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Shift, Not Drift: Towards Active Demand Response and Beyond ¹

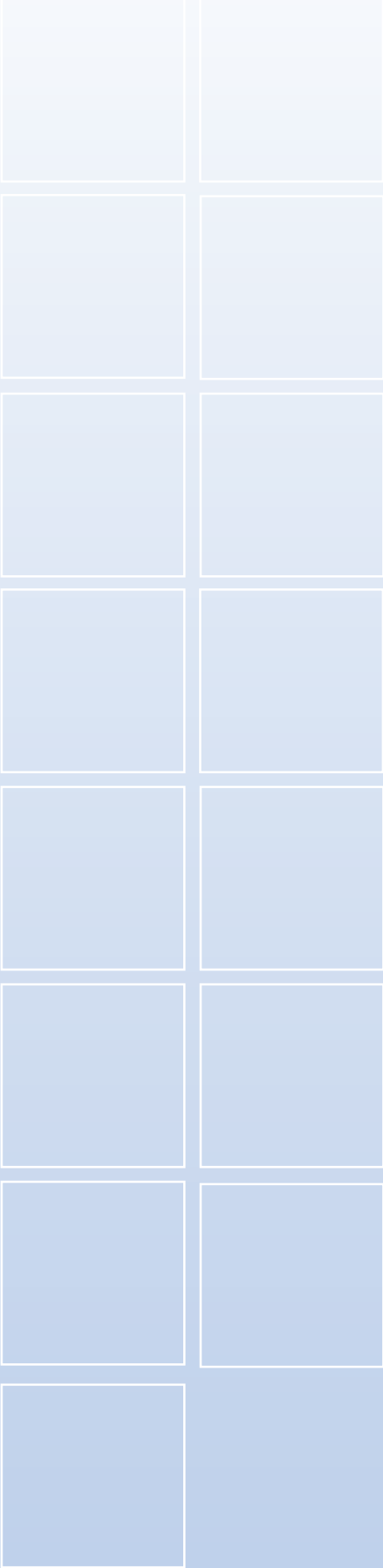
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Highlights

- European electricity systems are evolving towards a generation mix that is more decentralised, less predictable and less flexible to operate due to the large-scale integration of renewables. In this context, additional flexibility is expected to be provided by the demand side. This implies consumers must be shifted from the current 'passive' role to providing 'active' demand response.
- The objective of the 11th THINK report is to assess how to realise this **shift** towards active consumers, using a consumer-centred approach. We recognise the need for 'software', such as contracts, to engage consumers in addition to the enabling 'hardware', such as smart meters and appliances. We propose recommendations for consumer empowerment tools, as well as for market design and regulation that would allow the full take-off of active demand response.
- A prerequisite of consumer engagement is to have an adequate range of contracts that match different consumer categories. The Think report demonstrates that consumers are diversified both

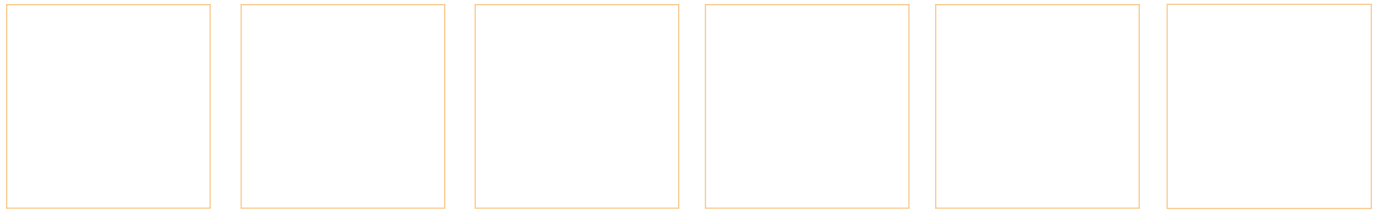
¹ Topic 11 of the EU's FP7 funded project THINK. The project report is available at: <http://think.eui.eu>.



in their flexibility potential and in their preferences on a set of criteria that affect their willingness to participate in demand response. We propose a consumer profiling tool that not only empowers consumers to make informed and appropriate choices, but also facilitates intermediaries to valorise active demand response.

- Our analysis shows that one single market player might not have incentives to offer an adequate range of demand response contracts. Therefore, it is essential to have diversified market players acting as demand response intermediaries. The entry of new market players, such as consumer cooperatives or third parties from non-electricity sectors, needs to be facilitated.
- The THINK report further illustrates that the retail market design needs to be adapted to accommodate active demand response. All consumers should be able to make deliberate choices about their electricity supply, and to valorise their flexibility through active demand response. We propose one such market design referred to as ‘real-time market’.
- Given the decentralised and local character of demand response, national authorities may be best placed to implement the necessary measures as proposed in the report. The EU’s role should be focused on promoting contract pilot studies, disseminating the results of decentralised pilot projects, providing guidance or framework regarding consumer empowerment and protection, and rethinking the design of retail market.





Background

Traditionally, electricity systems are operated in a 'load following' fashion, meaning that the flexibility to maintain the instantaneous balance between electric power supply and demand is mostly provided by the **generation side**, which is dominated by centralised, large-scale dispatchable power plants. Nowadays, the European electricity systems are evolving towards a generation mix that is more decentralised, less predictable and less flexible to operate, due to the large-scale integration of renewables to meet the 20-20-20 targets. In this context, additional flexibility is expected to be provided by the **demand side**.

Indeed, in the short term, demand response can both reduce congestion by shifting the load to times when there is idle grid capacity, and reduce the generation costs by shifting the demand to times when there is more renewable power available. As a consequence, the long term value of demand response lies in reduced or postponed investments in network and generation capacity.

The importance of demand response as a means of flexibility has been widely recognised among stakeholders and policy makers in Europe, e.g. in the Energy Roadmap 2050 ("*energy saving and managing demand: a responsibility for all*"), in the Internal Market Communication ("*stronger demand response in distribution networks*") and in the Energy Efficiency Directive ("*demand response is an important instrument for improving energy efficiency*"). The gradual roll-out of smart meters at residential level and the deployment of smart grids are expected to provide the 'hardware' for demand response. Thus, how to engage consumers to participate in demand response is becoming a pressing issue.

There is, however, significant scepticism about consumer engagement. Some argue that the financial impact on consumers' electricity bills is too small for the consumer to react. Some claim that consumers do not like or cannot handle the additional complexity introduced by demand response. Privacy concerns and fear of reduced consumption autonomy make up two more arguments against a meaningful level of active demand response. Accepting these statements means that we leave consumers to **drift** on their own and admitting that there is no future for demand response. In this report, we challenge that vision and provide an analytical framework to assess consumers' potential and willingness to participate in active demand response. On that basis, we present recommendations to empower and protect consumers in their **shift** to active demand response participants.

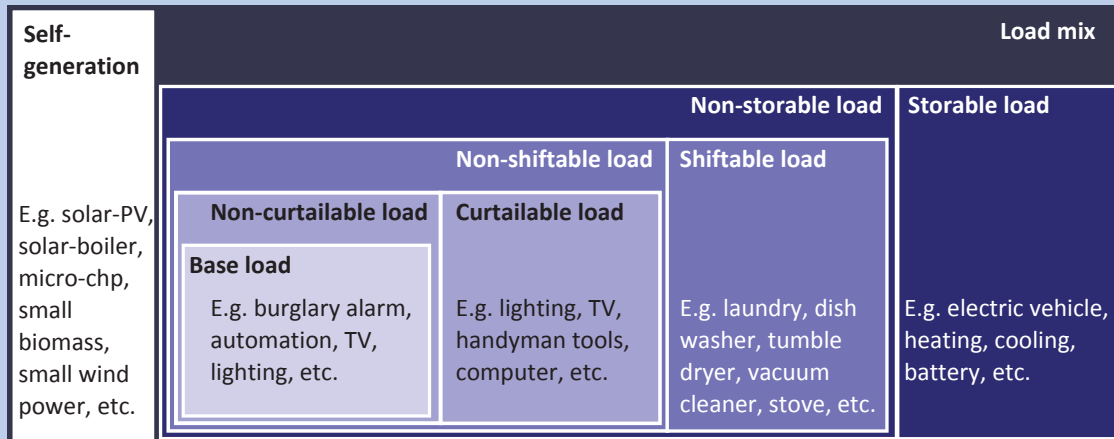
Consumers' potential and willingness to participate in demand response

Recent pilot studies show a divergent response by consumers: some consumers opt out or drop out of the studies, some show limited signs of responsiveness and other consumers effectively and significantly respond to signals. It is thus important to realise that consumers have diverse preferences which are engaged by different signals.

To capture this consumer diversity we propose a two-dimensional framework to categorise consumers: (1) according to how consumers are potentially able to participate in demand response as reflected in their **load mix**, and (2) according to the **preferences** on a set of criteria that affect their willingness to participate in demand response.



Box 1: Load mix decomposition (own depiction)



Categorisation dimension 1: Consumer load mix

The potential of consumers to participate in demand response is determined by the flexibility of their load. It is noteworthy that such flexibility is related not only to the capacities of the smart appliances that a consumer possesses, but also to how the consumer uses his smart *and* dumb appliances. To capture this richness, we propose a categorisation of load as depicted in Box 1.

Consumer load, i.e. the electric power consumption, can first be categorised in (1) *storable load* (e.g. heating, fridge, electric vehicle, etc.) and *non-storable load*. Next, non-storable load can be further categorised in (2) *shiftable load* (laundry, tumble dryer, dish washer, etc.) and *non-shiftable load*. Non-shiftable load then is further categorised in (3) *curtable load* (lighting, TV, kettle, stove, etc.) and *non-curtable load*. The remaining non-curtable load can be classified as (4) *base load* (TV², burglary alarm, au-

2 Depending on how a consumer uses an appliance to generate end-user services, an appliance can be base load (e.g. World

tomation, etc.). The load refers to net electric power consumption from the grid and is thus equal to the total power consumption corrected for (5) *self-generated* electricity by the ‘prosumer’. The flexibility increases from the base load to storable load.

Together, the different proportions of these load types make up the consumer load mix. Consumers can then be categorised according to their dominant load type, indicating their degree of flexibility.

Categorisation dimension 2: Consumer preferences

The willingness of consumers to participate in demand response can be associated with the consumer preferences on a wide range of criteria that includes, but is not limited to, financial compensation, prosocial motivation, price and volume risk, complexity, and autonomy and privacy.

Cup final on TV) one moment and curtable (e.g. a re-run of a TV series) at other times.



Box 2: Contract interpretation of consumer criteria

Contract	Price risk	Volume risk	Complexity	Autonomy/ Privacy loss	Financial compensation
Time of use pricing	Limited	None	Limited	None	Limited
Dynamic pricing	High	None	High	None	High potential
Fixed load capping	None	Limited	High	Limited	Limited
Dynamic load capping	None	High	High	Limited	High potential
Direct load control	None	None	None	High	Limited/ High potential

It is important to note that consumers are not homogenous in their perception of these criteria. For instance, loss of autonomy can be a cost for one consumer whilst a benefit for another; and different consumers might attribute different values to the same criterion as risk might be highly relevant for one consumer and a minor issue for another. Therefore, consumers' different preferences on these criteria will also condition the way they wish to participate in demand response. Consumers can then be categorised according to similar sets of preferences.

Demand response contract: the missing piece in the puzzle?

Contracts are currently a missing piece in the puzzle of demand response take-off; they have been relatively under-researched, especially regarding the consumer-oriented impact. However, contracts with demand response intermediaries (sometimes

referred to as 'aggregators') are the 'software' for consumers to participate in demand response. The contract terms regarding the financial compensation, the periods of activation, the capacity requirement, etc. are closely related to consumers' potential and willingness to participate in active demand response. Without understanding the full implication of the contract, a consumer can hardly be mobilised into an active consumer. Therefore, the THINK report adopts a consumer-centred approach and focuses on demand response contracts.

Based on the established literature and experiences from industrial consumers' demand response and pilot studies, we distinguish five generic³ contract types: (1) price-based static contracts, e.g. time of use (TOU) pricing; (2) price-based dynamic contracts, e.g. dynamic pricing, real-time pricing, and critical

³ The generic contract type encompasses a great variety in exact contract terms, i.e. the actual establishment of price, quantity, time intervals et cetera.



peak pricing; (3) volume-based static contracts, e.g. fixed load capping; (4) volume-based dynamic contracts, e.g. dynamic load capping and interruptible contracts; and (5) control-based contracts, e.g. direct load control contract. We demonstrate that there is an interaction between the contract types and the consumers' load mixes/preferences.

The first interaction: consumer load mix and contract

Consumers' load mixes may determine whether they are able to meet the requirements of certain demand response contracts. For instance, a *curtailable load mix* can interrupt load instantly and is thus particularly able to respond to dynamic contracts, such as dynamic pricing and dynamic load capping. A *shiftable load mix* needs some planning of load and thus benefits from static signals that are notified well in advance and are less volatile during the day. Hence, it matches TOU pricing and fixed load capping.

The second interaction: consumer preferences and contract

The five retained contract types also give an explicit or implicit interpretation to the aforementioned consumer criteria⁴. As shown in Box 2, some contracts impose high risks to consumers (dynamic pricing and load capping contracts), whereas other transfer limited or even no risk to consumers (TOU pricing, fixed load capping and direct load control); complexity is higher for volume-based contracts and for dynamic contracts; autonomy/privacy loss is absent in pricing contracts, while high for direct load control; and financial compensation has a higher

⁴ Except for prosocial motivation which is intrinsic to the consumer, and should apply equally to all contract types.

potential when more risk and complexity is passed on to consumers. As a result, consumers may prefer certain contracts depending on their preferences on these criteria.

A toolkit of consumer empowerment and protection

The above analysis demonstrates that there is no clear best contract for all consumers; the appropriateness of a contract depends on consumers' specific load mix as well as their preferences on a series of criteria. Hence, there is a need for an adequate range of contracts, including the five contract types discussed above. In other words, consumers need to be provided with enough options in order to be engaged in active demand response.

But this availability of contract options alone is not enough; consumers also need to be empowered to make informed and appropriate choices. Indeed, even if the adequate range of contracts exists, consumers may still face difficulties to choose the right contract because of a lack of knowledge about their flexibility potential, insufficient awareness of the implications of contracts, misalignment of their load mix and preferences, etc. The THINK report further proposes a toolkit of consumer empowerment and protection as follows:

- (1) Mandatory consumer profiling is key to raise consumers' awareness and to educate them on impacts of different options. The profiling should be the result of a standard survey on the consumer's load mix and preferences on a set of criteria that are implied by the contract. This profiling could also facilitate market players to establish their business models with consumers.



- (2) Independent contract comparison tool needs to be established. The provider of such tool should be certified and the methodology (e.g. included parameters) should be regulated. Transparent information, e.g. through disaggregated billing, should be mandatory to allow adequate contract benchmarking in the comparison tool.
- (3) Monitoring and optimisation of the range of contracts helps to limit the complexity of contract terms, while still allowing competition and innovation in contract design.
- (4) Adequate data protection is needed to raise consumers' trust to reveal personal information before and after signing a contract.
- (5) Effective dispute resolution is necessary as a fall-back option to enable efficient switching of contracts or intermediaries by consumers.
- (6) Vulnerable consumers should have access to assistance and protection to prevent them from being penalised for their inability to provide active demand response.

What is beyond? — The market design

While the aforementioned recommendations empower consumers to handle demand response contracts, these contracts are embedded in an existing market design, with market players freely proposing contracts to potential customers, valorising active demand response in different market places. Using the contract as a starting point, we then address the following issues:

How to guarantee there is an adequate range of contract for consumer choices?

Our analysis shows that one single market player might not have incentives to offer an adequate range of demand response contracts, because of their divergent business objectives and risk preferences. Therefore, it is essential to have a diversified set of market players acting as demand response intermediaries. We further identify what may hinder an adequate range of intermediaries to emerge, and propose the following measures for facilitating market entry for new market players:

- (7) A demand response license provides a 'quality label' for new actors to build trust with consumers.
- (8) Disaggregated billing allows better comparison of offers from intermediaries who offer bundled services (e.g. supply and demand response) and those who do not.
- (9) Non-discriminatory entry to the demand response market and freedom to offer services to consumers for intermediaries.
- (10) Non-discriminatory access to electricity markets, including balancing markets, and bilateral procurement mechanisms for ancillary services and congestion management.
- (11) Non-discriminatory access to data, e.g. to prevent the transfer of information from the regulated activities to the deregulated activities in an integrated supplier-DSO.



Is the current retail market design suitable to accommodate active demand response?

The current retail market starts from the assumption of low elasticity of demand, which is expressed by at least two facts: first, the supply contracts are by default offering unlimited electricity supply to consumers, and in many Member States, at a regulated retail tariff; second, balancing costs are socialised, partly by the supplier among his customers, and partly by the TSO among all network users. Such arrangements severely reduce the incentives for consumers to become active. Therefore, in the long term, it is necessary to rethink the market design with the anticipated active role of consumers in mind. The THINK report proposes one such design referred to as ‘**real-time market**’:

- (12) The real-time market implies that both the supply and the demand side need to express their willingness to sell and buy guaranteed electricity in real time. It thus allows all consumers to make deliberate choices about their electricity supply, and to incorporate their flexibility into such choices. As a result, balancing costs are largely dissocialised, providing incentives for active demand response.

Conclusion

To sum up, the scepticism about consumer engagement is fallacious, as we have demonstrated in our original approach focusing on contracts, that **consumers can be engaged** if they have options that reflect their diversity and are adequately empowered to make choices. The THINK report also provides recommendations on **how to get there**, including a toolkit of consumer empowerment and protection, necessary adaptation of market rules and regulation, as well as a new retail market design. Therefore, the **shift** towards active demand response requires substantial efforts, but it is feasible and necessary. Indeed, a functioning retail market could not materialise without the active participation of consumers, and the decarbonisation targets can hardly be achieved without flexibility provided by the demand side. The long term paradigm shift of the electric power systems needs to be translated in a step-wise process that should start already now.

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The Florence School of Regulation

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