SURVEY ON METHODS AND TOOLS FOR PLANNING OF 'ACTIVE' DISTRIBUTION NETWORKS

Khalil EL BAKARI
Elitechs BV – Netherlands
k.el.bakari@tue.nl

Clinton CARTER-BROWN
Eskom – South Africa
cartercg@eskom.co.za

Samuel JUPE
Parsons Brinckerhoff – UK
JupeS@pbworld.com

Alex BAITCH
BES (Aust) Pty Ltd – Australia
baitch@besaust.com.au

Chad ABBEY
Hydro-Québec – CANADA
abbey.chad@ireq.ca

Alexandre RASI AOKI
LACTEC – Brazil
aoki@lactec.org.br

Mingtian FAN
CEPRI – China
mailto:mtfan@epri.sgcc.com.cn

Chikashi NAKAZAWA
Fuji Elecric Co., Ltd. – Japan
mailto:nakazawa-chikashi@fujielectric.co.jp

Fabrizio PILO
University of Cagliari – Italy
pilo@diee.unica.it

ABSTRACT

Many electricity utilities are currently orienting their passive distribution grids towards actively controlled networks in order to efficiently host increased levels of distributed energy resources. This development might lead to re-engineering the planning process as well as adding the necessary procedures, methods and tools. The state of this development is still undetermined.
This paper presents the results of a worldwide survey conducted as part of Cigré working group C6.19 activities. on the tools and methods used in utilities for the planning and optimization of the distribution network. The objective of the survey was to determine the state-of-the-art and the required enhancements to the planning process in order to transition to an active distribution network.

INTRODUCTION

In recent years distribution utilities have started to evolve their passive distribution grids towards actively controlled networks, which can incorporate significant levels of distributed energy resources (DER) in an efficient and cost effective manner. In some cases these efforts have led some utilities to re-engineer their planning processes while adding the necessary procedures, methods and tools to support the development of active distribution networks.
This paper presents the results of a survey conducted by Survey Taskforce, part of the Cigré C6.19 working group (WG) [1], on the tools and methods used in companies for the planning and optimization of the distribution network. The aim of this survey is to determine the state-of-the-art and identify which developments are needed for the planning of active distribution network. In addition, the paper summarizes the bottlenecks in existing planning procedures. These bottlenecks are derived from the responses to a questionnaire which was distributed by the EURELECTRIC [2] and the WG members to energy utilities and universities worldwide. Moreover, this paper elaborates on the problems and barriers identified by respondents that constrain the planning and development of active distribution networks.
The paper starts with the targets of the survey and the intentions of Cigré WG C6.19, followed by an overview of the survey results. Conclusions drawn from the survey results are then presented.

SURVEY OBJECTIVES AND METHOD

Information obtained from the survey is being used by Cigré WG C6.19, which aims to address the planning and optimization of active distribution systems. This survey aims to clarify the following aspects:

- The state-of-the-art and needed developments to facilitate the planning of active distribution network;
- Bottlenecks in existing planning procedures;
- Problems and barriers which respondents are experiencing during the planning and development of active distribution networks.

Based on the typical distribution utility network planning process, a questionnaire was developed that aims to assess the extent to which utilities are factoring in active networks into their planning. After distribution to energy utilities and other role players, the responses were grouped into geographical regions: Africa, Oceania, North America, South America, Eastern Europe, Western Europe and Asia. Regional reports were compiled to create a survey report that includes the knowledge and experiences of the WG C6.19 members from the specified regions.
As per Fig. 1, more than 90% of respondents confirmed that they follow the traditional steps of the typical distribution network planning process. There are, however, significant differences in how these activities are done, including whether active control is included in the planning process. Furthermore, an average of around 50% of the respondents indicated that they conduct planning activities in addition to those of the typical planning process included in the questionnaire.

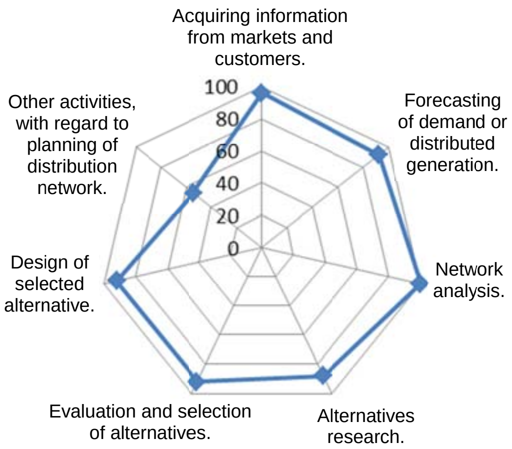

Fig. 1 Alignment with typical planning process

OVERVIEW OF SURVEY RESULTS

Each main activity of the typical distribution utility planning process was assessed through questions related to the development of active distribution networks. This commenced with inquiries related to the information used for the planning of distribution networks as shown in Fig. 2.

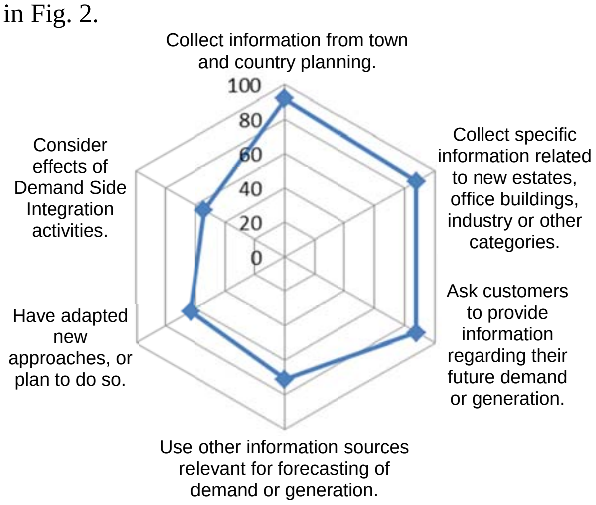

Fig. 2 Information from markets and customers

Based on the responses shown in Fig. 2, the majority of respondents utilize information from customers and markets. An increasing number of respondents access other sources of relevant information, and are adapting new approaches for the prediction of future demand and generation. More than 50% of respondents strive to consider the effects of demand side integration.

With regard to the forecasting activities, Fig. 3 illustrates the wide range of activities that are conducted by the respondents. The low score of 'extrapolation of historical data' confirms that most forecasts are based on information from markets and customers

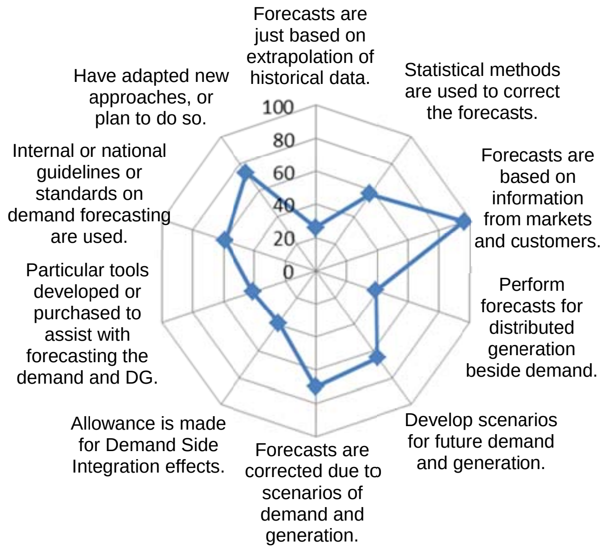

Fig. 3 Forecasting of demand and distributed generation

Interestingly, only a few develop their plans on a statistical basis. It is also notable that few develop forecasts for distributed generation (DG), and hence only focus on the traditional forecasts of load demand. This may be a result of the 'Fit and Forget' strategies that have historically been implemented. The lack of DG forecasting appears to be compromising the accuracy of the demand forecasting and could be a key obstacle impeding the planning of active networks. As confirmed by respondents this dilemma continues during the network analysis that is based on the forecasts, see Fig. 4.

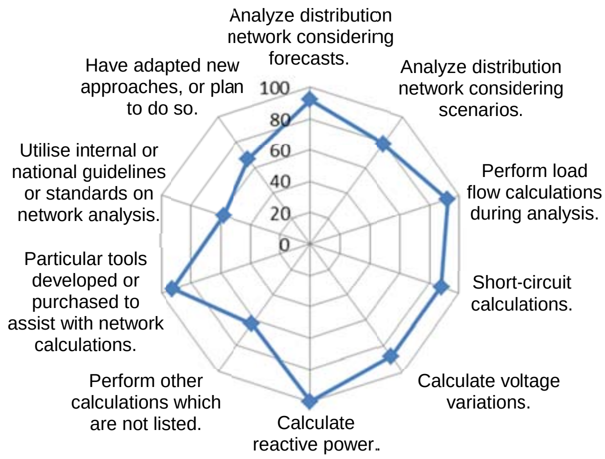

Fig. 4 Network analysis

The summarized responses in Fig. 4 confirm that essentially only the traditional network calculations are conducted during network analysis. Constraints are addressed via solutions that reflect the policy and objectives of the utility concerned, see Fig. 5.

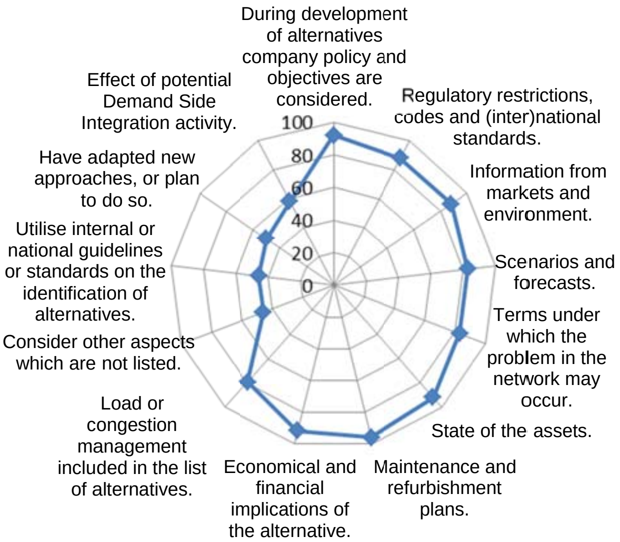

Fig. 5 Alternatives research

It is apparent that alternative research presently makes little consideration for active network solutions (left side of Fig. 5). It is also notable that the majority of respondents make no use of internal or national guidelines during the development of solutions for possible bottlenecks. This is also confirmed in the evaluation and selection of alternatives as shown in Fig. 6.

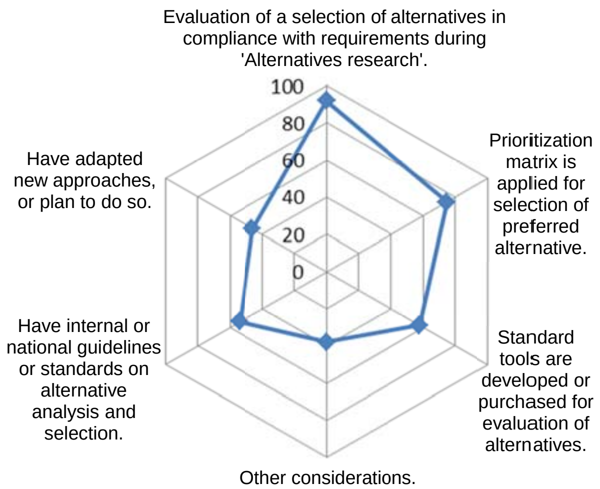

Fig. 6 Evaluation and selection of alternatives

As per Fig 6 almost half of the respondents indicate that they do not to use standard tools for the evaluation of alternatives. On the contrary, the design of selected alternatives is generally based on predefined conditions, as shown in the right half of Fig. 7. Moreover, the answers in Fig. 7 reveal that the majority of respondents implement active control for the HV and MV levels. Very few respondents apply active control at the LV level.

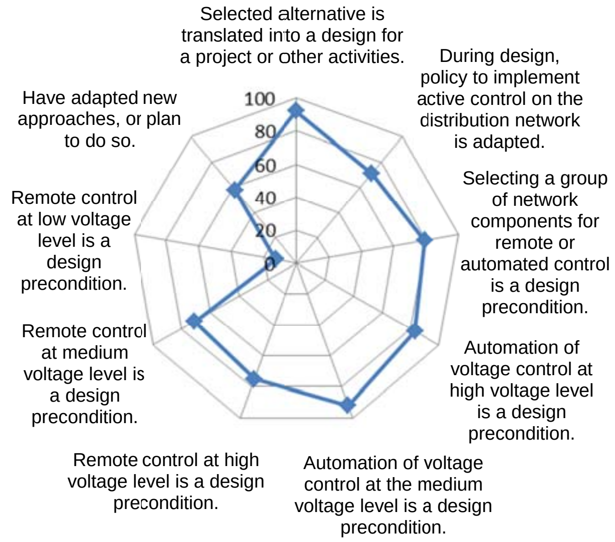

Fig. 7 Design of selected alternative

SURVEY RESULTS PER REGION

The analysis and conclusions of the previous section do not reveal any particular regional differences. However, the table in the Appendix provides the same results divided by region.
This information enables researchers to generate benchmarks on active distribution networks in a certain region alongside the overview provided in pervious section.

CONCLUSIONS

Based on the survey results and analysis, discussed in this paper, the following conclusions can be abstracted:

- The planning process at present hinges very strongly on data related to customers usage and city planning to form accurate load forecasts, which is the main input into the technical planning portion of the study.
- At present, little or no consideration is given to distributed generation or demand side integration in the development of these forecasts.
- While of interest to many utilities, demand-side integration and active distribution network concepts fail to be taken seriously by utilities as viable alternatives in the planning process.

The scores in previous figures and in the Appendix can be used as references by utilities and researchers in order to determine the state and required developments of active control on the distribution networks. This information creates also the possibility to generate benchmarks on the development of active distribution networks.
Moreover, the questionnaire results and analysis feed into the other task teams on WG C6.19 to help guide their work.

REFERENCES

[1] Cigré Study Committee C6, 2010, "Distribution Systems and Dispersed generation", on-line, available: http://www.cigre-c6.org/Cigre Study Committee C6, website: www.cigre-c6-org.

[2] EURELECTRIC, The Union of the Electricity Industry, website: www.eurelectric.org.

[3] F. Pilo, S. Jupe, F. Sivestro, K. El Bakari, C. Abby, C. Celli, J. Taylor, A. Baitch, C. Carter-Brown, 'Planning and Optimisation of Active Distribution Systems – An Overview of Cigre Working Group C6.19 Activities', Cired Workshop, paper 135, Lisbon, Portugal, May-2012.

ACKNOWLEDGEMENTS

This work could not have been accomplished without the support of Cigré and the contributions of energy companies which have responded to the questionnaire. The following table includes the list of participating organizations.

Region	***Country***	***Contributions / Respondents***
Africa	South Africa	Eskom
		City of Cape Town
Asia	China	State Grid
	Japan	J-power
		CHUBU Electric Power
		Tokyo Electric Power
		The Kansai Electric Power co. ltd.
		Hitachi, Ltd.
		Mitsubishi Electric
		University of Fukui
		Fuji Electric Co., Ltd.
North America	USA	USA - EPRI
	Canada	Hydro-Quebec
South America	Brazil	CEMIG Distribuicao SA
		CPFL
		Enersul
		Eletropaulo
Eastern Europe	Slovenia	Elektro Ljubljana d.d.
	Romania	FDEE Elektra Distributie Transilvania Sud
Western Europe	Ireland	ESB Networks
	Spain	Endesa SA
	Sweden	Operation Nordic
	UK	Scottish Power
	Austria	EVN Netz GmbH
Oceania	Australia	Endeavour Energy
		Ergon Energy
		Energex
		Powercor Australia Ltd and CitiPower Pty
		Western Power
	New Zealand	Unison
		Powernet
		Network Waitaki

APPENDIX

	Questionnaire * ***(Total "Yes" of answers)***	**Africa**	**Asia**	**North America**	**South America**	**Eastern Europe**	**Western Europe**	**Oceania**
I	**Planning of distribution network, in general**							
1	Acquiring information from markets and customers.	100	44	100	100	100	80	100
2	Forecasting of demand or distributed generation.	100	56	50	100	100	80	100
3	Network analysis.	100	100	100	100	100	100	100
4	Alternatives research.	100	78	100	75	100	60	100
5	Evaluation and selection of alternatives.	100	44	100	75	100	80	100
6	Design of selected alternative.	100	56	100	50	100	100	100
7	Other activities, with regard to planning of distribution network.	50	11	50	75	50	40	63
II	**Information from markets and customers**							
1	Collect information concerning town and country planning.	100	100	100	75	100	80	100
2	Collect specific plans concerning new estate, office buildings, industry or other categories.	100	100	50	100	100	60	100
3	Ask customers to provide information regarding their future demand or generation.	100	100	100	100	50	60	100
4	Use other information sources relevant for forecasting of demand or generation.	100	0	100	25	50	80	88
5	Have adapted new approaches, or plan to do so.	100	0	100	0	50	60	88
6	Consider effects of Demand Side Integration activities.	0	25	100	25	100	40	75
III	**Forecasting of demand and distributed generation**							
1	Forecasts are just based on extrapolation of historical data.	0	60	0	25	50	0	38
2	Statistical methods are used to correct the forecasts.	50	40	0	50	50	20	100
3	Forecasts are based on information from markets and customers.	100	80	100	100	100	80	100
4	Perform forecasts for distributed generation beside demand.	0	20	100	0	0	40	75
5	Develop scenarios for future demand and generation.	100	40	100	50	0	80	63
6	Forecasts are corrected due to scenarios of demand and generation.	0	40	100	50	50	80	88
7	Allowance is made for Demand Side Integration effects.	0	20	100	25	0	20	63

*Questionnaire ** *(Total "Yes" of answers)*		Africa	Asia	North America	South America	Eastern Europe	Western Europe	Oceania
8	Particular tools developed or purchased to assist with forecasting the demand and distributed generation.	50	20	100	50	50	0	38
9	Internal or national guidelines or standards on demand forecasting are used.	50	0	100	75	50	50	63
10	Have adapted new approaches, or plan to do so.	100	20	100	50	50	50	88
IV	**Network analysis**							
1	Analyze distribution network considering forecasts.	100	67	100	100	50	80	100
2	Analyze distribution network considering scenarios.	100	44	100	100	50	80	75
3	Perform load flow calculations during analysis.	100	100	100	75	50	100	100
4	Short-circuit calculations.	100	89	100	75	100	80	88
5	Calculate voltage variations.	100	100	100	75	100	60	100
6	Calculate reactive power.	100	100	100	100	100	100	100
7	Perform other calculations which are not listed.	50	22	100	75	50	60	50
8	Particular tools developed or purchased to assist with network calculations.	100	67	100	100	100	60	100
9	Utilize internal or national guidelines or standards on network analysis.	50	33	50	75	100	60	50
10	Have adapted new approaches, or plan to do so.	50	33	100	50	50	60	75
V	**Alternatives research**							
1	During development of alternatives company policy and objectives are considered.	100	86	100	100	50	80	100
2	Regulatory restrictions, codes and (inter)national standards.	100	86	50	100	50	80	100
3	Information from markets and environment.	50	71	100	100	50	80	100
4	Scenarios and forecasts.	50	71	100	100	50	60	100
5	Terms under which the problem in the network may occur.	50	86	100	75	50	80	100
6	State of the assets.	100	43	100	100	100	80	88
7	Maintenance and refurbishment plans.	100	50	100	100	100	80	100
8	Economical and financial implications of the alternative.	100	43	100	100	50	80	100
9	Load or congestion management included in the list of alternatives.	0	57	100	100	50	80	88
10	Consider other aspects which are not listed.	0	14	50	25	50	60	63
11	Utilize internal or national guidelines or standards on the identification of alternatives.	50	14	50	50	50	40	50
12	Have adapted new approaches, or plan to do so.	50	43	100	50	50	20	50
13	Effect of potential Demand Side Integration activity.	0	57	100	75	50	40	63
VI	**Evaluation and selection of alternatives**							
1	Evaluation of a selection of alternatives in compliance with requirements during 'Alternatives research'.	100	100	100	100	50	80	100
2	Prioritization matrix is applied for selection of preferred alternative.	50	25	50	100	50	80	88
3	Standard tools are developed or purchased for evaluation of alternatives.	50	25	100	75	50	40	63
4	Other considerations.	0	25	50	0	50	20	63
5	Have internal or national guidelines or standards on alternative analysis and selection.	50	0	50	100	50	40	50
6	Have adapted new approaches, or plan to do so.	50	25	50	0	50	40	63
VII	**Design of selected alternative**							
1	Selected alternative is translated into a design for a project or other activities.	100	100	100	100	50	80	100
2	During design, policy to implement active control on the distribution network is adapted.	50	60	100	100	50	80	63
3	Selecting a group of network components for remote or automated control is a design precondition.	50	80	100	100	50	80	88
4	Automation of voltage control at high voltage level is a design precondition.	100	25	50	100	50	80	88
5	Automation of voltage control at the medium voltage level is a design precondition.	100	80	100	100	50	100	100
6	Remote control at high voltage level is a design precondition.	100	25	50	50	100	80	75
7	Remote control at medium voltage level is a design precondition.	50	80	100	50	100	100	63
8	Remote control at low voltage level is a design precondition.	0	0	50	25	0	20	0
9	Have adapted new approaches, or plan to do so.	50	25	100	25	50	80	50

* The regional data in above table is based on received responses until February-2012.