities.
- The public became aware of the mandated ToU tariffs. Consumer groups conducted independent studies on the planned tariffs and calculated that they would prove punitive for low income and vulnerable consumers.

In 2010, the public backlash against the Smart Meter rollout in general and ToU tariffs in particular, forced the Government to halt the rollout and order a review of all decisions taken to date. They came to the conclusion that while the Smart Meter rollout would continue, the ToU tariff mandate would be withdrawn. The tariffs would become opt-in.
A.2.1 A description of the ToU tariff

Given the public reaction to the ToU tariff mandate, Australian suppliers are now cautious about launching ToU tariffs for their residential and SME customers. Origin offers such a tariff among several options on their website for smart meter enabled customers but it is not actively marketed as yet. They are choosing instead to focus their efforts on creating comprehensive feedback programmes which can help customers control the rising costs of electricity. The tariff which is currently offered is described below.

- Peak energy shoulder energy off-peak energy system access charge:
  - 38.907¢ per kWh (incl. GST);
  - 29.843¢ per kWh (incl. GST); and
  - 15.037¢ per kWh (incl. GST).
- Peak energy (on-peak): Electricity supplied from 1 pm to 8 pm on business days.
- Shoulder energy (Mid-peak): Electricity supplied from 7 am to 1 pm and from 8 pm to 10 pm on business days and 7 am to 10 pm on weekends and public holidays.
- Off-peak energy: Electricity supplied from 10 pm to 7 am on every day

Figure 24 describes the on- and off-peak rates and time variations within the Origin Victoria ToU rates.

A.2.2 How was the pilot/trial/product rolled out

The ToU tariff is currently offered on the Origin website as one of several pricing options. This is clearly a soft launch with a limited marketing budget. The branding of the dynamic
tariffs has also changed, they no longer brand these rates as ToU but rather they are now called “flexible tariffs”.

Origin has indicated in interviews that when smart meter rollout is completed and consumers are better acquainted the web portal; they will perform a full dynamic tariff launch.

A.2.3 A view of the quality of consumer experience

Origin does not have information on this at present. They are concentrating on engaging consumers through their newly launched web portal. When they do launch a full flexible tariff offering, they plan to ensure that it is simple and includes low price variables to ease public acceptance.

A.2.4 Rollout results

Not applicable

A.2.5 Participants feedback

Not applicable

A.3 France

In France, peak consumption has grown twice as fast as base consumption, for the past 12 years causing peak capacity issues and regional network strain. Household electricity consumption has also increased by more than 75% since 1990. This growth is due to the introduction of brown products such as computers, cell phones etc. and the growing use of electric heating.

As the use of electric heating drives peak consumption in France, the market does not face critical peak hours but rather critical peak days. This is reflected in the ToU tariff structures introduced by the incumbent utility, where high prices tend to remain elevated for 18 hours on critical peak days rather than only for a few hours as in California, Arizona, Texas and Australia.

There are a number of dynamic tariffs which have been introduced by EDF in the past. These include:

- “Green tariffs” (1956) for large firms or buildings such as those at La Defense: Many price options according to season/hour and localisation/use.
- “Off-peak hours” tariffs for residential market and businesses (1965) (10 p.m. to 6 a.m. week days and Sundays) adding up to around 2,000 hours in summer and 2,000 hours in winter.
- “Peak day step back” (1982) for residential market: reduce consumption at critical times (22 days of 18 hours between 1st November and 31st March) high price during this period and low price for the rest of the year.

These were replaced by the Tempo Tariff in 1995.
A.3.1 A description of the Tempo Tariff

The utility introduced a six-rate tariff which divides the year into three types of days and each day into two periods. The three groups of days are marked by colours; blue, white and red, with blue being the cheapest and red the most expensive.

- **22 red days** from 1\textsuperscript{st} November to 31\textsuperscript{st} March, Monday to Friday (Saturdays, Sundays, holidays are never red and there cannot be more than five consecutive red days);
- **43 white days** spread over the year mainly from October to May but not on Sunday;
- **300 blue days** for the rest of the year (Sundays are blue);
- The ratio between red and blue (highest vs. lowest) is 7; and
- The ration between white and blue days is 1.7.

Should all the 22 days not be used during the winter – EDF will place them in the month of March. Though many households use little electric heating at this time, the practice is not appreciated by consumers. Table 3 describes the results of the EDF Tempo Tariff CPP tariff.
### Table 3 – EDF Tempo Tariff

<table>
<thead>
<tr>
<th>Utility</th>
<th>EDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>France</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>Tempo Tariff</td>
</tr>
<tr>
<td>Launch date</td>
<td>1995</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>N/A</td>
</tr>
<tr>
<td>Number of participants</td>
<td>Tempo has been chosen by 1.2% of households in France. These are usually large consumers with electric heating who benefit from the 300 days of exceptionally low-cost electricity</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>4% of national peak</td>
</tr>
<tr>
<td>Energy savings</td>
<td>On average, participants reduced daily consumption by 45-60% during red days compared to blue days, and by 15-24% during white days compared to blue days.</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>N/A</td>
</tr>
<tr>
<td>Customer segmentation</td>
<td>Although Tempo Tariff is still available to residential customers, EDF is no longer actively marketing it.</td>
</tr>
<tr>
<td>Notification of event</td>
<td>Once the colour of the next day is decided, the signal is transmitted to the customer and displayed both on their meter and on a small box which can be plugged into any power socket. The box also indicates the day’s colour and the current hourly rating. This system of “traffic light” coupled with various energy control systems offers a cheap and efficient way to inform participants</td>
</tr>
</tbody>
</table>

**Participant feedback:** An EDF survey assessed the level of customer satisfaction which generated the following results:\(^{10}\):

- 84% of customers have been quite or very satisfied;
- 59% said that they had made average or substantial savings;
- 53% considered the option as slightly restrictive or entirely unrestrictive; and
- 87% have understood the tariff principle very well.

Though these customer satisfaction results are high, during one-on-one interviews with participants, it seemed that customers on such tariffs view it as something of a necessary evil. The Tempo Tariff which helps heating large houses with electricity while keeping down their electricity costs.

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\(^{10}\) EDF, Smart Metering Europe, 2007.
**A.3.2  EDF day-night tariff**

Over and above the Tempo Tariff designed to lower national critical peaks on the coldest days of the year, EDF also offers a day night tariff. In France, 27% of homes have electric water heaters and this number is increasing year on year. EDF offers a ToU day-night tariff for these consumers. Table 4 describes the results of the EDF Day-Night tariff rate.

<table>
<thead>
<tr>
<th>Utility</th>
<th>EDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>France</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>EDF day-night tariff</td>
</tr>
<tr>
<td>Launch date</td>
<td>1980s</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-in</td>
</tr>
<tr>
<td>Number of participants</td>
<td>Approximately a third of households (10 million) are on the night-day tariff which represents about 60% of the electricity consumed by the residential sector.</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>6 GW is shifted daily</td>
</tr>
<tr>
<td>Energy savings</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>Unknown</td>
</tr>
<tr>
<td>Customer segmentation</td>
<td>Residential customers</td>
</tr>
<tr>
<td>Notification of event</td>
<td>None</td>
</tr>
</tbody>
</table>

**Description of the tariff:** Many consumers have automated water boilers which are programmed to respond the tariff change.

The tariff is a day-night tariff lasting from approximately 6 a.m. to 10 p.m. and the boilers are programmed to turn on when they receive the signal of a low price. However ERDF (the electricity distribution arm of EDF) adjusts this price regionally to help handle regional capacity issues. They will trigger the price in one region with an earlier peak at 5:00, another at 5:15 etc. In this way the programme is both a *regional and national program*.

The day price ratio is 1.46 times the night-time price. Figure 25 describes the Day-Night tariff rate and time variations offered by EDF.
Consumer experience:  There is widespread acceptance of the tariff which has been in place since the 1980s

When smart meters are rolled out in France it is expected that this tariff and automation mechanism will disappear. If this is the case, ERDF and EDF are concerned about the sudden introduction of 6 GW of load during peak hours.

A.4 Italy

Enel Distribuzione started working on its Telegestore Automatic Meter Management System (AMM) project in 2000. It prepared a business case for developing a two-way smart meter that could be used for remote meter management. This is now seen as part of a bigger scheme to automate as many functions in Distribuzione as possible. Table 5 describes the results of the Enel regulated day-night tariff.
Table 5 – Enel regulated day-night tariff

<table>
<thead>
<tr>
<th>Utility</th>
<th>Enel Distribuzione</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Italy</td>
</tr>
<tr>
<td><strong>Time of use programme</strong></td>
<td>Regulated electricity tariffs. The tariff is a day-night tariff lasting from 8 a.m. - 7 p.m. Monday to Friday. The day price ratio is 1.1x the night tariff</td>
</tr>
<tr>
<td>Launch date</td>
<td>2010</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-out</td>
</tr>
<tr>
<td>Number of participants</td>
<td>Approximately 80-90% of residential consumers</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>None measured</td>
</tr>
<tr>
<td>Energy savings</td>
<td>None measured</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>None measured</td>
</tr>
<tr>
<td>Customer segmentation</td>
<td>Residential customers</td>
</tr>
<tr>
<td>Notification of event</td>
<td>N/A</td>
</tr>
</tbody>
</table>

One of the main drivers of the smart meter rollout has been reducing both commercial losses and theft, which was a significant problem in Italy; managing bad payers (of whom there are about 3 million).

The Italian regulator has decided to gradually familiarise Italian consumers to ToU pricing. Between July 2010 and January 2012, all residential customers on the regulated electricity tariffs, were moved to a two-period ToU tariff.

**Introduction of tariff:** The strategy of the authorities is to introduce ToU with very low price differentials in order to give customers time to adjust their behaviour. The Italian regulator states "..., to give everyone time to get used to knowing their consumption during different times of the day, the Authority has decided that until January 2012, the differences in price between the time slots will be quite small (about 10%) but sufficient to provide a pricing signal."

Figure 26 describes the time and rate variations for the Enel regulated day-night tariff.
Marketing: In order to introduce the tariff, Enel sent out letters informing consumers the new tariff structure was going to be introduced.

Consumer experience: There is little feedback on the day-night tariff. Enel has recently performed interviews with customers and many are unaware that they are on a day-night tariff.

A.5 California, USA

The introduction of smart meters and dynamic tariffs in California is directly linked to the energy crisis of 2000. Since the opening of the retail electricity market in California, generators were able to exercise market power in the ancillary services markets, which could feed back into the prices in the Power Exchange. Starting in the summer of 2000 generators and traders (such as Enron) were ruthless in exploiting market power, gaming market rules, and pushing up prices for a year. This resulted in market collapse and the Direct Access programme of competitive choice was suspended in September 2001.

A lack of demand response to mitigate market power is acknowledged as a determinant factor in the crisis. The California Public Utilities Commission (CPUC) began rulemaking in June 2002, which it ended in November 2005 where it concluded the necessity of “developing demand response as a resource to enhance electric system reliability, reduce power purchase and individual consumer costs, and protect the environment”.

As part of this mandate California planned to launch an opt-out ToU tariff for all residential and small business consumers. However, due to delays in the smart meter rollout this is now scheduled for 2013-14. Residential consumers are currently on a tier tariff but can also opt-into a dynamic tariff (in this case they are on both at once).

Historically, Pacific Gas & Electric (PG&E) has been offering two period ToU tariff since the 1980s but only a limited number of consumers chose to participate. Daily peak started at 2 p.m. and ended at 6 p.m.. The average peak shift in summer was 16% and in
winter 6%. The rate has since been discontinued and is replaced by the SmartRate program.

**A.5.1 Description of CPP Smart Rate Programme**

The SmartRate programme is a Critical Peak Programme (CPP) programme started in 2008 for residential and small business consumers equipped with a smart meter. Table 6 describes the results of this programme. Table 6 describes the Critical Peak Price Smart Rate Programme offered by PG&E.
<table>
<thead>
<tr>
<th>Utility</th>
<th>PG&amp;E (California)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>USA</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>Critical Peak Programme - Smart Rate Program</td>
</tr>
<tr>
<td>Launch date</td>
<td>2008</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-in</td>
</tr>
<tr>
<td>Number of participants</td>
<td>As of July 2012 there were 47,000 active or pending accounts and on an average CPP day and 23,000 active participants. The level of enrolment has remained steady for 2 years due to the fact that in 2010 the regulator announced the rate offering would end in 2011 and PG&amp;E stopped advertising it. However the regulator has since reversed this decision and the utility plans to begin marketing the rate again. Approximately 4,800 consumers are also enrolled in PG&amp;E’s SmartAC program. This scheme allows for the provision of automated reduction of air conditioning thermostat settings during CPP days.</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>Peak load reductions per event: 5.6 MW per event.</td>
</tr>
<tr>
<td></td>
<td>Average peak load reduction per household 2012: 13% average reduction.</td>
</tr>
<tr>
<td></td>
<td>Load reduction by segment: CARE (low income) customers reduced load on average by 7% while non-CARE consumers reduced load on average by 20%. Consumers with a low likelihood of air-conditioner ownership shifted 10%.</td>
</tr>
<tr>
<td>Energy savings</td>
<td>N/A</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>Over the four month summer period, SmartRate customers saved an average of $27 (€ 21), or 8% of their total bill. 80% of consumers benefited from the tariff.</td>
</tr>
<tr>
<td>Customer segmentation</td>
<td>There is a separate price system for low income consumers on the CARE program.</td>
</tr>
<tr>
<td></td>
<td>Consumer responsiveness: Customers in the top percentile of usage are more than twice as likely to be high responders than the average customer</td>
</tr>
<tr>
<td></td>
<td>Customers who have a higher likelihood of air-conditioner ownership and those who are also enrolled in SmartAC program, provide greater impacts than customers who are less likely to own an air-conditioner.</td>
</tr>
<tr>
<td></td>
<td>Large Agriculture and Large Commercial and Industrial Business customers are already on Time-Varying Pricing. Small and Medium Businesses begin the transition to Time-Varying Pricing in November 2012. Small and Medium Agriculture Customers begin the transition in March 2013.</td>
</tr>
<tr>
<td>Notification of event</td>
<td>When signing up for the tariff, customers are asked to indicate whether or not they want to be notified about events through emails and calls.</td>
</tr>
</tbody>
</table>
Below is the average impact for the summer of 2011.

**Rate description:**

- High price period from 2 p.m. to 7 p.m.
- Up to 15 event days per summer.
- Credits apply to non-peak usage from June through to September (inclusive) for those on the rate for the first time.

For residential customers, the additional peak-period charge on SmartDays is 60¢/kWh plus their base rate at the time. As all consumers in California are on a tier system, their rates are increasing with their usage over the month. The SmartRate differential may therefore become more pronounced as the month continues.

**Bill Protection:** In order to encourage enrolment, prospective SmartRate participants are offered bill protection during their first year. Bill protection is offered from the time they start on SmartRate through to the end of the first full summer they are on the rate (May 1 through October 31). During the summer of 2011, only 13% of SmartRate customers were covered under bill protection. This is a large change from 2010 when over 60% of customers had bill protection.\(^\text{11}\)

**Event Notification 2011:** When signing up for the tariff, customers are asked to indicate whether or not they want to be notified about events through emails and calls. Roughly 50% of customers do not provide PG&E with event contact information. Of those who do provide information, 15% of customers were not successfully notified. 35% of customers were successfully notified once per event, 32% were notified twice per event and almost 20% were notified either three or four times for the average event.

Customers who receive successful notifications shifted two to three times more than those who did not. It is difficult to determine whether the significant increase in load reduction with successful notifications is due to self-selection, greater event awareness or both. (Those more interested in the programme may be more likely to provide their contact information to PG&E when signing up.)

**Consumer experience:** Given that PG&E has 4.5 million residential customers, the proportion of customers having selected the SmartRate programme is small. The rate can be seen as a soft launch prior to the full ToU rollout. Those on the rate seem satisfied and the plan has maintained a steady level of participation for the last 4 years.

**A.5.2 Small businesses tariffs**

Under a mandate by the California Public Utilities Commission (CPUC), PG&E has started to apply dynamic pricing to its small- and medium-sized business customers since November 2012.

**A description of the ToU tariff**

Summer (Service from May 1 through October 31):

- Peak: 12:00 noon to 6:00 p.m., Monday through Friday (except holidays).
- Partial-peak: 8:30 a.m. to 12:00 noon, Monday through Friday (except holidays) AND 6:00 p.m. to 9:30 p.m.

\(^{11}\) Freeman and Sullivan 2012
- Off-peak: 9:30 p.m. to 8:30 a.m., Monday through Friday All day Saturday, Sunday, and holidays.

Winter (Service from November 1 through April 30):
- Partial-Peak: 8:30 a.m. to 9:30 p.m. Monday through Friday (except holidays).
- Off-Peak: 9:30 p.m. to 8:30 a.m. Monday through Friday (except holidays) All day Saturday, Sunday, and holidays.

How was the product rolled out

Before the mandatory ToU pricing, CPUC mandated one year’s worth of interval meter data (hourly usage) to give SME customers enough information to understand the changes and adjust to them.

PG&E created a rate comparison tool that could demonstrate the impact. It sent custom rate comparisons by mail twice during the data-gathering year. The utility made person-to-person contact with more than 60,000 customers, including the 23,000 likely to be most impacted. Meetings with influential community groups were arranged, including civic groups, government entities, and media. Digital media was used to get the message across that rates would go to TOU starting in November 2012.

A view of the quality of consumer experience

PG&E’s study of SME customers prior to the roll out shows:
- that 50 percent of the business customers would have no adverse annual bill impacts, even without behavioral changes. Two percent would see an average $8 (€6) per month increase in their bill.
- Additional service offerings are given to the customers, including energy audits, rebates on more efficient appliances and equipment and rate analysis tools to determine strategies for managing energy use on TOU rates.
Table 7 – PG&E small business tariff

<table>
<thead>
<tr>
<th>Utility</th>
<th>PG&amp;E (California)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>USA</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>SME ToU Pricing</td>
</tr>
</tbody>
</table>
| Launch date      | Small and Medium Business: November 2012  
                                 Small and Medium Agriculture: March 2013 |
| Opt-in or opt-out| Mandatory                  |
| Number of participants | Approximately 500,000 small business customers. |
| Peak shifting    | PG&E has targeted at 16 megawatts reduction in peak demand (Its large commercial/industrial customers, on TOU rates for years, have shaved 138 MW off the peak.) |
| Energy savings   | Not Applicable             |
| Savings on the bill | Unknown                   |
| Customer segmentation | Small and Medium Business |
| Notification of event | Website announcement     |

A.6 Maryland, USA

Pepco in Maryland is rolling out 28,000 smart meters. The utility is now applying for a mandated Critical Peak Rebate (CPR)\(^\text{12}\) rate from the regulator with the aim of moving consumers to a CPP rate in a few years’ time. Currently the standard offer is a three-period ToU rate with only 1 cent differential between peak and off peak.

Pepco will begin by rolling out its CPR service to 5,000 residential consumers in late 2012 or early 2013. Then, the CPR scheme is expected is expected to be extended to all residential and small business consumers as the standard Pepco offer. The rate level (price differentials) is not set, but is undergoing review by the regulator.

**Opt-in/Opt-out**: Maryland has a competitive retail market, which means consumers can opt out of the Pepco rate by choosing another retailer.

**Settlement**: When asked if the retail settlement will be based on the actual hourly meter reads the Pepco interviewee stated:

> “Use the best data for settlements? How could you justify not doing that? Other options are not fair to suppliers or consumers. There is obviously more data but, that’s the direction of the world”

\(^{12}\) In a Critical Peak Rebate program, consumers are paid a rebate to lower consumption during critical peak event.
The upcoming rate offering will be based in the learnings from the **Power Cents DC pilot**.

The results of this pilot are described below.

### A.6.1 A description of the Power Cents DC tariffs

In 2007, the Smart Meter Pilot Program, inc (SMPP) initiated Power CentsDC to test the impact on consumer behaviour of a range of dynamic tariffs, smart meters and automated thermostats in the District of Columbia. The ToU rates used were:

- Critical Peak Pricing (CPP);
- Critical Peak Rebates (CPR); and
- Hourly Pricing (HP)\(^{13}\).

Each of the 900 customers involved received a smart meter and a select group was also offered a price sensitive automated thermostat for their central air-conditioner. Below is a detailed description of the tariffs used and their results.

**PowerCents DC Critical Peak Price (CPP):**

The first pricing tariff tested was a Critical Peak Price tariff. A description of this tariff is below:

- **Time Variables** 2 p.m. - 6 p.m. (1\(^{st}\) June to 30\(^{th}\) September, 12 critical peak days); and
- 6 a.m. - 8 a.m. and 6 p.m. - 8 p.m. (1\(^{st}\) November to 28\(^{th}\) February, 3 critical peak days)

Price Variable: 7 times base price for the Rebate. Base price was 11 cents per Kwh

Critical Peak Rebate was 76 cents per kWh in summer 2009 and 36 cents per kWh in winter 2009.

Figure 27 depicts the PowerCents DC Critical Peak Price summer and winter rates.

---

\(^{13}\) During hourly pricing the price follows through from the wholesale market and the prices change hourly.
Figure 27 – PowerCents DC Critical Peak Price summer and winter rates

Table 8 provides an overview of the results of both the Critical Peak Price tariffs and the Critical Peak Rebate tariffs.

PowerCents DC Critical Peak Rebate (CPR):
Table 8 provides an overview of the results of both the Critical Peak Price tariffs and the Critical Peak Rebate tariffs.
The critical peak rebate tariff provides a reward for lowering consumption during critical peak hours rather than the threat of a price increase as is done in a CPP price. A description of the pricing variables and timeframes is below:

- 2 p.m. - 6 p.m. (1st June to 30th September, 12 critical peak days); and
- 6 a.m. - 8 a.m. and 6 p.m. - 8 p.m. (1st November to 28th February, 3 critical peak days)

### Table 8 – Critical Peak Price (CPP) and Critical Peak Rebate tariffs

<table>
<thead>
<tr>
<th>Utility</th>
<th>Pepco (Maryland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>US</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>Power Cents DC tariff</td>
</tr>
<tr>
<td>Launch date</td>
<td>2008</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-out</td>
</tr>
<tr>
<td>Number of participants</td>
<td>900 (excluding control group)</td>
</tr>
</tbody>
</table>

#### Critical Peak Price (CPP):
- 2 p.m. to 6 p.m. (1st June to 30th September, 12 critical peak days);
- 6 a.m. to 8 a.m. and 6 p.m. to 8 p.m. (1st November to 28th February, 3 critical peak days)

**Price Variable:** 7 times base price. Base price was 10.9 cents per Kwh Critical Peak Price was 75 cents per Kwh

#### PowerCents DC Critical Peak Rebate (CPR):
- 2 p.m. - 6 p.m. (1st June to 30th September, 12 critical peak days);
- 6 a.m. - 8 a.m. and 6 p.m. - 8 p.m. (1st November to 28th February, 3 critical peak days)

**Price Variable:** 7 times base price for the Rebate. Base price was 11 cents per Kwh Critical Peak Rebate was 76 cents per kWh in summer 2009 and 36 cents per kWh in winter 2009.

#### Peak shifting
- **CPP:** 34% (peak reduction summer), 13% (peak reduction winter),
- **CPR:** 13% (peak reduction summer) and 5% (peak reduction winter).

**Low income** consumers participated only in the CPR program. Their average savings was 11% peak reduction.

<table>
<thead>
<tr>
<th>Energy savings</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savings on the bill</td>
<td></td>
</tr>
<tr>
<td><strong>CPP:</strong></td>
<td>2% on average bill</td>
</tr>
<tr>
<td><strong>CPR:</strong></td>
<td>5% on average bill</td>
</tr>
</tbody>
</table>
**Price Variable:** 7 times base price for the Rebate. Base price was 11 cents per kWh. Critical Peak Rebate was 76 cents per kWh in summer 2009 and 36 cents per kWh in winter 2009. Figure 28 depict PowerCents DC Critical Peak Rebate summer and winter tariffs.

**Figure 28 – PowerCents DC Critical Peak Rebate summer and winter tariffs**

Source: EMeter Strategic Consulting (2010)

**Hourly pass-through:**

The third tariff tested was an hourly pass through of the real time wholesale market price. The results of this tariff are described in Table 9.
### Table 9 – DC real time pricing

<table>
<thead>
<tr>
<th>Utility</th>
<th>Pepco (Maryland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>US</td>
</tr>
<tr>
<td>Time of use programme</td>
<td>Real-time wholesale market pricing</td>
</tr>
<tr>
<td></td>
<td>Prices change hourly following wholesale prices.</td>
</tr>
<tr>
<td></td>
<td>High prices typically occur on summer weekday afternoons and winter mornings / evenings and prices could range from 1 cent to 37 cents.</td>
</tr>
<tr>
<td>Launch date</td>
<td>2008</td>
</tr>
<tr>
<td>Opt-in or opt-out</td>
<td>Opt-out</td>
</tr>
<tr>
<td>Number of participants</td>
<td>N/A</td>
</tr>
<tr>
<td>Peak shifting</td>
<td>4% (peak reduction summer), 2% (peak reduction winter).</td>
</tr>
<tr>
<td>Energy savings</td>
<td>N/A</td>
</tr>
<tr>
<td>Savings on the bill</td>
<td>39% on average bill (wholesale prices fell during the pilot). Rates were designed to be revenue neutral as the principle underlying the trial was that participants who did not react to price changes should not be penalized. However 91% of CPR and CPP participant paid less on the smart rate.</td>
</tr>
<tr>
<td>Customer segmentation</td>
<td>N/A</td>
</tr>
<tr>
<td>Notification of event</td>
<td>N/A</td>
</tr>
</tbody>
</table>

#### A.6.2 How was the pilot rolled out

Prior to the pilot start, the participants received an education package which included a pricing leaflet, conservation brochure and refrigerator magnet displaying the Critical Peak hours. Once the pilot started, the participants received new informative bills, along with monthly graphical consumption reports and price information inserts.

#### A.6.3 A view of the quality of consumer experience

Prior to the start, participants were interviewed as to which tariff offering they would prefer. There was a strong preference shown for Critical Peak Rebates – due to its positive reward qualities.

After the pilot, participants were interviewed again. They were asked if they were satisfied with the programme and if they would recommend it to friends and family. As can be seen from the responses below the consumers’ reactions were positive toward the project:

- 74% were satisfied with the programme and only 6% were dissatisfied;
93% expressed a preference for the PowerCents DC pricing over the standard offer service (flat rate); and

89% would recommend the PowerCents DC rates to friends and family.

The main motivation for participating was:

- For 73% of the consumers, saving money was the primary consideration;
- 34% of the customers wanted to reduce carbon emissions;
- 33% wanted to explore Smart Grids; and
- 32% wanted to assist policymakers.

The most common method for load-shifting was through the avoided use of appliances (60%) and reducing air conditioning load (59%).

A.7 Brazil

Regulator Aneel has paved the way for the introduction of time-of-use tariffs for low voltage residential and business customers.

There is a piece of regulation which makes provision for a “white tariff” with three levels, based on the cost of generation. This will apply on weekdays, with the highest rate applicable to the evening peak period, a low rate applicable during most hours of the day, and an intermediate rate. On weekends and holidays, the lowest rate will apply.

In a statement Aneel said the aim of this “white tariff” is to encourage consumption at the times when the cost is lowest, with the aim to reduce consumers’ bills and the need to expand peak generation. However, it is optional and if a consumer doesn’t wish to change their consumption habits, a conventional tariff will remain available.

According to Aneel the new tariff structure will be introduced by distributors in their tariff reviews between 2012 and 2014. However, it will become applicable only after electromechanical meters are swapped out with electronic meters.

Under the regulation a further change that will become effective January 2014 is the introduction of a “traffic light” system, with green, yellow and red flags reflecting the prevailing cost of generating energy. Green will indicate the lowest cost, yellow will be a warning indicating that costs are increasing, and red will indicate that costs are at their highest. This will be for all low and high voltage customers connected to the National Interconnected System (SIN).

A.8 Romania

Since there is no legislation to regulate time of use tariff for the deregulated market, most of the suppliers allow tariff negotiation with certain conditions stipulated in the supply contract and prefer to offer the simplest form of energy billing with one price component for the energy consumption regardless to different time zones.

A.8.1 Types of tariffs

For household consumers, the type of energy tariffs available are active energy\textsuperscript{14} tariffs:

\textsuperscript{14} Order ANRE 25/2012 for the approval of regulated tariffs for electricity supplied by default suppliers and providers of last resort household and assimilated households
For credit meters
- Tariff CS – optional social type, has different price components depending on energy consumption thresholds.
- Tariff CD – optional single component without subscription, with one price component for the energy consumption.
- Tariff CA – optional single component with subscription, with two price components for the energy consumption and subscription fee.
- Tariff CA2 – optional single component with differentiated rate (with subscription), time of use tariff with two price components for the energy consumption and subscription fee.
- Tariff CA3 – single component with differentiated rate with subscription based on time of use tariff for three time zones (peak, normal, off-peak) with two price components for the energy consumption and subscription fee.

For meters with pre-payment:
- Tariff CP – optional single component with subscription based on two price components for the energy consumption and subscription fee.
- Tariff CP2 – optional single component with subscription based on time of use tariff with two price components for the energy consumption and subscription fee.
- Tariff CP3 – optional single component with subscription based on time of use tariff for three time zones (peak, normal, off-peak) with two price components for the energy consumption and subscription fee.

Each tariff type has different prices depending on the voltage level (Low Voltage, Medium Voltage) with exception of the tariff CS (optional social type), which is provided only for low voltage.

Very few household consumers have used their eligibility right and most of them use the simplest form of energy billing, with one price component for the energy consumption.

On the customer side a behavioural inertia has shown that consumers are reluctant to time of use tariff, maybe because of the complicated bill with different prices for different time zones. This behaviour determines a big gap between off-peak and peak consumption which stresses the power system and leads to high prices in peak time. For this reason, an ANRE legislation to mandate time of use tariff for the deregulated market would help the entire power market.
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ANNEX B – EVALUATION CRITERIA

B.1 Background

In order to evaluate the different options for ToU, we have created:

- a set of criteria which relates to the deployment issues of ToU tariffs; and
- a more detailed set of criteria which are specific to the customer savings which can be generated with the implementation of ToU tariff options.

Initially, we attempted to base our evaluation criteria on the three fundamental objectives of energy policy: cost, security of supply and sustainability. However, this approach is limited as it introduces false separations between the evaluation criteria, and would not lend itself to the necessary level of detail.

- there are some critical choices in relation to practicality which need to be understood;
- the evaluation of options for ToU tariffs must include a view of how successfully the alternative options can deliver changes in customer behaviour:
  - the successful delivery of changed customer behaviour in turn leads to improvements in all three of the fundamental objectives of cost, security of supply and sustainability.

We have therefore delivered a set of criteria relating to deployment issues for ToU tariffs as well as the basis for another set of criteria specifically to capture the effectiveness of alternative options in delivering the necessary changes in customer behaviour, and how these changes in customer behaviour themselves in turn to reduced costs of operating the electricity system. This is an effective proxy for the other considerations of improved security of supply and of sustainability.

The criteria we have outlined incorporate our present understanding of the policy objectives which the CER aims to achieve and the potential impact of the options on the different parts of the system. We have refined the evaluation criteria in the course of the project.

B.2 Time of use Tariffs context

In theory, the implementation of smart metering and ToU tariffs could reduce operating and capital costs across the electricity system, through impacts on power generation, the activities of the TSO and/or the DSO. Table 10 provides a first assessment of the potential sources of savings under the implementation of various forms of ToU tariff.
Table 10 – Means by which tariffs may impact on costs of the electricity system

<table>
<thead>
<tr>
<th>Effect of tariffs</th>
<th>OPEX implications</th>
<th>CAPEX implications</th>
</tr>
</thead>
</table>
| Generation             | A Reduced operation of (inefficient) peak thermal generation  
B Increase in the load factor of off-peak (more efficient) generation at the expense of less efficient generation  
C Reduction in the level of wind curtailment due to generation exceeding demand (excluding system operation issues =F below) | D Reduction in thermal generation capacity requirements                                |
| Transmission System    | E Reduced part-loading of thermal plants for inertia, system balancing issues  
F Reduced need to curtail wind for inertia, system balancing purposes | G Reduction in transmission build requirements                                         |
| Distribution System    | H Potential reduction in technical and non-technical losses | I Reduction or deferral of network reinforcement requirements                        |

The key to achieving the cost savings above lies in the ability to deliver different changes in consumer behaviour. In Table 11, we list various types of consumer behaviour change which could influence system costs (using the identifiers from Table 10 above) and set these against the type of ToU tariff which could deliver this behavioural change.

There are some underlying assumptions we have made with regards to how consumer behaviour is triggered or incentivised to deliver these cost savings. These assumptions are:

- that the price differential which is experienced by the end consumer is down to the Supplier; and
- that customers will alter their behaviour and respond to the prices they see.
Table 11 – Customer behaviour change arising from ToU tariffs

<table>
<thead>
<tr>
<th>Customer behaviour change (and main associated cost saving from Table 1):</th>
<th>Type of tariffs suitable to meet the objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce total consumption at all times (A, D, G, H, I)</td>
<td>Static tariff, in-home display, public information</td>
</tr>
<tr>
<td>Reduce absolute system peak demand (increase demand at other times) (A, B, C, D, E, G, H, I)</td>
<td>Static tariff, public information</td>
</tr>
<tr>
<td>Reduce system effective peak demand (i.e. net of wind generation) (marginally increase demand at other times) (A, B, C, D, E, G, H, I)</td>
<td>Static tariff could deliver some savings, dynamic would be more effective with high wind penetration</td>
</tr>
<tr>
<td>Increase the effective off-peak demand (marginally reduce demand at other times) in order to accommodate wind output/avoid curtailment (C, F)</td>
<td>Dynamic tariff would be most effective, as the time when this is most needed would depend on overnight wind patterns</td>
</tr>
<tr>
<td>Automated demand provision of frequency response (E, F)</td>
<td>Dynamic demand with automation in response to frequency trace – no ToU tariff or real-time instruction required</td>
</tr>
<tr>
<td>Demand provision of system reserve to TSO at time of need (D, E, F)</td>
<td>Real-time instruction/automation or remote control by TSO would be required</td>
</tr>
<tr>
<td>Reduce localised (distribution) system peak demand (increase demand at other times) (H, I)</td>
<td>Static tariff helps initially but in future if there is a high level of demand response in localised areas, this may require dynamic input/instruction from DSO</td>
</tr>
</tbody>
</table>

The types of behaviour change (and therefore cost saving) which may be achieved depend on the type of ToU pricing signal which can be transmitted to customers, although ultimately consumer acceptance will determine their effectiveness. The ability of the ToU tariffs in delivering behavioural change and therefore cost savings will depend primarily on three design choices:

- the temporal resolution of the ToU tariff:
  - i.e. how many separate tariffs there will be in a given period (ranging from half-hourly pricing to prices for peak and off-peak per season);

- how often the tariffs are updated to account for changing system conditions;
  - at its simplest, this is a matter of whether static or dynamic tariffs are implemented;

- the extent to which the TSO and/or DSO are able to ‘supplement’ the prices seen by the customer (and with what temporal and spatial resolution and frequency of update; and
  - e.g. real-time remote control in specific locations vs. static time of use at all places or at specific voltage levels.

The behavioural changes outlined above have the potential to contribute to each of three strategic policy objectives which the CER aims to meet; namely cost, security of supply and sustainability. For example, by reducing the absolute peak demand on the system, ToU tariffs could improve security of supply (or reduce the cost of delivering a given level
of security of supply) while also reducing output from the most inefficient (carbon-emitting) peak generation.

In addition to the generic evaluation criteria set out below, we propose to use this assessment of the types of customer behaviour change and the associated cost savings as a set of additional evaluation criteria for the ToU tariff options.

The relative economic value of the savings from different types of behaviour change depends on the underlying electricity system\textsuperscript{15}. It is not yet clear where the greatest savings can be gained along the value chain, and this merits further consideration.

We note that the design of the ToU regime is subject to major constraints such as the cost and complexity of the supporting metering equipment and communications infrastructure, and also the essential point of consumer acceptance. Therefore, not all of these potential benefits above may be achievable. These practicalities will also form part of the assessment options.

4.4 Evaluation criteria relating to deployment issues

4.4.1 Introduction

We have therefore outlined in Table 12 our view of the set of evaluation criteria which relate to deployment issues for ToU tariffs.

\textsuperscript{15} The extent to which cost savings can be attained from static rather than dynamic tariffs depends on a range of factor, including the level of wind penetration (and the scale of wind curtailment), the flexibility inherent in the remaining generation fleet (and its cost) and the relative peakiness of the system. The network-related cost savings also depend on the system: network issues may be location specific, may not be easily predictable, and the pattern of wholesale energy prices may not always support the needs of the network operators e.g. if cheap overnight energy leads to new distribution peaks at specific locations.
### Table 12 – Common set of evaluation criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ToU (electricity only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of deployment</td>
<td>understand impact of option from the perspective of:</td>
</tr>
<tr>
<td></td>
<td>Suppliers;</td>
</tr>
<tr>
<td></td>
<td>DSO; and</td>
</tr>
<tr>
<td></td>
<td>TSO/SEMO.</td>
</tr>
<tr>
<td></td>
<td>similarities with other EU countries</td>
</tr>
<tr>
<td></td>
<td>deal with DUoS tariffs</td>
</tr>
<tr>
<td>Ongoing costs</td>
<td>understand impact of cost of the option from the perspective of:</td>
</tr>
<tr>
<td></td>
<td>Suppliers;</td>
</tr>
<tr>
<td></td>
<td>DSO; and</td>
</tr>
<tr>
<td></td>
<td>TSO/SEMO.</td>
</tr>
<tr>
<td>System cost savings</td>
<td>as outlined in Table 11</td>
</tr>
<tr>
<td>Risks and scale of change</td>
<td>overall scale of change compared with existing systems;</td>
</tr>
<tr>
<td></td>
<td>technical reliability of the end-to-end smart system relating to ToU</td>
</tr>
<tr>
<td></td>
<td>robustness to data transfer failure (accidental or malicious)</td>
</tr>
<tr>
<td></td>
<td>data security issues;</td>
</tr>
<tr>
<td></td>
<td>modular deployment;</td>
</tr>
<tr>
<td></td>
<td>realisation of benefits from 2015 onwards;</td>
</tr>
<tr>
<td></td>
<td>speed of deployment; and</td>
</tr>
<tr>
<td></td>
<td>future-proofing/scalability</td>
</tr>
<tr>
<td>Consumer acceptance (Business customers = B and Residential customers = R)(^{16})</td>
<td>Consumer acceptance leading to behavioural change</td>
</tr>
<tr>
<td></td>
<td>simplicity of tariffs and ease of interpretation (B and R);</td>
</tr>
<tr>
<td></td>
<td>data protection and confidentiality (B and R);</td>
</tr>
<tr>
<td></td>
<td>showstoppers – overall perception of increase in cost to end consumer (B and R);</td>
</tr>
</tbody>
</table>

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\(^{16}\) B next to an evaluation criteria implies that the criteria applies to Business customers while an R means that the criteria applies to a Residential customer.
• showstoppers – too much complexity resulting in delays in communication;
• protection of customers in financial hardship (R only);
• consumer acceptance – behavioural change (B & R); and
• consumer acceptance mandate – possibility of outright rebellion; (B & R).

Supplier issues and competition

• incentives for Suppliers to participate (profiles);
• prospects for supplier competition;
• competition in other services (home technologies etc.); and
• furthering competition in generation as demand contributes to pricing.

An underlying issue is the degree to which the options require proprietary solutions (which will constrain future options and increase long-term costs) or whether they require solutions which have not yet been proven.
Annex C – TOU Options for Gas

The following provides an overview of the potential for gas TOU tariffs. Gas TOU tariffs in Ireland would apply to approximately 400,000 customers if implemented. The TOU tariffs for gas have not been mandated as part of the CER Smart Metering Decision Paper on the 4 July 2012.

Pöyry Management Consulting has been asked, as part of this process, to provide a high level overview of the types of options which could be implemented for gas TOU tariffs.

C.1 Purpose of Gas TOU tariffs

Gas TOU tariffs are intended to provide public benefits by eliciting changes in customer behaviour that alter the pattern of consumption and encourage the more efficient consumption of gas across Ireland. These public benefits could potentially include:

- an overall reduction in gas consumption in Ireland which would contribute towards the energy efficiency targets;
- reducing absolute peak demand thereby reducing or deferring the network reinforcement on the system;
- providing tools which allow shippers to offer more innovative products to their customers and therefore potentially contributing to the gas market competition objective; and
- providing enough information on actual costs of gas to offer customers the ability to make more informed decisions, thereby improving their customer experience.

C.2 Differences between gas and electricity TOU

There exists a fundamental difference between gas and electricity TOU tariffs.

The primary benefit of gas TOU tariffs is an overall reduction in consumption as consumers will react to daily prices and become more cost conscious. The gas TOU trials carried out by the industry during Phase I of the smart metering programme showed an overall average reduction in gas consumption of 2.9% in the gas TOU trials.

Gas TOU tariffs will also lead to a reduction in peak demand. Savings can be achieved through reducing demand at peak times which would generate a reduction in network reinforcement requirements. There is less potential to deliver demand response for system peak with gas TOU tariffs as the relevant ‘peaks’ last for a day. Although it may be possible to shift some of the heating for an hour or so a day, it is not necessarily enough in gas terms to make a significant difference to the peak demand. While demand can be shifted to ‘off-peak’ periods with for example, the use of water and heat storage facilities, the need for shifting demand spans a much longer time period compared to electricity.

C.3 Building blocks for gas TOU tariffs

We have provided below a number of options for gas TOU tariffs based on the same building blocks used for electricity TOU tariffs in Section 2. The building blocks are illustrated in Figure 29.
Figure 29 – Evolution of ToU tariffs for gas

The building blocks include:

- the time band of the tariff which would be anything between 2 and 365 for every year;
- how fixed, pre-determined or flexible the time intervals of the ToU tariff are and therefore with how much freedom the supplier has in defining the time bands as per the definitions in Section 2.2;
- the flexibility of the tariff in how suppliers are able to change the tariffs at different points in time, subject to giving customers enough notice;
- the inclusion of network charges in terms of whether they would vary in line with the tariffs;
- the use of interval metered data in settlement in terms of whether actual interval meter data would be required or new artificial profiles; and
- the visibility of the tariff to the customer through the IHD, other means of communication and energy statements

C.4 ToU tariff options

The following three ‘straw man’ tariff formats are options which could be considered for the delivery of gas ToU tariffs. It is important to stress that these forms are illustrative rather than definitive. The three formats use the building blocks outlined above in their construction.

C.4.1 Option 1 – Bi-Monthly or monthly gas tariff

This particular tariff is similar to the one used in the smart metering trial. Its features include the following:
Six¹⁷ or Twelve pre-determined monthly time bands, and shippers are able to choose one or the other;
- the tariffs would be fixed and pre-determined for the length of the contract with the customer;
- network charges would be shown separately from energy rates;
- new artificial profiles would be required for settlement purposes;
- the IHD would simply display the tariff rate that applied on any given day; and
- customers could change their supplier with the same frequency as at present.

This tariff is illustrated in Figure 30.

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**Figure 30 – Bi-monthly or monthly gas tariffs**

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**C.4.2 Option 2 – Variable gas tariff**

This particular tariff has a more variable aspect to it. Its features include:

- Twelve time bands which would reflect a price for every month.
- The tariffs would be more variable in that the contract between the shipper and the customer would specify a particular goal with regards to a maximum level of consumption for the month. Any gas consumed above the specified level would be charged at a different price.
- Network charges would be shown separately from energy rates.
- New artificial profiles would be required for settlement purposes.
- The IHD and other means of communication would simply display the tariff rate that applied on any given day as well as 'message' the customer.
- Customers could change their supplier with the same frequency as at present.

This tariff is illustrated in Figure 31.

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¹⁷ Bi-monthly tariffs were used in the trial
C.4.3 **Option 3 – Daily pass through**

This particular tariff would be a daily pass through of the gas price to the end consumer. Its features include:

- 365 time bands which would reflect a price for every day which would match the daily settlement in line with the gas target model;
- network charges would be shown separately from energy rates;
- IHD would provide day ahead prices as well as ‘messages’ to the customer; and
- daily settlement process would be required using interval meter reads as opposed to artificial profiles.

This tariff is illustrated in Figure 32.

A variant on this option would include customers being incentivised to target a particular threshold with regards to their consumption of gas. Above a certain level of daily consumption, they would be charged a different price which would be the daily price + a premium.
C.4.4 Next steps

These options would need to be assessed to define their feasibility and their applicability to the market in Ireland. With the smart meter and other means of communication, including the IHD being deployed, the potential for gas ToU tariffs should not be overlooked (they contributed significantly to the positive NPV for gas smart metering in the CBA), especially as they provide a means of offering more competitive and innovative products to the end consumer.
# QUALITY AND DOCUMENT CONTROL

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<th>Date</th>
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<td>Asheya Patten</td>
<td>December 2012</td>
</tr>
<tr>
<td>Approved by:</td>
<td>Stephen Woodhouse</td>
<td>December 2012</td>
</tr>
<tr>
<td>QC review by:</td>
<td>Beverley King</td>
<td>December 2012</td>
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## Document control

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