Energy System Efficiency: How to maximise the contribution of consumers to cost-effectively accelerate the clean energy transition

smartEn White Paper

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EXECUTIVE SUMMARY

The EU is facing multiple, overlapping challenges: increase the EU energy resilience, address skyrocketing energy prices and achieve the long-term climate neutrality objective.
All of them must be achieved in an efficient way: the EU cannot afford to waste resources and consumers of all types must be allowed to play a leading role, while being rewarded.

How to do that?
Which investment decisions should be taken? How to avoid stranded assets?
How can digitalisation and decentralisation support?
How to monitor progress towards such an efficient pathway?
And, most importantly, how to ensure that an efficient transition towards climate neutrality has consumers as its main drivers?

smartEn has engaged in an internal exercise to provide answers to these questions.
We are convinced that **a more efficient energy system is possible, with active consumers at its heart.**
Consumers must be enabled to contribute to an acceleration towards an efficient, secure and fully decarbonised energy system, instead of being the passive victims of a centralised and fossil-dependent energy system.
This is possible if consumers of all types - from households to industrial players:

- reduce and optimise their energy needs through energy efficiency measures;
- generate, store and share renewable electricity in the local community they are part of;
- shift energy consumption in a time-dependent way when renewable electricity is abundant in order to reduce electricity production by fossil fuels - notably during peak hours.

While it is crucial to speed-up the implementation of the European Green Deal, we are currently facing the risk of keeping the existing, inefficient centralised energy system or boosting obsolete solutions.
smartEn believes that the efficiency of the clean energy transition is an urgent priority objective that the EU should agree upon.

To support this objective, it is essential to:

- set a legal definition of energy system efficiency in EU law which recognises the contribution of system-integrated consumers, including at community level, in making the energy system more efficient. The following proposal is put forward:

"Energy System Efficiency" means an energy system that relies on efficient and flexible consumers that maximise the use of clean, available digital and decentralised energy resources to achieve climate neutrality in the most secure and cost-effective way.
Improvements in decarbonisation, affordability and resilience shall be used as metrics to measures progress toward energy system efficiency"

- introduce metrics to monitor, measure and stimulate the achievement of the EU climate neutrality objective, with consumers onboard, in a cost-effective way. smartEn proposes to introduce ***3 core KPIs of Decarbonisation, Affordability and Resilience*** and a set of more granular KPIs to clarify the elements that would support their achievement.

This should prove useful in the context of the REPowerEU plan and the implementation of emergency interventions to address high energy prices, as well as the negotiations on the Fit for 55 package and the revision of the Electricity Market Design.

I. DEFINING ENERGY SYSTEM EFFICIENCY

While energy efficiency improvements across sectors are fundamental to save energy, the flexible consumption of end-users should have equal relevance since it supports the cost-effective integration of variable renewable generation, mitigates peak electricity prices, avoids congestion, curtailment costs as well as grid expansions and investments in unnecessary back-up generation.

smartEn believes that efforts to improve static energy savings in end-user sectors should continue to be encouraged, but also urges to contemplate a systemic and dynamic approach to efficiency. This requires taking a step back and looking at the impacts and benefits individual assets can have on the whole energy system.

Currently, this systemic dimension of the Energy Efficiency First principle is missing from EU legislation although some proposals are currently contemplated in the 3rd revision of the Energy Efficiency Directive[1] and it was included in the 2021 European Commission's Guidance to Member States on how to implement the Energy Efficiency First Principle[2].

To fill this gap, smartEn proposes the following definition:

"Energy System Efficiency" means an energy system that relies on efficient and flexible consumers that maximise the use of clean, available digital and decentralised energy resources to achieve climate neutrality in the most secure and cost-effective way.
Improvements in decarbonisation, affordability and resilience shall be used as metrics to measures progress toward energy system efficiency"

Energy system efficiency would require a shift in focus: the efficient consumption of energy is complemented with the efficient penetration of variable renewables thanks to flexible consumers fully integrated in the energy system.
This definition would maximise the value of low consuming end-use sectors, such as buildings, transport and industries, in supporting the cost-effective integration of more variable renewable electricity in the energy system through the activation of their demand-side flexibility potential.

This implies giving priority to efficient and flexible demand-side solutions whenever they are more cost-effective than other investments in meeting the policy objectives of affordability, security and sustainability, in line with the application of the Energy Efficiency First Principle at system level.

Similarly, the term "demand-side flexibility" should be defined as this is an inherent enabler to an efficient energy system. Currently, such a definition is missing from EU legislations. Building on the Electricity Market Design, smartEn suggests defining it as follow:

"Demand-side flexibility means the capability of any active customer to react to external signals and adjust their energy generation and consumption in a dynamic, time-dependent way, individually as well as through aggregation.
Demand-side flexibility can be provided by smart decentralised energy resources, including demand management, energy storage, and distributed renewable generation to support a more reliable, sustainable and efficient energy system"

Such definition is needed to stress that flexibility can be also provided by different sources other than large generation plants, interconnection or large storage facilities.

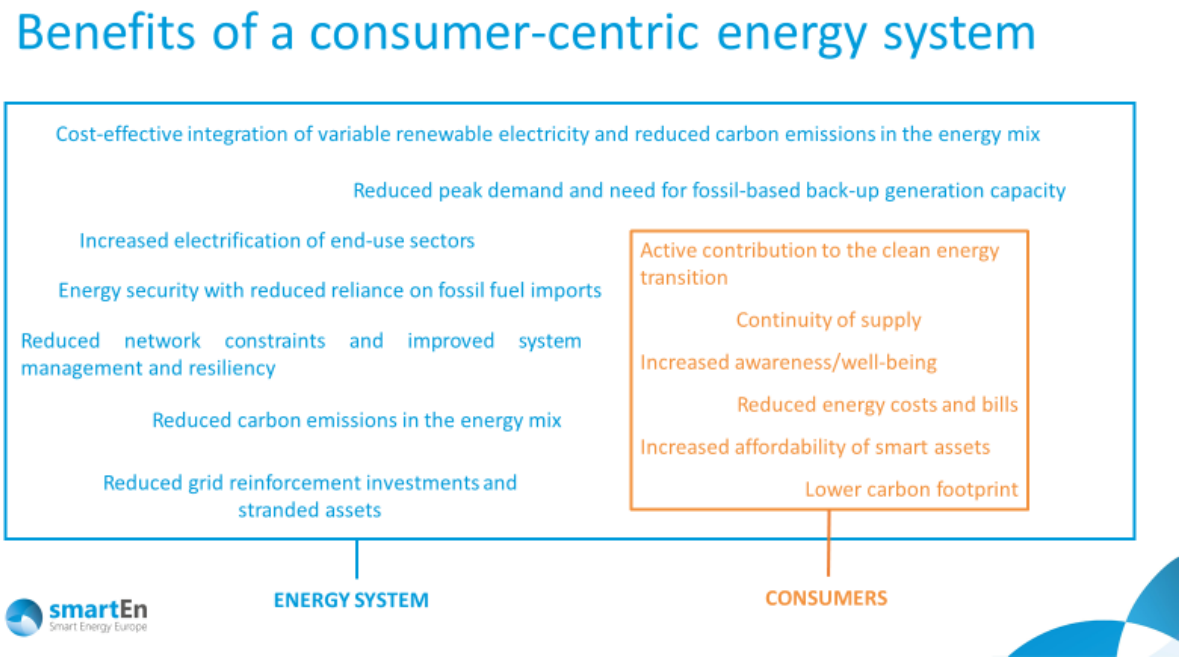
[1] The Commission's proposals for the Fit for 55 package and in particular the revision of the Energy Efficiency Directive recognise the need to apply the Energy Efficiency First principle taking primarily the system efficiency approach into consideration. However, no definition was proposed by the Commission, nor was address by the Council. The European Parliament has however engaged in different efforts to fill this gap notably by proposing such a definition.
[2] The Guidance stressed that demand-side flexibility shall be recognised as part of the energy efficiency solutions that can improve the efficiency of the energy system, whenever they represent a cost-effective decarbonisation pathway https://ec.europa.eu/energy/sites/default/files/eef_recommendation_ref_tbc.pdf

Demand-side flexibility can come in different forms and can stem from different smart assets and end-use sectors: from loads in industry to residential and commercial buildings, from local energy communities to EV smart and bidirectional charging, etc.

II. CONSUMERS AS DRIVERS OF ENERGY SYSTEM EFFICIENCY: THE BENEFITS OF A CONSUMER-CENTRIC APPROACH

Consumers are integral parts of the energy system and their active contribution, through a flexible, time-dependent adaptation of their consumption and generation, can increase the efficiency of local energy systems as well as of the whole energy system.

The many benefits of activating demand-side flexibility are for both consumers and the system at large, as illustrated in the graph below:



Efficient and flexible consumers would:

- ensure that clean energy is used, generated, transmitted, distributed and consumed at the right time, in the right way;
- lead to reductions in peak electricity demand which usually requires the activation of polluting and fossil-based power plants;
- mitigate high wholesale electricity prices;
- contribute to reduce stress to the (local) grid, thus minimising operational cost for the system and investment costs in supply-side resources such as fossil fuel generation and grid infrastructure.

As a result, efficient and flexible consumers would contribute to the achievement of the EU decarbonisation target, while reducing the overall EU's dependence on fossil fuel imports.

In a first-of-a-kind effort, DNV quantified many of these benefits in the EU in 2030 to highlight the indispensable contribution of flexible consumers in supporting the cost-effective clean energy transition[3].
Among others, the following results were found following a full activation of consumer's flexibility:

- 37.5 million tonnes can be saved annually in GHG emissions
- €11.1 - €29.1 bn can be saved annually in distribution grid investments
- €71 bn would be saved annually by consumers directly

[3] https://smarten.eu/wp-content/uploads/2022/09/SmartEN-DSF-benefits-2030-Report_DIGITAL.pdf

- 15.5 TWh (61%) would be the avoided renewable curtailment
- €2.7 bn would be saved annually in avoided peak generation capacity

However, to enable demand-side flexibility to support the achievement of an efficient energy system it requires:

- Eliminating all national regulatory barriers preventing demand-side flexibility activation and participation in electricity markets, as outlined in smartEn monitoring report on the implementation of the EU Electricity Market Design[4];
- Prioritising direct electrification of end-use sectors to replace fossil fuels in buildings, heating and cooling, transport and industry, notably through the Fit for 55 package[5] and the REPowerEU's revision of Resilience and Recovery Funds;
- Establishing a digital ecosystem supporting demand-side flexibility and prosumer business models. This means having seamless communication between System Operators, flexibility service providers and consumers to allow them to optimise their energy consumption, storage and generation in reaction to external signals and to offer their demand-side flexibility in various markets.[6]

III. MEASURING ENERGY SYSTEM EFFICIENCY

Today there is no clarity on the criteria that qualify an energy system as an efficient one. Neither is the valorisation of the active contribution of consumers in achieving it.

smartEn tries to fill this gap to help track progress towards a more efficient system. Identifying what needs to be measured will support EU policymakers, Member States, regulatory authorities and system operators in drawing relevant methodologies for assessing the system efficiency impacts of energy planning, policy and investment decisions.

What to measure?

As highlighted in the definition for "Energy System Efficiency", smartEn recommends focusing on three core key performance indicators (KPIs) to measure and quantify energy system efficiency improvements, namely:

- **Decarbonisation**
- **Affordability**
- **Resilience**

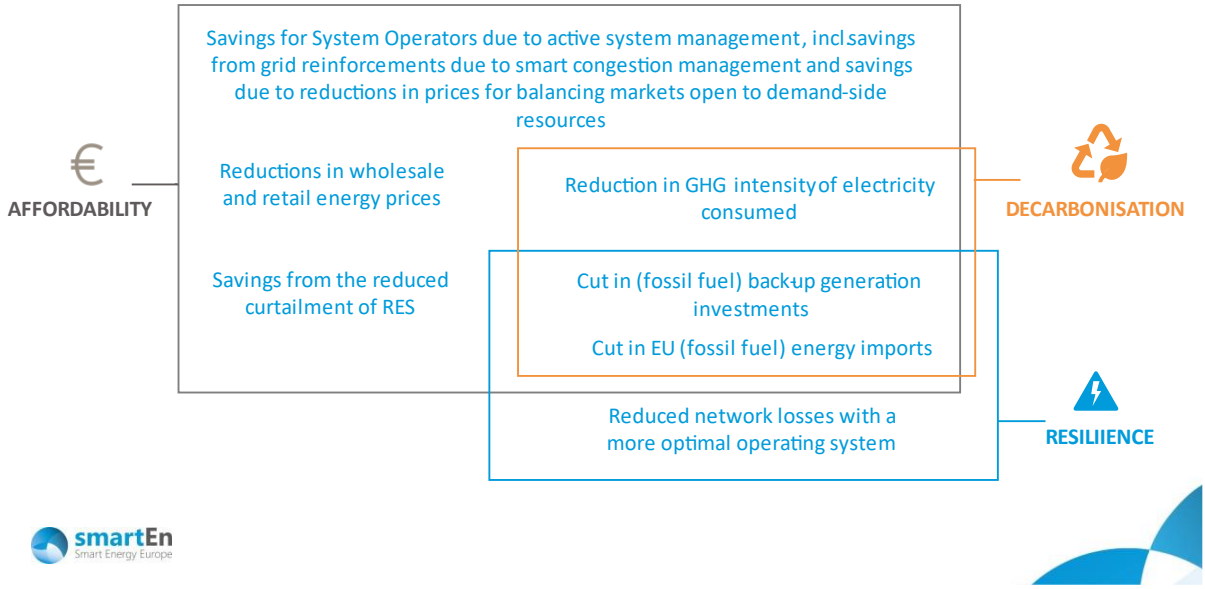
These three core KPIs would allow to measure and assess progress against a counterfactual scenario and represent the three overarching objectives of EU energy policy. An efficiency energy system would therefore achieve these three goals in the most cost-effective way.

These core KPIs should be composed of more granular KPIs to clarify the elements that would support their achievement.

The below graph provides an overview of our proposal for a nested KPI approach that identifies metrics that need to be used for assessing and achieving an efficient energy system.
This will ultimately allow to quantify how demand-side flexibility contributes to achieve energy system efficiency and thus incentivise its activation.

[4] See second edition of smartEn report on the implementation of the Electricity Market Design
5 See smartEn proposals for amendments on the Fit for 55 package
[6] See smartEn position paper: Setting a digital strategy for a cost-effective decarbonisation of the energy system

System Efficiency: What to measure?



- **KPIs for decarbonisation**

Measurable values for achieving decarbonisation should include:

- Reduced fossil fuel consumption and avoided fossil-based generation capacity investment, in particular to address peak times.
- Reduction in GHG intensity of electricity consumed in end-use sectors thanks to greater penetration of renewable energy.

- **KPIs for affordability**

Measurable values for achieving affordability should include:

- Cost savings for system operators due to active system management, resulting in reduced grid reinforcements or reduced congestion and balancing costs as well as grid stability reserve costs.
- Cost savings for system operators and reduced revenue losses for renewable generators from the avoided curtailment of renewable energy. Already today, renewable curtailments prove to be a major source of wasted energy and losses of revenue sources for renewable generators. It also incurs costs to system operators where they are required to compensate renewable generation when curtailed. If nothing is done to enable the flexible integration of renewable, the problem will aggravate with rising renewable shares in the European electricity mix.
- Reduction in wholesale and retail energy prices, notably due to shorter periods of peak prices leading to the reduction in the operation of fossil fuel plants with high marginal costs.
- Reduction in the Value of Lost Load estimates which can result in system cost savings.
- Cost savings in unnecessary generation investments, such as (fossil-fuel) back-up generation such as gas-peaking power plants.
- Cost reductions in EU (fossil fuel) energy imports following the shift in consumption to avoid peaking gas-power plants.

- **KPIs for resilience**

Measurable values for increasing resilience should include:

- Cost savings from avoided blackouts/brownouts (at value of lost load) due to a shift in peak demand and ensuring continuity of supply.
- Cost savings from avoided fossil-based generation capacity to ensure security of supply.
- Reduced network losses with a system operating closer and more often in its optimal operating range.

The identified KPIs shall rely on access to reliable data in particular regarding the share of renewable energy, peak electricity demand and grid efficiency (network constraints and congestions, renewable curtailment). Market parties and regulatory authorities should therefore be able to access this data, to guide measures and track progress in improving the efficiency of the energy system.

IV. RECOMMENDATIONS

EU policymakers, Member States, regulatory authorities and system operators should apply the identified (core and granular) KPIs to take the most effective investment and planning decisions and to measure energy system efficiency improvements.

smartEn recommends implementing the proposed nested KPI approach in the following initiatives:

- **Revised Energy Efficiency Directive**

The ongoing revision of the Energy Efficiency Directive is the opportunity to further detail and enshrine in EU legislation this systemic approach to the Energy Efficiency First principle.

The Energy Efficiency Directive should:

- set out a legal definition of system efficiency and clarify the systemic dimension of the Energy Efficiency First principle;
- require the relevant entities in charge of approving and monitoring the application of the Energy Efficiency First principle to take utmost account of these KPIs, including in the methodologies and guidance defined by regulators for the cost-benefit analyses;
- enable Energy Savings Obligations Schemes to support system efficiency, by expanding the current scope beyond savings resulting from static energy efficiency measures and include dynamic savings achieved thanks to demand-side flexibility.

- **Planning and investment decisions by system operators for all different geographical scopes**

The proposed nested KPI approach should be applied at different geographical scopes covering the different 'systems' that compose the whole energy system. The scope of such a 'system of systems' should encompass cross-border grids, transmission systems, distribution systems, micro grids and behind-the meter, with each level seeking to increase their own 'system' efficiency taking full advantage of the demand-side flexibility of end-users, while contributing to increase the whole system efficiency all the way up to the chain.

For instance, a local efficient energy system can be particularly resilient to larger scale power interruptions through a combination of local generation and storage. It will also allow to measure with more granularity the outcome and benefits of a more efficient energy system for the consumers, such as affordability and decarbonisation, thus better reflecting the service provided at the level of the end user.

For transmission and distribution system operators, an incentive or performance-based regulation that uses the identified KPIs and links the remuneration of system operators to outcomes consistent with the ex-ante expectations from the cost-benefit analyses should be considered. This would accelerate grid digitalisation and encourage the procurement of flexibility by system operators as alternatives to grid expansion when drawing network development plans. The reduction in renewable electricity curtailment caused by grid constraint should also be considered as an efficiency improvement measure that can be taken by network operators on all voltage levels.

Innovation in electricity transmission and distribution infrastructure should be incentivised to achieve energy system efficiency and should be integrated in common Smart Grid Indicators (SGIs). This will help to guide infrastructure investment and maximise the value and benefits for grid users.

- **EU Member States' Recovery and Resilience Plans and National Energy and Climate Plans**

As part of the REPowerEU plan presented by the Commission, the introduction of a dedicated REPowerEU chapter in the national Recovery and Resilience Plans has been proposed. Such chapter should include investment and reforms that promote demand-side resources supporting a more efficient energy system as they will contribute to the REPowerEU related objectives of a more affordable, sustainable and resilient energy system.

Member States should make use of the identified KPIs to guide their investment and reforms decisions under these plans. The KPIs should also be part of the assessment criteria that the Commission will use to evaluate the investments and reforms included in this new REPowerEU chapter.

Similarly, the progress report that Member States need to submit every two years on their National Energy and Climate Plans should be used as an opportunity for the Commission to assess progress based on the identified KPIs and orient Member States towards the implementation of the Energy Efficiency First principle at system level.

- **A comprehensive Energy System Efficiency Strategy to guide improvements to the Electricity Market Design**

To ensure consistency among different initiatives towards decarbonisation, ensure optimal use of resources and avoid unnecessary costs for consumers in the clean energy transition, the European Commission should launch an Energy System Efficiency Strategy to define the key features of an efficient system with active customers at its heart and to track progress in efficiency improvements of the current energy system in a quantifiable manner.

The present White Paper should provide an inspiration to this effort which should go hand in hand with the medium-term improvements of the Electricity Market Design.

CONCLUSION

An efficient and flexible consumption of direct clean electricity would allow to achieve decarbonisation in a much more efficient way.
However, at the moment, no metrics are identified to monitor, measure and stimulate the achievement of the EU climate neutrality objective in an affordable way, increasing the EU overall energy resilience.
The current crisis might accelerate the European Green Deal, but at the risk of keeping the existing, inefficient centralised energy system or boosting obsolete solutions.

While it is crucial to speed-up the clean energy transition, smartEn believes that the efficiency of this transition is also an urgent priority to tackle by:

- setting a legal definition of energy system efficiency in EU law. This definition should recognise the contribution of system-integrated consumers, including at community level, in making the energy system more efficient;
- stimulating an efficient evolution towards climate neutrality by measuring progress. This will be only possible if a set of metrics is agreed upon, as those proposed in this White Paper by smartEn.

smartEn stands ready to engage in further discussions on how to achieve climate neutrality in a digitally-enabled, decentralised and efficient way.

About smartEn - Smart Energy Europe

smartEn is the European business association integrating the consumer-driven solutions of the clean energy transition. We create opportunities for every company, building and car to support an increasingly renewable energy system. Our membership consists of the following companies:

The positions expressed in this document represent the views of smartEn as an association, but not necessarily the opinion of each specific smartEn member.
For further information about smartEn, please visit www.smarten.eu