IEA Implementing Agreement on Demand Side Management Technologies and Programmes

Task XVII

Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages

Definition of the Task extension: Draft 4.0

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1 Motivation

Energy policies are promoting distributed energy resources such as energy efficiency, distributed generation (DG), energy storage devices, and renewable energy resources (RES), increasing the number of DG installations and especially variable output (only partly controllable) sources like wind power, solar, small hydro and combined heat and power.

Intermittent generation like wind can cause problems in grids, in physical balances and in adequacy of power.

Thus, there are two goals for integrating distributed energy resources locally and globally: network management point of view and energy market objectives.

Solutions to decrease the problems caused by the variable output of intermittent resources are to add energy storages into the system, create more flexibility on the supply side to mitigate supply intermittency and load variation, and to increase flexibility in electricity consumption. Combining the different characteristics of these resources is essential in increasing the value of distributed energy resources in the bulk power system and in the energy market.

IEA has several Implementing Agreements dealing with distributed generation (DG) (such as wind, photovoltaic, CHP), energy storage and demand side management (DSM). However, the question of how to handle the integration of various distributed energy resources is not actually studied.

This Task is focusing on the aspects of this integration.

2 Objectives

The main objective of this Task is to study how to achieve a better integration of flexible demand (Demand Response, Demand Side Management) with Distributed Generation, energy storages and Smart Grids. This would lead to an increase of the value of Demand Response, Demand Side Management and Distributed Generation and a decrease of problems caused by intermittent distributed generation (mainly based on renewable energy sources) in the physical electricity systems and at the electricity market.

Thus the integration means in this connection

- how to optimally integrate and combine Demand Response and Energy Efficiency technologies with Distributed Generation, Storage and Smart Grids technologies, at different network levels (low, medium and high voltage)

- and how to combine the above mentioned technologies to ideally support the electricity networks and electricity market

The Task will provide the integration based solutions and examples on successful best practices to the problems defined above to the different stakeholders.

3 Approach

The first step in the Task was to carry out a scope study collecting information from the existing IEA Agreements, participating countries with the help of country experts and from organized workshops and other sources (research programs, field experience etc), analyzing the information on the basis of the above mentioned objectives and synthesizing the information to define the more detailed needs for the further work. The main output of the first step is this state-of-the art report and the proposal for the future work to be carried out as a second step of the Task.

4 Main results of the scope study

4.1 Outputs

The following public reports were produced during the first phase of the Task:

- Task XVII - Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages - Final Synthesis Report vol 1. December 2008 (http://ieadsm.org/Publications.aspx?ID=18)
- Task XVII - Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages - Final Synthesis Report vol 2. (http://ieadsm.org/Publications.aspx?ID=18)

Vol l. includes the main report and Vol 2. is the annex report with detailed country descriptions, analysis tools etc. These reports are available at the IEADSM-website.

Two public workshops were also arranged in Petten and in Seoul. The presentations can be found from web-site: (http://ieadsm.org/ViewTask.aspx?ID=16&Task=17&Sort=0)

In spite of these public reports the secure web-site includes the answers to questionnaires of the experts and descriptions of about 50 case studies.

4.2 Main findings

4.2.1 Overview of the situation

The main topics discussed in the final report are DER and electricity supply, flexibility in electricity demand, communications and IT, integration analytics, regulation, policy and business opportunities as well as market in participating countries.

4.2.2 Pilot case studies

More than 50 case studies, experiments and research projects in the participating and some other countries have been collected and categorized.

Although a general conclusion of the case studies is difficult, some elements can be pinpointed:

Most of the case studies are still in research, pilot or field test level and only very few were actual business cases. Integration technologies with different characteristics exist; metering and communication technology are still expensive to install and maintain, optimization algorithms for aggregated portfolio exist but are not public available yet, market rules which allow the integration of different generation units - especially aggregation of production and consumption – differ between countries.

4.2.3 Concluding remarks

As a conclusion of the analysis it can be said that the increased penetration of DG as well as the technology and market developments result in

– new roles of the different stakeholders meaning new business environment and possibilities; on the other hand new tools are also needed in this new business area,

– metering and ICT technologies are developing rapidly,

– the above development will result in new products, services and pricing policies which can activate the more deep participation of final consumers in the market

Successful integration means that different technologies in supply and demand side as well as in ICT are developed to the level where their integration is feasible both technically and economically and that regulation, policy and market give the successful framework for the integration.

The table below gives the summary on the situation of integration on the basis of the analysis and expert group opinions. For each item, the experts have agreed on a status among the following:

- Early: R&D
- Young: Pilots / Field tests
- Existing: Available, at least one vendor; early adopters involved
- Mature: Widespread commercial

Electricity supply	**Fossil fuel based technologies** ▪ fuel cells ▪ micro chp ▪ conventional chp	 Young Existing Mature
	Renewables ▪ Wind ▪ pv ▪ small hydro ▪ waves, tidal ▪ biomass	 Mature Existing/Mature Mature Young/Mature Young/Mature
	Renewable production forecasting	Young/Existing
	Electrical energy storage ▪ energy management ▪ bridging power ▪ power quality	 Young/Mature Existing/Mature Early/Existing
	Economic dispatch, SCUC software	Mature
	Resource planning techniques, tools	Mature
	Real-time grid operation tools	Mature
Electricity demand	**Many DSM techniques**	Mature
	Automated DR devices	Young
	Pricing granularity (smart rates) ▪ Small customers ▪ Large customers	 Early Existing
	Consumer response and production	Early

Communication, control and monitoring	**Communication networks**	Mature
	High-speed digital monitoring ▪ Generation ▪ Transmission (EU) ▪ Transmission (USA) ▪ Distribution	 Mature Mature Young Early
	Smart meters deployment	Young/Existing
	Cyber-security	Young/Existing
	Interoperability	Existing
	Functional Automation/Monitoring ▪ for large assets ▪ for DER	 Mature Young
	Intelligence/Smart behaviour	Young
	User/primary process feedback	Young/Existing
	Intelligent agents and distributed controllers	Young
	Communication semantic and content	Young/Existing
Integration analytics	**Modelling electricity system impacts**	Young/Existing
	Understanding relative costs and benefits	Existing
	Controlling and coordinating parts	Young
	Good, real data	Early / Young
Regulation, policy and business	**How to capture benefits**	
	Incentives and subsidies	
	How to pay for everything	
	Taxation	
	Aggregator business	Young/Existing

Table 1. Summary of the status of integration.

4.2.4 Ideas for the future work

On the basis of the analysis, it was noted that there are needs for the future work inside this Task XVII. Especially topics which are at the level of young/existing give possibilities to mutual development and sharing experiences.

The expert group selected a list of interesting topics, out of which the most supported ones were

- **Future needs for better metering and better data across the system (prices etc).** The slow spread of advanced meters that allow customers to participate in ToU rates and sophisticated demand response offerings is an obstacle as well as the lack of widespread dynamic rates and price signals to reveal to customers the value of electricity across time and place

- **Quantitative effects of DER penetration into existing power systems, for.ex electric vehicles, heat pumps; understanding costs and benefits of different stakeholders**

- **Comparison of best practices and recommendations on national level**

In addition, there were some other topics which might deserve further development, such as

- How much does the early status of high-speed monitoring especially at distribution level hold back the system's evolution? Where are the best benefits?
- More detailed analysis of the Integration analytics and ICT to see how much they delay the integration of DER?
- Power quality questions related to DER, positive and negative effects of DER to the power quality, improvement of power quality management
- Isolated systems: islanded systems in rural areas and on islands, islanded operation of network connected systems (microgrids and larger islanded subsystems)
- Increasing of predictability of generation and demand (forecasting also consumer response)
- Market design aspects: analysis of the effects in different countries, interoperability between countries and regions
- Potential surveys of DER
- Legal frameworks to DER
- Guidelines for the interoperability
- Rate design and applications of incentive schemes for installing DER
- Aggregator business analysis, comparison and development
- Customer behaviour and response to price-responsive demand response options.

It was decided that the topic related to the assessment of the effect of DER penetration to the costs and benefits of different stakeholders and the whole system will be further elaborated by the Operating Agent.

5 Subtasks of the Task extension

As mentioned above, the main topics of the Task extension is to assess the effects of the penetration of emerging DER technologies to different stakeholders and to the whole electricity system. The emerging DER technologies to be discussed include

- plug-in electric and hybrid electric vehicles (PEV/PHEV)
- different types of heatpumps for heating and cooling
- photovoltaic at customer premises
- micro-CHP at customer premises
- energy storages (thermal/eletricity) in the connection of previous technologies
- smart metering

– emerging ICT

– Other technologies seen feasible in 10 – 20 years period, especially by 2020.

The main Subtasks are (in addition to Subtasks 1 – 4 of the phase one):

Subtask 5: Assessment of technologies and their penetration in participating countries

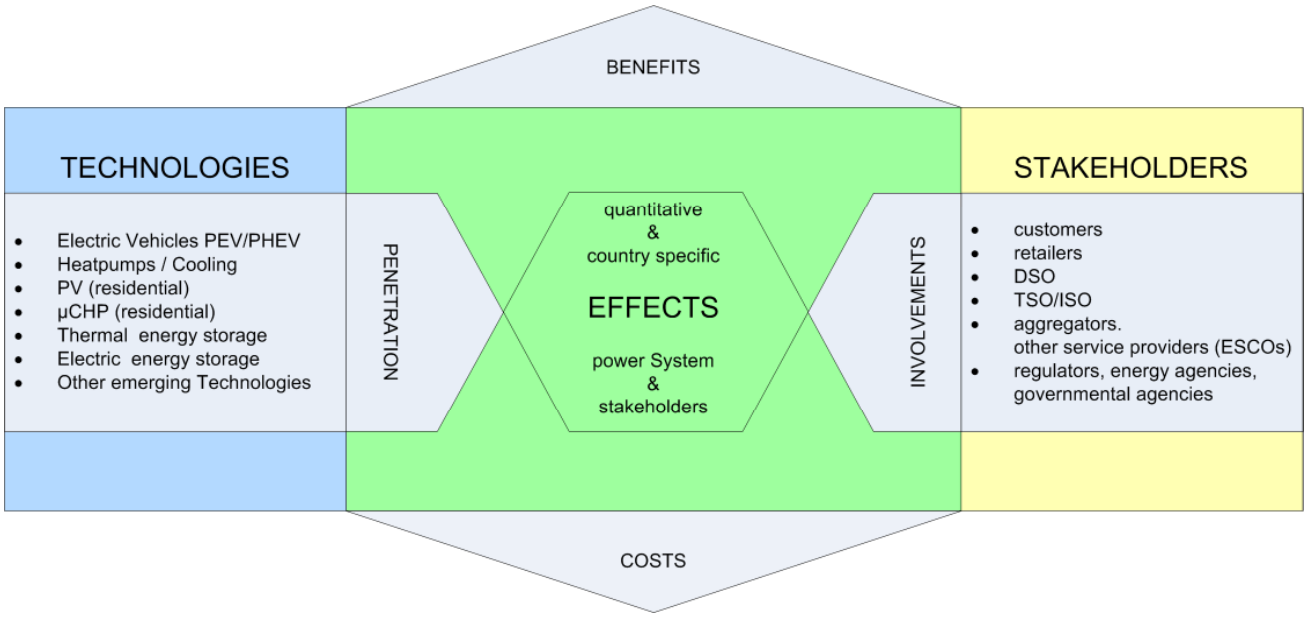
Subtask 6: Pilots and case studies

Subtask 7: Stakeholders involved in the penetration and effects on the stakeholders

Subtask 8: Assessment of the quantitative effects on the power systems and stakeholders

Subtask 9: Conclusions and recommendations

The figure below describes the concept of this extension. The more detailed descriptions of the subtasks is given below



5.1 Subtask 5: Assessment of technologies and their penetration in participating countries

Assessment of technologies:

Operating Agent produces a general description of each technology and the foreseen technological development. The specific features related to each technology will be described like

– typical load/generation curves

– control possibilities and flexibility related to consumption/generation

– metering technologies

– what kind of services the technology can produce to different stakeholders (ancillary services etc)

Country experts review and add country-specific features like

– what kind of heating and cooling systems are used in existing and new buildings with heat pumps, what kind of control technologies can be used

– what kind of infrastructures are planned/available for charging of electric vehicles (at homes and at public places, oneway-twoway systems, metering and billing, restrictions at networks/network connections etc)

– what kind of DG technologies are seen feasible at customer side in 10 – 20 years.

Penetration of technologies

Each country experts produces scenarios on the penetration and market shares of technologies in their market/networks in 10 – 20 years and especially by 2020. OA produces comparisons and general views.

Output of Subtask 5: technology and penetration report

5.2 Subtask 6: Pilots and case studies

To continue the collection of information from pilots, case studies and demonstrations staretd in Phase 1.

5.3 Subtask 7: Stakeholders involved in the penetration and effects on the stakeholders

Involvement of different stakeholders

Description of stakeholders involved in the penetration of technologies. Stakeholders include at least

– customers

– retailers

– DSO

– TSO/ISO

– aggregators and other service providers like ESCOs

– regulators/energy agencies/governmental agencies

What kind of incentives, pricing, market rules and regulation are used? What kind of business models can be used and what are the transactions between stakeholders? Country experts produce the country-specific descriptions and OA synthesis and generic descriptions.

Effects on the stakeholders

Description of the effects of the penetration of technologies on the stakeholders (both qualitative and quantitative (measurable) effects)

- costs (operational and investment costs), what are the main factors effecting on the costs like load curves, penetration levels etc.
- benefits: income, business possibilities etc.
- what are the alternatives to increase benefits/decrease costs (like intelligent charging of PHEVs, selling services to system balancing etc.)

Stakeholder workshop will be arranged in the connection of expert meeting to get feedback from the stakeholders

Output of Subtask 6: report and workshop presentations with summary

5.4 Subtask 8: Assessment of the quantitative effects on the power systems and stakeholders

Assessment tools and methods

Collection of tools and methods used for quantitative analyses (done by OA and experts). Assessment of tools and methods. Examples from the literature

Country specific case studies

Country experts collect information on the case studies on the analysis of the effects of the penetration of technologies and on the main findings how these technologies can help to decrease problems caused by variable output generation in power systems. Comparison of the results with the penetration scenarios of Subtask 5.

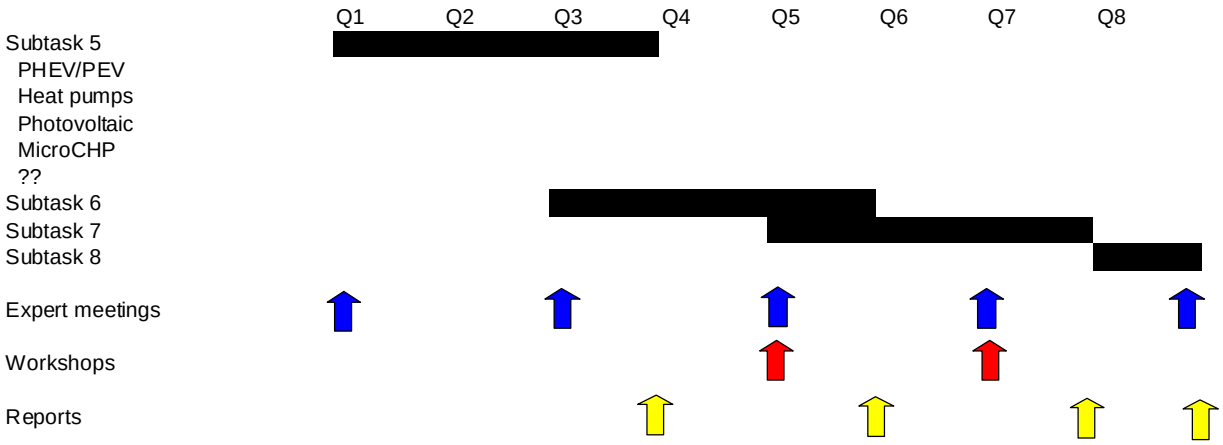
Open workshop with stakeholders will be arranged on case studies and to get feedback on the preliminary findings of the Task

5.5 Subtask 9: Conclusions and recommendations

Final report of the Task

6 Time schedule

The total length of the Task is 2 years starting in the beginning of March 2010.



7 Task deliverables

The main deliverables are

- Subtask reports and final report
- Workshop proceedings

8 Estimated resources needed

Operating Agent

Personnel costs (12 person months)	174000 €
Travels and workshops	21000 €
Total	**195000 €**

The costs are divided into 2 years evenly

Costs are divided evenly between participating countries. Costs per country depend on the number of participants according the table below.

Annual costs per country (€)	**2010**	**2011**	**Total**
4 countries	16250	32500	48750
5 countries	16250	22750	39000
6 countries	16250	16250	32500
7 countries	16250	11607	27857
8 countries	16250	8125	24375

Country experts

Estimated input of the country experts is 2 person months