DemSi – A Demand Response Simulator in the context of intensive use of Distributed Generation

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Abstract— **Demand response can play a very relevant role in future power systems in which distributed generation can help to assure service continuity in some fault situations.**

This paper deals with the demand response concept and discusses its use in the context of competitive electricity markets and intensive use of distributed generation.

The paper presents DemSi, a demand response simulator that allows studying demand response actions and schemes using a realistic network simulation based on PSCAD. Demand response opportunities are used in an optimized way considering flexible contracts between consumers and suppliers.

A case study evidences the advantages of using flexible contracts and optimizing the available generation when there is a lack of supply.

Keywords—**Demand response, distribution networks, electricity markets, loads, power systems, simulation**

I. INTRODUCTION

Power systems (PS) deregulation and the power sector restructuration led to competitive and liberalized electricity markets (EM) which are operating for some years in most developed countries [1]. In competitive EM a large set of players of diverse nature follow their own strategies to accomplish their goals. The whole system should be able to attain common goals, including demand satisfaction within accepted reliability levels and compliance with general rules (such as applicable legislation for electrical safety and environmental constraints). In this context, available energy resources (ER) should be adequately managed taking into account individual and common goals.

Pioneering visions of EM envisaged relevant advantages concerning increase in power consumption efficiency and price reduction due to the end of monopolies [1]. EM operation evidenced problems that showed that this market exhibits very specific characteristics which make some rules and methods that are usually used in other commodities market not useful in EM context. This is mainly due to the unique characteristics of electrical energy which is a commodity for which balance between supply and demand must be assured at all moments and that can only be stored in very limited ways and quantities.

One of the points in which EM are well below initial expectations is demand response (DR) [2]-[6], in several cases the level of DR being lower than before deregulation. This means that demand side (DS) players are not using the set of new business opportunities offered by EM in a satisfactory way. This is especially difficult for smaller DS players but even larger DS players are evidencing difficulties.

Aggregation is being more and more used so that EM players can join their resources and efforts to gain competitive advantage [5] in EM but DR has very specific needs that even large aggregators have difficulties dealing with it.

The current state of the art does answers these problems and does not show signs of having found the correct path so that the required solutions are obtained in a short time horizon. As the efforts that have been put in DR issues are very relevant, the poor results evidence a need to use a different approach to address DR issues.

This paper contributes to such approach, addressing some of the most important present difficulties. It proposes that entities as Energy Service Providers (ESP) offer advanced services in this field (presently the services offered are very limited) to DS players, supporting strategic decisions and operations functions for the planning of their DR actions and contracts. DemSi, a demand response simulator that allows studying demand response actions and schemes using a realistic network simulation based on PSCAD, will provide the business models, the methodologies and the computational implementation to support these services. These services can also be provided by some aggregators of large dimension.

After this introduction, this paper is organized in the following sections:

Section II explains the importance of demand response in the context of the electricity markets and the most important concepts related with demand response;

Section III describes the Demand Response Simulator (DemSi);

Section IV presents a case-study concerning an incident situation; demand response, obtained through market tools, is used by the distribution company to strategically minimize load curtailment and the costs in this situation.

Finally, Section V presents the most important conclusions of the presented work.

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II. Demand Response in Competitive Electricty Markets

PS are operated according to the optimization of the available resources. Traditionally decisions were mostly undertaken in a centralized way based on supply and network resources. Electricity Markets created new business opportunities that are changing the way electric energy is bought and sold and consumers can play an active role influencing market results [5], [6].

DS players must strategically manage their ER and can aggregate themselves [5]. DS can take advantage of this aggregation philosophy in terms of the access to the aggregated resources but also benefit from an increase in scale resulting from aggregation, making easier to address topics as energy efficiency and Demand Response (DR). PS require a permanent balance between supply and demand in real time. Recent studies have proved that loads are not rigid, exhibiting elasticity that can be used for mutual benefits of PS and consumers. DR should be considered as an ER that can be used, together with other ER (generation, storage) to assure this balance and to optimize PS operation [5].

Changes in electricity price over time and incentive payments are able to evidence demand flexibility as end-use customers intentionally modify their electricity consumption patterns as a response to exterior stimulus. Competitive EM gives place to more active DS strategic behavior. DR can be contracted over longer or shorter periods either as result of its inclusion in capacity markets or directly through bilateral contracts. Real time pricing can be used as a means to optimize distribution network operation, to reduce incident consequences, and to reduce wind curtailment [6]. Usually the actions that result from DS behavior or that are intended to manage consumer behavior are referred as DR, load management and DS management (DSM). Traditionally these are seen as measures taken to encourage consumers to reduce their electricity consumption during times of especially high demand [7] and usually done through utility load management programs aiming essentially at obtaining peak reduction.

DR can be defined as the changes in electricity usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time. Further, DR can be also defined as the incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized [2]. DR includes all intentional electricity consumption pattern modifications by end-use customers that are intended to alter the timing, level of instantaneous demand, or total electricity consumption [8].

DR programs can be classified into two main categories: Incentive-Based Programs (IBP) and Price-Based Programs (PBP) [2],[3] which are sometimes referred under different designations. IBP can be classical programs (customers receive payments for their participation, usually as a bill credit or discount rate) and market-based (participants are rewarded with money depending on the amount of load reduction during critical conditions). Classical IBP include Direct Load Control programs and Interruptible/Curtailable Load programs. Market based IBP include Emergency DR Programs, Demand Bidding, Capacity Market, and the Ancillary services market [3], [9],[10].

It was hoped that EM, opening new business opportunities for DR, would increase DR when compared to the traditional regulated utility industry. However, in spite of all the interest in the subject and very diverse and relevant experiences all over the world [11]-[17], results show that the level of DR is below the expectations and in many cases are even below the levels prior to deregulation [4]. This can be due to the fact that the DR level in a restructured market is highly sensitive to the market design. Experience shows that even in a market which has been deregulated to a large degree, regulatory intervention and special DS programs may be needed.

The present reality is not according to the initial visions of the future of PS and electricity markets in which the focus was the potential for improved efficiency in consumption. With some years of experience in operating EM, it is time to address the problem of DS participation in a more systematic way and taking into account the empirical evidence. This is required to establish baseline conditions, develop standardized methods to assess DR availability and performance, and to build confidence among policymakers, utilities, system operators, and stakeholders that DR resources offer a viable, cost-effective alternative to supply-side investments [9].

Recent studies point to success in designing a competitive market that will properly value and accommodate DR, if the past experience is considered and adequate DS analysis is undertaken [5],[6],[10]. However, there are no signs that the problem of supporting DS participation in this market is being correctly addressed. Unlikely producers, consumers are still much on their own, without access to adequate tools to support their decisions. Even medium size consumers and consumer aggregators show difficulties in operating in such a complex and dynamic environment. This is exactly the point to be addressed by DemSi, aiming at pointing to new business models that can frame DS role and increase DR in EM.

A. *Benefits of Demand Response*

The main benefit of DR is the improvement of efficiency of electricity production, since a closer alignment between customers' electricity prices and the value, they place on electricity is established. A variety of benefits related to this increase of efficiency can be summarized in four groups namely customers, whole market, reliability, and market performance benefits [18].

Customers financial benefits are mainly the bill savings and the incentive payments earned due to the adjustment of their electricity demand in response to time-varying electricity rates or incentive-based programs.

Lower wholesale market prices is a benefit for the whole market since DR can avoid the need to use the electricity generation provided by high cost power plants.

Other benefit can be seen at the level of the reliability by the improvement of operational security. This way, the probability and consequences of forced outages, which lead financial costs and inconveniences to customers, can be reduced.

Lastly, DR can increase market performance mitigating the market power made by raising power prices above production costs.

B. Characterization of DR programs

Demand response programs can be divided in two wide groups namely, Price-based demand response and Incentive-based demand response [2].

Price-based demand response is related with the changes in energy consumption by customers in response to variation in the prices they pay. This group includes time-of-use (TOU), real time pricing (RTP) and critical-peak pricing (CPP) rates. For different hours or time periods, if the price varies significantly, customers can respond to the price structure with changes in energy use. Their energy bills can be reduced if they adjust the time of the energy usage taking advantages of lower prices of some periods and avoiding consumption when prices are higher. Response to price-based demand response programs, changing energy consumption time periods, is entirely voluntary.

TOU is a rate that includes different prices for usage during different periods, usually defined for periods of 24 hour. This rate reflects the average cost of generating and delivering power during those periods.

RTP is a rate in which the price of electricity is defined for shorter periods of time, usually 1 hour, reflecting changes in wholesale price of electricity. Customers usually have the information of prices on a day-head or hour-head basis.

The one that actually has higher difficulties of implementation is CPP that is a hybrid of the TOU and RTP programs. The base program is TOU and a much higher peak pricing is used in specified conditions like when system reliability is compromised or supply cost is very high.

Incentive-based demand response includes programs that give customers incentives that are additional to their electricity rate which may be fixed or time varying. These can be established by utilities, load-serving entities, or a regional grid operator. Some of these programs penalize customers that fail the contractual response when events are declared. This group includes programs such as Direct Load Lontrol (DLC), Interruptible/Curtailable Service (ICS), Demand Bidding/Buyback (DBB), Emergency Demand Response (EDR), Capacity Market (CM), and Ancillary Services Market (ASM) Programs.

DLC is a program that considers a remote shut down or cycle of a customer’s electrical equipment by the program operator. These programs are primarily offered to residential or small commercial customers.

ICS is based on curtailment options integrated into retail tariffs that provide a rate discount or bill credit for agreeing to reduce load during system contingencies and includes penalties for failure in contracted response. These programs are traditionally offered to largest industrial customers.

In DBB programs, customers offer bids to a curtail service and large customers are preferred. EDR can be seen as a mix of DLC and ICS but targeted for periods when reserve becomes insufficient. In CM programs, customers offer load curtailments as system capacity to replace conventional generation. ASM programs are similar to DBB but the offer is specifically made for the ancillary services market. As traditional ancillary services, ASM can be paid for reserve and energy provision separately.

C. Why is Demand Response Important?

Several financial and operational benefits of demand response for electricity customers, load-serving entities and grid operators are nowadays recognized.

Since electricity cannot be economically stored, load and generation balance must be maintained in real time. Moreover, grid conditions can change in both short and medium term and even within moments. Another feature is that the electric system is highly capital-intensive, and generation and transmission system investments have long lead times and multi-decade economic lifetimes. These features of electric power systems require power grids planning and management to assure the reliability of the system considering uncertainties on future demand and fuel sources.

In a competitive electricity market, load entities and retailers buy or generate their electrical energy in advance considering that they will be able to generate or purchase enough electricity to meet changes on system demand.

These challenges and uncertainties make demand response higher valuable since it offers flexibility at relative low cost. Grid operators can use demand response programs to curtail or shift loads preventing the need of building more generation plants. In spite of requiring time to establish contracts with customers, well-structured price and incentive-based demand response can produce significant savings making possible lower costs than supply-side resources [19].

D. Price elasticity

In the aim of implement demand response programs, system planners and regulatory entities need to know how it is expected that loads will be changed by end customers when a change in price occurs. This is traditionally measured by price elasticity rate that is a normalized measure of the intensity of how usage of electricity changes when its price changes by one percent. In the opposite way, demand elasticity is a measure of how price changes when usage of electricity changes.

Measuring this elasticity, two types can be distinguished [2]. The first one is the own-price elasticity which measures how customers will change the consumption due to the price, regardless the period of variation. This rate is expected to be negative since an increase in price should cause a reduction on load and is useful to measure how customers adjust both the consumption of electricity and other goods.

III. Demand Response Simulator

This section presents DemSi, a Demand Response simulator that has been developed by the authors to simulate the use of diverse DR programs. DemSi considers the players involved in the DR actions and results can be analyzed from the point of view of each specific player. This includes three types of players: electricity consumers, electricity retailers (suppliers) and distribution network operators (DNO).

PSCAD is used as the basis platform for the network simulation. The used network can be chosen by a set of already available networks or can be created by the user. As an alternative to introduce a new network from scratch, DemSi provides user with functionalities that allow modifying already existing networks.

Consumers can be characterized on an individual or in an aggregated basis. The simulation requires knowledge about load data and about the contracts between clients and the electricity supplier. These contracts may include flexibility clauses that allow the network operator to reduce or cut the load and/or circuits of specific clients. On the other hand, response of each client to the used tariff scheme is also defined, allowing analyzing the impact of alternative schemes.

Each simulation begins with a scenario that specifies what are the generation resources and load demand for the simulation horizon. When facing a generation shortage (e.g. in case of an incident), the DNO can make use of flexible contracts and/or use RTP to condition consumers behavior.

When such a situation occurs, the solution is found in two phases:

- Phase I – The available energy production is evaluated and it is analyzed if it is sufficient to supply the critical loads. These loads should never be shed, unless it is absolutely impossible to supply them, due to security and/or economic reasons. The critical load status should be adequately addressed in the contracts between these loads owners and their suppliers. If all critical loads can be satisfied and there is a surplus of energy, the way in what this energy should be used, is determined in phase II;
- Phase II – The remaining loads that should be completely of partially supplied are determined using an optimization approach. This aims at minimizing the costs of the incident, from the point of view of the suppliers and/or the DNO.

A. Loads and Contracts

Detailed knowledge of demand side is crucial for the success of the use of demand response. From the point of view of each consumer or an aggregated set of consumers, this allows to take the best advantage of the existing opportunities. From the point of view of DNOs, this allows to take decisions that minimize operating costs.

From the point of view of demand response, loads mainly differ on the conditions they impose for eventually being curtailed or reduced, under specific situations. This determines if each load must be considered in Phase I or in Phase II as well as the Value Of Lost Load (VOLL), established in the contract.

DemSi considers three different typical load profiles, as follows:

- Critical loads (CL) which should be supplied in every situation. When not supplied, these loads receive high compensation values, as determined by the contracts between their owners and their supplier;
- Clients with flexible supply contracts (FS), which have contracted the priority of their circuits and/or loads in case of supply shortage. The DNO can control these clients' overall load or some of their circuits. Financial terms for this supply flexibility are established in the supply contracts;
- All other loads are considered as regular loads (RL).

Based on these profiles, some clients can establish flexible supply contracts with their suppliers. The information concerning the quantity of load that can be cut or reduced and the corresponding compensations for each client are considered by DemSi.

B. Mathematical formulation

As referred above, Phase II aims at minimizing the costs of a generation shortage situation. After completing Phase I with all the critical loads supplied, this can be modeled as an optimization problem. Problem characteristics lead to a mixed-integer linear model. The objective function is formulated with the aim of minimizing the total cost that the DNO and the suppliers have to pay for non-supplied loads (VOLL).

It is important to note that Phase II always corresponds to a situation for which there is a lack of supply. Considering that critical loads are fully supplied, the power that can be considered to supply the remaining loads (P_{Gen}) is equal to the generated power (P'_{Gen}) minus the critical loads ($P_{Critical}$), the required reserves ($P_{\mathrm{Re}serve}$) and the losses (P_{Losses}) (1).

$$P_{Gen} = P'_{Gen} - P_{Critical} - P_{\mathrm{Re}serve} - P_{Losses} \tag{1}$$

The objective function can be expressed as follows (2)

$$Min\,C = \sum_{b=1}^{nb} \left(P_{LoadRed(b)} \times c_{LoadRed(b)} + P_{LoadCut(b)} \times c_{LoadCut(b)} \right) \quad (2)$$

taking into account the following constraints:

$$P_{Gen} = \sum_{b=1}^{nb} \left(P_{Load(b)} - P_{LoadRed(b)} - P_{LoadCut(b)} \right) \quad (3)$$

$$P_{LoadCut(b)} = PP_{LoadCut(b)} * X_{C(b)} \quad (4)$$

$$P_{LoadRed(b)} \leq PP_{LoadRed(b)} \quad (5)$$

where

C	Total cost for one period
$c_{LoadCut(b)}$	Cost of cut load in bus b
$c_{LoadRed(b)}$	Cost of reduced load in bus b
nb	Total number of buses
$P_{Critical}$	Active power necessary to supply critical loads
P_{Gen}	Active power available for optimization
P'_{Gen}	Total generated active power
$P_{Load(b)}$	Active power of load in bus b
$P_{LoadRed(b)}$	Active power of reduced load in bus b
$P_{LoadCut(b)}$	Active power of cut load in bus b
$P_{Reserve}$	Required active power reserves
$PP_{LoadRed(b)}$	Possible active power to reduce in bus b
$PP_{LoadCut(b)}$	Possible active power to cut in bus b
$X_{C(b)}$	Load cut decision variable in bus b

Using this approach and having knowledge about load profile to establish supply contracts, a DNO can manage loads reaching his objectives.

C. Software Implementation

DemSi aims at providing a flexible tool to analyze demand response actions and schemes, providing realistic simulation results. This requires modeling all relevant demand response schemes and also a realistic network simulation.

After some preliminary experiences, PSCAD® is being used for network simulation evidencing good results. PSCAD® allows to have detailed models of electrical equipment and to consider transient phenomena. On the other hand, it also allows to realistically modeling distributed generation resources. This had a strong influence in the decision of using PSCAD® because we aim to apply the developed simulator to study demand response in the context of future electrical networks. These are characterized by intensive use of distributed generation and the need of adequate management of distributed energy resources in the context of smart grids.

To fully attain our goals, PSCAD® is linked with MATLAB™ and GAMS™. This allows using programmed modules able to model the relevant players' behavior and all the relationships among them, namely the contracts between each client and each supplier. The solution of the formulated optimization problem is found using MATLAB™ and/or GAMS™. Using diverse approaches for solving the optimization problems, it is possible to derive the best approach for each type of situation. This is important because our ultimate goal is to develop a software application that can be used by DNOs and consumers to optimize their resource management.

Figure 1 shows the general architecture of DemSi.

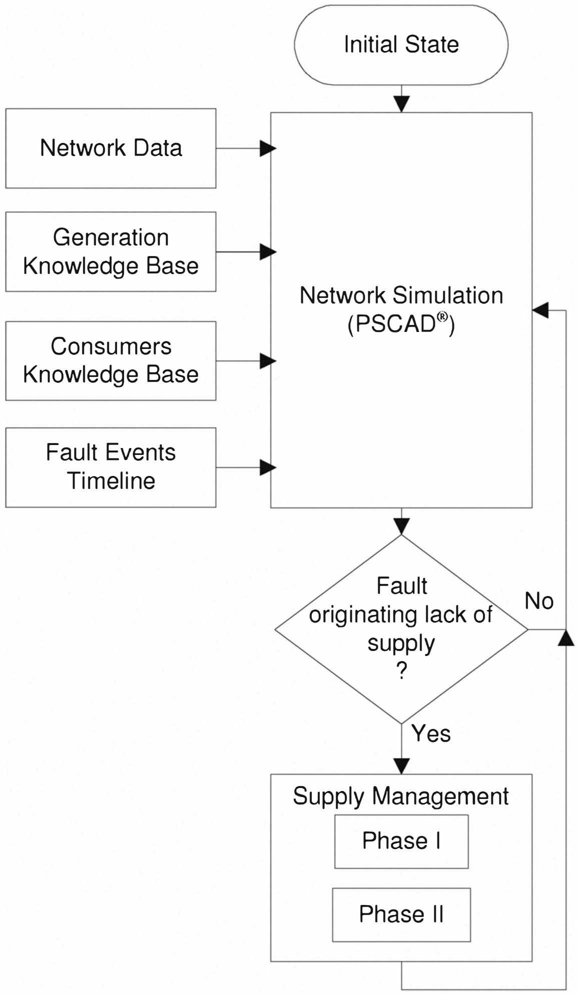

Figure 1. DemSi general architecture

Every time the simulator is initiated an initial state (e.g. value of loads, state of breakers, etc.) is considered as the departing simulation point. Once the simulation is launched, the generation knowledge base and the consumer knowledge base have the required information that allows determining generation and demand evolution over time, allowing simulation to go on.

From time to time a fault occurs, according to a priori defined fault events timeline. For each occurred fault, the situation is analyzed in terms of the balance between supply and demand. When a lack of supply occurs, the supply management module is run, including Phases I and II, as previously referred.

IV. CASE STUDY

This section presents a case study that illustrates the use of the developed demand response simulator DemSi. Let us consider a distribution network with 32 buses, from [20]. This network does not include any distributed generation. As our aim is to study the use of demand response in the context of intensive use of DG, we have included DG in this network, considering its evolution over time, since the initial date (2008) to 2040. For this purpose, several studies were done with the aim of determining the size, technology and the location of DG in each bus, over time. Similar studies were done to determine load evolution at each bus over time. Figure 2 depicts the network obtained for 2040. The dashed lines represent reconfiguration branches that are not considered in the present case study.

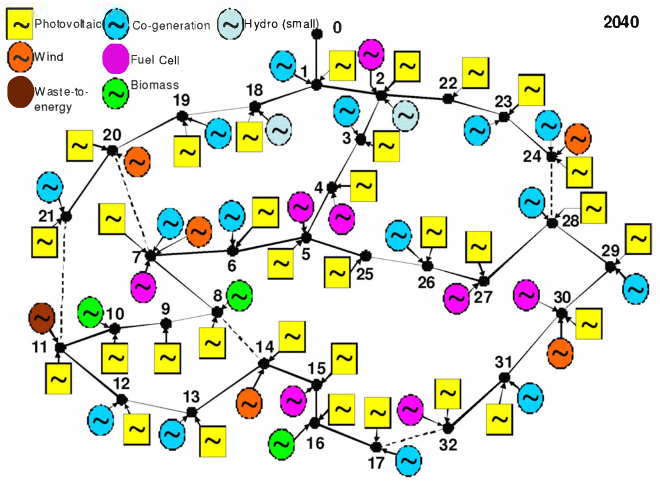

Figure 2. Configuration of the network in 2040

This network is connected to the larger distribution public network through bus number 0.

Loads are modeled as constant impedances whose value can be defined for each moment in terms of active and reactive power.

For this case study, we consider a fault in line 0-1 that connects bus 0 to the distribution grid. As a result of this fault:

- The considered network presented in figure 2 turns into an island where DG is the only means of electricity generation;
- The available DG is not sufficient to supply all the demand but is sufficient to supply critical loads (CL) and to assure an adequate amount of reserve;
- The remaining DG must be optimally used to supply additional loads, according to their profiles and contract clauses.

GAMS™ software has been used to find the optimization results. Once these results are available, the network simulation proceeds with the new load values.

A complete day has been simulated for this case study. Figure 3 presents the value of the total load and total DG for this period. The load diagram corresponds to the consumers demand. After the occurrence of the above referred fault, DG is the only generation means so only a part of this demand can be supplied.

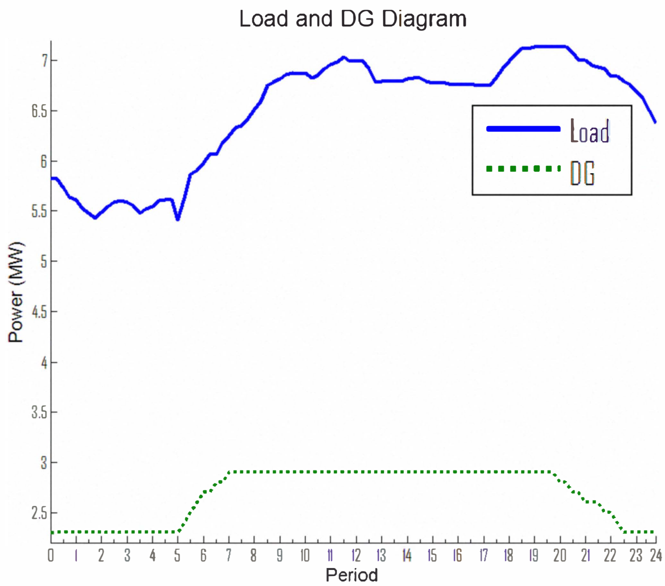

Figure 3. Diagram for load and DG along the simulated day

The considered fault keeps line 0-1 out of service, starting in instant 0 and lasting the whole day. Table I shows the results obtained for the considered scenario, with and without flexible contracts (FC) for the first period of 15 minutes. In this period the total generation is $P'_{Gen} = 2300kW$.

Loads are classified according to their contracts which are considered not to change along the time.

Table I indicates for the total load connected to each bus the value in kW of the non-supplied load (NSL), the unitary value of lost load (UVoLL) and the monetary value of the lost load (VoLL). The case study considers two different situations: with and without flexible contracts (FC). Without flexible contracts, the VoLL is calculated according to the value attributed to each individual load, according to its characteristics. With flexible contracts, the VoLL is calculated using the clauses of each load contract; these clauses determine the conditions under which a part of the load may be curtailed. These values are calculated for each individual load, the total value for the load connected to each bus is presented in Table I. This scenario considers two types of flexible contracts (FS1 and FS2) which only differ on the specific contract clauses (percentage of load- 80% and 50% respectively - that the clients accept to be curtailed and contract tariffs).

TABLE I. CASE-STUDY RESULTS FOR 1ST PERIOD

Bus	Demand (kW)	Without FC			With FC			
		NSL (kW)	*UVoLL (€/kWh)*	*VoLL (€)*	*Supply Contract*	*NSL (kW)*	*UVoLL (€/kWh)*	*VoLL (€)*
1	169.1	169.1	7	295.9	FS1	135.3	0	0.0
2	148.9	148.9	5	186.2	RL	148.9	5	186.2
3	147.1	0.0	40	0.0	CL	0.0	40	0.0
4	145.5	0.0	9	0.0	FS2	72.8	0	0.0
5	94.2	94.2	7	164.9	RL	0.0	7	0.0
6	311.1	311.1	5	388.9	FS1	248.9	0	0.0
7	308.7	308.7	6	463.0	FS2	154.3	0	0.0
8	89.3	89.3	6	133.9	RL	89.3	6	133.9
9	90.6	90.6	5	113.2	RL	90.6	5	113.2
10	67.0	0.0	30	0.0	CL	0.0	30	0.0
11	91.1	91.1	8	182.2	FS1	72.9	0	0.0
12	91.3	91.3	7	159.9	FS2	45.7	0	0.0
13	181.3	0.0	30	0.0	CL	0.0	30	0.0
14	91.1	91.1	8	182.1	RL	0.0	8	0.0
15	91.1	91.1	5	113.8	RL	91.1	5	113.8
16	91.9	0.0	50	0.0	CL	0.0	50	0.0
17	135.5	135.5	3	101.6	RL	135.5	3	101.6
18	152.4	152.4	6	228.5	FS1	121.9	0	0.0
19	151.7	151.7	5	189.6	RL	0.0	5	0.0
20	151.6	151.6	5	189.5	RL	75.8	0	0.0
21	151.5	151.5	3	113.6	RL	151.5	3	113.6
22	147.3	0.0	7	0.0	FS1	117.8	0	0.0
23	674.8	0.0	9	0.0	RL	674.8	9	1518.3
24	669.3	669.3	7	1171.3	RL	669.3	7	1171.3
25	93.8	93.8	5	117.2	RL	93.8	5	117.2
26	93.2	0.0	25	0.0	CL	0.0	25	0.0
27	92.2	92.2	4	92.2	RL	92.2	4	92.2
28	183.0	183.0	8	366.1	FS2	91.5	0	0.0
29	295.3	0.0	50	0.0	CL	0.0	50	0.0
30	225.4	0.0	20	0.0	CL	0.0	20	0.0
31	315.1	315.1	3	236.3	RL	315.1	3	236.3
32	89.8	89.8	5	112.3	RL	89.8	5	112.3
Total	**5831.3**	**3762.5**	**-**	**5302.5**	**-**	**3778.8**	**-**	**4010.1**

From the presented results, we can conclude that the total VoLL is substantially decreased when considering a part of the loads with types CL and FS contracts. It is important to note that the values presented in this table only refer to the VoLL concerning a 15 minutes period. The total annual decrease in the VoLL value depends on the number, duration and characteristics of the faults that cause a lack of supply.

Figure 4 shows the amount of non-supplied load considering and not considering flexible contracts. These two curves are very similar because they correspond to the use of the amount of DG available along the day.

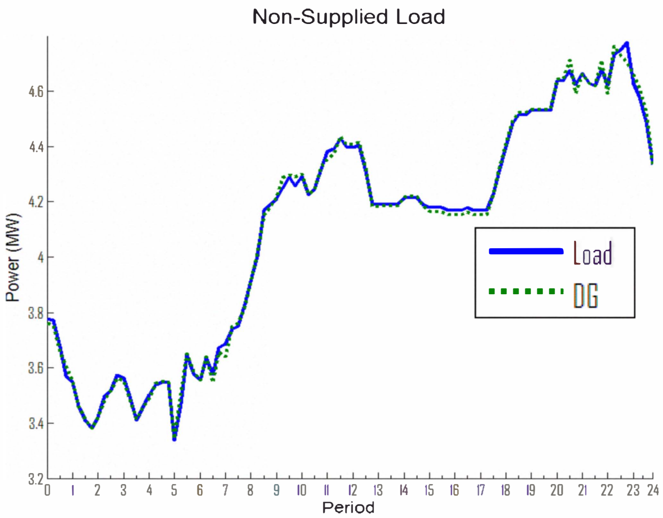

Figure 4. Non-Supplied Load with and without flexible contracts along 24h

In spite of this similarity, the VoLL presents very different values in the two situations as shown in figure 5.

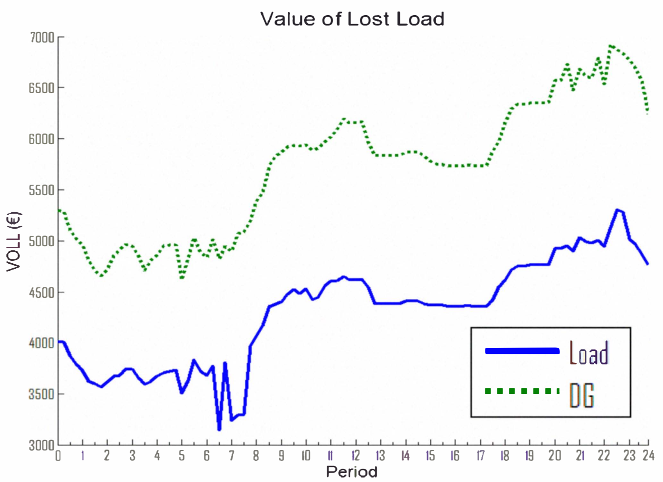

Figure 5. Value of Lost Load with and without flexible contracts along 24h

The results presented in figure 5 clearly show that an adequate use of flexible contracts can significantly decrease the VoLL.

V. CONCLUSIONS

Future power systems should accommodate an intensive use of distributed generation what requires to adequately address the technical problems that this use arises. Moreover, distributed generation brings new possibilities of increasing service quality, namely in case of incidents. In these future scenarios, demand response must be considered a relevant energy resource that can be used by consumers to take advantage of their elasticity and by suppliers and distribution operators to increase service quality and/or decrease costs.

This paper presents DemSi, a demand response simulator that allows studying demand response actions and schemes using a realistic network simulation based on PSCAD. DemSi allows simulating a variety of demand response methodologies and to optimally use the available generation according to the relevant demand response opportunities.

A case study considering a fault evidences the advantages of using adequate methodologies to manage demand response in this kind of situation.

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