Valorising demand-side flexibility in energy system-wide methodologies and modelling scenarios

smartEn Position Paper

Smart Energy Europe
Rue d'Arlon 63-67,
BE-1040 Brussels

+32 (0) 2 58 88 992
info@smarten.eu
www.smarten.eu

July 2021

smartEn
Smart Energy Europe

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INTRODUCTION

Climate neutrality requires a step change in whole system coordination and planning. President von der Leyen herself invoked systemic modernisation as a key effort in her first State of the Union speech in 2020 to support the achievement of the European Green Deal.

As we move on from traditional energy systems, new, smart solutions will be required to manage the increasingly variable generation mix, whilst maintaining affordability and ensuring security of supply. Flexible demand and decentralised energy resources (DERs), including distributed renewable generation, demand response and energy storage, will be crucial features of the future energy system. Consumer empowerment, prosumer and sharing economy are going to revolutionise several sectors and require a significant shift in mind-set, both in energy system management and planning.

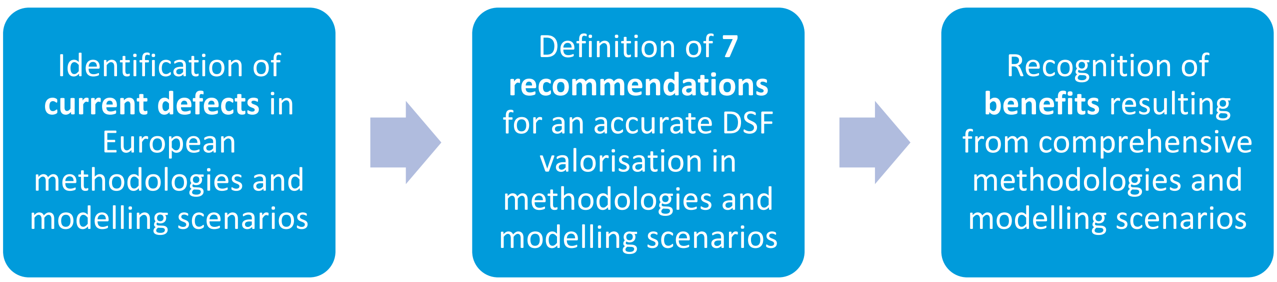
Methodologies for cost-benefit analyses, modelling scenarios and impact assessments must duly reflect this fundamental change to valorise all DERs and their contribution to a smart, efficient, and integrated energy system.

This is particularly relevant for the definition of methodologies for:

- the forthcoming Impact Assessment by the European Commission for the Fit for 55 package;
- the Energy System-wide Cost-Benefit Analysis to be defined by ENTSOs, as required by the revised TEN-E Regulation,
- the Resource Adequacy Assessment, as required by the Electricity Market Design,
- the definition by Member States of State aid, following the new requirements set by the Guidelines on State aid for climate, environmental protection and energy 2022.

These methodologies would provide an opportunity to valorise demand-side flexibility (DSF), also in the context of the identification of Projects of Common Interest (PCIs), definition of TSOs' Ten-Year Network Development Plans (TYNDPs) and identification of solutions to fill any infrastructure gap, including through non-wire alternatives, including at local network level.

Current methodologies developed at European level have proven to persistently oversee the crucial contribution of DSF. smartEn urges competent authorities to consider our recommendations in the definition of such methodologies to valorise distributed flexibility, avoid stranded assets and ensure climate neutrality is reached in the most cost-effective way.



CURRENT DEFECTS IN EUROPEAN METHODOLOGIES AND MODELLING SCENARIOS

Until now, cost-benefit analyses, modelling scenarios and impact assessments at European level do not consider properly the active participation of all end-users to the clean energy transition.

One of the most influential modelling exercises is the Impact Assessment published by the European Commission to justify its EU legislative proposals and define pathways for the medium and short-term future. The used PRIMES economic model fails to fully represent the contribution of the demand side in the electricity system because:

- the modelling tools are focused only on technology investment costs (while operational costs are the main cost structure for DSF),
- the model mostly limits the participation of demand response to peak shaving, transferring power from peak to baseload. The amount of energy reduced in peak hours is compensated the same day by additional energy consumption in other time segments,
- it does not take into account the benefits that DSF brings to overall system efficiency and does not reflect the potential cost/energy savings that consumers can benefit from, nor does it reflect the economic, environmental and social benefits of peer-to-peer and community trading.

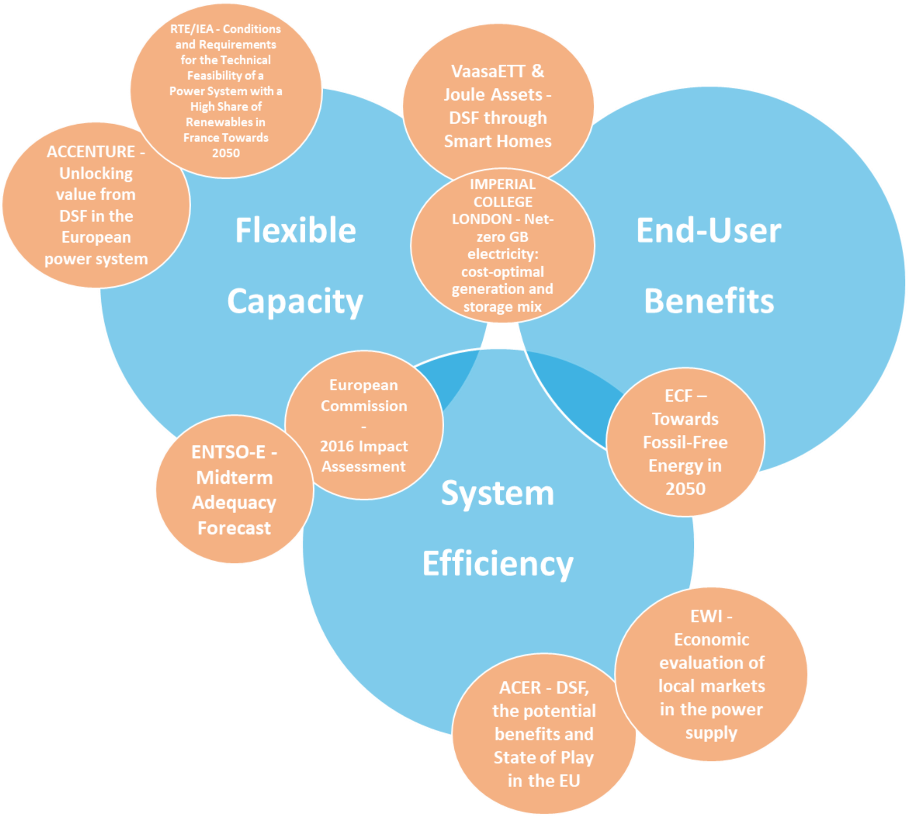
Other influential modelling exercises like ENTSO-E's TYNDPs and Resource Adequacy studies also underrepresent the DSF potential. They usually approach energy modelling from a *silo* perspective, focusing on some of the services a specific technology can provide, not representing the full range of flexibility opportunities. This has made these scenarios slanted towards traditional generation and consumption trends.
In the latest versions of these studies[1], more technologies like storage, EVs or heat pumps are considered, but they are still evaluated from a narrow perspective and their DSF potential is not sufficiently addressed, also because local energy trading is completely disregarded.
In addition, it is rare that these studies consider data-driven energy services and solutions, that play a key role in enabling both consumers and the energy system to fully benefit from flexibility services.

These biases in modelling methodologies result in an underrepresentation of the DSF potential and benefits of an increasing engagement from energy consumers and prosumers in the clean energy transition.

This is the conclusion of a smartEn analysis of more than twenty studies to investigate how DSF is considered in these reports in view of identifying recommendations for improvement in future scenario-building exercises. Although the scope and timeframe of the analysed studies vary significantly, all of them have somehow examined the value of DSF from the following perspectives:

- System Efficiency (e.g. reduction in overall system costs)
- Flexible capacity available (either in GW or GW/h)
- End-user benefits (mostly economic savings)

[1] ENTSOs TYNDP 2022 Scenarios Final Storyline Report, April 2021



As highlighted in the following table, which includes a selection of analysed studies[2], none provided a comprehensive valorisation of distributed flexibility. This was the source of inspiration for our recommendations for future methodologies and modelling scenarios.

[2] An extended excel version with more detailed information, coving all studies analysed, is available exclusively to smartEn members.

Study	Quantified Outcomes	Time Horizon	smartEn Assessment
RTE/IEA - Conditions and Requirements for the Technical Feasibility of a Power System with a High Share of RES in France Towards 2050 (2020)	•6,5 GW DR capacity	FR - 2028	•Evolution of DR capacity and necessary flexibility in the system over the next decade. Uses a complete range of DSF technologies and services
ACCENTURE - Unlocking value from demand-side flexibility in the European power system (2018)	•55-90 GW additional flexible capacity	FR, DE, UK, IE, NL, ES - 2030	•Scope of study limited by its assumptions on the services provided by flexibility and by its sources. Importance of flexibility to deal with electrification is highlighted.
IMPERIAL COLLEGE LONDON - Net-zero GB electricity: cost-optimal generation and storage mix (2021)	•125,5 GW storage capacity in high DSF scenario •2,2 pence/kWh reduction of electricity costs	GB - 2035	•Showcases the role of flexibility in decarbonisation through cost optimisation. Wide range of relevant metrics, from total capacity available to system savings. However, limited services considered for DSF.
EU COMMISSION - Impact Assessment (2016)	•160 GW DR theoretical potential •5,9 bn € economic savings (with level playing field)	EU - 2030	•Ambitious DR potential figures that informed the CEP. However, limited by the METIS and PRIMES modelling methodologies that are focused on technology investment costs and do not valorise flexibility.
ENTSO-E - Mid-Term Adequacy Forecast (2020)	•17,4 GW DR potential in NO, FR, FI, IT, ES	EU - 2025	•Fragmented and conservative methodology dependent on traditional generation.
VaasaETT and Joule assets study on Smart Homes (2017)	•7 GW DSF capacity •3,42 bn€/y annual savings	FR,IT,UK,DE - present day	•Thorough representation of flexible capacity and savings to end-users that smart appliances could be providing today in a wide range of services including, implicit, explicit DR and energy efficiency.
ECF – Towards Fossil-Free Energy in 2050 (2019)	•23bn € energy savings for households •44% in DE,70% in ES reduced net demand through the use of DR	DE, ES - 2050	•Comprehensive methodology analysing: reduction of fossil fuel generation, reduction demand by the use of flexible technologies, economic savings for households and jobs created.
ACER - DSF, The Potential Benefits and State of Play in the EU (2014)	•45 bn €/y financial benefits	EU - 2050	•Representation of potential benefits of flexibility disaggregated for implicit and explicit DSF. No other study does this.
EWI - Economic evaluation of the benefits of local coordination mechanisms in the power supply (2021)	•2,4 bn €/y avoided grid investments	DE - 2035	•Thorough focus on distribution level benefits of DSF with concrete yearly savings provided.

Legend
- Flexible Capacity
- System Efficiency
- End-user Benefits

SEVEN RECOMMENDATIONS FOR AN ACCURATE VALORISATION OF DSF

To overcome the current deficit, an accurate valorisation of distributed flexibility is necessary in the methodologies that should be developed at EU level. The following recommendations should be considered:

1. Consider *all* market participants and distributed flexibility assets in the integrated energy system

While most of the current activated flexibility assets are industrial, the highest potential lies in building and transport sectors. The increase in decentralisation and direct electrification, in all end-use sectors, and their interoperability in the digital ecosystem of the future, will increase the volume of distributed flexibility resources.

Although the consideration of all flexibility resources and their integration is a major shortcoming of current modelling efforts, some studies are moving towards a more technology-inclusive approach, considering a broader spectrum of assets and services they can provide, notably by bridging transport and energy sectors. For example, the Accenture study "Unlocking value from demand-side flexibility in the European power system" (2018) considers the potential lying in the uptake of electric vehicles and heat pumps until 2030. They estimate a range between 55 and 90 GW of additional capacity in the six analysed countries and stress the importance of an increase in flexibility to address the higher demand.

2. Assess the full set of flexibility services and value streams accessible for DSF

A distributed energy resource that only provides delayed consumption of energy represents a suboptimal use of a flexibility asset. Beyond load shifting and peak-shaving, which are usually considered in most modelling exercises, DERs are inclusive solutions that can offer additional services, making the case for a diversified investment.

Flexibility services also reduce the total cost of ownership of smart solutions, or rather accelerate the return on investment, for example in acquiring smart appliances or electric vehicles, even if their main activity is not to provide energy services (i.e., non-dedicated assets). These assumptions are not reflected in any modelling scenarios and leave out a significant incentive to consumers and prosumers owning these flexibility assets.

These defects are apparent in the PRIMES[3] model used by the European Commission as its main input data are investment costs. For example, electric vehicles are only considered as a form of stationary storage. No vehicle-to-grid capabilities, smart charging, and the possibility of electric vehicles to provide grid balancing services through flexibility are included in the modelling.
The full set of flexibility services and value streams accessible for DSF should also be included in the cost assumptions of technologies in the PRIMES model.

Similar shortcomings can be found in ENTSO-E's 2020 Mid-term Adequacy Forecast[4]. Storage assets like stationary batteries, electric vehicles and heat-pumps are considered only as dispatchable generation and peak-shaving tools, leaving out other flexibility services they can provide (e.g., load-shifting and ancillary services).

[3] http://www.e3mlab.eu/e3mlab/PRIMES%20Manual/PRIMsd.pdf
[4] https://www.entsoe.eu/outlooks/midterm/

3. Examine the impact of a widening of marketplaces

An uneven playing field for the participation of demand-side resources in existing electricity markets and mechanisms is still a major barrier to DSF activation. Although with long time delays[5], the implementation of the Electricity Market Design at national level should help eliminate this barrier and allow an equal treatment of generation and demand-side resources.

New marketplaces would be also created, like local flexibility markets at distribution level or transactive energy platforms that integrate retail and wholesale markets to dynamically optimise the use of these energy assets. Some examples of these new markets are Piclo Flex[6] (the first contracts signed in 2019 delivered 18.1 MW of flexibility), Enera[7] and Grid Singularity's energy exchange platform.

Very few studies consider the impact in participating in active local energy markets that optimise and encourage individual and community investments in renewable resources.

All these developments would increase the market frameworks to realise the value of distributed flexibility with a potentially significant commercial stimulus to the activation of demand-side resources, to be duly accounted in the methodologies.

4. Consider the increasing cooperation among system operators

In the medium-term, interoperability of marketplaces will increase both in horizontal and vertical terms:

- electricity markets at different time-frames would be able to communicate, also in a cross-border perspective, to allow a horizontal participation of demand-side assets, where they are most needed (e.g., balancing markets by different TSOs could be able to interface and share resources, also cross-nationally),
- the enhanced TSO-DSO cooperation would connect markets at all levels and enable distributed flexibility to participate in different marketplaces while avoiding double activation of the same resource,
- the establishment of decentralised identification registries for energy assets would enhance the level of interoperability and improve access for small energy assets.

This evolution would lead to increased opportunities for the activation of distributed resources which should be reflected in methodologies.

5. Equally ponder investment and operating costs

Both investment (CAPEX) and operating costs (OPEX) should be considered in the methodologies. The focus on upfront infrastructure investment costs (the main input to modelling scenarios like PRIMES) is misleading as some climate-neutral solutions (e. g. demand response) do not imply high investment costs and are by default excluded from a CAPEX-only approach.

Considering a TOTEX approach in methodologies, to take into account both capital and operating expenditures, would contribute to valorise flexibility.

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[5] smartEn Monitoring of the Implementation of the Electricity Market Design, 2020

[6] Launched in June 2018 for buyers and sellers of flexibility in the UK. Currently, six DSOs in the UK are Piclo Flex members, providing them a single platform to access all types of DSO tenders. Thereby, it enables streamlined procurement, dispatch and settlement. In March 2019, the first flexibility tenders to deliver flexibility needs were organised by UK Power Networks on Piclo Flex.

[7] Its goal is to develop and demonstrate scalable standard solutions with a high share of renewable energies over large “showcase regions” for an environmentally friendly, secure and affordable power supply. Within the enera project, the energy group EWE AG and the European Power Exchange EPEX SPOT have launched a local market platform for flexibility sources. With this market platform, the project partners aim to efficiently tackle the issue of grid congestion. The platform provides a transparent market mechanism for flexibility providers who wish to participate in market-based congestion management. Locational order books centralize flexibility offers that can be used by TSOs and DSOs to alleviate congestions.

6. Recognise benefits to all end-users

Beyond improving the efficiency of the overall system, DSF can bring benefits to individual end-users, whether they actively participate or whether they do not engage in the flexible management of their distributed resources. Methodologies and modelling scenarios should take these benefits into account as drivers for the DSF activation.

An estimation on cost and energy savings for active end-users was done by VasaaETT and Joule Assets which described the benefits for residential end-users that participate in explicit and implicit DR programmes with their smart appliances[8] (2017). The study demonstrates that in Germany, for example, households could annually save €1.11 billion and provide an estimated flexible capacity of 1.7 GW to the system. This has the potential of lowering the payback period of their smart appliances considerably and eventually be a profitable revenue stream.

Beyond active customers, all consumers benefit from the fact that DSF can increase the efficiency of the energy system and can thus help bring down electricity costs for all. By playing an active role, these end-users transfer part of their benefits to society at large. For example by reducing system operation costs resulting in lower tariffs for all consumers, or through the health benefits achieved from a reduction in CO_2 emissions. Modelling methodologies should consider these societal benefits, complementary to the individual benefits of active consumers.

In addition, non-financial benefits for the adoption of DSF by consumers of all kinds should be also taken into account in methodologies and modelling scenarios. This is in particular true at a stage where price signals and financial benefits are limited.
For example, non-financing benefits are enhanced capabilities and performance of appliances, better control through Energy Management Systems. An increase in automation and resilience are also benefits that customers might factor in when deciding for flexible solutions. Finally, a large segment of consumers activate distributed flexibility to contribute to the clean energy transition. This is valid for both households and companies that want to show climate and energy leadership.
These benefits are challenging to quantify, but need to be reflected in a methodology assessing the drivers for the uptake of DSF.

7. Profit of all available energy system data

In order to perform a precise modelling which valorise the impact of DSF, accurate data is required from regulated entities and market parties.
While the ENTSO-E Transparency Platform aims to increase data transparency at TSOs level, insufficient information can be found at DSO level.
No data is provided regarding peaks, the efficiency of the grid and the actual grid costs which would improve the accuracy of methodologies for long-term network development plans and resource adequacy assessments. The lack of locational data, e.g. for congestion, is also a significant deterrent when trying to establish a business case for DSF providers, preventing them from assessing where their services could be most beneficial.

[8] https://esmig.eu/sites/default/files/dsf_through_smart_homes_18_08_2017.pdf

BENEFITS

If the methodologies developed at EU level take into account the above-mentioned seven recommendations, the potential of DSF and consumer empowerment would be adequately emphasised and recognised. This would send clear signals to decision-makers, leading to correct policy decisions and efficient measures.

Methodologies and modelling scenarios that would duly valorise DSF and a consumer-centric energy system have several benefits:

- Achieve climate neutrality in a cost-effective way

Methodologies and modelling scenarios that valorise DSF would stress that the combination of clean energy technologies, notably from the demand-side, can offer the same level of grid services as conventional power plants, but at lower costs and CO2 emissions. As highlighted in a recent report[9], in the UK around half of the clean capacity needed to replace gas plants in a cost-competitive manner can be provided by storage and demand-response.

Failing to model appropriately the contribution of DSF to the achievement of the objectives of the European Green Deal would increase the costs of the clean energy transition. A 2021 study by Imperial College London[10] estimates the need to double the 2030 targets in generation, both renewables and nuclear, to achieve the national net-zero objective. This comes at a significant cost increase for the system, in large part due to increased subsidies to build new renewables. The study overlooks the contribution of demand-side resources that would reduce the need for more investments in generation and grid reinforcements.

A few positive examples of a comprehensive approach to DSF supporting the efficient transition to climate neutrality can be mentioned:

- the European Commission calculated that if DSOs address network constraints at local level through the use of flexible loads, avoided investments can be of the order of up to €5 billion per year up to 2030[11];
- in Germany, a recent study calculated that with the use of local flex markets, the reduction of congestions and the need for infrastructure investments, total costs can reduce up to 57% with total savings of 53 billion Euro until 2050[12];
- in the UK, the application of flexible technologies to electricity grids could reach £8 billion/year savings in 2030 in operating and investment costs[13];
- ACER estimates up to 45 bn/year € financial benefits from the use of DSR by 2050.

- Set clear investment signals to activate distributed flexibility

If demand side solutions are included in methodologies and modelling scenarios for future grid needs (ideally with location-specific information), they could send clear investment signals to:

- System operators to identify those investments in future-oriented grid solutions needed to support their evolution towards smart grids, like grid flexibility and interaction between system operators' operational platforms, to increase both effectiveness and efficiency,
- End-users (in that location) to engage in demand-side flexibility schemes (both implicit and explicit), to collectively defer grid reinforcements and support a smarter operation of the grid,

[9] Carbon Tracker Initiative, https://carbontracker.org/reports/foot-off-the-gas/, February 2021
[10] Net-zero GB electricity: cost-optimal generation and storage mix, Imperial College London, June 2021
[11] https://ec.europa.eu/commission/commissioners/2019-2024/simson/announcements/speech-commissioner-simson-smart-energy-europe-smarten-online-symposium_en
[12] Ökonomische Bewertung des Nutzens lokaler Koordinationsmechanismen in der Stromversorgung, March 2021
[13] UK National Infrastructure Commission

- Aggregators to pool flexibility services provided by end-users and energy communities.

This approach would enable a long-term predictability of procurement needs by system operators. As currently tested in the US by the California Public Utilities Commission[14], any "forecast grid need" is accompanied by "annual procurement goals" to fill the identified needs.
In this sense, the planned CAPEX investment that a system operator would project to address the capacity need would be achieved through the use of non-wires alternatives.
Forecasting an active participation of end-users would recognise the contribution of DERs as reliable alternatives to grid reinforcements and stimulate prosumers business models.

- Fill infrastructure gaps with decentralised projects

Energy infrastructure decisions have an impact of several decades, making today's decisions crucial to achieving a climate neutral energy system by 2050. While the interconnection of the European system remains important, smart and decentralised energy systems made of internet-connected and smart devices in buildings, demand-management programmes in industry and smart charging could be valuable alternatives, highlighted in methodologies and modelling scenarios that duly take into account the potential of DSF.

- Reduce concerns over public acceptance for new infrastructure investments

The clean energy transition must be an inclusive process and a top-down imposition of new (cross-border) infrastructure projects might detach EU civil society from this common goal.

Methodologies and modelling scenarios that valorise DSF would lead decision-makers to adopt efficient policies and cost-effective investment decisions to activate non-wires alternatives. Enabling all end-users to be engaged and contribute with their own resources would reduce infrastructure investments, and reward them for playing an active part in the energy system.
In this light, concerns by citizens on the need to build new infrastructures would be reduced if the activation of distributed flexibility would be prioritised, when more cost-effective than grid expansions and reinforcements.

[14] https://enefirst.eu/events/webinar-putting-efficiency-first-into-practice-insights-from-the-us-and-the-eu/

CONCLUSION

Current methodologies and modelling schemes are short-sighted with regard to distributed flexibility. This is the conclusion of a smartEn analysis of more than twenty studies carried out by institutions, research institutes, companies and other stakeholders.

For the achievement of the European Green Deal in a cost-effective way, any methodology and modelling scenario must duly valorise the contribution of demand-side resources.
smartEn identified seven recommendations that should be taken in due account for the development of accurate methodologies and modelling studies. The outcome of this comprehensive approach would lead to the development of studies that will:

- outline how to achieve climate neutrality in a more efficient way;
- set clear investment signals to activate distributed flexibility;
- demonstrate how to fill infrastructure gaps with decentralised projects;
- stress how concerns over public acceptance for new infrastructure investments could be reduced.

This is an opportunity that should not be missed in view of the forthcoming Impact Assessments by the European Commission to support the Fit for 55 package, the Energy system-wide cost-benefit analysis to be defined by ENTSOs, the accurate Resources Adequacy Assessment and the methodologies to be shaped by Member States following the new requirements set by the Guidelines on State aid for climate, environmental protection and energy 2022.

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.
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