TOOL: HOW TO ESTIMATE YOUR LOAD SHIFTING POTENTIAL

Abstract

This tool is intended for those who want to make a rough estimation of the potential for a consumer's peak levelling savings and electricity energy shift from limited input data. The calculation based on the actual consumption data and on behaviour type of consumer gives the upper limit regardless of what characteristics the loads possesses. The tool Peak reduction and energy shift calculation, programmed in MS Excel, is intended for demand response service providers, employees in sales and consumer recruitment positions. This written tool gives a description of how to use the excel tool.

What is it?

The tool Peak reduction and energy shift calculation is an Excel application containing the samples of consumer consumption data and calculations for the energy shift. The tool gives a first indication of the expected amount of flexible energy for different SME branches. The inputs, such as consumption profile and peak levelling characteristics, are used for the calculation of the potential amount of energy which can be shifted and the amount of financial savings at peak reduction. The tool includes representative consumption profiles and peak reduction amounts for different industrial branches and peak prices. This written tool gives a description of how to use the excel tool.

The tool is developed based on the experience of multiple peak levelling and demand response system installations in various SME branches. It assumes that a particular branch has specific consumption characteristics and that their production processes have a certain level of operational flexibility for peak reduction (see Table 1). From the characteristic peak reduction value and the given consumption profile, the tool calculates the amount of flexible energy, which may be shifted for the period of the peak duration (see Figure 1).

SME branch	Average peak demand	Average peak savings	%
Metal	3.800 kW	410 kW	12,4
Wood	3.960 kW	330 kW	10,0
Textile	2.390 kW	257 kW	11,9
Glass	6.500 kW	750 kW	11,5
Paper	9.830 kW	2.300 kW	17,1

SME branch	Average peak demand	Average peak savings	%
Rubber	8.950 kW	980 kW	11,0
Foundries	4.950 kW	1.130 kW	21,3
Machinery	6.350kW	650 kW	10,5
Steel	38.000 kW	5.000 kW	13,2
Clothing	1.550 kW	140 kW	10,5
Food	1.300 kW	150 kW	11,5
Other	3.250 kW	303 kW	12,5

Table 1: Peak levelling results in various SME branches (source: INEA)

The second part of the tool estimates the cost savings due to the reduced peak consumption assuming there is a dynamic tariff in place for electricity consumption and the return on investment for the automatic control system if the consumer would decide to install it. The peak consumption price is usually prescribed by the regulatory body and may be country-specific.

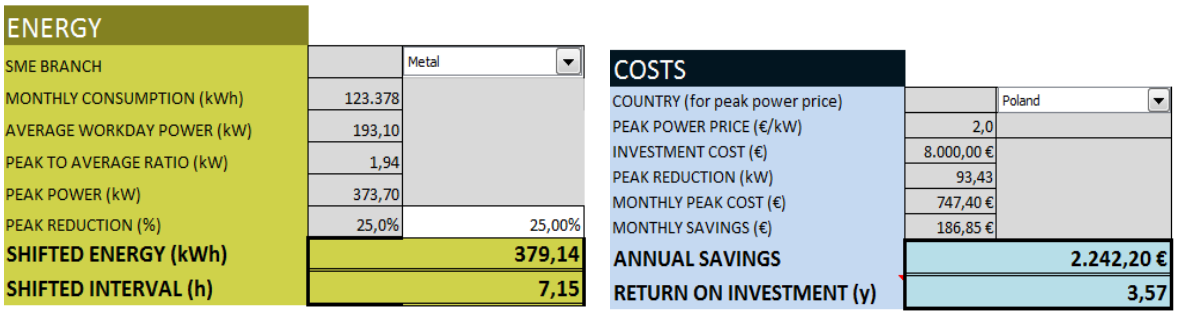

Figure 1: Calculation of the energy shift (left) and peak levelling savings (right) – snapshots from the tool.

The return on investment depends on the cost of the installed control system for the peak levelling. The prices in the calculation tool again reflect the experiences from previous installations, which can be classified in 4 types according to the installed electricity consumption capacity:

- Small systems (up to 10kW of installed power) cost around €150 (€15 per kW);
- Systems for medium-sized SMEs (up to 100kW of installed power) cost around €1.200 (€12 per kW);
- Systems for large SMEs (up to 1MW of installed power) cost at least €8.000 (€8 per kW);
- Large installations (more than 1 MW of installed power) cost more than €20.000.

As already mentioned the tool can be used to get a first estimation, but a thorough analysis would be needed to estimate the flexibility potential and accompanying savings for a specific company (see guideline Introducing demand side management to SMEs).

When to use?

The tool may be used by the utility or service provider for approaching the candidates for automatic demand response or peak levelling service. The tool gives a first indication on the consumer's suitability and capability for the service. It is intended for non-technically skilled people (marketing, sales) to get the demand response functionality basics and pass the results to the technically educated experts for further analysis. It may also be used by consumers themselves to estimate their flexibility and saving potential.

The tool is intended to be used in the beginning of the execution phase of the smart grid roll out or project at engagement of the consumers to estimate their flexible energy amount available and accompanying installation costs.

For the peak levelling savings the tool assumes that the consumer is involved in the Critical Peak Pricing (CPP) tariff system, which charges according to the maximal power (€/kW) consumed in a certain period (e.g. one month). This is a usual practice for large consumers and SMEs. The tool may be used also for small consumers, which are not involved in CPP but usually pay fixed amount regarding the connected power. The tool may give them the first estimation if they can apply for lower amount of connected power at distribution company and reduce cost.

What do you need to do?

The description relates to the MS Excel tool which offers two functionalities: 1) calculation of the flexible energy and 2) calculation of the peak levelling savings. For each calculation the tool user needs to enter parameters to get a set of results as described below.

Calculation of flexible energy

Entering parameters

The tool user enters the following parameters:

1. *Choose SME branch*
   First one uses drop down menu control to select the SME branch, which corresponds to the consumer. If none of the available profiles corresponds to the tested consumer then one may choose “parameterized” option (see details at item 4). The option “manual entry” is described under item 5.

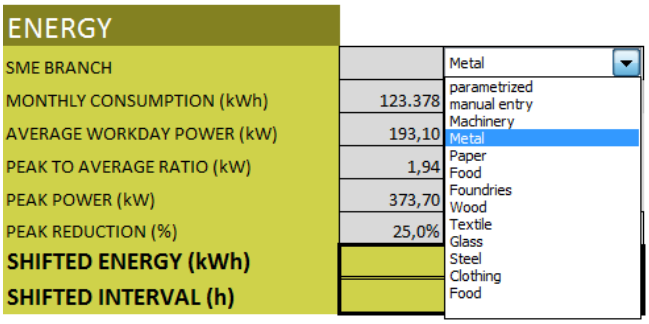

Figure 2: Selecting a branch

The tool loads data of the corresponding consumption profile. The consumption profile is displayed from Monday to Sunday.

2. *Adapt the total consumption*

The chosen profile has a specific amount of energy consumed as default, which probably does not correspond to the consumer under analysis. The amount may be adjusted by activating the "Manual entry" selection box in the "monthly consumption" line. By activation of the selection control the tool user is allowed to enter the value, which corresponds to the typical monthly consumption of the consumer (from the bill), and the energy profile is adapted accordingly. However, the other parameters are kept as default for this branch.

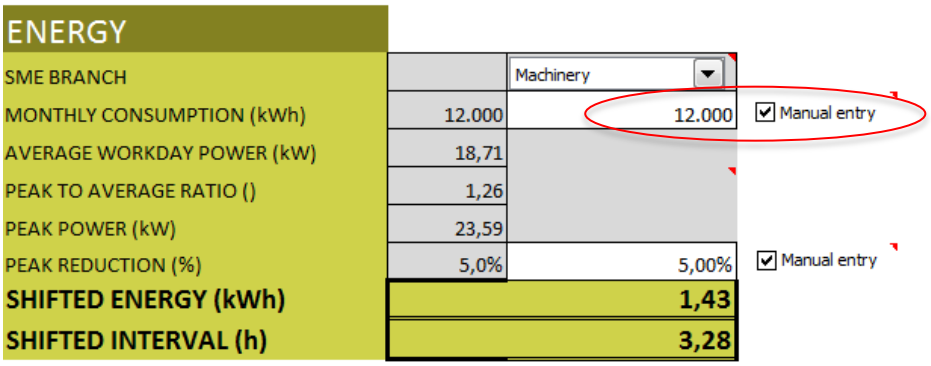

Figure 3: Entering total consumption

3. *Set a peak reduction*

The peak reduction ratio is loaded automatically according to the chosen branch (see Table 1) and is expressed as a percentage of the peak power. Since this value is an average based on past experience and may not be valid

for the particular consumer under analysis, the tool user may adapt it by activating the select control in the “peak reduction (%)” line.

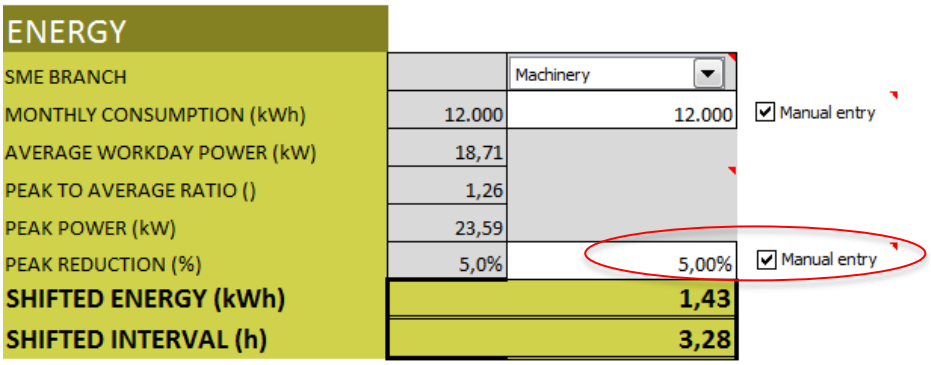

Figure 4: Entering peak reduction ratio

4. *Configuration of the “parameterized” profile*

In the case the tool user has not find any suitable branch profile from the drop down menu, he can choose the “parametrized” option. The tool loads an artificial consumption profile which corresponds to the typical SME with intensive daylight consumption and strong daily periodic behaviour. The option automatically offers the manual configuration of i) total consumption, ii) peak reduction ration and additionally iii) peak to average ration. The last parameter enables the tool user to adapt calculation according to the analysed consumer characteristics. This value may be simply calculated from the consumer bill by dividing the peak consumption power and average (monthly) power (monthly energy consumed divided by number of hours in the month – 30 days x24 hours). The value of the parameter usually ranges between 1.05 and 2.0.

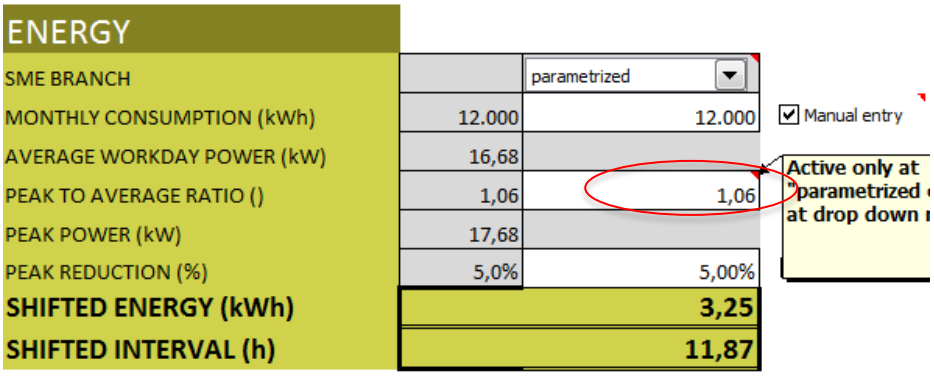

Figure 5: Entering peak to average ration parameter

5. *Enter actual consumer data*
   In the case there are real consumer consumption data available, they can be directly entered into the tool. One needs 15 min measurements of total power for a period at least for one week. It is recommended that the first measurement is on Monday at 00:00. At the selection of the "manual entry" additional column "Manual Entry" becomes visible on the right hand side. The tool user simply copy-paste the measurements into the column.

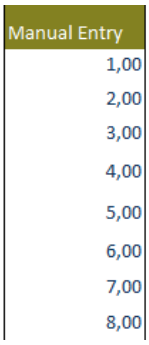

Figure 6: Entering measurements into the tool.

Explanation of results

The tool calculates the following results:

1. *Calculation of the profile parameters*
   The tool calculates the typical profile parameters like average working day power, peak power and peak to average consumption ratio. The last parameter is the most representative for the estimation of the peak levelling potential. A large ratio means that there is a lot of potential for peak levelling and vice versa.

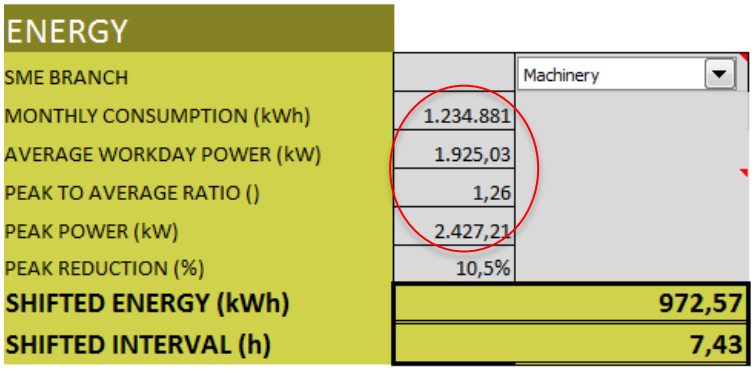

Figure 7: Calculation of the profile parameters

2. *Calculation of the shifted consumption profile*

The "Original consumption" - data are in the tool's database – is used to calculate the "Shifted consumption" with the reduced peak. The tool shifts the energy above the power limit to later time, when the power is below the limit. Both results – original and shifted consumption are presented on the chart on the right hand side.

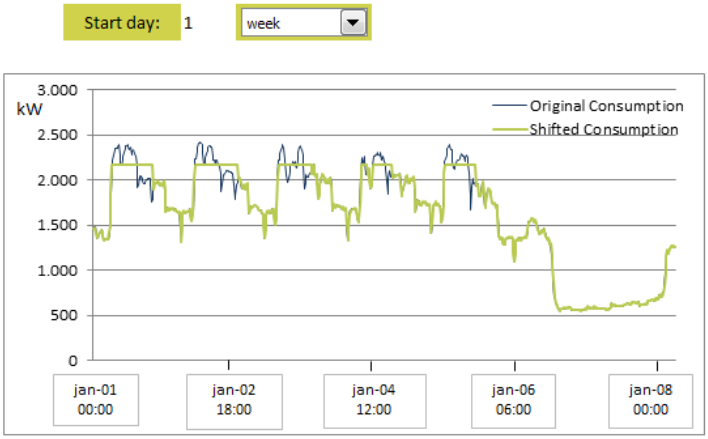

Figure 8: Examination of the shifted consumption

For the detailed examination of the calculation the user may choose a shorter interval from the drop down menu above the chart and select the start day for the time history.

3. *Shifted energy and shifted interval*

The results of the calculations are the "shifted energy" and the "shifted interval". The shifted energy is calculated as a difference between "Original consumption" and "Shifted consumption" on the daily bases. The "shifted interval" is the time difference of the shifted energy usage i.e. the load consumption is delayed for 7 hours). The data for maximal daily amount of shifted energy is presented.

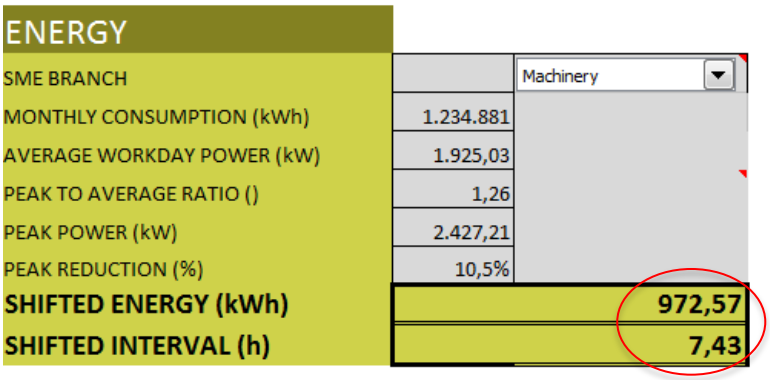

Figure 9: Calculation of the shifted energy and interval

The shifted energy is the amount of energy the consumer of the specific branch most probably possesses within his process. The result may also be understood in another way – it is the required amount of flexible energy which the consumers must find in process loads (in the form of i.e. thermal storage, material warehouse, etc.) to achieve the desired peak reduction. The shifted interval is another technical parameter describing the "time capacity" of the energy storage in the form of the consumption loads – i.e. for how long the storage is capable to keep the energy.

Calculation of the peak levelling savings

The results of the flexible energy calculation also enter as input for the calculation of the peak levelling savings.

Entering parameters

The following parameters are needed for the calculation of the savings

1. *Setting the peak price*

   The peak price for the consumer's peak consumption is usually defined by the national regulatory body. The calculation tool database contains prices for certain countries, which may be chosen from the drop down menu. The prices are for orientation only since they are subject to regular changes over time.

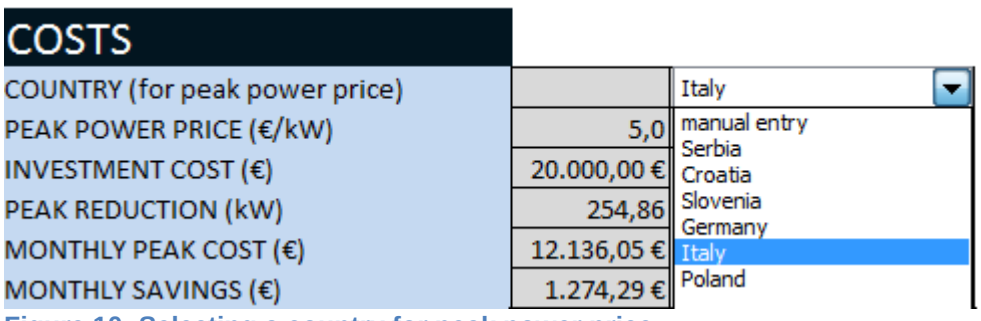

Figure 10: Selecting a country for peak power price

If a specific country is not on the list, the tool user is encouraged to choose the “manual entry” option and enter the price manually. The prices usually range between 2 and 10 €/kW and the cost is accounted monthly (i.e. the highest consumption power within the month is charged).

2. *Peak reduction amount*
   The peak reduction amount, which is needed for the calculation of savings, is calculated from the flexible energy calculation as a multiplication of the peak power and peak reduction ratio. If the tool user wants to change this value, he needs to change the peak reduction ratio parameter in the previous section.

COSTS		
COUNTRY (for peak power price)		Croatia
PEAK POWER PRICE (€/kW)	4,2	
INVESTMENT COST (€)	20.000,00 €	
PEAK REDUCTION (kW)	254,86	
MONTHLY PEAK COST (€)	10.194,28 €	
MONTHLY SAVINGS (€)	1.070,40 €	
ANNUAL SAVINGS		**12.844,80 €**
RETURN ON INVESTMENT (y)		**1,56**

Figure 11: Using the peak reduction amount

3. *Investment cost*
   Investment cost is needed to calculate the return of investment. The investment costs are the installation costs of the hardware and software equipment for automatic peak levelling and demand response services at the consumer. The investment cost depends on the size of the consumer and number of loads connected to the control system. The tool uses the approximation from the peak power as described in the “What is it?” chapter, which is strongly correlated to the consumer size, to estimate the costs of the installation.

Explanation of results

The tool calculates the following results:

1. *Peak costs and peak savings*
   Using the peak reduction from the previous part the tool calculates peak cost, which is accounted on the monthly bases and correspond peak cost savings.

COSTS		
COUNTRY (for peak power price)		Croatia
PEAK POWER PRICE (€/kW)	4,2	
INVESTMENT COST (€)	20.000,00 €	
PEAK REDUCTION (kW)	254,86	
MONTHLY PEAK COST (€)	10.194,28 €	
MONTHLY SAVINGS (€)	1.070,40 €	
ANNUAL SAVINGS		**12.844,80 €**
RETURN ON INVESTMENT (y)		**1,56**

Figure 12: Calculation of costs and savings

2. *Annual savings and return of investment*
   The main results of the calculation are estimated annual savings and the return on investment (simple payback time). The first is simply calculated from monthly savings. The second is monthly savings divided by investment cost.

3. *Savings portion*
   On the right hand side a cake diagram presents the portion of monthly peak levelling savings corresponded to the total peak costs (peak costs before intervention are sum of peak costs after intervention plus savings, thus the graph indicates what share of old peak costs will be the new peak costs).

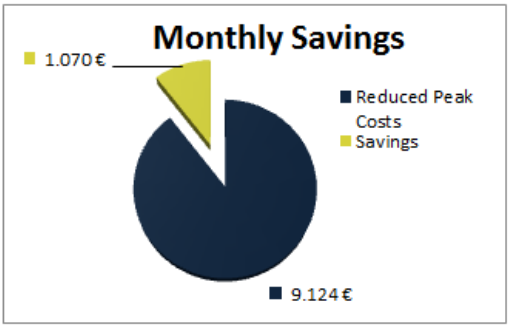

Figure 13: Presentation of peak levelling savings

Do's and don'ts

- **Enter peak levelling prices.** If the country drop down menu does not contain the end user location, one can add it on the sheet "DropDownData" and add corresponding peak price. It also enables the tool user to correct the actual peak levelling prices
- **Print the tool result.** The sheet "Loadshift" has defined print area to print the calculation result on two pages.
- **Do not (yet) make promising conclusions based on to the tool result.** The tool provides the initial information about the consumer suitability for energy adaptation system, but more detailed information is necessary to see if there is real load shifting capacity behind. In the case the tool gives promising result (i.e. short shift interval and small return on investment), further actions are taken like detailed analyses of the consumer consumption loads (see guideline Introducing demand side management to SMEs). Otherwise no further action is taken, since the consumer does not have technical and/or commercial potential for the smart grid service.

Testing of the tool on the SME representatives (Kibernet, SLO)

The tool was designed for the S3C project but its idea was sourced from sales department engaging the SMEs for peak levelling. Originally the sales process needed at least two visits at the consumer location and the sales representative needed to be accompanied with the energy expert before the relevant data for the cost benefit calculation were provided. The tool is designed to get a relevant energy and cost estimation already at the first visit and attract the consumer representative for the service with concrete data. During the S3C project the tool was tested on the representative of the foundry and machinery branches.

The foundry average monthly consumption is 2.500 MWh with average peak around 6,5 MW. The analyses showed the flexible energy potential of 1,5MWh for more than 2,5 hours and a peak reduction for 1,5MW what suggested the return of investment in less than 1 year only from the address of peak levelling. The consumer is a candidate for further analyses for demand response system.

The machinery average monthly consumption is 1.200 MWh with average peak around 2,4 MW. The analyses showed that 5% of peak reduction requires flexible interval of more than 3 hours and only 150 kWh of flexible energy. The return of investment is almost 5 years what suggested that the representative is not suitable for further processing.

More information on: http://www.kiber-net.com/

Further reading

- Maggiore, S. et al. (2013). Description of candidates to from the “Family of Projects” (S3C D2.1). http://www.s3c-project.eu/Deliverables.html
- Enernoc, Engaging business customers (2015), http://www.enernoc.com/for-utilities
- Leonardo Energy (2009). *Electric Load Management in Industry* http://www.uie.org/sites/default/files/generated/files/pages/LoadManagement.pdf
- Michael Starke, Nasr Alkadi, Oak Ridge National Laboratory (2013). *Assessment of Industrial Load for Demand Response across U.S. Regions of the Western Interconnect.* http://info.ornl.gov/sites/publications/files/Pub45942.pdf

---

This guideline was developed in the S3C project, and is freely available from www.smartgrid-engagement-toolkit.eu.

S3C paves the way for successful long-term end user engagement, by acknowledging that the "one” smart consumer does not exist and uniform solutions are not applicable when human nature is involved. Beyond acting as a passive consumer of energy, end users can take on different positions with respective responsibilities and opportunities. In order to promote cooperation between end users and the energy utility of the future, S3C addresses the end user on three roles. The *smart consumer* is mostly interested in lowering his/her energy bill, having stable or predictable energy bills over time and keeping comfort levels of energy services on an equal level. The *smart customer* takes up a more active role in future smart grid functioning, e.g. by becoming a producer of energy or a provider of energy services. The *smart citizen* values the development of smart grids as an opportunity to realise “we-centred” needs or motivations, e.g. affiliation, self-acceptance or community.

S3C performed an extensive literature review and in-depth case study research in Smart Grid trials, resulting in the identification of best practices, success factors and pitfalls for end user engagement in smart energy ventures. The analysis of collected data and experiences led to the development of a new, optimised set of tools and guidelines to be used for the successful engagement of either Smart Consumers, Smart Customers or Smart Citizens. The S3C guidelines and tools aim to provide support to utilities in the design of an engagement strategy for both household consumers and SMEs. The collection of guidelines and tools describe the various aspects that should be taken into account when engaging with consumers, customers and citizens. More information about S3C, as well as all project deli*verables, can be found at www.s3c-project.eu.