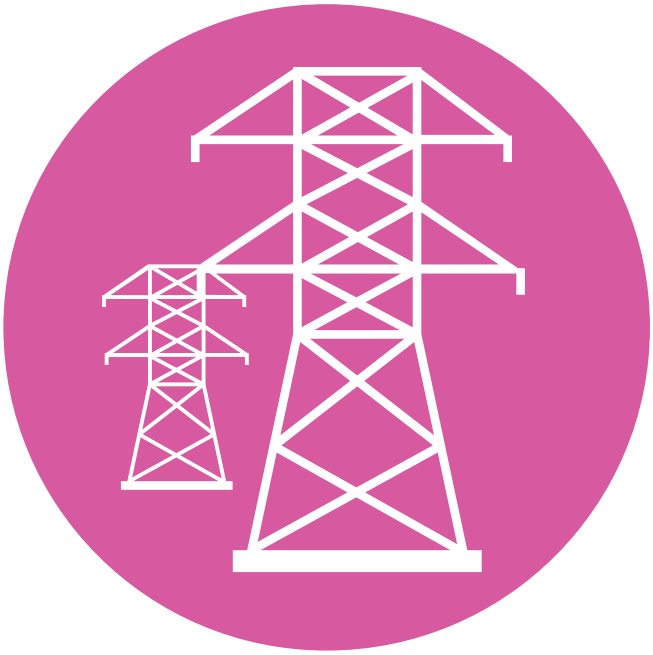
Core Theme 4

Core Theme 4

Electricity Networks



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CA-RES CONCERTED ACTION RENEWABLE ENERGY SOURCES DIRECTIVE

1 In a Nutshell

Core Theme 4 (CT4) continued the work already done by Working Group 6: Electricity Networks from the first phase of the Concerted Action (CA-RES I). This Working Group focused primarily on the issues arising from the implementation of the provisions of Article 16 "Access to and Operation of the Grids" in the Renewable Energy Sources (RES) Directive 2009/28/EC. At the conclusion of the first phase, it was decided that CA-RES II should build on the progress already achieved during the first phase, while looking at how to find solutions to challenges facing transmission and distribution system operators, ministries and regulators in implementing the RES Directive.

During CA-RES II, Core Theme 4 continued to cover Article 16 and identified points of interaction between the areas of system operation, policy and regulation, while discussing the challenges of integrating increasing amounts of renewable generation in the energy system. The Core Theme also addressed the realities of planning and operating electricity networks and explored the importance of a reliable, long-term accompanying policy and regulatory framework. Additionally, the goal of the CT was to better understand how the technical challenges of integrating renewables in the energy system interact with energy policy and regulation, with a view to ensuring that on-going development of energy policy interventions and regulatory regimes, are fully and properly informed by the realities of planning and operating electricity networks with increasing amounts of renewable generation.

Among other topics, participants discussed the roles and responsibilities of all players with regard to the deployment of necessary infrastructure, the importance of social acceptance and what policy makers, regulators and system operators can do to build public capacity to participate in decision making on renewable energy infrastructure, security of supply and the integration of variable renewable generation as well as flexibility options in electricity systems. In addition, barriers to enhancing participation of RES in ancillary services and balancing markets were addressed and ideas on practical solutions were exchanged. The work undertaken by this Core Theme contributed to a common understanding among system operators, regulators and ministries about the cross-cutting nature of the challenges posed by integrating renewables into the electricity generation.

Despite the enormous strides participating countries have made in integrating renewable energy sources into the grid, many challenges remain. Participants identified several issues, including incentivising the increase in system flexibility, the development of reliable energy storage and economic assessment of curtailment/grid development, that need to be tackled until 2020 and beyond.

2 Topic in the Spotlight: Flexibility

Participants agreed that flexibility of the overall electricity system is key for the integration of high RES shares and that various different options for flexibility exist. During the interactive session discussions, participants identified options for dealing with a surplus of electricity, including making existing conventional power plants more flexible, demand side management (DSM) (increasing demand for power), using excess power in other sectors, expanding storage capacities, and exporting power and curtailing renewable electricity. Participants were also keen to discuss options for dealing with a deficit of electricity; over the course of the CT4 sessions, participants listed demand side management (reducing or shifting load) or building new flexible conventional power plants as viable options to deal with a deficit situation.

Through the discussions, it became clear that a discrepancy between the strategic value of different flexibility options and their economic feasibility exists. In order to guarantee long-lasting, sustainable solutions, there is a clear need to lower the costs of flexibility options. Participants agreed that flexibility must be efficient, incentivised and market driven.

A holistic approach was perceived by CT4 participants to be integral for utilising the full potential of all flexibility options. In general, the grid needs to become more intelligent, thereby enabling multi-directional flows of electricity and the balancing of fluctuations in demand.

As regards the challenges for the electricity grid, increasing shares of renewable electricity generation will require transmission system operators (TSOs) to adapt to this development to ensure that renewables fluctuations are managed efficiently, while continuing to ensure the safe and sustainable operation of the electricity system.

In this context, the important role of interconnections in improving market integration, increasing competition, enhancing security of supply, reducing congestion and promoting international exchanges was emphasised. The role of interconnection was also discussed against the background of the 10% electricity interconnection target set out in the Commission Communication of 25 February 2015 (COM (2015) 82) and its importance for the creation of an internal market, energy security and decarbonisation of the energy mix. Electricity interconnection levels will need to be further increased by the implementation of Projects of Common Interest (PCI); in parallel, regional cooperation should also be strengthened. Balancing and cross-border cooperations were also brought up as points in the discussions on flexibility; it was clear that flexibility resources and options should be identified in order to see how they could be optimised on a cross-border basis to increase the flexibility of the entire EU grid, especially of less well-connected markets. Interconnections require a supportive policy framework and depend on cooperation between participating countries. However, though an increase of interconnections is vital for the widespread integration of renewables in electricity networks, existing interconnections should also be continually improved.

A key insight gained from the sessions on flexibility is that it has two key drivers: the evolution of electricity networks as they respond to increasing levels of renewables and market developments, notably EU market integration. The main issue until 2020 remains that the cost impacts of increasing levels of renewable generation on existing systems remains unclear.

3 Challenge Meets Solution

Core Theme 4 examined a number of issues that currently hinder the efficient integration of RES into electricity networks.

3.1 Highlights from the Discussions

The discussions of CT4 touched not only upon the technical, socio-economic, regulatory, and administrative barriers to the efficient integration of RES in electricity networks, but also upon ancillary services, demand side flexibility, and security of supply.

3.1.1 Coherency Among System Operation, National Regulation and Policy

In order to support the effective implementation of Article 16 of the RES Directive, it was important to achieve a common understanding of the definitions of the key terms of the Article. During the first plenary meeting, a "case study" approach was used to provide perspectives on methods to integrate renewables into electricity networks of all important players, namely representatives from ministries, regulators and system operations. Participants discussed their understandings of issues and challenges that would arise, thereby stimulating thinking on the future work of CT4. The discussions revealed that achieving a sufficient understanding of the technical issues around the integration of renewables is of utmost importance to ensure that optimal conditions are created for the effective deployment of renewables. Three levels of concern were listed as issues associated with Article 16: appropriate development of infrastructure, minimising curtailment (priority access, non-discriminatory tariffs) and priority dispatch.

In the last plenary meeting, Core Theme participants identified barriers of varying types and degrees for the implementation of Article 16 of the RES Directive, e.g. communication between electricity grid operators and RES plant operators, grid connections speculation leading to reservation of grid capacity for plants that are unlikely to be built, lack of trust in judicial system by plant operators. Concrete solutions identified e.g. non-judicial resolutions, communications' platforms and fees to reserve capacity, but no single solution was identified as being appropriate to all countries. However, grid connection, operation and development issues are likely to remain a challenge as Member States work towards RES-E 2020 targets. Therefore, there is a need for enhanced coordination between grid operators and RES-E project developers.

3.1.2 Security of Supply and Integration of Variable Generation

Security of supply and integration of variable renewable generation, like solar and wind, were also looked at from the operational, regulatory and policy perspectives in order to continue the inter-disciplinary approach of the group. CT4 participants identified a number of important issues for future consideration, including the ongoing development of an EU-wide concept of system adequacy, the incentivisation of system flexibility, storage and greater understanding of the economic impacts of curtailment.

Since variable renewable generation differs so fundamentally from fossil fuel generation, the integration of high levels of RES generation presents energy policy makers with the challenge of ensuring a secure and sustainable electricity supply. System operators are also faced with the responsibility of maintaining grid stability and acceptable levels of generation adequacy, while also increasing the share of renewables on the grid. At the same time, regulators are faced with the challenge of balancing the goal of providing electricity at low cost to consumers, while still allowing those costs to provide for sufficient investment to make sure that the electricity systems fit the needs of the 21st century.

Due to the small scale of grids in most peripheral Member States, especially when compared to the more interconnected Member States, peripheral Member States are already being faced with effects and challenges of variable renewable generation. In the future, the electricity systems of Member States will be faced with increasing demands on capacities for ramp up and frequency control.

Furthermore, CT4 participants highlighted that the role of the distribution system operator (DSO) in the overall system operation is also evolving as a result of the increasing levels of variable renewables. During the discussions, the need to develop clearer arrangements for the interaction of transmission and distribution system operators with regard to their respective roles in integrating increasing levels of renewable generation was identified as a key issue in the period to 2020.

3.1.3 Flexibility

The topic of flexibility was not only examined in the CT4 sessions (see above), but also in two joint sessions with Core Theme 1: Support Schemes for Electricity, where CA-RES II participants discussed the question of the importance of incentivising flexibility and its importance for the long-term market design. Additionally, participants outlined how markets could be designed to support the transition to a low-carbon future. Such a transition could be achieved by ensuring that the market provides the right signals for sufficient investment in the flexible capacity needed to integrate variable renewables in the system.

An overarching priority, identified from many perspectives during the group's discussions, was the imperative of achieving the level of system flexibility necessary to allow for the ongoing increase of variable renewable generation that will be needed out to 2030, and beyond to 2050.

Developing flexibility in demand, distributed storage, the participation of variable renewable generation in the balancing market and export of renewable electricity were four longer term possibilities identified by the group. It was also agreed that optimising the demand curve could help reduce grid costs in the longer term. Allied to this, was the identification of the issue of how the increased grid costs that would in any event arise from achieving greater system flexibility should be shared where their benefits were felt beyond a particular country.

3.1.4 Social Acceptance

During discussion on the issue of cross-border cooperation, the topic of social acceptance and public opposition was discussed. Experts participating in Core Theme 4 worked together to identify the reasons and the different types of public opposition. Among others, participants identified environmental and landscape impacts, economic concerns, incomplete information, health fears, and lack of transparency and policy coherence as common reasons for opposition. A lack of meaningful consultation at the project start was identified as one of the main reasons for strong public opposition. Rather than conducting a superficial consultation just for appearances, key actors in the planned project should ensure that the target audience has the capacity to meaningfully participate in the consultation process. It became evident that if the underlying reasons for oppositions are not fully understood, they can present critical barriers to a project's progress. Therefore, aligning stakeholders is critical for dispelling doubt and mistrust among players. In this regard, building local capacity can play an important role in helping to engage key, relevant stakeholders in the consultation process, thereby making the project more relevant and effective. Strengthening local capacity can also have an additional benefit: citizens can help identify and explore locally appropriate energy projects that may otherwise have been overlooked.

CT4 participants were in agreement that local communities should be engaged from the conceptual stage of the project in order to increase acceptance. It was found that proactive approaches by government, planning authorities and developers can be key to enhancing local community participation in the planning and implementation of renewable energy projects.

3.1.5 System Services and Capacity Remuneration Mechanisms

In countries where there are significant amounts of renewables in the system, the development of capacity remuneration mechanisms (CRMs) is a system operator response to integrating renewables into the system and to ensuring security of supply. In contrast, in those Member States where increasing volumes of RES are now beginning to come on to the system, relevant TSOs are now becoming alert to the need to consider capacity mechanisms. There are currently a number of CRM models across Europe, but no cross-border mechanisms; this is leading to a lack of homogeneity across borders. Regarding long-term CRM purchasing mechanisms, three main types were identified: centralised, decentralised (with standard products) and decentralised (without standard products). Participants were of the opinion that decentralised CRM options are better than centralised options, where standard products are concerned. During the discussions, CT4 participants highlighted the importance of the participation of and co-ordination among TSOs on CRM from an EU internal market perspective.

With regard to system services, there is broad consensus that the portfolio of services will need to be expanded with the adoption of higher levels of RES to the electricity networks. Many participants were of the belief that the cost of system services will continue to be an issue in the future and that this issue may require a system operator mitigation response.

Participants concluded that functioning long-term markets require mechanisms for the provision of firm capacity, participation of demand in long-term markets, and design of long-term cross border products by using the transmission grid. The scope for harmonisation of CRM models and a critical need for TSOs to become involved and to communicate better with neighbouring TSOs were some other key messages, which emerged from CT4 sessions.

3.1.6 Demand Response and Storage

Participants identified the issues of demand response and storage as important components to enhance the integration of renewables in the system.

On the issue of whether demand response should be prioritised over RES integration, CT4 participants had diverse opinions that were guided by experiences in their own countries. Some participants considered there was no need for demand response, while others considered that demand response must go hand-in-hand with the growth of renewables in the system. On storage, however, participants agreed that the market has to be designed in such a way that energy storage constitutes a viable option. As increased volumes of wind enter the electricity system, additional system services and storage solutions will be required.

Energy storage was also identified as a critical element in meeting system operation challenges up to and beyond 2020. While it was thought that better interconnected systems would have less need for storage, at least in the short- to medium-term, the challenge will be how to incentivise its delivery. One solution may be to incentivise storage as a tool for short-term balancing. In the long-term, storage could provide an alternative to the cost of further grid development. It was asserted that there is what may be called a 'tension' between the drivers for the development of energy storage, and those underpinning the development of an EU super grid. CT4 participants agreed that such a solution (increased storage supplanting the need for some grid development), would require very significant analysis, to ensure a full understanding of the costs and benefits of storage offsetting over a need for grid development/ building of additional interconnection. The need for market signals sufficient to give storage developers confidence to make the long-term investments necessary was also identified by Core Theme 4. Improving energy storage facilities will also play an important role in ensuring secure system operation as levels of variable renewable generation increase across the EU.

TABLE 1 Key Challenges and Solutions to Developing Storage

Challenge	Solution
Different storage technologies with variable specifications	**Develop a portfolio for technologies to allow optimisation**
Margin between peak and off peak hours too small to make it palatable	
No regulatory framework in place	**Revision of framework, licensing, incentives**
Absence of clear market signals in some countries for development of storage	**Create marker signals for development of storage**
Lack of water reservoirs for storage	**Capacity on run-of-river hydro plants to convert them to pumped storage**
Storage other than hydro is expensive	**Expansion of hydro storage must be subject to environmental assessment**
Expensive in comparison to alternatives	**The need to make storage cheaper**

Core Theme 4 participants also discussed the potential and challenges of demand response at the domestic level. They found that a number of measures in areas such as awareness raising, data protection, price considerations and contractual arrangements with final consumers are necessary for the potential to be tapped. In addition, there is a need for adaptation of regulatory frameworks to allow the participation of demand response aggregators in balancing services markets. In discussions, a number of participants noted that predicting load and demand in the domestic market is less challenging than predicting industrial demand. Finally, incentives for domestic consumers must be appropriate and meaningful and should not negatively impact on the level of comfort of consumers.

3.1.7 Enhancing Participation of RES in Ancillary Services and Balancing Markets

Participating countries are facing similar challenges when it comes to the grid integration of increasing shares of intermittent RES electricity and the accompanying needs of avoiding system imbalances and increasing system flexibility. Barriers in ancillary services and balancing markets have been often cited as obstacles to further increasing the share of renewables in the electricity system.

The key challenges for Member States with regard to cross border balancing are the following: the diversity of national markets, the specificity of national balancing resources (e.g. those MS with high interconnection and/or access to pumped-hydro storage (PHS) are at an advantage compared to more poorly connected, peripheral markets), and the situation around electricity flow in central Europe.

In order to address those challenges, a holistic approach taking account of policies, financial incentives, costs and tools to deal with ancillary services, such as operating reserves, frequency regulation, provision of reactive power, etc. is needed.

The balancing market is where flexibility must be delivered and it is this market that must incentivise flexibility. The key challenges that lie ahead include ensuring price signals are effective to stimulate appropriate investment and plant performance, and to cope with the operational necessity of aligning market outcomes with system needs. Therefore, future market design needs to address both capacity and flexibility. To ensure price signals are effective, they must adequately address price scarcity (i.e. flexibility) and allow demand side participation in price formation.

This is why the balancing market is such a challenging element of market integration. The first step must be to get the intra-day market right and allow generators to participate in the market and to treat renewable generators on an equal footing. Renewable generation must provide system services, as do conventional generators. However, their effective participation must be based on appropriate market rules. It is the role of the TSO to identify the scarcities and then it is the role of the National Regulatory Authority to introduce an appropriate regime. TSO's must be equipped to carry out their task efficiently. Balancing prices must be fully reflective of system costs and demand side should participate as much as possible in all markets.

However, this heightens the risk for renewable generators – how will that risk be hedged? Will the market deliver hedging instruments or will they need to be provided as part of the regulatory regime? It is critical that there is cross-border cooperation on this issue to undertake an EU-wide 'scarcity assessment'. This is necessary to identify where the flexibility resources/options are across the EU and how they could be optimised on a cross-border basis to increase the flexibility of the wider EU grid, including less well connected markets. This work is important to inform the development of adequate hedging products which will in turn underpin investment decisions for new power generation capacity.

The balancing market is a complex one and this is why the development of the Balancing Regulation for market integration has been a particular challenge. It is also why a step by step approach has been taken, with regional projects undertaken first. The huge difference between power systems in the EU makes it very difficult to create common balancing arrangements. Nevertheless, the balancing market is the last point for ensuring system stability so it is not possible to introduce harmonisation straight away.

There are several on-going pilot projects between several countries. Much has been learned from the pilot projects to date and measures of harmonisation have been achieved in several cases. However, much has also been learned of the challenges relating to issues such as the lack of convergence on balancing products, National Regulatory Authorities (NRA) concerns regarding capacity allocation, the differences in settlement rules (including issues around central dispatch vs. self-dispatch) and the difference in the synchronous nature of systems.

3.2 Good Practices

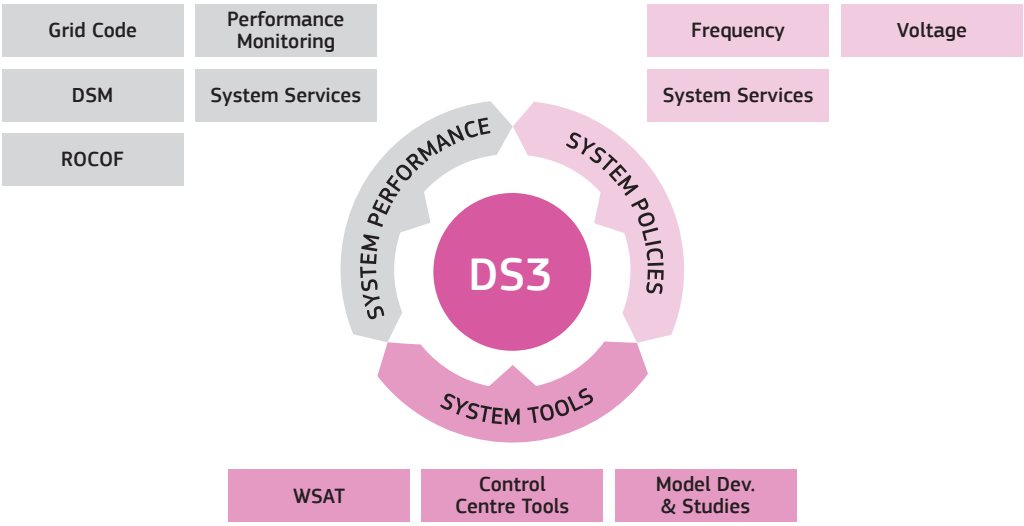
During the CA-RES II plenary meetings as well as the CT parallel sessions, numerous Member States presented several good practice examples that successfully tackled the many problems and barriers that were identified during the discussions. The examples below represent a select few of all the good practices that were presented.

3.2.1 Ireland: DS3 Programme

Demand response and storage have both been operational in Ireland since the 1970s. Demand response in particular has been a growth area in the last four years with the removal of barriers to market entry. Ireland has committed that by 2020 some 40% of electricity generated will be from renewable sources. Of this figure, the TSO is working to a target of 37% of demand being met from onshore wind. Compared to Great Britain, Continental Europe and Scandinavia, this is a very high target. It has put Ireland in a position where it is currently addressing the challenges arising from the operation of a system with high levels of renewables. These challenges will also affect other Member States as increased levels of non-synchronous renewables come on to their networks.

To meet the operational challenges posed by up to 75% of electricity demand being met by onshore wind, the Irish TSO has embarked on the DS3 programme, which is currently underway. The DS3 Programme is made up of 11 workstreams that fall under the pillars of System Performance, System Policies and System Tools. The programme involves many different stakeholders and brings together different aspects, including the development of new operational policies and the development of financial incentives for better plant performance.

FIGURE 1: DS3 Programme



SOURCE: EirGrid Group

Both demand response and storage can be part of the solution to integrating renewables into the electricity system. In Ireland, system services are driving innovation with a number of large multi-national companies making investments in Ireland to try out innovative demand response and storage systems. These companies are making investments in the belief that solutions developed in Ireland can be scaled up to larger markets with high levels of renewables. As increased volumes of variable non-synchronous renewables come on to the system, additional new system services will be required.

3.2.2 Cyprus: Automatic Curtailment Application

The small island country of Cyprus often faces unique challenges due to its geographic location and resource limitation. Unlike other Member States in the European Union, Cyprus has no connection to the electric system of neighbouring countries. Cyprus aims to have 16% renewable electricity by 2020 and has made significant investments towards the growth of PV systems and wind generation. While wind power generation in Cyprus continues to grow steadily, wind forecasts remain unreliable with a variation exceeding in many cases of +/- 20-25% during a half hour period. Additionally, photovoltaic solar power is gaining ground in Cyprus, which, combined with wind, is increasing the proportion of variable renewable generation in the electricity system.

Cyprus has developed in-house an automatic wind power curtailment application implemented on the Supervisory Control and Data Acquisition - SCADA/EMS system that effectively controls the instantaneous maximum allowable wind penetration. In 2013, the curtailment of wind was successfully kept to 1%. The SCADA/EMS system is able to control each individual wind farm, thereby also simultaneously preserving system security. The system calculates the maximum renewable penetration based on a range of criteria, thus allowing for priority dispatch, while also implementing curtailment when system security needs dictate. Though photovoltaic solar power is the most suitable form of renewable generation for Cyprus' climatic conditions, there are challenges to its controllability. Many Member States are currently trying to come up with solutions to dealing with this persisting challenge.

3.2.3 Development of System Services in Denmark

In 2015, some 42% of Danish electricity generation was met from wind power. This is expected to increase to more than 50% in 2020. Denmark has applied several innovative methods to increase flexibility of the electricity system and provide system services.

First of all, Denmark has well-functioning short term markets, where market actors can correct their imbalances. However, the Danish TSO, Energinet.dk, has the final responsibility for balancing the system and therefore Energinet.dk assumes responsibility 45 minutes before the operating hour. An important development has been to focus on predicative rather than reactive responses for imbalances. The key to this change has been the use of online measurement of demand and wind power to construct improved predictions of the near term imbalances. This allows Energinet.dk time to react to a predicted imbalance and to contact a neighbouring transmission system operator in a timely fashion.

Additionally, the flexible combined heat and power (CHP) plants contribute to balancing the mainly RES-based electricity system. Generation by CHP plants is regulated according to demand, and the majority of the fossil-fuelled plants can also be run in condensing operation mode, i.e. generating electricity without producing district heating. This mode allows for greater flexibility in the electricity system, in particular in the summer when demand for heating is low. The CHP plants also have low load capabilities, meaning they are very flexible in regard to production load. The large-scale CHP plants are connected to the transmission grid and provide system stabilising properties such as inertia, reactive effect, etc. and thereby maintain the stability of the grid.

Furthermore, investments in VSC-HVDV interconnectors, synchronous compensators and static var compensators (SVC), which can deliver system stabilising properties, also helps to balance the system and has also reduced the need for "must run" central power plants.

In the past, wind power was considered a "must run". Today many modern wind turbines have the technological ability to regulate their production downwards, when needed. This is an increasingly important factor in balancing the electricity system.

4 Main Findings and Achievements

The work undertaken by this Core Theme contributed to a common understanding among transmission system operators, regulators and ministries about the cross-cutting nature of the challenges posed by integrating renewables into the electricity generation.

Participants concluded that a stronger integration of electricity markets is needed, which requires stronger interconnections to achieve price convergence. Interconnections require a supportive policy framework and depend on cooperation between Member States. Demand response and storage solutions can effectively enhance the integration of renewables and be scaled to larger markets with high shares of RES. The provision of system services is driving innovation and interest in demand response and storage.

The main findings of CT4 can be summarised as follows:

- The strategic challenge for policy makers in the future is to realise the potential of renewable energy for economic development and energy security in a way that is environmentally sustainable, that is publicly-accepted and is cost-effective for consumers.
- Stronger, comprehensive cross-border cooperation is needed to facilitate the integration of variable RES units into the electricity system
- An increase of interconnections is vital for the widespread integration of renewables in electricity networks. However, existing interconnections should also be continually improved.
- Interconnection is not just required by more peripheral markets, but also those in central Europe, where complex RES-E flows are creating network volatility.
- Differentiated flexibility options, which should be tailored to a supply deficit or a demand deficit situation, are needed to further integrate shares of renewable energy into the electricity system.
- The main challenge for Member States with regard to cross-border balancing is the diversity of national balancing markets.
- Engaging all relevant stakeholders at the beginning of an infrastructure project can help pro-actively dispel doubts and concerns
- There is a need to achieve dispatchability of renewables, while ensuring equitable cost-sharing.
- Though priority access for renewables to the grid is important, the rate of build of grid connections constitutes the critical enabling factor regarding network development until 2020.
- Demand response is becoming increasingly important as an additional balancing resource for TSOs, which could help in reducing total system costs.
- There is a need for enhanced coordination between RES-E project developers and grid owners in order to guarantee system stability.

As the EU moves towards 2020 and looks beyond that to achieving a low carbon economy by 2050, the increased need for close cooperation between ministries, regulators and system operators, based on a common understanding of the strategic and technical issues involved in RES integration, becomes even more acute. While the issues discussed within the scope of Core Theme 4 are critical for individual Member States, the fundamental importance of understanding the cross-border dimension of these issues for electricity networks across the EU is central to managing the shift towards renewables in a way that is in the economic and social interest of EU energy consumers.

5 Abbreviations

Participating countries are referred to according to their two-letter country codes as defined by ISO 3166-1 alpha-2 standard (AT – Austria, BE – Belgium, etc.).

Abbreviation	Meaning
CA-RES	Concerted Action on the Renewable Energy Sources Directive
CA-RES I	First phase of the Concerted Action on the Renewable Energy Sources Directive
CA-RES II	Second phase of the Concerted Action on the Renewable Energy Sources Directive
CHP	Combined Heat and Power
COM	European Commission
CRM	Capacity Remuneration Mechanism
CT	Core Theme
CT4	Core Theme 4: Electricity Networks
DSM	Demand Side Management
DSO	Distribution System Operator
EMS	Energy Management System
EU	European Union
HVDV	High-Voltage, Direct Current
MS	Member State
NRA	National Regulatory Authorities
PCI	Projects of Common Interest
PHS	Pumped Hydro Storage
PV	Photovoltaics
RES	Renewable Energy Sources
RES-E	Renewable Energy Sources for Electricity
SCADA	Supervisory Control and Data Acquisition
SVC	Static Var Compensators
TSO	Transmission System Operator
UCTE	Synchronous Grid of Continental Europe
VSC	Voltage Source Converters

This is a public CA-RES report

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The Concerted Action to support the implementation of the RES Directive 2009/28/EC (CA-RES) was launched with the participation of the responsible authorities from 30 EU countries and supported by Intelligent Energy Europe (IEE) in July 2010 to provide a structured and confidential dialogue on how to address the cost-effective implementation of the RES Directive 2009/28/EC.

For further information please visit **www.ca-res.eu**