Packaging R&D results for dissemination in the multi-actor, multi-technology field of Distributed Energy Resources

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There is an increasing interest for Distributed Energy Resources (DER), at political, economic, research and investment levels. Disseminating research results addressing the DER field at large implies to target various stakeholders with very diverse expectations. The dissemination methodology developed by Technofi allows packaging research results and designing coherent messages to be sent in a differentiated manner to the various audiences identified. This paper details the application of such methodology to the EU-DEEP project, combining a set of over 50 research results into a unified body of knowledge ready for dissemination to 9 classes of players. The paper concludes on the possible extension of the designed knowledge structure to the European DER research field and on the further use of the methodology in other research topics.

***Index Terms* — Information packaging, targeted dissemination of R&D results, multi-stakeholder research, Distributed Energy Resources, EU-DEEP Integrated Project.**

I. Disseminating research findings to the DER community at large: challenges

Distributed Energy Resources[4] (DER) have become a critical issue in today's society, touching either the politician, the energy industrial, the investor, the researcher, or the final energy consumer.

Indeed, the EU policy is now clearly supporting a more massive use of renewable energy resources and the improvement of energy efficiency, two objectives which DER can contribute to via a large spectrum of available technologies. DER is raising interest from governments, national or local institutions, new actors emerging from the electricity market liberalization process, investors perceiving the DER growth potential, as well as consumers, smoothly shifting their energy consumption behavior to take account of environmental concerns and economic gains.

Results from the research and demonstration activities led lately in the DER field are therefore of interest for all these stakeholders, even though each of them has a different perspective on the raised issues and expects different benefits from DER expansion.

Besides, research activities focusing on DER integration to the network can address a very wide spectrum of topics, reflecting the broad range of technologies addressed, but also the variety of technical, market and regulatory issues related to the deployment of such technologies. Quite illustrative of this diversity, the EC-supported EU-DEEP[5] research project on DER integration was one of the first so-called Integrated Project from the 6th EC Framework Programme, initiated by European utilities and aiming at the identification of fast tracks to overcome barriers impeding the development of DER. Driven by the need of a clear understanding of energy demand and grid impacts of decentralized energy resources, it covered the use of Renewable Energy technologies, cogeneration and storage systems, as well as smart metering, and active network management devices. Technical issues covered DER impacts on the network, network design rules for tomorrow, but also new network cost allocation rules in a world with more DER. Last, market and regulatory issues were also investigated, with a focus on the economic valuation of DER in the electricity market, the new services that DER can provide to the network, and the related regulatory framework to develop.

Making the results from DER research, whatever the topic addressed, available, interesting and, of use by the whole set of players mentioned above is a challenge. Disseminating R&D results to the DER community at large implies to deliver messages to a heterogeneous audience with various and specific interests, on a broad set of research topics.

II. Methodology for differentiated dissemination

The dissemination approach developed by Technofi is a generic approach that can be applied to different sectors presenting the characteristics of a multi-player, multi-technology framework. It addresses all types of research results, whether mere knowledge, methodologies, or tools.

The key point of the method consists of clustering the R&D results to be disseminated into a set of high-level messages, for one part generic to all types of audience, and for another part specific to the distinct interests of the various targeted

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4 Distributed Energy Resources are here defined as DER comprises distributed generation (DG), the storage of electrical and thermal energy and/or flexible loads. DER units are operated either independently of the electrical grid or connected to the low or medium voltage distribution level of the main network. They are located close to the point of consumption, irrespective of the technology, but are smaller than 10 MWe of electrical power.

[5] EU-DEEP, "The birth of a European Distributed EnErgy Partnership that will help the large-scale implementation of distributed energy resources in Europe", is an Integrated Project supported by the EC 6th Framework Programme on RTD, and completed in June 2009.

stakeholders.

The messages for dissemination can therefore be organized along three components with specific objectives:

- An introduction, aiming at presenting the context of research, the key challenges addressed and the approach adopted by the given research,
- A factual, analytical dimension presenting each individual R&D result valid for all players
- A player-driven section, based on the previous one, focusing only on the key messages to pass on to the different audiences targeted.

As a first step, the complete set of stakeholders to be targeted by the dissemination is identified. For each of them, the key challenges of the research carried out are formalized in order to design the introductory framework. Then, an overall structure is sought for to organize all the results into one single set of knowledge that proves coherent. Each individual research result is thus packaged according to a common format focusing on a few key items. The packaged results are assessed by adopting each stakeholder's point of view. Last, a set of high-level messages are build based on the previous "subjective" evaluations of results, providing differentiated messages to each audience.

Structuring the complete set of results into one single coherent body of knowledge is a critical issue. Results are first listed and organized both in the analytic and the synthetic organization of knowledge:

- Clustered per topic of knowledge according to the key high-level objective which they contribute to reach during the project
- Filtered according to the players' perspective.

This iterative process is requested to ensure a full consistency of the messages.

The systematic, analytical description of the individual results follows a common template that focuses on a limited number of items:

- A background to position the topic,
- The challenges addressed by the results,
- A summary of the result,
- Some references and contact information.

Adopting the different stockholder's perspectives, the packaged results are assessed according to their usability with regards to each audience. They are qualified according to three levels of usability:

- For information: the result has some interest limited to awareness for the given stakeholder,
- For implementation: the result is directly usable for implementation by the given audience, close-to-market,
- For further research: the result is not yet ready for implementation by the given audience, but is of great interest for further research efforts.

This evaluation allows highlighting, for each stockholder's class, the key results of interest. A high level message can then be designed for each target, embedding these key results.

III. Applying the dissemination methodology to the EU-dEEP project results

A. The EU-DEEP project

Initiated by eight European utilities, EU-DEEP was a research and development project coordinated by GDF-SUEZ. This five and half -year project, supported by the European Commission Sixth Framework Programme for Research and Technological Development, was completed in June 2009. It gathered 41 organizations to address the technical, market and regulatory challenges and solutions required to massively integrate DER into the existing electricity networks. The EU-DEEP consortium included organizations such as utilities, manufacturers, research centres & academics, business developers, investors and regulators.

The overarching goal of EU-DEEP was to design, develop and validate an innovative methodology, based on future energy market requirements, and able to produce innovative business solutions for enhanced DER deployment in Europe by 2010. The scientific ambitions of the project were to address the removal of the above barriers by providing solutions based on a demand-pull approach:

- Innovative business options to favour DER grid integration, by investigating three business models using the aggregation concept,
- An in-depth understanding of the effect of large penetration of DER on the performances of the electrical grid system and on the electricity market,
- Market rules recommendations to regulators and policy makers that support the three studied aggregation routes.

B. Dissemination challenge

The project brought over 50 results including methodologies, tools, and recommendations covering the four above-mentioned items, produced by partners ranging from academics to industrials, from national energy agencies to investors.

An overall coherence was required to combine the amount of individual results into a single, unified, and organized set of knowledge ready for dissemination towards a wide range of targets reflecting the diversity of the project partner profiles.

The following sections will focus on the first step of the dissemination methodology as applied to the EU-DEEP project, i.e. the identification of the targets and the construction of a unified body of knowledge.

C. The targets identified

The EU-DEEP project addressing in parallel some economic, technical, market and regulatory issues, a list of nine dissemination targets was identified:

1. Policy makers
2. Regulators
3. Transmission System Operators (TSO)
4. Distribution System Operators (DSO)
5. Electricity producers and retailers

6. Manufacturers
7. Investors
8. Electricity consumers and energy facility managers
9. Research community and research funds.

D. Result organization around three research objectives

The knowledge produced was differentiated into three types and organized along three high-level objectives:

	Knowledge type	Objective of the knowledge
1	Knowledge consistent and robust enough to support a sustainable DER expansion	Create the necessary conditions for sustainable DER expansion
2	Knowledge gained by exploring DER aggregation profitability in three business cases	Explore DER aggregation businesses
3	Integrated knowledge for further technical research and business investigation.	Propose recommendations and referenced knowledge

To give an illustrative aspect to this overall knowledge structure, the image of a temple was used as a backbone, each of the three knowledge types representing a part of the building. Respectively, knowledge type 1 constitutes the foundations, knowledge type 2 the pillars, and knowledge type 3 the roofing of the temple, as shown below in Fig 1.

Fig. 1. The Temple image used to represent the overall knowledge structure.

E. Structuring further the "Foundation" knowledge

What is regarded as "foundation knowledge" is the knowledge consistent and robust enough to support a sustainable DER expansion. This means, the research results that help create the necessary conditions for sustainable DER expansion.

This "foundation knowledge" was further organized according to six different domains covered by the related results:

- T: Technical knowledge,
- E: Knowledge related to the energy value of DER,
- N: Knowledge related to the network value of DER,
- S: Knowledge related to the service value of DER,
- A: Knowledge related to the aggregation as a way to optimize the DER values,
- TESTS: Validation brought by field tests on the previous domains of knowledge.

The technical knowledge aims at answering the following question: ***How to determine and improve the DER hosting capacity of the electric system?***
Answers deal with impacts of DER integration on existing and future grids as well as the consequences of different modeling and analysis approaches. Integration addresses system design issues and system operation issues.

The next three domains of knowledge (the E, N, S previously mentioned) address the three types of values that can be brought by DER:

- Energy value: consists of selling energy, whatever its type: electricity, heating or cooling,
- Network investment saving value: DER can, to a certain extent, be considered as a substitute for network investments,
- Supply of ancillary services: when aggregated, DER can provide additional services.

On these three DER values identified, the research results aimed at answering the following questions:

- ***E: How can demand analysis and modeling approaches help setting up profitable DER units?*** Answers deal with energy value capture and monitoring based on consumer needs and acceptance at using DER units: this in turn leads to market segmentation and market areas where DER can bring an energy value including the flexibility of the end-user.
- ***N: How to unveil the value of DER as network replacement?*** Once connected, DER can bring value to the distribution network, helping for instance a DSO face issues such as network expansion.
- ***S: Which services can DER bring to the system?*** Once aggregated, DER units may contribute to the electric system. For instance, when incidents occur, TSOs could call for generators and consumers directly connected to the network to modify very rapidly their generation or consumption patterns[6].

The next domain of "foundation knowledge" gathers the results that explored the aggregation concept, assuming that non-integrated DER cannot capture the full potential of the above mentioned streams of revenue. Aggregation allows the integration of local DER into the global dynamics of the markets. The related results explore ***Aggregation as a way to optimize the three different DER values*** detailed above (energy, network, and service values).

[6] It is noticeable that, recently, regulators have been addressing cross-border TSO balancing procurement rules between France, UK and Ireland

The last domain of knowledge defined within the foundations deals with ***the five field experiments*** that allowed the knowledge developed in the T, E, N and S domains to be confronted with reality, and to test and validate some of the tools and methodologies developed.

F. Structuring further the "Pillar" knowledge

The results grouped within the "pillars" aim at exploring DER aggregation businesses. In practice, the profitability of three different business models was studied in-depth:

- Business model I: Aggregating commercial and industrial demand response to balance intermittent generation
- Business model II: Integrating residential scale flexible Micro-CHP into electricity markets
- Business model III: Leveraging on the flexibility of aggregated CHP units and demand response to extend the conventional Energy Service Company business

The results of the profitability assessment were structured in 5 layers for each business model:

1) The business idea: a fine description of the business model idea, of the stakeholders involved, of the relationships and flows between stakeholders, and of the sources of value created.

2) An application case in one country, validated through experiments. Each business model has been developed in one specific local context (UK, Belgium, and Germany). Using the tools developed in the project, the opportunities offered by the local market and regulatory context are investigated. The demand of a specific portfolio of end-users is analyzed to value its flexibility. The aggregation of load flexibilities and distributed generation means is simulated. The resulting economic evaluation is confronted to real experiments.

3) A sensitivity analysis of the local business plan to the key parameters influencing profitability

4) The expansion of the business model to different countries. Five European national contexts were studied in detail (the UK, Germany, Greece, France and Spain).

5) The projection of the business model in different futures: four scenarios for the future energy landscape were designed to "test" the business models according to varying key business parameters. Three main drivers that will shape the future energy policy in Europe were considered: market competitiveness, CO2 reduction, and security of supply. For the first three scenarios, one driver is prevailing over the two others, while the fourth scenario is an intermediate one.

G. Structuring further the "Roofing" knowledge

The Roofing refers to the knowledge gained through the efforts of integration of all other project results. They include recommendations for future large-scale experiments, on network design and regulation, as well as on standardization issues.

In practice, these results can serve in the future to develop further technical research and business investigation.

H. Complete knowledge building

In total, 56 individual results were organized in the so called "knowledge building" structure show in Fig.2. Each result is referred to as a knowledge block.

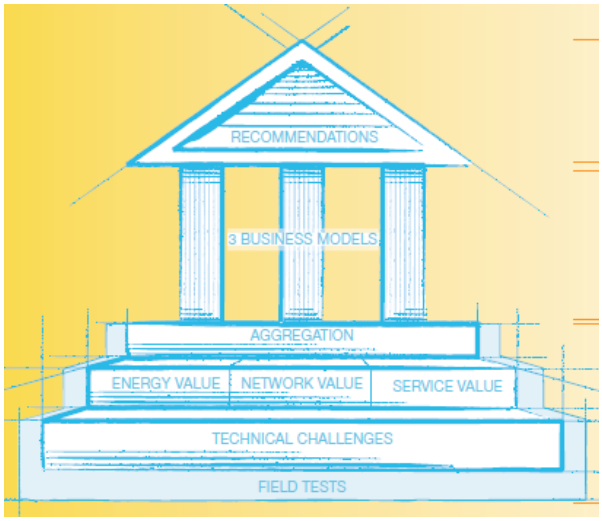

Fig. 2. Detailed structure of the knowledge building of EU-DEEP..

IV. Final Dissemination Book

Within the knowledge domains described above, each individual results (or knowledge blocks) was assessed as presented in the methodology, i.e. according to the different stakeholders' perspective, and in terms of usability of results, from 'information' level to 'direct application' level. Such qualification of the results allowed building synthetic, high level messages to the different targeted audience.

The complete dissemination tool developed therefore includes 1) an introduction to DER integration challenges and EU-DEEP research orientation, 2) the analytical description of 56 knowledge blocks and 3) synthetic messages adapted to the specific interest of each targeted audience.

This formalization allows a reading by different entry, either generic and analytical, or audience-specific.

A website has been developed under the same format (www.eu-deep.org) and displays the resulting body of knowledge..

V. Conclusions

The structure developed within EU-DEEP to package all project results so as to ensure their wide dissemination is generic enough to cover most issued addressed by the research initiatives on DER integration issues. It organizes the main R&D topics investigated around a Temple structure divided in three building components:

- Foundations, gathering the knowledge developed to create the necessary conditions for sustainable DER expansion,

(Paper published on April 15th 2008), which shows that such markets will grow in the coming years.

- Pillars, focusing on the knowledge explore DER aggregation businesses, and
- A Roofing, bringing together the proposed recommendations and referenced knowledge.

It also provides several complementary levels of reading, from a generic, analytical description of results, to a set of 9 synthetic messages targeting specific classes of stakeholders interested in DER integration.

This structure could therefore be used further to present and position the results of current and coming European RTD projects on DER integration, by adding new knowledge blocks to the EU-DEEP Temple. For instance, new findings on aggregation business models, such as results from the FENIX project on Commercial Virtual Power Plant, could be regarded as new "Pillars" reinforcing the knowledge building. In the same way, the future results of the GROWDERS project investigating DG and transportable storage use for network reliability could strengthen the "Foundation" of the Temple. With regards to the "Roofing", the coming recommendations of the SOLID DER project about consolidation of the European DER research may constitute additional bricks of knowledge.

On a methodological standpoint, the approach developed can serve as a tool for scientific dissemination in any other multi-actor framework than DER. It has been already used in the mechanical engineering field for technology roadmap building exercise. It is particularly adapted when the field of knowledge is characterized by a) multiple technologies with a high level of expertise b) cross cutting technologies with transversal perspectives c) multi players game with established stakeholders and new entrants d) evolving regulatory framework due to new customer behavior, new technologies or new businesses. First, the method developed enables to build up a coherent body of knowledge providing a fine and objective description of all research findings. Then in parallel, it allows delivering specific messages to the different types of actors to be targeted by the dissemination. Within EC supported projects, it could guide the partners to elaborate their plan for use and dissemination of knowledge.

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VII. References

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VIII. Biographies

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