DSM Task XVII – Phase 3 – Definition Proposal

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

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1 Introduction

The aim of this task is the exchange of experiences and knowledge transfer on integration of demand side management (DSM) and demand response (DR) in residential and commercial buildings in order to achieve optimal embedding of renewable energy resources in electricity networks and markets. In the framework of this project, the role of available technologies like PV systems, electric vehicles, electric and heat storage systems, heat pumps, micro-CHP in combination with energy management systems and smart meters for implementing dynamic tariffs will be assessed.

Besides, the existing experiences of conducted and ongoing pilot projects which combine these aspects will be analyzed and discussed. The application and realization of executed projects in participating countries with respect to the specific regional differences and requirements are in focus.

Phase 3 of IEA-DSM Task 17 will address the current role and potential of flexibility in electricity demand and supply of systems of energy consuming/producing processes in buildings (residential, commercial and industrial) equipped with DER (Electric Vehicles, PV, storage, heat pumps, ...) and their impacts on the grid and markets. The interdependence between the physical infrastructure of grid and the market side will also be looked upon. The scalability and applicability of conducted and ongoing projects with respect to specific regional differences and requirements will be explored.

Phase 3 has been preceded by two prior phases, where VTT was the operating agent.

1.1 Phase 1

Subtask 1: Information collection on the characteristics of different types of DER in the integrated solutions
Subtask 2: Analysis of the information collected and preliminary conclusions (state of the art)
Subtask 3: Feedback from the stakeholders: Workshop
Subtask 4: Final conclusions and the detailed definition of the further work

1.2 Phase 2

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 of phase 2

2 Phase 3

2.1 Scope

Renewable energy resources are increasingly integrated in distribution grids and increasingly pose challenges in keeping the market and the grid balanced at any moment in time. The aim of this task is the exchange of experiences and developments in the field of this embedding, focusing on distributed and dispersed renewable energy generation resources and flexible demand in homes and buildings. Technologies like PV systems, smart electric vehicle (EV) charging and discharging, optimization of electricity storage and of operations of heat pumps and (micro)-CHP, in earlier phases explored from a technological point of view, will be considered in relation to energy management systems and energy services. Furthermore, utilization of the smart metering infrastructure is considered as a enabler/provider of dynamic and real-time tariffs. The smart meter allows taking small consumers out of standard profiles that currently socialize market effects to one aggregated profile for a large number of customers instead of to individual profiles allowing much stronger incentives for demand response than current tariff schemes. These smart meter based allocation and short term reconciliation schemes expose small customers directly to the electricity market and reward them for their flexibility. In task 17, existing experiences of pilot projects which combine these aspects will be analyzed and discussed. The application and realization of successful projects in participating countries with respect to the specific regional differences and requirements are in focus.

2.2 Stakeholders

In the residential and commercial sector, the maximization of the local use of renewable energy will be more and more important. Variable output dispersed resources like PV and wind pose balancing problems at a commercial and physical distribution grid levels in the grid. The flexibility and the adaption to dispersed and distributed generation is an increasingly important factor for successful integration. Heat pump boilers, heat pumps and electric vehicle charging units have a high demand response potential. Additionally, if they are operated from renewable electricity, they decarbonize the fossil fuel and the transport sector considerably. Alliances for intelligent demand response are currently being formed (openADR, Flexible Power Alliance, …) As an example, for regarding EV-integration there are fast developments in the standardization (CEN/CENELEC/IEC) and in the electric energy economic market (e-laad.nl, www.amp.at). Analysis of stake holder roles will compared for unbundled and bundled market environments.

The following stakeholder categories are discriminated and their mutual interactions are analyzed:

- *Aggregators and service providers(ESCOs, communities)* These are increasingly seen as essential enablers for realizing the required balancing functionality
- *Retail and commercial customers.* Cost and benefits of different home / smart energy management systems for integration of smart grid technologies (PV, EV, ES, HP) in the international context are analysed. Independent recommendations, as well as functionalities will be described.
- *Industrial customers in a B2B-setting.* Building and process industry interface schemes and developments to overcome current, specific technology barriers. Evaluation of transnational standards for interoperability (e.g. grid connection of building management systems, charging infrastructure of EVs in office buildings). The CEN/CENELEC developments will be closely followed and evaluated.
- *Decision makers regarding new regulation schemes and market designs.* What measures und political framework could form the basis for various penetration scenarios of DR and DG technologies. How can the development of suitable market solutions for participation and integration of various technology solutions be supported. How can support of business models for aggregators (“mobility provider”) or local market participation of customers be grown.
- *Network operators.* What are solutions for utilities to deal with future impacts of DERs, based on the collected best-practices and pilot projects (e.g. black-start supporting heat pumps, controlled charging of EVs)
- *Retailers.* Currently the first generation of smart meter linked HEMS, CEMS systems have been delivered to tens of thousands of retail customers. Being targeted as a gadget, these ‘early adopter’ systems have led to more feedback, but not yet contributed to significant value creation.
- *Traders and balance responsible parties.* With the increasing number of small generation systems at customer’s premises, keeping the balance in the portfolio with fixed-profile customers is becoming a problem for traders.

2.3 Task subdivision

The following subtasks further structure the activities to handle this emerging DG-RES and demand side challenge:

Subtask 10: Role and potentials of flexible consumers/producers (households, communities and buildings)
Subtask 11: Changes and impact on grid and market operation
Subtask 12: Sharing experiences and finding best practices
Subtask 13: Conclusions and recommendations

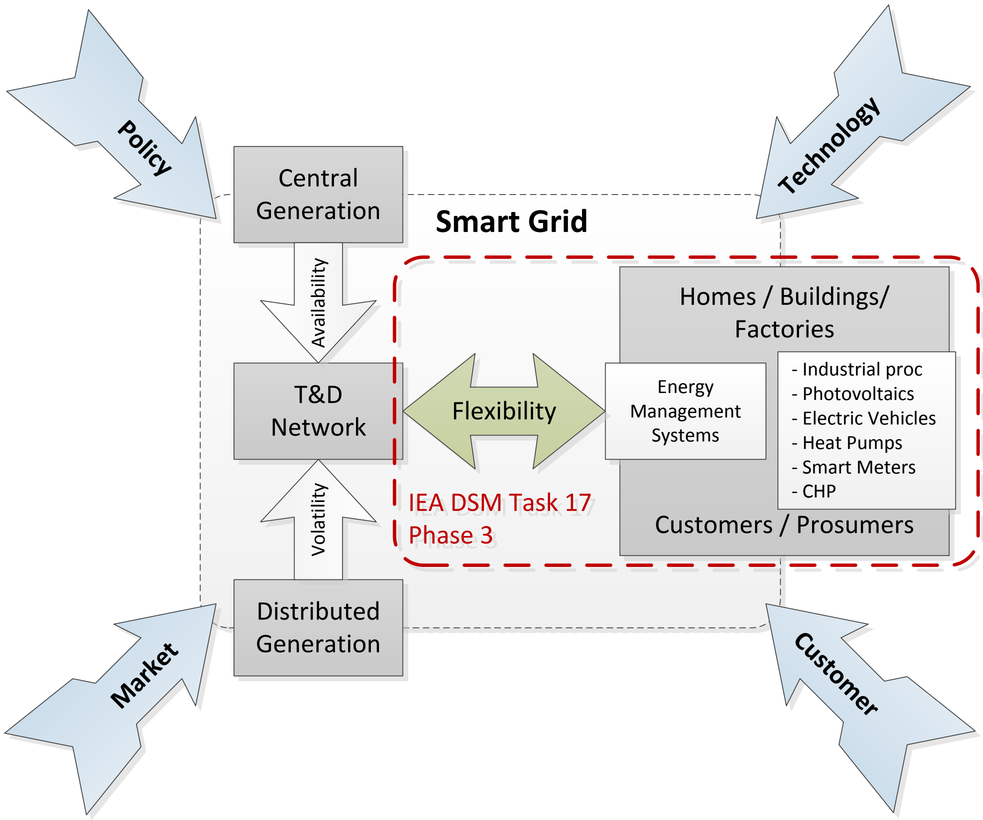

Figure 1 Focus of the IEA DSM Task 17 Phase 3 on enabling the consumption and production flexibility consumption

Figure 1 gives an overview of the focus of the Phase 3 of IEA-DSM Task 17. The arrows indicate the focus points of the task.

Figure 2 and Figure 3 show the conceptual model of the Smart Grid Interaction Point (SGIP) proposed by the CEN-CENELEC-ETSI Smart Grid Coordination Group. The SGIP is the interface of the customer with the grid and market. The requirements and specification of SGIP are essential for the interaction with the various functions and business models in the smart grid, e.g. demand response, ancillary services and metering.

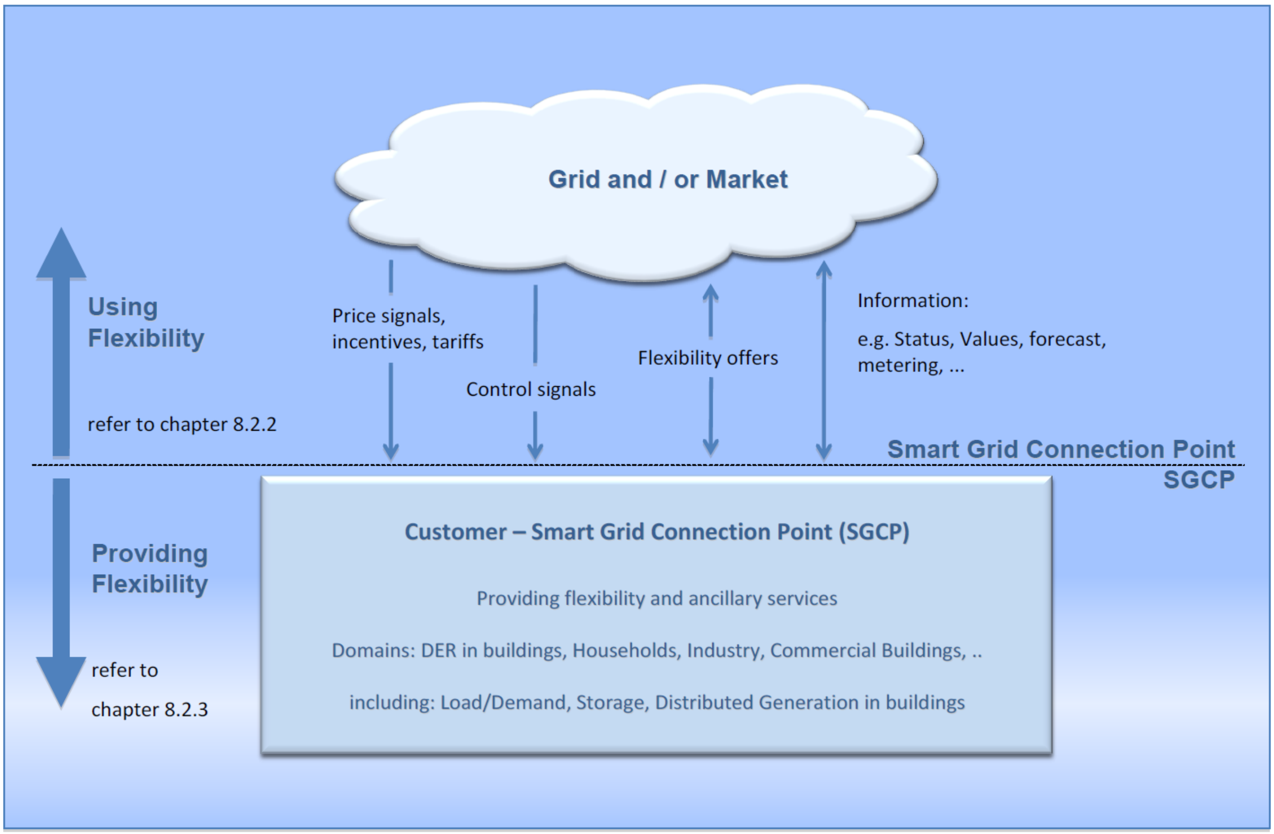

Figure 2 Providing network user's flexibilities - Smart Grid Connection Point – conceptual model (CEN-CENELEC-ETSI Smart Grid Coordination Group – Sustainable Processes) [1]

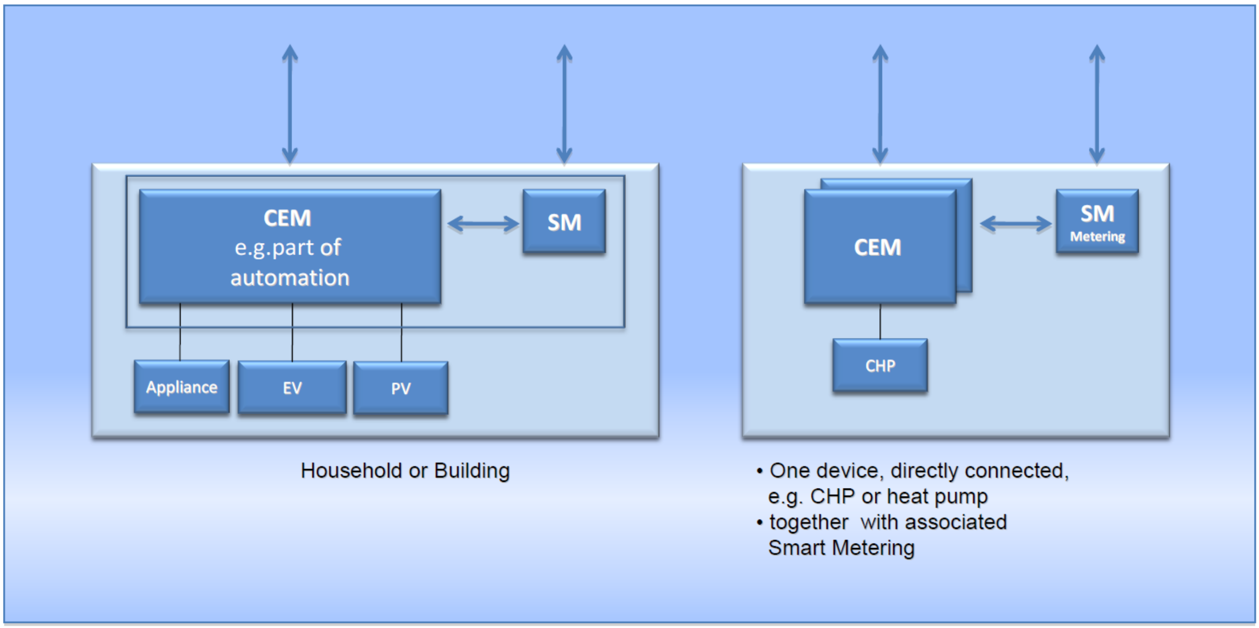

Figure 3 Examples for Customer Energy Management (CEM) configurations (CEN-CENELEC-ETSI Smart Grid Coordination Group – Sustainable Processes) [1]

2.4 Subtask 10 – Current role and potentials of flexible consumers/producers (commercial segment, households, communities and buildings)

Apart from traditional players in the energy field, also energy communities and energy suppliers in new roles as energy service companies are coming up as stakeholders in the market. The regulatory and market design frameworks in different countries as well as the physical topology of the transmission and distribution networks differ considerably on a country-by-country basis. Therefore, barriers and opportunities also differ on a per-country basis. From the policy point of view currently there is a strong momentum for harmonization; from the technical point of view standardization processes are enforced. In this context, the introduction of the ICT-enabled communicating meter for retail consumers can be seen to not only to lead to increased possibilities to provide consumer/prosumer feedback, but also allows for actively monitoring electricity usage and production by stakeholders to optimize operation from a market or electricity distribution point-of-view. Instead of a very loosely-coupled role for retail customers in the market, receiving one overall yearly bill based on a fixed tariff, virtually without any incentive for honoring demand response, a smart meter allows a more direct exposure of this customer category to the commercial electricity market and value creation as an asset in the operation of the physical grid infrastructure becomes possible.

Objectives of the tasks

Assess the concepts and implementations of customer and home energy management systems (CEMS/HEMS), possibly linked to the smart meter, in different (participating) countries by:

- Comparing DR and DG specific requirements in households, communities, functional (office) buildings and industrial processes
- Role of Smart Meters (SM), (CEMS/HEMS gateways) and their interaction with flexible demand/supply devices as well as distributed energy resources in the terms of technical concepts
- Role of telemetry and existing process control systems and their interface to the HEMS or SM
- Evaluating strengths and weaknesses of ICT enabled aggregations of flexible demand and controllable DERs in the form of energy communities

Technologies:

In order to enable implementation of demand response, demand side management and controllable DERs, existing functionality and requirements of SM and CEMS according to the specifications (EU mandate M/441 on interoperability of electricity metering to increase consumer feedback; implemented in a country specific ways) will be analyzed regarding the following aspects:

- What are the local levels of balancing / local markets of the generated power/energy in relation to the consumption specific to country or control zone linked energy markets
- How is controlled charging and discharging of EV enabled
- How is integration electrical storages and heat pumps achieved
- The extent into which they support aggregation to participate in markets and grid operation.

Country Experts input:

Country experts are requested to provide specific information about ongoing work (regulatory, or research) on functional requirements for CEMS platforms in conjunction with smart meters and the utilization of CEMS for market and grid purposes. Together with the country experts, innovative applications in projects and pilots will be projected to future developments by discussing penetration scenarios based on previous subtask 5, conducted in phase 2.

Operating Agent activities:

The operating agent provides a structured guided discussion and analysis of the country specific inputs. A methodology for generalized application and estimation of demand response potential in the future based on the provided data will be developed. As a result of the European M/490 EN Smart Grids mandate a SGAM (Smart Grids Architecture Model) has been set-up allowing a clear categorization of these roles in relation to one another.

Deliverables:

IEA-DSM-17.3.10: "Roles and potentials of providing flexibility in production/consumption using CEMS/HEMS systems"

The following activities are envisioned and their planning for the country expert and the operating agent (in person hours) is as follows:

Country Expert Activity	Hrs
EMS requirements in households and office buildings	16
SWOT analysis on the basis of re-assessing the extended project inventory	16
Energy balancing potential specific to country energy system	16
Technologies and role of smart meter i. r. t. CEMS/HEMS	32
Sum:	**80**

Operating Agent Activity	AIT/hrs	TNO/hrs
Compile and assemble requirements	24	8
Extend project database; compile SWOT analyses	32	8
Estimate balancing potential to grid functions in different countries	8	32
Assess technologies and smart meter role irt CEMS/HEMS	36	4
Interact with IEEE-workgroup in relation to CEMS/HEMS standard definition	24	4
Deliverable IEA_17_Phase_3.10	24	8
Sum:	**148**	**64**

2.5 Subtask 11 – Changes and impacts on grid and market operation

Currently, in a number of European countries, connection of large scale and DG-RES leads to problems on the electricity market (negative prices for electricity in case of massive Wind supply in periods of low consumption) and problems with Voltage level and stability (especially in rural areas with large PV-production and low local demand). Furthermore, substitution of energy transports and storage of gas and liquid fuels by electricity leads to capacity problems in existing electricity grids. Examples of the latter are EVs and heat pumps. This theme has been the subject of a number of national and international research projects. Also, on the EU-level and in the US, inventories of project portfolios have been made. The introduction of renewable energy resources in competitive energy market environments can be seen not to have the effects originally targeted. Goal in this subtask is combining all this information in a common methodology for deriving quantitative information on these issues and how the flexibility uncovered in subtask 10 can be utilized to counteract inefficiencies. Smart Grid technologies currently are in the infancy phase.
For software engineering in the 70s by the Carnegie-Mellon institute a Capability Maturity Model (CMM) was defined, which was used very extensively in the industry as a yardstick for measuring the software process in an organization. Recently, a similar initiative for assessing the introduction of Smart Grids has been developed, which is also used in ISGAN. Therefore, a link to the work done in ISGAN using the SGMM (Smart Grid Maturity Model) is foreseen.

Objectives:

Assess the impact on grid and market operation based on technology penetration scenarios developed in subtask 5 and 9 (developed in phase 2) by investigating the following areas of interest:

- Energy balancing possibilities and potentials for commercial and grid operation optimization objectives of CEMS.
- Optimization potentials from a technical and market point of view using the SGAM framework
- Design a methodology to estimate potential and to cost effective activation in-line with SGAM and SGMM.
- Regulatory and market design issues for grid and (local) market operations

Interaction:

How can CEMS be used by flexibility operators (aka. aggregators) for different services in offered on markets and for network operators?

- Impact on the grid operation (use of technical flexibility)
- Impact on the market (use of market flexibility)
- Use cases which are technically feasible but where optimization is necessary
- Requirements for establishing this grid operating and market mechanisms? – regulatory and legislative
- Installation and operation costs vs. delayed network investments.

Country experts input:

Provide data and information to support the analysis of the impact on grid and market operation. This should include information from distribution network operators, system operators, energy trading and market operators.

Operating agent activities:

Analyze the country specific information and summarize the information for general recommendations, also based on the quantified effects of subtask 8.

Deliverables:

IEA-DSM-17.3.11: "Financial and maturity assessment of technologies for aggregating DG-RES, DR and electricity storage systems"

The following activities are envisioned and their planning for the country expert and the operating agent (in person hours) is as follows:

Country Expert Activity		hrs
Collect grid operation use cases in project database		16
Collect market operation use cases in project database		16
Assessing the aggregator role and responsibilities in these use cases		24
Stakeholder cost-benefit analyses in pilot projects		32
Optimization potentials		16
Interaction with ISGAN as to regulatory and market design issues		8
	Sum	**112**

Operating Agent Activity		AIT/hrs	TNO/hrs
Extend grid operation use case database		8	24
Extend market operation use case database		8	24
Smart Grid maturity assessment of use cases		4	24
Contextual framework for cost-benefit analyses		16	32
Stakeholder cost-benefit analysis assessment		16	48
Interaction with ISGAN as to regulatory and market design issues		40	16
Deliverable IEA_17_Phase_3.11		16	24
	Sum	**108**	**192**

2.6 Subtask 12 – Analysis, sharing experiences and finding best practices

Objectives:

Based on the collected pilots and case studies from the previous subtasks, the results and findings of the finished projects in term of successful implementations, barriers and effectiveness will be analyzed.

- Lessons learned from existing pilots derived from workshops (e.g.; E-Energy Germany, EcoGrid-EU Bornholm, PowerMatchingCity-I and –II, NL-TKI, model city Salzburg, Amsterdam SmartCity, …)
- Innovation projects with large scale demand response in industry
- Comparisons and analysis of country specific differences in the implementation
- Assessment and development of a methodology to apply different demand response mechanism to individual countries.
- Extrapolation of the results from previous collected projects on applicability on a large scale.

Knowledge sharing (Country experts and operating agent):

- Successful DSM projects in International context and EU context.
- Knowledge and exchange of experience – best practices
- During workshops

Country experts input:

Provide data and information to support the analysis of the impact on grid and market operation of CEMS in current demonstration projects or research acticities. This should include information from distribution network, market and system operators.

Operating agent activities:

Analyze the country specific information and summarize the information for general recommendations, also based on the partly quantified effects of subtask 8 of phase 2.

Deliverables:

IEA-DSM-17.3.12: "Best practices in applying aggregated DG-RES, DR and Storage for retail customers"

The following activities are envisioned and their planning for the country expert and the operating agent (in person hours) is as follows:

Country Expert Activity		hrs
Compile lessons learned on a country basis		16
Barriers and opportunities (required market and legislator changes)		16
Scaling and replication potential		16
Generic business models requirements		8
Best practices		8
	Sum	**64**

Operating Agent Activity		AIT/hrs	TNO/hrs
Lessons learned workshop		8	32
Barriers and opportunities		32	8
Generic business models recommendations		8	32
Compile best practices		32	8
Deliverable IEA_17_Phase_3.11		16	16
	Sum	**96**	**96**

2.7 Subtask 13 – Conclusions and Recommendations

Recommendations will arrived at in close interaction with the experts' opinions and will at least provide a ranking based on impacts, costs and likely future penetration of the technologies.

Deliverables:

IEA-DSM-17.3.13: "Conclusions and recommendations for applying DG-RES, DR and storage in electricity grids"

The following activities are envisioned and their planning for the country expert and the operating agent (in person hours) is as follows:

Country Expert Activity	hrs	
Ranking projects	16	
Update of penetration scenario's from phase 2	16	
Recommendations (together with local stakeholder resonance group)	16	
Sum	**48**	
Operating Agent Activity	**AIT/hrs**	**TNO/hrs**
Assessment and ranking methodology	8	32
Update overall penetration scenarios	32	8
Deliverable IEA_XVII_Phase3.13	32	32
Sum	**72**	**72**

3 Collaborations and Dissemination

Collaboration with internal and external activities in the field will be initiated:

3.1 IEEE-Standards Association (IC-CSHBA)

OAs currently are within the IEEE-Standards Association Industry Connections. A standard on - *Convergence of Smart Home and Building Architectures* (IC-CSHBA) is set-up and a contribution to the white paper on harmonization of home and building energy management systems.

3.2 ISGAN

Collaboration on reporting and dissemination, including common workshops, contribution to ISGAN reports:
Annex 1: Requirements for enabling flexibility,
Annex 2: Use Cases and implementation models; Best and bad practices
Annex 3: Impact on stakeholders; Cost and benefits
Annex 4: Recommendations

3.3 Smart Grid Expert Group

Liaison with EU Smart Grid Expert Group via national expert of the Netherlands;
Information exchange and bilateral meetings;

3.4 National Stakeholder Groups

An essential pre-requisite is national dissemination of project results. Per participating organization stakeholders resonance platforms are set-up. The following platforms are being composed.

Country	Entity
Austria	National Technology Platform Smart Grids / Industry and utility stakeholder group
Finland	National project consortium and industry stakeholder group
Netherlands	Industry and utility stakeholder Group
Switzerland	Expert Group on Smart Grids

Austria: National Technology Platform Smart Grids / Industry and utility stakeholder group
Netherlands: Industry and utility stakeholder Group
Switzerland: Expert Group on Smart Meter
Finland: National project consortium and industry stakeholder group.

3.5 Other IEA-DSM Tasks

Task 23 The Role of Customers in Delivering Effective Smart Grids – t.b.d.

Task 24 Closing the Loop – Behaviour Change in DSM: from theory to policies and practice – t.b.d.

4 Time schedule, budget and resources

IEA-DSM TASK XVII - Phase 3	Q1 14	Q2 14	Q3 14	Q4 14	Q1 15	Q2 15	Q3 15	Q4 15
Subtasks								
Subtask 10 - Role and potentials of flexible consumers	■	■	■	■				
Subtask 11 - Changes and impact on the grid and market operation				■	■	■	■	
Subtask 12 - Sharing experiences and finding best practices	■	■	■	■	■	■	■	
Subtaks 13 - Conclusion and recommendations								■
Expert meetings								
Biannual country expert meeting	■		■		■		■	
Workshops								
Workshops with stakeholders and experts			■				■	
Reports								
Subtasks reports			■				■	
Final report								■

The estimated budget and resources needed are summarized below.

Management and feedback on OA-activities:

Country Expert Activity		hrs
Half-year progress meetings		16
Number of occurrences		5
	Sum	**80**

Operating Agent Activity		AIT/hrs	TNO/hrs
Half-year progress meetings		16	16
Number of occurrences		5	5
	Sum	**80**	**80**
ExCo-meetings (twice a year)		16	16
Number of occurrences		4	4
	Sum	**64**	**64**
Travel and subsistence (500 Euro per meeting)		**4500**	**4500**

Operating agent (cost shared)

Overall summed financial picture

Country Expert Activity	hrs
Subtask 3.10	80
Subtask 3.11	112
Subtask 3.12	64
Subtask 3.13	48
Progress meetings	80
Sum (hrs):	**384**

OA-Activity	AIT/hrs	TNO/hrs
Subtask 3.10	**148**	**64**
Subtask 3.11	108	192
Subtask 3.12	96	96
Subtask 3.13	24	24
Progress meetings	144	144
Sum (hrs):	**520**	**520**
Travel and subs.:	**4500**	**4500**

The administrative efforts for the operating agents are travel costs and personnel costs / resources necessary for editing and analyzing country specific inputs for the reports. Total cost of phase 3 is in the order of 140-160 k€ and will be covered by task fees per participating country. As in other tasks in the annex, the task fee is defined by the number of participants and a measure of the size of the electricity system of the country. It is assumed that the minimum number of participating parties is 5.

Country experts (task shared)

The estimated resources needed for the inputs of the committed country experts is 2.5 person months. With an increase of the number of countries, some extra coordination overhead is included.

Total operating agent costs per country				
Number of countries	5	6	7	8
Costs per country	30k€	27k€	24k€	20k€

5 References

[1] Mandate on Smart Grids, M/490, *Smart Grid Standardization and Practice,* CEN/CENELEC, DKE, VDE

[2] Smart Grid projects in Europe: Lessons learned and current developments, Update 2013. Vincenzo Giordano, Alexis Meletiou, Catalin Felix Covrig, Anna Mengolini, Mircea Ardelean, Gianluca Fulli (DG JRC), Manuel Sánchez Jiménez, Constantina Filiou (DG ENER) 2012 update

[3] ISGAN Project Annex 3, BENEFIT & COST ANALYSES AND TOOLKITS FINAL REPORT AJOU UNIVERSITY, March 2013, Prime Investigator: Suduk Kim (Professor, Ajou University)