Tackling the trilemma through coordination

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Summary (1/3) – 5 examples of policy coordination 'hotspots' aimed at maximising benefits across energy policy goals

International coordination helps to achieve benefits across the energy policy trilemma of sustainability, reliability and affordability

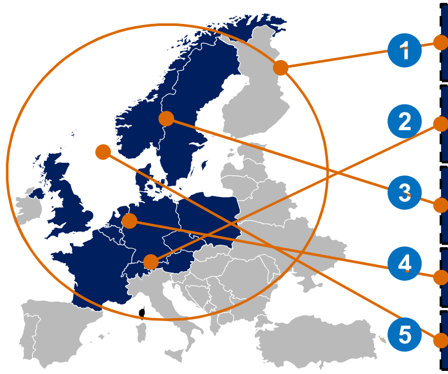
- Coordinating energy policies and strategies internationally helps to achieve the three societal objectives of the European energy transition: sustainability, reliability and affordability – the energy trilemma.
- Last year we conducted a study, that clearly showed the benefits of coordinating energy policy and markets: benefits could add up to €40bn annually, in case power markets are fully integrated. In this year's study, we explore how benefits arise across all parts of the trilemma when coordinating between countries.
- Policy coordination takes place at various levels:.
  - Firstly, at **EU** level, in 2014, the European Commission proposed an Energy Union. This Union establishes a high-level framework for coordination, with an interconnectivity target (10% of installed generation capacity in 2020, 15% in 2030) and a commitment to facilitate projects of common interest. It has earmarked €87bn out of €315bn of the recent European Fund for Strategic Investments (the "Juncker Plan") for interconnection projects. The Commission finalized a consultation round on a new energy market design in October.
  - Secondly, various **bilateral and regional** initiatives take shape that realised benefits with a simpler political process. These initiatives can be a flywheel for broader political coordination. In our view, such a 'hotspot' (regional) approach can speed up the process by showing quick results.

The need for coordination is not only limited to policymakers. Private initiative is crucial to drive changes in our energy system and reach our energy goals.

Lessons can be learned from cases where international coordination has produced clear benefits across policy goals

- To see how coordination has helped to achieve significant benefits across the three policy goals, we analyse five cases against the historical perspective. We geographically focus on 'hotspots' in Germany and neighbouring countries, as these countries already brought forward great examples that demonstrate the benefits of coordination.
- The cases provide insights into future coordination areas ("what") in order to achieve additional benefits. They secondly offer specific lessons learned of successful coordination of European energy markets ("how"). These lessons in both areas will be addressed in the following two pages.

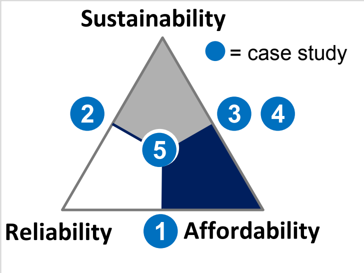
Case studies used in this report



1. Cross-border infrastructures in North-West Europe (NorNed)
2. Balancing services for power
3. Joint renewable electricity support schemes (Sweden/Norway)
4. LNG as a transportation fuel
5. Offshore wind in the North Sea

Summary (2/3) – There are various ways to tackle the policy trilemma through cross-country coordination

Tackling the trilemma through policy coordination – five cases



It is difficult to achieve all three objectives at the same time, as often objectives are counteractive; hence the term trilemma. The cases in this study show that the achievement of the three objectives simultaneously can be brought closer by cross-border coordination of energy policies or energy investments.

1. **Increase interconnection to make energy systems more reliable and affordable.** NorNed, the interconnector between the Dutch and Norwegian markets was constructed to drive affordability benefits and improve reliability in both markets. It has additionally yielded sustainability benefits as low carbon Norwegian electricity found a wider user base. Europe can further drive benefits by connecting Italy and Spain, as well as improving connections of France and Germany.

   Increased interconnection is a prerequisite for a number of the other cases, like joint balancing or cost-efficient deployment of renewables. Having interconnections also implies that countries should align their national grid plans as investments spill over into adjacent countries.

2. **Realise joint balancing to achieve sustainability and reliability at lowest costs**. Integrated balancing markets help to maintain a reliable system while connecting ever more renewables. Increased interconnection levels also allow joint optimisation of balancing reserves, leading to lower costs for the overall system. Unnecessary investments can be avoided by connecting countries with low balancing capacity to those with overcapacity. Several pilots have started to give proof of concept and allow for troubleshooting issues.

   Taking a 'hotspot' approach will help to realise joint balancing as fast as possible. The savings potential by 2030 is €300-500m[1].

3. **Enable joint renewable support schemes for cost-efficient deployment of renewables.** At €15.5-30bn[2], renewables support is the largest synergy area for cross-national coordination. The joint renewable certificate scheme of Sweden and Norway is a bilateral example. Achieving a sustainable energy supply in a cost-effective manner was the main driver as a joint market improves liquidity, investor confidence, and cost efficiency. By harmonising and integrating support schemes around Europe, we can roll out renewables at lowest possible cost. The Sweden-Norway case shows that joint support schemes are easiest to realise in well-interconnected countries with a history of cooperation.

4. **Start with coordinated connection of offshore wind farms to the grid.** Offshore wind can become an important renewable energy source, if the costs come down in the coming years. One cost driver is the connection to the grid, especially when the farm is located further away from the coast. Joint planning of offshore parks and overseas interconnections could minimise connection costs when farms are built further from shore.

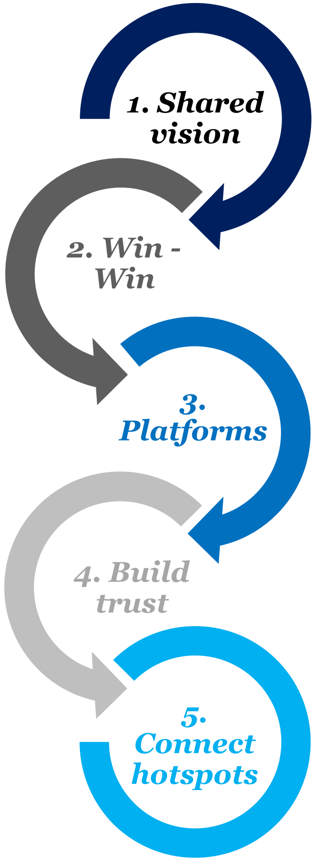
5. **Unlock the potential of new, lower carbon fuels by using economies of scale**. Cross-country coordination can help in developing new energy markets. LNG for instance delivers sustainability benefits compared to oil-based transportation fuels, is cheaper, and has a strong base of worldwide suppliers. A large amount of coordination of market parties as well as policymakers has gone into solving the chicken-and-egg problem to new infrastructure investments. If done well, this can lead to rapid development of new systems (5 years from first ideas to serious investments in the case of LNG for transportation).

Source: [1] EC, DGENER(2013), [2] Booz & Co 2013

Summary (3/3) – Successful coordination often starts in 'hotspots' and requires a shared vision, clear and effectively communicated benefits (win-win), and platforms (for policymakers and market parties) which help to eliminate barriers for investment

How to achieve successful coordination?

Successful coordination requires effective policy coordination. From our cases, we have specific lessons learned of successful coordination of European energy markets ("how"), have derived the following key success factors that help to realise good quality policies as well as speed up the decision-making process:



1. Ensure a shared vision on coordination between countries

- Several cases show that a joint strategic vision is key for proper energy policy coordination. In the case of the joint Swedish-Norwegian RES-E scheme, a shared belief in the benefits of coordination and a joint long-term vision were key to fostering public and political support. For NorNed, several government actors were involved in approving and financing the project. For all of them, the vision of an integrated European energy market was the key decision driver.

2. Proven win-win situations drive coordination and can be analysed from a trilemma perspective

- In our study, we find that the cases with the clearest win-win for parties involved show the fastest development. The Offshore grid case shows that all countries involved need to have a positive business case to ensure political support. The required benefits can accrue to any of the policy trilemma goals. The Cross-border balancing case demonstrates the value of using pilots to assess and communicate the benefits, as well as improving key issues before scaling up. Other cases, could benefit from a pilot approach, actually proving the benefits and finding solutions to the main hurdles along the way.

3. Platforms facilitate the development of a shared vision between countries as well as detailed policy proposals

- Formal and informal platforms are needed as they allow for bottom-up initiatives and ideas to emerge which can be taken over by policymakers. In the case of LNG, governments and market parties have worked together to develop a vision and secure commitment of the sector. This allowed for fast development of LNG in transportation.

4. Governments and regulators need to be aligned to build trust towards investors

- Policies should be aligned at various government levels (European, national and local, as well as regulators) in the countries involved to ensure smooth realisation of projects. Furthermore, as our Cross-border power balancing case shows, well-functioning governance is of importance to take and guide the required initiatives as well as agree on responsibilities and decision making processes. Together with a clear and consistent shared vision over time, trust can be built so market parties start investing and financial institutions issue financing.

5. Apply the right mix of EU wide and 'hotspot' approaches

- Political agreements between many countries can be difficult to realise. Our cases of coordination with fewer countries and clear benefits yield faster agreement. Like-minded countries can work on projects with a large savings potential to quickly realise benefits. Other countries can be included afterwards. This 'hotspot' approach can yield quick proof of concept which helps secure political and public buy-in and pave the way for a more comprehensive approach at the EU level.

Contents

Introduction

In last year's study, we concluded that deeper coordination of European energy markets and policies can lead to significant benefits for society

Benefits of coordination

- In 2014, we published a report titled 'The Benefits of Coordination', a set of essays on the benefits of coordinating energy policy and markets across Europe. We concluded that lack of coordination of national energy policies in the European Union leads to suboptimal outcomes. Cross-border coordination of the use of existing assets (static efficiency) and of investment in production capacities and transmission networks (dynamic efficiency) need to be improved. This will allow electricity and investment flows the flexibility to find their welfare-maximising routes. The benefits include direct and indirect benefits:
    - **Direct** benefits (decreased operational and investment costs) have been quantified at various ranges. Booz & Company (2013) has quantified the benefits of coordination at €18.8-69.6bn annually, of which €12.5-40bn for market integration with current policies, and €15.5- 30bn for coordinated RES-E investment[1]. The academic literature estimates benefits to be 1-10% of system costs (Booz & Co, 2013). A study of welfare gains per border (ACER, 2013) identifies benefits ranging from several millions of euros – to over € 250 million of trade gain per year per border.
    - **Indirect** benefits include benefits such as the improved investment climate and new economic activities related to innovation. Those effects may very well be larger than the direct effects in the longer run, but they are much more difficult to quantify.
- But these benefits are not only of monetary nature, they can arise across the three elements of the policy trilemma: sustainability, security of supply and affordability.

Policy coordination

- In last year's report, we focused on potential policy actions for the Dutch and German governments to optimise market coordination. This has resulted in the following recommendations:

Incentives harmonisation	Further exploring harmonisation of subsidies and taxes facing renewable energy producers to align incentives
Market integration	Improving market integration by increasing market transparency and aligned market rules
Joint infrastructure planning	Cooperating in challenges of grid integration, such as (cross-border) infrastructure planning and development of offshore grid infrastructure
Joint projects	Developing joint projects and using statistical transfers in the field of renewable generation
Joint innovation clusters	Cooperation on R&D and industrial policies for renewables to simulate innovation and develop joint clusters

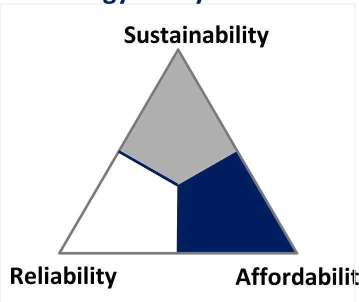
[1] Totals do not add up as the study identifies several minor negative effects of coordination

The purpose of this study is to identify how successful coordination can be achieved in order to optimise three public energy goals across countries

International policy coordination is ever so relevant to achieve sustainability, reliability and affordability goals

- Meanwhile in the past year, energy policy coordination has been firmly placed on the political agenda. The Juncker Commission has proposed an Energy Union, establishing a framework for coordination, with an interconnectivity target (10% of installed generation capacity in 2020, 15% in 2030) and the commitment to facilitate projects of common interest. This plan is however currently not very concrete – key decisions are still to be made. The commission has further earmarked €87bn out of €315bn of the recent European Fund for Strategic Investments (the "Juncker Plan") for interconnection projects.
- Secondly, various **bilateral and regional** initiatives take shape that realised benefits with a simpler political process. These initiatives can be a flywheel for broader political coordination. In our view, such a 'hotspot' (regional) approach can speed up the process by showing quick results.
- The need for coordination is not only limited to policymakers. Private initiative is crucial to drive changes in our energy system and reach our energy goals.

The Energy Policy trilemma



We aim to provide concrete recommendations for policy coordination improvement…

- This document has been prepared by the WEC's national member committees of the Netherlands in cooperation with Vattenfall, DNV GL, Shell, Siemens, ECN and PwC. It provides a follow-up to last year's study on the Benefits Of Coordination of Dutch and German energy markets and policies.
- This year we want to extend the scope to larger geographic region to identify benefits of coordination on a multi-country scale for a number of real-life cases. The focus of this study is the impact of policy coordination between countries on the energy goals, and in particular the coordination of countries in the electricity and gas market. We hope to inspire the agenda setting of an energy policy debate between North-Western European countries and provide concrete recommendations for policy coordination improvement.

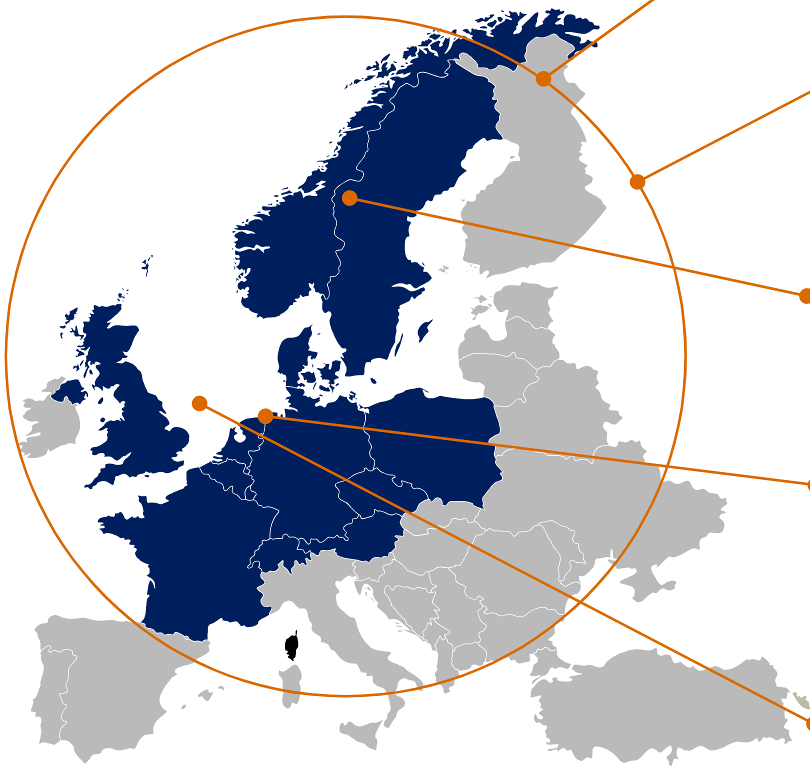
… by using a series of historical case studies

- This year's WEC study assesses the impact of coordination through a series of case studies. Case studies can help to make the subject tangible, inspire policymakers, and create 'stories' on successful coordination. The individual cases provide evidence for the lessons learned in coordination between countries in the European gas and electricity market.
- The cases provide insights into future coordination areas ("what") in order to achieve additional benefits. They secondly offer specific lessons learned of successful coordination of European energy markets ("how").
- In order to come to a full understanding about the benefits of coordination, the impact is quantified where possible. The basis for expressing the impact is through the energy trilemma.

There is a great potential for cross-border coordination in Europe. The following five cases are analysed in the study

Our cases studies

We have performed five case studies to come to practical advice in a number of relevant areas for policy coordination. We focused our efforts on Germany and surrounding countries as these countries have already rolled out some coordinated policy initiatives which offer valuable lessons.



Cross-border infrastructures in North-Western Europe (NorNed)	From 1921 onwards, cross-border interconnection of power markets has increased, driven affordability and reliability benefits. Interconnector capacity was constructed and power markets were integrated, driven by various platforms in coordination with hotspot geographies.
Balancing services for power	Integration of balancing markets can prevent unnecessary investments in balancing capacity and improve the use of existing balancing resource. Small-scale proof of concept is used in order to gain experience with the various aspects and tackle key issues to enable larger-scale roll-out.
Joint renewable electricity support schemes	Sweden and Norway agreed on a joint certificate market for renewable electricity in 2012. It took 9 years to come to an agreement and realise the scheme, but the benefits of jointly stimulating renewables were clear and drove the countries to realise a joint scheme.
LNG as a transportation fuel	Europe may soon switch to LNG as a transportation fuel, as it delivers various benefits. The main roadblock is an underdeveloped LNG infrastructure. Cross-border coordination can help solve the chicken-and-egg problem reach optimal investment levels.
Offshore wind in the North Sea	In the coming years, the installed capacity of offshore wind farms in the North Sea is planned to increase rapidly. Cross-border coordination of offshore grids (especially when located further from shore) could decrease costs. But costs and benefits must be present and optimised over countries in order to be sucessfull.

Case studies

Case 1: Cross-border infrastructures

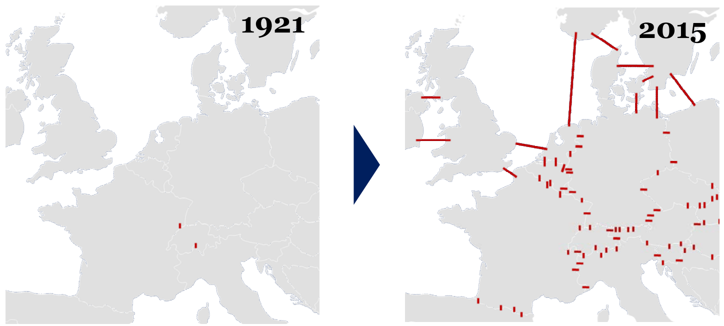
Introduction to cross-border infrastructure

Europe has a long history of building cross-border infrastructure, such as transportation and communication infrastructure as well as energy networks. Over time, European cross-border infrastructures expanded to reap the benefits of integration, like decreased transportation costs or connecting to export markets. Integrated markets are connected, and liquid (i.e. power is actually traded).

To realise a cross-border connection between at least two countries, a certain level of policy coordination between the different national stakeholder is needed. The main focus of this case study is the contribution of policy coordination to the success of cross-border infrastructure.

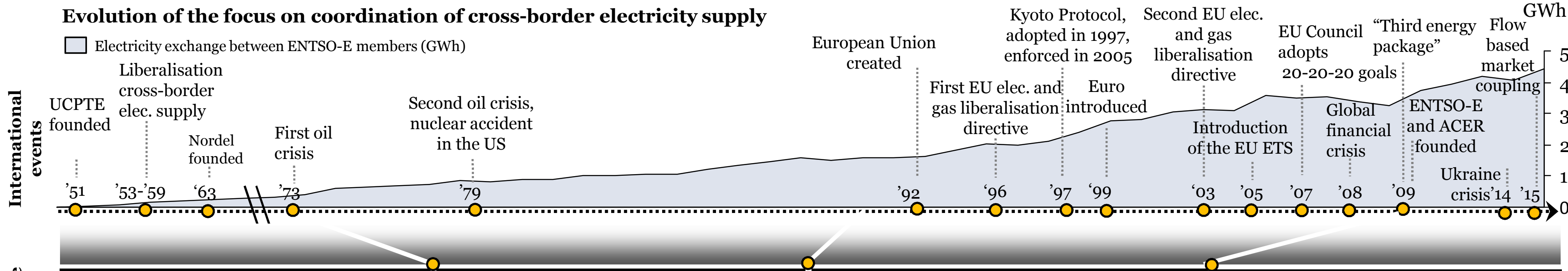
We start this case study by providing a historical overview of interconnection in Europe, focusing on energy infrastructure (electricity) to illustrate how cross-border coordination has intensified over time. We then describe a specific case study (NorNed electricity interconnection cable between Norway and the Netherlands) to analyse the role of policy coordination and the lessons we can learn from this example. Finally, we reflect on future policy coordination.

Development of electricity interconnection infrastructure



Europe has seen a marked increase in policy coordination and electricity trade in the past 60 years

Evolution of the focus on coordination of cross-border electricity supply



1 Affordability as a driver for interconnection

2 Security of supply (diversification) stimulates interconnection further

3 Creating a single European market

4 Sustainability in interconnected markets

Policy focus

Organised cross-border coordination of interconnection in Europe started with the foundation of the UCPTE (Union for the Coordination of Production and Transmission of Electricity) in 1951.

Also in other countries, like Scandinavian countries, the Iberian peninsula and France, similar organisations were set up.

Electricity exchange was based on bilateral contracts between countries. National regulations were however "…complex and not sufficiently well suited for the present grid operation system" (Lagendijk 2008). In order to address this issue, cross-border supply of electricity was liberalised between 1953 and 1959 through a joint effort of the UCPTE and OEEC (Organisation of European Economic Co-operation).

The first oil crisis in '73 resulted in a need to diversify energy supply by means of energy efficiency and a more diverse fuel mix (coal, nuclear). Increased interconnection could help to diversify electricity supply. At the same time, the rapid growth of electricity consumption challenged the availability of the system and increased the need for interconnection to prevent shortages and load shedding.

During the 70s and 80s the interconnection in the grid developed gradually. By the mid 1980s, 12 countries were included in the UCPTE network (Spain, Portugal, Greece and the former Yugoslavia were added) and connections with Scandinavia, UK and COMECON (eastern Europe) region were gradually developed.

The '90s was a highly dynamic period in terms of regulation changes, driven by the foundation of the European Union. Also, Eastern Europe started to open up after the fall of the Soviet Union in 1991, posing questions on grid interconnection.

The 1996 and 2003 Electricity Directive created a set of common rules in pursuit of a Single European electricity market, including unbundling of generation, transmission and distribution. In 1997, the UCPTE became responsible for defining the technical rules for interconnection, followed in 1999 by the creation of the Association of European Transmission System Operators (ETSO) by UPTCE , and its Scandinavian, British and Irish counterparts (Nordel, UKTSOA and ATSOI). It aimed at developing economic and legal procedures for international electricity transits and trade.

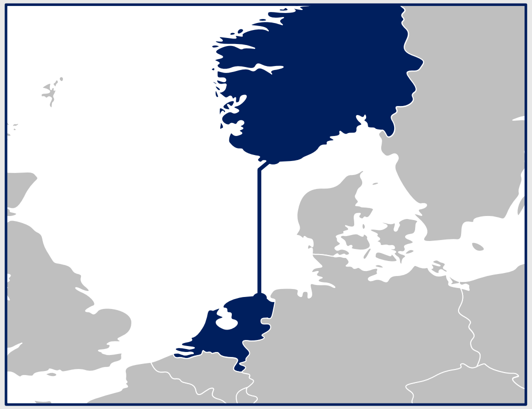
Driven by concerns on climate change, sustainability became a prominent driver of energy policy. The share of renewable power subsequently changed, which led to unexpected new cross-border flows of power and price fluctuations affecting neighbouring countries.

The third energy package was the result of EC objectives in reaching the 2020 energy goals. Acceleration of interconnection investments and diversified energy sources were the main issues addressed.

A new entity, ENTSO-E (European network for TSOs for electricity), was created with the objective to integrate renewable energy in the market and complete an internal energy market.

Sources: Lagendijk (2008), UCTE (2009)

The NorNed electricity interconnection aimed at optimising resource use in Norway and improving sustainability and affordability of power supply in the Netherlands



Project description

- The NorNed project refers to a 580 km long HVDC power cable between Feda (Norway) and Eemshaven (Netherlands), which was the first interconnection between both countries.
- The longest submarine power cable in the world with a voltage of ±450 kV and 700 MW capacity is jointly owned (50/50) by Dutch TenneT and Norwegian Statnett.
- Annual revenues were primarily estimated at €64 million. In May 2012, 4 years after the start of the operation, TenneT announced already half of the capital invested (appr. €600 million) has been recovered so far.

Sources: Statnett/TenneT (2008), TenneT (2012)

Short history of the NorNed interconnector

A first agreement in principle for an interconnection had been signed in 1991 between the Dutch SEP (state-owned Electricity Generating Board) and the Norwegian transmission system operator (TSO) Statkraft. In the 90s the SEP was abolished and an uncertain investment situation due to regulatory changes (Dutch liberalisation of the energy sector) and low fuel prices did not offer good conditions for actual investments in the cable.

The plan was revived in 2004 when a joint project of Statnett and TenneT was started. By the end of 2004, the plans for electricity exchange via NorNed were approved by the ACM (at that time DTe), the Dutch Competition Authority and Norway's ministry of petroleum and energy. The European Investment Bank financed nearly 50% of the NorNed project as an Energy trans-European Networks (TEN-E) project.

The goal of NorNed was to enable electricity exchange, by creating the first power grid connection between Norway and the Netherlands and contribute to the 90s EU strategy of creating a single European electricity market. The cable was expected to positively impact all trilemma policy goals (affordability, sustainability and security of supply):

- The Dutch and Norwegian production parks could solve the limitations of each system, overall leading to a more efficient system with converging prices of both countries. During daytime cheap hydropower (about 96% of Norway's production in 2013) could be exported to the Netherlands, while during night time redundant low-cost Dutch electricity could be imported by Norway to fill up water reservoirs.
- The cable was expected to reduce CO_2 emissions due to the supply of renewable energy.
- Finally, the cable could help to increase the reliability of electricity supply through (geographical) diversification of sourcing in both countries.

Key milestones in the project

- '91: First agreement on transmission link between NE and NOR
- ..'90s: Modification of Dutch energy market (liberalisation) delayed the project
- '04: Decision made for NorNed project between TSOs
- '06 '07: Installation of cable and stations
- '08: Commercial operation started with capacity auction (5 May '08)
- '08: Simultaneous "Opening" of the cable by Dutch/Norw. Ministers (11 Sept. '08)
- '11: Integrated in European Market Coupling System
- '12: Intra-day trading on NorNed

The development of NorNed was initiated by the TSOs and supported by the European vision to increase cross-country transmission capacity

The TSOs involved drove the development of the NorNed cable

The SEP and Statnett initiated the NorNed project in the ‘90s. The project initially did not come off the ground due to the many regulatory changes in Europe in that time despite the fact that all required building permissions, etc. had been arranged.

TenneT and Statnett decided to revive the project in the early 2000s as building permissions were about to expire. After permission by the regulators, final agreement was reached in 2004 to start the construction of the cable.

The regulator was initially not conducive for the investment…

Permission by the Dutch regulator DTe was an important hurdle for realising the project. Given its role in regulating tariffs, TenneT needed DTe’s permission to finance the capital costs and operational costs from the auction income of NorNed. Key consideration for DTe were the high risks involved in developing a large-scale infrastructure project for which Dutch consumers were the ultimate bearer. DTe was further initially only willing to consider the investment from a merchant perspective, excluding societal benefit from the overall business case. A substantial debate took place with the TSO and assumptions were adjusted reflecting the opinion of the regulator, but the remaining business case was sufficient to approve the project.*

… but permission was granted based on European policy goals

Despite lengthy discussions on the business case, DTe finally did give permission for the NorNed cable in 2004, partly by the inclusion of €2m societal benefit in the business case. A key consideration was Europe’s TEN-E policy to increase transmission capacity, which made explicit reference to the NorNed initiative.

This European vision was also a key consideration for the Norwegian ministry’s licence to Stattnet for licensing the export and import of power.

To further illustrate the complexity and influence of policymakers, 24 licences in four countries had to be given and 22 agreements with existing cable and pipeline owners needed to be made.

Europe did more than supply moral support

Under the Trans European energy networks (TEN-E) strategy 2006-2013 aimed to increase transmission capacity, the NorNed project was supported with € 3 million to be used as a catalyst for investment (e.g. studies/ preparatory activities). The actual construction of the NorNed cable was financed partly by a €100 million loan of the Nordic Investment Bank to Statnett and by the European Investment Bank (EIB) with €280 million, which contributed nearly 50% to the NorNed project (total construction costs of about €600m).

Return on Investment remains an issue

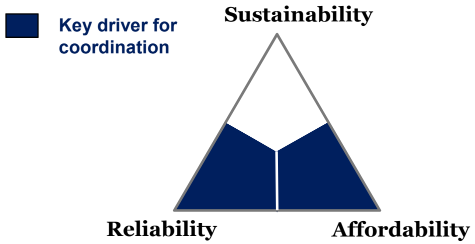
The regulator not only gives permission for infrastructure investments, but also decides on tariff regulation. Some European regulators apply a cost-plus methodology, allowing TSOs and DSOs to fully recover costs, others apply a yardstick model which applies efficiency discounts to lower costs. The ACM applies the latter, which gives better incentives for efficient operations, but makes it hard to recover investment costs in general. Additionally, yardstick regulation inhibits investments to some extent as it introduces uncertainty on future regulated rates.

* DTe made some changes to the business case (e.g. the lifespan of 40 years reduced to 25 years, WACC of 6.3% adjusted to 9%), which led to a negative discounted cash flow. Given effects on other parts of the policy trilemma (e.g. security of supply), the NPV was assumed to be 0.
Sources: Interview with TenneT, DTe (2004), DTe (2006), EC (2004) TEN-E priority projects, NIB (2007)

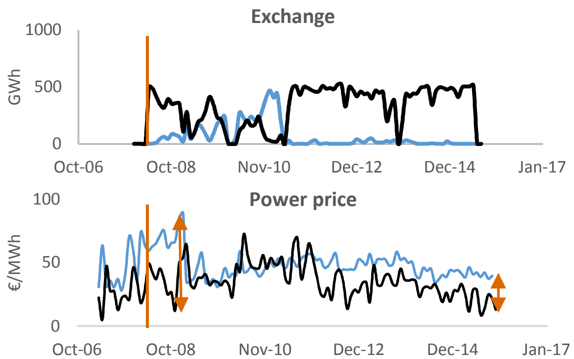
The NorNed interconnector influenced all three policy goals at a systems level, but the impact per country differed

Tackling the Trilemma

Reliability and affordability drove the development of the NorNed interconnector



The goal of NorNed was primarily achieving price convergence to improve affordability for Dutch consumers and Return on Investment for Norwegian low carbon power investors. Reliability was an additional driver as it allowed better usage of Norway's hydro based storage potential.



Impact on reliability

The NorNed cable was predominantly used in the NO-NL direction. Security of supply increased:

- The increased level of interconnection led to an increased capacity to meet peak demand in both countries. This so-called reserve margin increased from 37% to 41% in the Netherlands. Half of this increase can be explained by the commissioning of the NorNed cable.
- A more diversified fuel mix. Since the NorNed cable was predominantly used in the NO-NL direction and the Norwegian fuel mix is mainly based on hydro, the use of renewable energy increased in NL. In Norway, hydro production increased with 4.3% in 2008 compared to 2007.
- Whether the NorNed cable increased storage is unclear. The use of Dutch night power was not as high as expected. Also, the impact on supply disruption is unknown.

Impact on sustainability

- The NorNed project contributed to European sustainable objectives. The impact on CO_2 emissions highly depends on the direction of power flows through the cable given the differences in production portfolio in the Netherlands and Norway. While in the Netherlands 89% of installed capacity is based on fossil fuel generation with high CO_2 emissions, Norwegian fuel mix is 96% based on hydro.
- In the first year, transports were mainly directed towards Norway leading to a net increase in CO_2 emissions in the system. In 2014, electricity flows from Norway to NL surpassed flows in the other direction leading to a reduction of around 5% of total CO_2 emissions of the Dutch power sector.

Impact on affordability

- Production costs decreased since import of cheap energy pushes more expensive plants out of the market and enables the Dutch fossil-fuelled power plants to run more efficiently at constant base load. Prices converged due to exchange over the interconnection.
- As Tennet stated, the NorNed cable increased the price stability in the Dutch wholesale electricity market: in the first weeks after start of operation of the NorNed cable, the APX index for Dutch next-day electricity would have been over three times higher without the buffering effect of NorNed.*

* As an example, the APX Index for 6 May 2008 reached 180 Euro/MWh, without the NorNed cable this price would have spiked to 500 Euro/MWh on several occasions.

Sources: NVE, ENTSO-E, Nordic HVDC Utilization and Unavailability Statistics 2013, TenneT (2008)

The NorNed project was challenged by EU's adjustments of energy policy in the 90s, but was realised due to a long-term vision on the benefits of a common grid

Policy framework in the 90s challenged the NorNed project…

- Lessons learned -

1. **Regulatory stability is key in cross-border infrastructure projects**. Quite after the first agreement in 1991, the project was delayed when Netherlands' transition to a liberalised power market in the 90s changed the institutional and economical situation. Furthermore the project started just when the European Union was created and a common energy policy was nascent. The NorNed projects show that it is key to have a stable legal and regulatory framework to offer incentives for investments in the European electricity grid.
2. **Long decision-making process might lead to uncertainty of business case.** Especially due to the long period between planning and final commissioning of an infrastructure project as NorNed the policy priorities or governments may change.
3. **Harmonise regulations and provide incentives to invest in | cross-border infrastructure projects**. The NorNed initiative had to deal with difficulties of regulatory uncertainty due to national yardstick regulation, which introduces uncertainty as to the feasibility of the business case for large-scale infrastructure projects. Since TenneT and Statnett built the NorNed cable, the European regulatory framework concerning interconnection has strongly caught up with the challenges. The framework now includes special rules concerning Projects of Common Interests, and introduces new financial incentives. It additionally enhances cooperation on licensing. Finally, the 10-year network development plans give a sense of direction so TSOs can work together in a coordinated fashion in realising a European grid.

… but it was maintained due to a strong vision of a common grid

- Key success factors -

1. **Shared cross-country strategy** Having a long-term European vision on the development of a trans-European grid is essential in order to plan welfare increasing connections and to stimulate the political decision-making process when approving investments in cross-border connections. As a TEN-E project, the NorNed cable was able to maintain attention as an important grid-developing project over the years until operation.
2. **A vanguard is essentially needed for bringing the different interests of market player together.** To drive the long-term strategy, institutions like ENTSO-E or other multilateral platforms, where technical standards as well as strategy conformed activities can be developed on a more informal, knowledgeable and non-political basis, are essential.
3. **Create a win-win-situation**. By interconnecting the electricity grids between countries, responsibilities, profits and risks can be shared equally among the countries involved. Policy coordination should aim at using each other's strengths to create a win-win- situation and increase the benefits on a systems level.

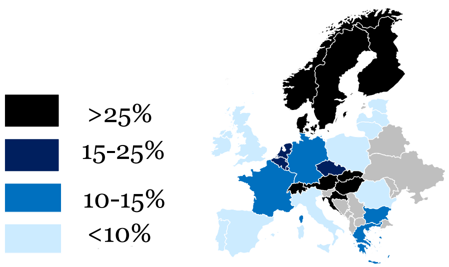
Sources: SEFEP (2012)

Further steps are necessary to benefit from cross-border interconnection and to cope with the challenges of integrating renewable energy into our electricity system

Future of coordination: A further increase in the level of coordination…

- Energy interconnection has been present for almost 100 years now, but is still a top priority in the evolving European electricity market. The benefits of an interconnected electricity grid for security of supply and a resilient European electricity market can't be dismissed but many countries are still not sufficiently connected, leaving bottlenecks in the energy grid. Interconnection levels below 10% in Spain and Italy, and below 15% in France and Germany are too low for an effective internal energy market. TenneT's COBRA and Nordlink cables are significant contributors to these policy goals.
- The energy union plans of the European commission reflect understanding of this issue and aim at reaching an interconnection of 15% of their installed production capacity in 2030 . Some parts of the country already are fairly interconnected (please refer to the picture below), but some countries like Spain and Italy still can benefit from increased interconnection.

Current Projects – Several projects are currently running to overcome these bottlenecks.
(Percentages refer to interconnection capacity as percentage of installed generation capacity)



Source: ENTSO-E

…and coordination in new areas is required since due to increased interconnection countries increasingly impact each other

1. **Coordinating renewables and storage** Dealing with intermittent supply is a key part of the challenge of integrating renewables in the grid. Interconnection is a vital component of dealing with this challenge, as it allows for smoothing of different intermittent supply patterns across countries and for some degree of hydro-based storage.
2. **Opportunities for joint balancing** An extensive cross-border transmission grid enables countries to better balance their load. However, without a substantial grid, these types of coordination will not exist. The first step, therefore, is to continue international grid extensions. Case 2 will go more deeply into the policy and market conditions for effective balancing.
3. **National and international grid planning** National grid plans need to be optimised and coordinated:
   - National grid plans currently do not sufficiently take into account bordering countries' or international plans. Calculations that form the backbone of the TSO grid capacity planning do not include expansion plans in neighbouring countries;
   - Some international grid plans fail or do not come off the ground as local grids are not reinforced to deliver the internationally traded power; and
   - Secure financing, easy permission rules, and closing regulatory gaps are key conditions to speeding up infrastructure investments. These aspects have been included in ENTSO-E's current e-Highway2050 study. This study analyses how to build a modular development plan for the European transmission network from 2020 to 2050 with a view to meeting EU energy policy objectives.

Sources

- **ENTSO-E (2012):** ENTSO-E views on energy roadmap 2050, 05.06.2012, https://www.entsoe.eu/fileadmin/user_upload/_library/news/e-Highway2050/120605-ENTSO-E_VIEWS_ENERGY_ROADMAP_2050-Final.pdf
- **ENTSO-E (2015):** Towards an Energy Union: ENTSO-E's Initial Proposals for a European Energy Union, Position Paper, 05/03/2015, https://www.entsoe.eu/Documents/Publications/Position%20papers%20and%20reports/150303_ENTSO-E_Position%20Paper_Energy%20Union.pdf
- **Lagendijk (2008):** Electrifying Europe, the power of Europe in the construction of electricity networks
- **NIB (2007):** Nordic Investment Bank - New subsea link a sustainability showcase, 10/2007, http://www.nib.int/news_publications/cases_and_feature_stories/new_subsea_link_a_sustainability_showcase
- **Nordic HVDC Utilization and Unavailability Statistics 2013**
- **SEFEP (2012):** Norway and the North Sea Grid, Working Paper 2012-1, 01/2012, http://www.sefep.eu/activities/publications-1/Norway%20and%20the%20North%20Sea%20Grid%20-%20SEFEP%20working%20paper.pdf
- **Statnett/TenneT (2008**): NorNed – Europe's link for the future, 08/2008, http://www.tennet.eu/de/fileadmin/downloads/Netz-Projekte/NorNed-Europes_link_for_the_future_tcm41-18745.PDF
- **Statnett (2011)**: Summary of Area Study of Southern Norway – Consequences of increased interconnector capacity", 28/09/2011, http://www.statnett.no/Documents/Nyheter_og_media/Nyhetsarkiv/Vedlegg%20til%20nyhetssaker/Vedlegg%202011/English%20summary%20of%20Area%20study%20Southern%20Norway.pdf
- **Tennet (2008):** Norned cable off to a promising start, 09/07/2008, http://www.tennet.eu/nl/news/article/norned-cable-off-to-a-promising-start.html
- **TenneT (2012):** NorNed cable yields positive results, 18/05/2012, http://www.tennet.eu/nl/news/article/norned-cable-yields-positive-results.html
- **UCTE (2009)**: The 50 Year Success Story – Evolution of a European Interconnected Grid

Sources

- **Dte (2004):** Kennisgeving NorNed-besluit, https://www.acm.nl/nl/download/bijlage/?id=5331
- **Dte (2006)**: Decision regarding the introduction of a specific auction system… http://www.tennet.org/english/images/071128_GridCode_UK_tcm43-15264.pdf
- **ENTSO-E (2012):** ENTSO-E views on energy roadmap 2050, 05.06.2012, https://www.entsoe.eu/fileadmin/user_upload/_library/news/e-Highway2050/120605-ENTSO-E_VIEWS_ENERGY_ROADMAP_2050-Final.pdf
- **ENTSO-E (2015):** Towards an Energy Union: ENTSO-E's Initial Proposals for a European Energy Union, Position Paper, 05/03/2015, https://www.entsoe.eu/Documents/Publications/Position%20papers%20and%20reports/150303_ENTSO-E_Position%20Paper_Energy%20Union.pdf
- **EC (2004):** Trans-European Energy Network, TEN-E priority projects
- **EC (2015):** Communication from the commission to the European parliament and the council, http://ec.europa.eu/priorities/energy-union/docs/interconnectors_en.pdf
- **Lagendijk (2008):** Electrifying Europe, the power of Europe in the construction of electricity networks
- **NIB (2007):** Nordic Investment Bank - New subsea link a sustainability showcase, 10/2007, http://www.nib.int/news_publications/cases_and_feature_stories/new_subsea_link_a_sustainability_showcase
- **Nordic HVDC Utilization and Unavailability Statistics 2013**
- **NVE (2009):** Energy in Norway 2008, http://www.nve.no/Global/Energi/Analyser/Energi%20i%20Norge%20folder/Energy%20in%20Norway%202009%20edition.pdf
- **SEFEP (2012):** Norway and the North Sea Grid, Working Paper 2012-1, 01/2012, http://www.sefep.eu/activities/publications-1/Norway%20and%20the%20North%20Sea%20Grid%20-%20SEFEP%20working%20paper.pdf
- **Statnett/TenneT (2008**): NorNed – Europe's link for the future, 08/2008, http://www.tennet.eu/de/fileadmin/downloads/Netz-Projekte/NorNed-Europes_link_for_the_future_tcm41-18745.PDF
- **Statnett (2011)**: Summary of Area Study of Southern Norway – Consequences of increased interconnector capacity", 28/09/2011, http://www.statnett.no/Documents/Nyheter_og_media/Nyhetsarkiv/Vedlegg%20til%20nyhetssaker/Vedlegg%202011/English%20summary%20of%20Area%20study%20Southern%20Norway.pdf
- **Tennet (2008):** Norned cable off to a promising start, 09/07/2008, http://www.tennet.eu/nl/news/article/norned-cable-off-to-a-promising-start.html
- **TenneT (2012):** NorNed cable yields positive results, 18/05/2012, http://www.tennet.eu/nl/news/article/norned-cable-yields-positive-results.html
- **TenneT (2015):** Interview
- **UCTE (2009)**: The 50 Year Success Story – Evolution of a European Interconnected Grid

Case 2: Balancing services for power

Effective power system balancing is a key component to ensuring security of supply

Introduction to the case

To optimise affordability, sustainability and reliability of the energy system in Europe, the European Commission aims to establish an internal energy market. Free movement of capital and labour, goods and services is an important factor to achieve competitive markets. Accordingly, uniform energy market rules and cross-border infrastructure enable and improve an efficient distribution of resources (energy supply and demand). Besides, such an integrated market should provide the right signals and incentives to both investors and consumers.

Since electricity cannot be stored like 'normal' goods (at least not in large amounts), supply and demand of electricity need to be balanced. This balancing act is crucial for the electricity system to ensure security of supply and thus to keep the lights on. Effectively and efficiently sharing and addressing the potential of balancing resources can increase reliability and decrease costs.

A critical success factor in this process is clear rules and guidelines, because of the complexity and the importance of cross-border balancing. Consequently, success depends on the extent to which barriers can be overcome to harmonise the rules.

In this respect, the aim of this case study is to identify what can be learned from the International Grid Control Cooperation (IGCC) case, by the way barriers encountered were addressed from an international policy perspective. After a brief description of the historical background, balancing and
cross-border balancing is explained in more detail. Subsequently, the case, the impact on the energy trilemma, the lessons learned, and success factors for future policy coordination is discussed.

History of balancing

From an international perspective, the history of balancing dates back to beginning of UCPTE (Union for the Coordination of Production and Transmission of Electricity) which was established (1951) to fuel the economy during the reconstruction phase after WWII, by supporting cross-border coordination and to optimise operational management of electric power plants (*please refer to the first case of this report*).

One of the successes of UCPTE was using surplus generation (mainly due to hydro) to balance a shortage in generation in another country. During the 1960s, the uniform 380 kV grid extended across the majority of Western and Central Europe enabling the control system of primary control (based on the common reference value the uniform frequency on the interconnected grid). Further cross-border balancing is the main topic of the Network Code on Electricity Balancing.

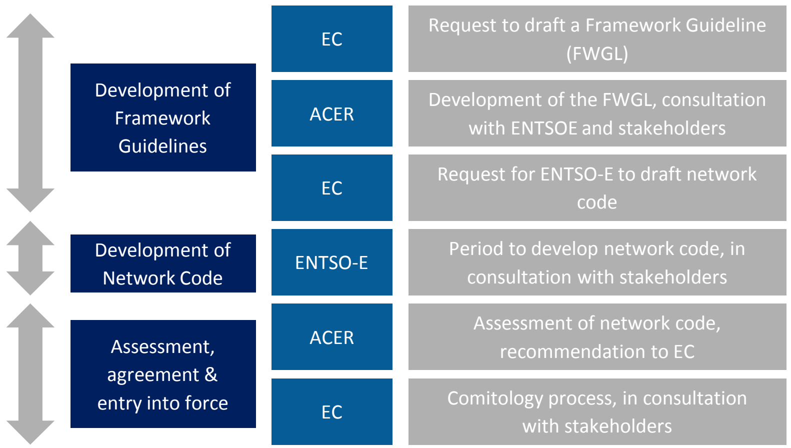
The increasing dependence on renewables for Europe's electricity supply increases the need for a cross-border balancing mechanism

Why is balancing important?

One of the key roles of TSOs is to ensure generation equals demand in and near real time. They do this after markets have closed (gate closure).

The European grid operates at a nominal frequency of 50Hz. Deviations from the nominal frequency can occur due to unexpected fluctuations in demand or generation. The three main causes of imbalance are events (disturbance/outage of generation, load or interconnector), stochastic imbalances like load noise, inaccurate control of generation and forecast errors, and market-driven imbalances because of ramping (between PTUs, at hour shift). However, the network frequency of a power system must always be maintained within predefined limits to ensure a reliable operation. To enable this, different categories of balancing resources are needed and should be available within a specified time.

Process of network code development



Network codes on balancing are increasingly aligned

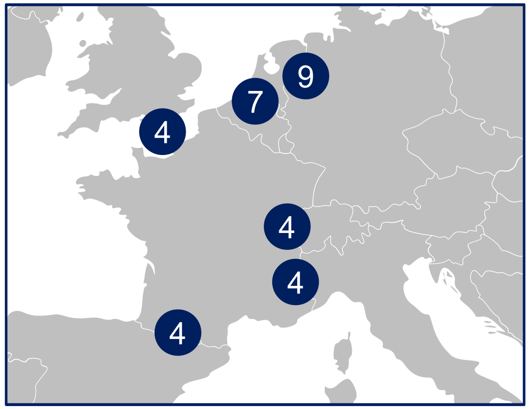
To achieve an internal electricity market requires significant reforms, as described in Directive 2009/72/EC and Regulation EC No. 714/2009 (3rd package), significant changes are needed in the way the system is operated. These arrangements are defined in Network Codes (NCs) endorsed by regulators, network operators and the European Commission (EC).

On December 21, 2012, the EC formally requested ENTSO-E start developing the NC on Electricity Balancing (EB) in line with the principles as set out by the Framework Guidelines on EB developed by ACER in 2011/2012, foreseeing arrangements to foster cross-border exchange of balancing services. The draft NC EB was delivered to ACER in December 2013 after public consultation in summer 2013. ACER provided its reasoned opinion in March 2014 and recommended the NC EB for adoption on 22 July 2015.

The rationale for the NC EB is that effectively sharing the balancing resources between countries can enhance security of supply, increase cross-border competition in the balancing time frame, reducing cost, thus increasing social welfare. Furthermore, it anticipates a number of developments, such as: (1) the growing share of renewable generation, potentially leading to higher balancing needs and lower balancing supply if the current balancing markets design remains unchanged; (2) the expansion of the power system with both synchronous and DC interconnections. Besides, the further restructuring of the electricity market can lead to changing needs for balancing resources.

The TSOs have agreed to use pilots to test out balancing arrangements before updating the network codes

Overview of balancing pilots



Source: ENTSO-E

Setting up pilots requires stakeholder involvement and alignment of interests…

To achieve and realise a successful implementation of the NC EB, a number of pilots have been started. An Electricity Balancing Stakeholder Advisory Group was set to involve all interested parties from the earliest phase possible regarding the design, implementation and governance issues related to pilot projects. The IGCC imbalance netting pilot (nr. 9 on the figure below) is one of the pilots that have been initiated to support a successful implementation of the Network Code on electricity balancing. Besides the IGCC pilot, also pilots for, among others, the integration of electricity balancing markets (nr.7), Trans-European replacement of reserves exchange (nr. 4 – TERRE), and for a cross-border market for FCR have been set up.

To foster the pilots, TSOs were supposed to form a "Coordinated Balancing Area" (CoBA) with at least one TSO operating in a different member state. The CoBAs form a vehicle to achieve integration in the different time frames, with the aim of the exchange of balancing services. Within a CoBA, every TSO is obliged to exchange at least one standardised product (exchanging balancing capacity, balancing energy or sharing reserves) or to implement the application of imbalance netting.

…and this pragmatic approach enables and fosters commitment, support and flexibility

It is believed by ENTSO-E and the stakeholders that this pragmatic and incremental approach will lead to the best outcome by allowing all stakeholders to gain and share experience. Developing a single overall solution from scratch is expected to take more time than starting and progressing with regional balancing markets. This approach enables both TSOs and balancing market participants to investigate and determine how to realise optimal results from cooperation. Seeing and understanding the lessons learned from practice will contribute to stakeholder support and commitment. Because of a phased approach, there is room for flexibility from the beginning. As time goes, cooperation within a CoBA between the TSOs becomes more intense. Eventually, a phase that can be characterised by framing and choosing will be reached, where also cooperation with neighbouring CoBAs will take place and increase. Finally, all CoBAs need to be aggregated to reach the target of a single pan-European common merit order list (goal FG EB).

ACER proposed certain amendments on CoBA functions, in its Recommendation No 03/2015 of 20 July 2015 on NC EB, by suggesting that each task executed in a CoBA has to be assigned to an entity that is appointed by all TSOs in that CoBA. The motivation of ACER for this requirement is providing clarity, ensuring efficient functioning of balancing markets, and to prevent the decentralised options for operation of regional balancing markets.

Detailed case study - IGCC as part of XB balancing reduces the need for balancing actions

International Grid Control Cooperation (IGCC) to stimulate netting of imbalance

In compliance with the aforementioned EC Regulation and Directive, the guiding principles of the NC EB are for integration, coordination and harmonisation of the balancing regimes in order to facilitate electricity trade within the EU. Accordingly, the main goal of the NC EB is to achieve a harmonised and coordinated set of procurement, capacity reservation and settlement rules. This can be applied to the various balancing products. Options for cross-border (XB) balancing are imbalance netting, common merit order, reserve sharing and exchange of reserves. These options can be distinguished by whether its about energy or capacity, whether it has an impact on volume or price and whether harmonisation of rules is necessary or not.

The objective of International Grid Control Cooperation (IGCC) is to increase the efficiency of balancing on European level through netting of imbalance.

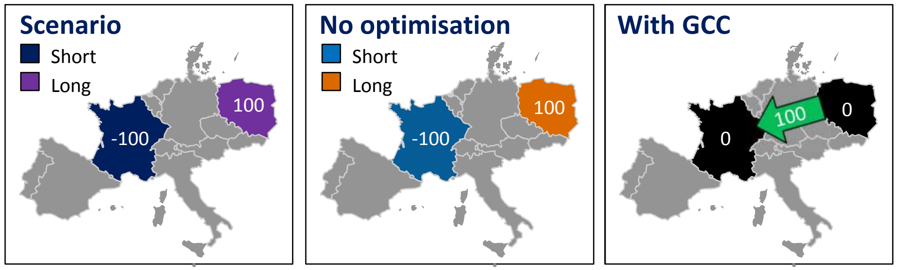
Technically, the IGCC performs an automatic netting of active power imbalances across control area borders. Through this, cross-border counter regulation is avoided which enables all participating Transmission System operators (TSO) to reduce their utilisation of control energy and increase their disposable control reserves to ensure system security. Based on the determined balancing requirement of individual TSOs, energy is transferred from a TSO whose control zone has too much energy (and is thus oversupplied) to a control zone that has too little energy (and is thus undersupplied). As a consequence, the demand for control power of each TSO is reduced and no more control power is deployed than needed to satisfy the remaining demand.

The International Grid Control Cooperation initiative builds upon Grid Control Cooperation, a joint balancing control area with joint coordinated procurement of secondary reserve capacity including all four German transmission system operators was established in 2010. This cooperation was extended in 2012 to the IGCC (International Grid Control Cooperation), which is limited to the avoidance of counter activation between two countries (imbalance netting). Hence there is no joint procurement or activation of FRR that could require the alteration of national framework conditions.

Additional participants since 2012 are Energinet.dk (Denmark), Swissgrid (Switzerland), CEPS (Czech Republic), Elia (Belgium) and TenneT TSO B.V. (the Netherlands). Due to the involvement of APG that joined IGCC in 2014, the project now consists of 10 TSOs from seven countries. Since its foundation in October 2011, the IGCC has produced cost savings of more than 100 million Euros.

As a next step, IGCC TSOs envisage to investigate enhancements of IGCC settlement. In addition, there are ongoing talks with further TSOs to join the IGCC (see example figure to the right).

How does Grid Control Cooperation work?

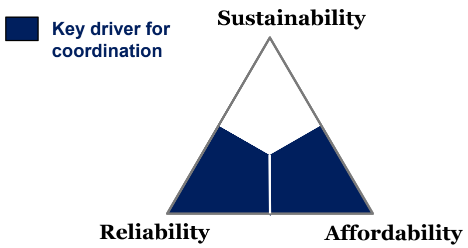


Source: based on Amprion, 2014

The IGCC case had a positive influence on two of the three policy goals and potentially also on the sustainability goal

Tackling the Trilemma

Reliability and affordability drove the development of the IGCC



The primary goal of the IGCC initiative was to deliver balancing services to guarantee security of supply at a lower cost level.

The most eye catching results of the pilot for IGCC are the annual reduction of balancing cost by more than 50 million Euros. The cumulative cost saving by avoiding positive, respectively negative counteracting secondary control energy already add up to more than 100 million Euros. Besides, the IGCC interchange improved the Area Control Error (ACE1) or Frequency Restoration Control Error (FRCE) quality of the single participating Control Blocks and of the joint ACE quality of the participating Control Blocks. The IGCC interchange also improves the joint frequency quality of the Synchronous Area.

Impact on reliability

- In the IGCC case, the reliability of power supply increases due to higher availability of reserves. This advantage may later (partly) disappear when a new equilibrium is in place at the same reliability as before the introduction of the IGCC. The extra reliability is then transferred in a cost advantage or in other words, there is a trade-off between reliability and cost.

Impact on sustainability

- Balancing itself has little influence on the sustainability of the power supply. It does, however, enable the integration of variable renewable energy which leads to a more sustainable power supply.
- Cross-border balancing proved to make the power system more flexible which enables increased integration of VRE which leads to increased sustainability. Cross-border balancing also leads to less requirement of combined reserve capacity which in the end leads to less investment in hardware which benefits the sustainability.

Impact on affordability

- IGCC leads to lower cost of balancing. The annual advantage with the present participants is estimated at 50-70 million Euros. The lower costs result in lower balancing prices and, therefore, in better affordability. Affordability will further increase since less overall investment is required (see also adjacent text about reliability. All in all social cost is lower.

The use of pilots and voluntary growth of countries involved were key success factors at the beginning of cross-country coordination of balancing

Contractual issues have slowed down the implementation of IGCC

- Lessons learned -

1. **Contractual issues can get in the way** – Because of the increased number of IGCC members, a multilateral structure was required to promote cooperation among the members. Accordingly, both the IGCC Steering Committee (IGCC SC) and the IGCC Expert Group (IGCC EG) were set up, with the first task to design a new multilateral agreement (MLA) building on the existing bilateral agreements with the German TSOs. Despite the fact that the MLA was constructed for an existing cooperation, the process raised several questions, resulting in a significantly longer drafting period than expected beforehand. Consequently, the learning point for other initiatives is that contractual issues can slow down and delay the implementation of new initiatives.

Organic growth and working with pilots were key success factors

- Key success factors -

1. **Voluntary growth of the countries involved** – In the first years of IGCC, the cooperation grew gradually as a set of bilateral cooperations between the German TSOs and the respective neighbour. Important success factor for the cooperation leading to the extension of IGCC with six more countries outside Germany was this organic growth (see also the adjacent figure with increasing number of participants).
2. **Working with pilots brings advantages** like a low threshold for starting and the possibility to quickly start initiatives. TSOs are learning from the pilot projects what the key issues are in cooperation and coordination. This will affect regional implementation models, imbalance settlement, products, pricing, algorithm, etc. that will result from the network code on electricity balancing (NC EB). It also contributes to implementation of network codes. Experiences are shared with establishing, extending and creating internal decision and working structures as well as high-level principles for used imbalance netting algorithm, opportunity price determination and settlement methodology.
3. **Well-functioning governance bodies** – A key success factor for further development of cooperation, coordination and integration is the establishment of well-functioning governance bodies. These bodies need to take and guide the required initiatives as well as agree on responsibilities and decision-taking processes.
4. **Stakeholder involvement** from beginning, ensuring open and transparent process while creating support, involvement and commitment.

There is further potential for coordination, for instance, by extending the imbalance netting throughout Europe

Future of coordination: extend IGCC imbalance netting…

There is more potential for cooperation, coordination and integration with regard to cross-border balancing. First thought would be to extend the imbalance netting throughout Europe. There is a non-disclosure agreement for the TSO(s) that wish to become member(s) and there is a plan to make a quick guide on how to join IGCC. As mentioned before, the annual advantage with the present participants is estimated at 50-70 million Euros. The share of electricity consumption of the participating countries compared to the overall ENTSO-E consumption is about 30%. Without further investigation of the imbalance situation in the other countries, one may expect an additional annual benefit of roughly 100-150 million Euros when netting would be implemented across Europe.

…improve current netting…

A second idea is to improve the current imbalance netting. The imbalance netting is limited to the available cross-border transmission capacity (ATC) values after intra-day allocation to market participants. Thanks to successful operation of the flow-based congestion management within IGCC, the GCC (grid control cooperation) is currently evaluating its usage within IGCC. Since the flow-based capacity is generally larger than the ATC-related capacity, more room for imbalance netting will evolve.

… and implement other types of balancing coordination further to reap additional benefits

Different system studies show further financial benefit from further coordination and integration of balancing. These additional benefits may be in the same order of magnitude as the benefits from netting (Booz & Co, 2013 and DIW, 2014). Total expected benefits are then roughly 100 –150 million Euros per year for the present power system. In future increasing RES will push the balancing effort and cost, and it is expected that potential benefits will then also increase. A study for the European Commission of 2013 indicates a saving of between €300m and €500m per year by 2030 from sharing balancing reserves (EC, DG ENER, 2013).

Further coordination and integration however will be more difficult than the fairly simple netting of imbalances. One idea for further coordination and integration is the integration of individual merit orders for the activation of balancing energy into a common merit order (CMO), thus ensuring the selection of the most efficient bids. Establishing a common merit order list for balancing energy requires a fair amount of harmonisation: the procurement procedures and time frames need to be harmonised as well as the products. Further the TSOs have to align on activation and settlement principles. Also governance and settlement will require more effort. Here, once again an incremental and regional-based approach is performed.

Besides further coordination and integration of the present balancing practice another opportunity for saving balancing cost would be the transition to a double-sided balancing power market. By making market parties responsible to cover their portfolio uncertainty, not only supply side but also demand side bidding is possible, which enlarges the balancing possibilities in a system with lower cost as a result (DNV Gl, 2015, E-Price).

An important factor of integrating balancing markets is that this process considers both market efficiency and system security in compliance with the relevant network codes. In other words, progressive harmonisation is preferred over the development and implementation of an overall single solution for harmonisation of all balancing markets. After all, the balancing services are a last resort for TSOs to ensure operational security, and thus to keep the lights on.

Sources

- Amprion, Grid Control Cooperation within Germany and in Grid Control Cooperation within Germany and in Europe, Andreas Walczuch, 06. February 2014
- Booz and co, Benefits of an Integrated European energy market, July 2013, https://ec.europa.eu/energy/sites/ener/files/documents/20130902_energy_integration_benefits.pdf
- TenneT, Elia, Design of a harmonised reactive balancing market with cross zonal optimisation of frequency restoration between LFC Blocks. Final report of step 2 of XB balancing pilot project BE-NL, 17 October 2014, http://www.elia.be/~/media/files/Elia/users-group/CoBa_phase_2report_V6_1710.pdf
- DIW Berlin , New Cross-Border Electricity Balancing Arrangements in Europe, 2014, https://www.diw.de/documents/publikationen/73/diw_01.c.470807.de/dp1400.pdf
- Mott Mac Donald, 2013, Impact Assessment on European Electricity Balancing Market, https://ec.europa.eu/energy/sites/ener/files/documents/20130610_eu_balancing_master.pdf
- ENTSO-E, Network code on electricity balancing, version 3.0, August 2014, https://www.entsoe.eu/Documents/Network%20codes%20documents/NC%20EB/140806_NCEB_Resubmission_to_ACER_v.03.PDF
- ENTSO-E, Electricity Balancing Pilot Projects 1 & 9 – Experience and Current Status, https://www.entsoe.eu/Documents/Network%20codes%20documents/Implementation/Pilot_Projects/140514_CBB_pilot_projects_1-9.pdf
- ENTSO-E, Balancing Pilot Projects, Brussels, December 2014, https://www.entsoe.eu/Documents/Network%20codes%20documents/Implementation/Pilot_Projects/141217_CBB_pilot_projects_overview.pdf
- ENTSO-E, Cross Border Electricity Balancing Pilot Projects, 2 Month Report on Pilot Project 9 (IGCC), Tomáš Bednář (CEPS), 25 June 2015, https://www.entsoe.eu/Documents/Network%20codes%20documents/Implementation/Pilot_Projects/D150625_Report_P9.pdf
- IGCC, International Grid Control Cooperation, 2012, Information on grid control cooperation and international development, http://www.tennet.eu/nl/fileadmin/downloads/About_Tennet/Publications/Other_Publications/plugin-Market_information_IGCC_tcm43-20521.PDF
- UCTE, The 50 years success story, 2011, https://www.entsoe.eu/fileadmin/user_upload/_library/publications/ce/110422_UCPTE-UCTE_The50yearSuccessStory.pdf
- “Exciting times for the Dutch grid. How to create a healthy electricity market for a new energy landscape?”, DNV GL 2015
- http://www.e-price-project.eu/

Case 3: Joint renewable electricity support scheme

The joint Swedish-Norwegian certificate market for renewable electricity – long-term predictability for investors through a politically stable system

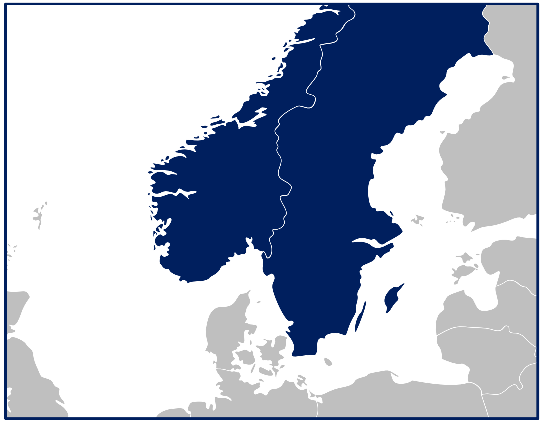
Introduction

With the establishment of the joint certificate market for renewable electricity in 2012, Sweden and Norway were among the first countries and so far the only ones to use cooperation mechanisms as provided by the Renewable Energy Directive 2009/28/EC. Negotiations between the two countries, though, already date back to before the Renewables Directive even provided the option of joint support schemes.

In 2003, Sweden introduced its renewable electricity certificate system, thereby implementing the Renewable Energy Directive 2001/77/EC for the promotion of renewable energy. Bilateral negotiations with Norway started shortly after that. The motivation for a joint support scheme primarily lay in the political desire for better market functioning by having a higher liquidity in the market and better price formation. It was also assumed that a bigger market would be more attractive to investors. A larger production base would furthermore increase cost efficiency. Established in 2012, the joint market is an example for political commitment of two countries, providing long-term predictability for investors through a politically stable system.

This case study highlights the milestones of the political process, points out the challenges and solutions found and draws lessons learned during the first three years of the joint market.

Joint Swedish-Norwegian RES-E certificate market



The evolution of policy coordination: nine years from first discussions to a joint certificate market

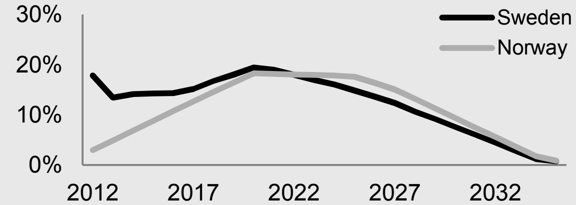
Key features of the certificate scheme

Sweden and Norway have a joint electricity certificate scheme since 2012. The mutual goal is to reach 26.4 TWh of renewable electricity by 2020. Under the scheme, eligible renewables production gets one certificate per produced MWh during 15 years.

The certificate price is created on the joint market as a result of supply and demand. Demand for electricity certificates arises due to an obligation for power suppliers and certain power customers to buy electricity certificates corresponding to a certain proportion (quota) of their sales or usage.

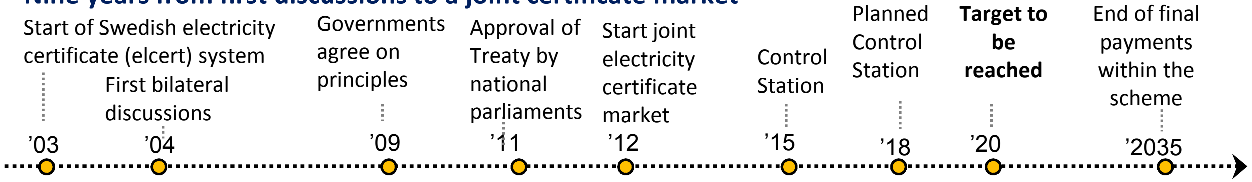
Both countries have individual quota curves, designed to stimulate the development of renewable power production. The respective countries' quota curves are calculated and set based on assumptions of future power demand. If the actual demand deviates from expectations, quota curves could be adjusted without changing the overall target of each 13.2 TWh.

Quota curve (percent)



Source: Lag (2011:1200)

Nine years from first discussions to a joint certificate market



First negotiations 2003 - 2006

The Swedish government decided to start a certificate scheme for promoting renewables electricity production in 2003. Among the reasons to choose a certificate scheme was that a certificate scheme could be extended to other markets. There was a strong belief among Swedish politicians that renewable deployment in the EU would be increasingly internationalised and jointly realised.

Active discussion between Norway, as a member of the European Economic Area (EEA), and Sweden about a joint system started in 2003. The motivation for joint support scheme primarily lay in the political desire for better market functioning by having a higher liquidity in the market and better price formation. It was assumed that a bigger market would be more attractive to investors and a larger production base would increase cost efficiency. Despite all efforts, negotiations failed in 2006 due to price projections showing too high price increases for Norwegian customers, and fear that investments would take place mainly in Sweden. The Swedish government did not approve the proposed low ambition for the quota curve to be applied in Norway.

Resumed negotiations in 2008 leading to a joint support scheme in 2012

In 2008 in relation to a cross-partisan compromise on Norwegian climate policy, parties agreed that Norway should resume negotiations with Sweden. Earlier hurdles were overcome and the principles for the joint scheme were agreed by both governments in 2009. A treaty containing growth ambitions and general specifications was signed in 2011. The joint market started on 1st January 2012.

Regular reviews ('control stations'), are scheduled every 5 years to ensure target achievements and flexibility in case change is required. Due to the overall economic, capacity and consumption situation, prices are currently low. Therefore investments have slowed down, but are still on track. Nevertheless, the scheme so far is successful given that it has incentivised new renewables at low costs for customers.

Based on political commitment, a joint system was created that ensures market-based support for renewables growth in both markets

Key issues and solutions in the development of a joint renewable certificate scheme

In the process of realising a joint renewable certificate scheme, various challenges had to be overcome:

- **Political acceptance that the market decides where built-out will take place**

  Initial worries in Sweden were that most of the production would be allocated in Norway due to hydro power potentials and good wind conditions. Similar concerns, that built out would take place in Sweden, were at the Norwegian side as Sweden benefited from several years of experience operating a certificate system. Still, both countries could agree on the market-based system because of political support.

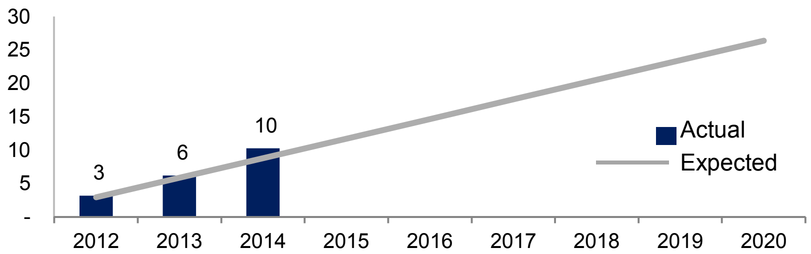
- **Contributions of both countries to target achievement**
  Moreover, ambition levels for renewables growth in both countries needed to be set. After initially more moderate ambitions by Norway, the two countries agreed to equally contribute to the 26.4 TWh target, which was also seen as needed to have public acceptability.

- **Harmonised and non-harmonised parameters to reflect country differences**
  As Norway was going to join the already existing Swedish certificate scheme, it needed to be clarified to what extent the Swedish specifications were applicable to Norway. In the end, the two countries decided to have both harmonised and non-harmonised parameters. There is, e.g. a difference in what production is eligible or which parties are obliged to fulfil the quota. Such differences don't undermine the overall target achievements, but are crucial to reflect national circumstances.

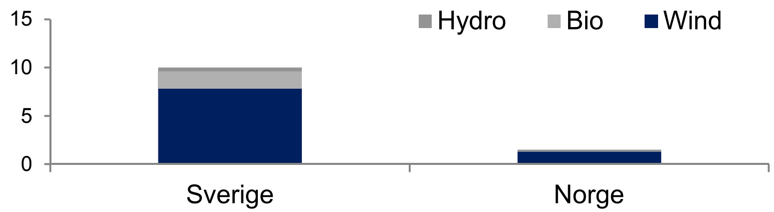
- **Ensuring continued cooperation and information exchange**
  The authorities have created a specific coordination board, with regular meetings for information exchange, planning of the control stations, etc. Regular meetings for politicians are set up. This is important to ensure continued political commitment.

- **The need for control stations to adapt system when needed**
  Another challenge was to provide a long-term stable policy framework for investors but at the same time have the necessary flexibility to react on developments. Therefore, coordinated control stations every 5th year, when adjustments can be made, regarding the quota, were set up.

Expected cummlative new RES-E production in Sweden and Norway given the 26.4 TWh target



New RES-E production 2014

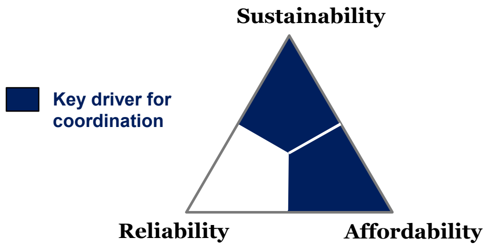


Source: Swedish-Norwegian electricity market - Annual Report 2014

Cost-efficient deployment of renewables as a key motivation for a joint support scheme

Tackling the Trilemma

Affordability and sustainability driver for renewable electricity support scheme



The motivation for a joint support scheme primarily lied within the political desire for better market functioning (higher liquidity in the market and better price formation). It was assumed that a bigger market would be more attractive to investors. A larger production base would also allow for reaching sustainability targets in a cost-efficient manner.

Impact on reliability

The Swedish and Norwegian power markets are both part of the integrated Nordic power market. Increase of cross-border transmission capacity was already, at the time of the establishment of the joint scheme, one of the key policy priorities. In addition, Sweden had in place a strategic reserve to ensure security of electricity supply.

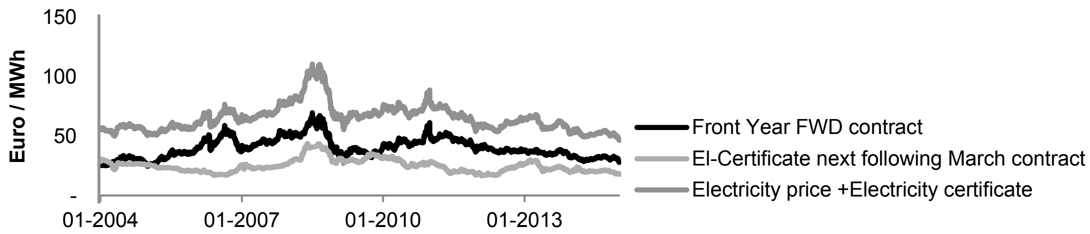
Impact on sustainability

Electricity production in both markets was low CO_2 emitting from the start of the joint support scheme, the two main generation sources being nuclear and hydro and an increasing share of wind.
Since the establishment of the joint support scheme, the renewable electricity production increased by 1.7TWh in Norway and 8.2TWh in Sweden. The overall fuel mix of the two countries did not change significantly; however, the amount of exported electricity increased.

Impact on affordability

One of the main objectives of a joint support scheme for renewables was to increase cost efficiency of renewables deployment. Comparing systems is not easy due to different designs like eligible production, exemptions from financing, etc. In 2013, Swedish customers paid 0.5 ct/kWh in comparison with, e.g. German customers that paid 3.6 ct/kWh, which are nevertheless not fully comparable prices.

Price comparison of products with different maturities



Source: Svensk Kraftmäkling

Well-integrated power markets are one of the key success factors for support scheme coordination

What facilitated the joint renewable certificate scheme agreement

- Key success factors -

- Sweden and Norway are well-integrated electricity markets. As part of the Nordic power market, a common power market exchange was created and border tariffs between the countries were removed. Having well-interconnected markets is an important prerequisite to setting up joint RES-E support schemes.
- Openness and good coordination between Swedish and Norwegian policymakers during the process.

Other success factors

- Broad political support for the joint support scheme from the start in Sweden and with the cross-partisan compromise in 2008 in Norway.
- No political detail steering but leaving the deployment of renewables to market mechanisms. There is no political favouring of locations or technologies that could lead to difference in opinion between the two countries.

What a joint renewable certificate scheme has taught us…

- Lessons learned -

- A support scheme based on competitive bidding procedures increases the options for cooperation. The Swedish government, e.g. explicitly chose the certificate scheme to be prepared for international cooperation. This would similarly apply for, in many member states, currently discussed tendering schemes.
- The consequences of different investment conditions (non-harmonised parameters) in the different jurisdictions should be investigated before entering a cooperation (taxes, write-off rules, etc.). Harmonisation of these parameters may be relevant as well to create a level-playing field. The more harmonised parameters in a joint support scheme, the better.
- A joint national scheme increases the political stability and consequently the stability for investors as two governments would also need to agree to changes.
- Even if the market is pretty small, with comparably few actors and small volumes, the price setting can work well.
- Willingness to pay for production in another country is a key issue and a potential showstopper. Therefore, to be trustworthy for customers/taxpayers in the cooperating countries, the ambitions should be aligned and reflect similar effort-sharing.

Integrated power markets and increased cross-border transmission capacity give rise to new opportunities for cooperation in renewables support going towards 2030

The joint Swedish-Norwegian certificate market is a successful example for energy policy cooperation between countries. General lessons learned for the cooperation with regard to renewable support can be drawn.

Cooperation on renewable electricity support requires:

- Cross-partisan political commitment is needed to ensure stable policy framework even with changing national governments over time
- Creating a level-playing field. The consequences of different investment conditions in the different jurisdictions should be investigated before entering a cooperation (taxes, write-off rules, etc.). Harmonisation of these parameters may be relevant as well to create a level-playing field.
- The more harmonised parameters in a joint support scheme or cooperation, the better.
- Public acceptance of cooperation can be achieved through transparency on the process and equal distribution of effort of participating markets.

The future of policy coordination:

With increasingly integrated power markets and transmission system, a cost-efficient deployment of renewables across Europe becomes more and more realistic. Governments should feel encouraged by the positive example of the Swedish-Norwegian market.

Sources

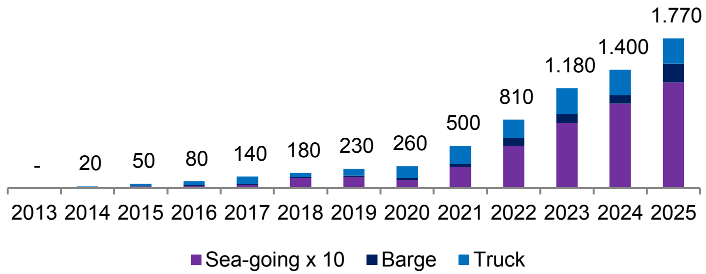
- Swedish-Norwegian electricity market - Annual Report 2014
- Svensk Kraftmäkling (2015) website: www.skm.se
- Lag (2011:1200) om elcertifikat; LOV 2011-06-24 nr. 39: Lov om elcertifikater
- Agreement between the Government of the Kingdom of Norway and the Government of the Kingdom of Sweden on a Common Market for Electricity Certificates (unofficial translation) - https://www.regjeringen.no/globalassets/upload/oed/pdf_filer_2/elsertifikater/agreement_on_a_common_market_for_electricity_certificates.pdf
- A Joint Norwegian-Swedish Market of Green Certificates – Cicero Working Paper 2013:03 (Gullberg), http://brage.bibsys.no/xmlui/handle/11250/192134
- Swedish Energy Agency, https://www.energimyndigheten.se/en/sustainability/the-electricity-certificate-system/
- Norwegian Water Resources and Energy Directorate, http://www.nve.no/en/Electricity-market/Electricity-certificates/

Case 4: LNG as a transportation fuel

Coordination is needed to create opportunities to use LNG in trucks, ships and trains

Greenstream, LNG fuelled inland tanker, source Shell 2013

Total Annual Estimated LNG Consumption for transport in Dutch market (Ton/y)



Source: Nationaal LNG Platform 2012

*Compressed Natural Gas (GNG) and Liquefied Petroleum Gas (LPG or 'autogas') may cause confusion since the abbreviation resembles LNG. CNG is natural gas at high pressure of around 200 Bar and is used in city buses, vans and passenger cars. The reach is lower than a vehicle fuelled by LNG because of the energy density (LNG being appr. 3 times higher). LPG is derived from oil as a product from refining. It is used as 'autogas' for light duty vehicles, and outside the transportation sector (e.g. industrial heating).

Introduction

The transportation sector is traditionally 'oil based'. The policy goals (trilemma) steer towards alternative energies, i.e. biofuels, electricity and hydrogen, and products derived from natural gas, such as LNG*. The alternatives displace oil products like automotive gasoil (AGO or diesel) and marine gasoil (MGO) or marine fuel oil (MFO). LNG for Transport is often referred to as 'small scale LNG' – starting from where 'large-scale LNG' ends.

This case deals with the benefits of policy coordination for LNG used for transport, i.e. the direct use of the liquid gas as energy carrier in trucks, ships and trains. To create opportunities to use LNG for cross-border transportation, e.g. in the Rhine area, investments need to be made in multiple countries, requiring a high level of coordination between market parties as well as governments.

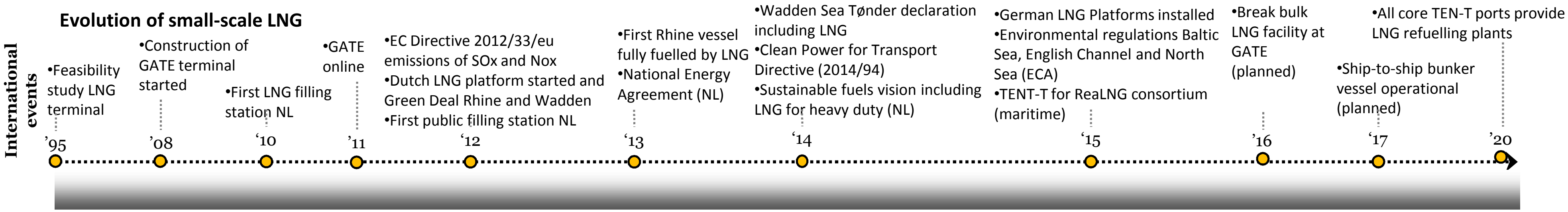
LNG explained

Natural gas is produced from wells, like oil. **Liquefied Natural Gas or LNG** is natural gas at a temperature of minus 162 degrees Celsius. LNG is a cryogen which means that it is a liquid gas at an extremely low temperature. The density is very high: 600 cubic metres of natural gas turn into 1 cubic metre LNG. Furthermore it's colourless, odourless, neither toxic nor inflammable. As soon as LNG evaporates and becomes natural gas again, it is inflammable in combination with oxygen. Because natural gas is lighter than air and disperses quickly, it's inflammable within limited boundaries.

Because of the high density, LNG is a very efficient way to transport natural gas from the producing source to the end users – especially when pipeline transportation is not feasible. Usually LNG is transported by tanker vessels and unloaded at its destination to a terminal in which re-gasification takes place before being imported into the natural gas grid. In the Netherlands the GATE (Gas Access To Europe) terminal receives the overseas tanker vessels to unload LNG to the North Western European market.

An initial LNG infrastructure and some applications in transportation have developed over the past few years. International environmental regulation was a main driver of the demand for small-scale LNG

Evolution of small-scale LNG



Phase

1 Piloting innovations – subsidised (EOS-UKR/Demo)

Policy focus

In 2010 the first LNG filling station was realised in Oss as a result of a joint effort of two operators of trucks – Vos Logistics and Van Gansewinkel – and LNG Europe. In 2012 the first public filling station opened in Zwolle, operated by LNG24 of Salland Olie. Since then the appetite for LNG has increased. GDF Suez (Engie) and Shell built their networks of LNG fuelling stations in the BeNeLux and other operators have become active in the LNG market for transport.

In Norway, Norgas – market leader in small scale LNG – has been successful in implementing LNG in ferries and coastal ships sailing the Fjords. Local air quality was the main driver of this transition from fuel oil to natural gas. The company operates small-scale production plants, tanker ships, a fleet of trucks and a network of terminals. Norgas became part of the Shell Group in 2012.

2 Scaling up, environmental policy as a key driver

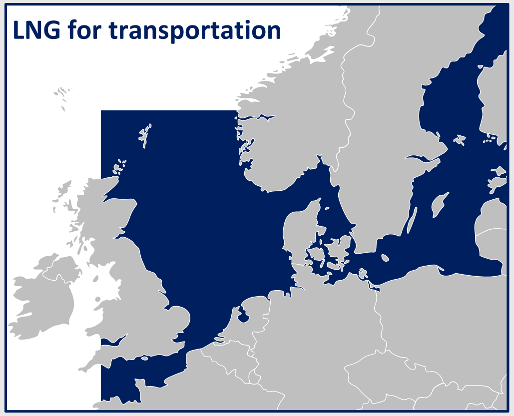
In 2012, the European Union adopted new environmental regulations. Member States had to achieve substantial reductions in 'air-quality emissions' such as sulphur oxides (SOx) and nitrogen oxides (NOx) for the Baltic Sea, English Channel and North Sea by January 2015. In implementing the Directive, the Dutch national government has adopted various measures, such as the abolition of heavy fuel oil and of fuels with a sulphur content above 1.2% of total mass. The 2014 Clean Power for Transport Directive (2014/94) additionally sets out the strategy and policy to realise the necessary infrastructure, recognising the role of LNG in displacing oil in road, rail and water transport modalities.

In 2013 the first Rhine vessel fully fuelled by LNG – the Greenstream – had its maiden voyage. The vessel carries oil products and chemicals for Shell in the Rhine area, Rotterdam/Antwerp to Basel. One year later the sister ship Greenrhine made her maiden trip. Both ships have an LNG installation that fuels a gas turbine. This turbine produces power for the electric propulsion. Similar technologies can be applied in trains on non-electrified tracks. Until then, inland LNG ships had been bi-fuel, a mix of LNG and Marine Gas Oil (MGO). Since end 2014 sea going vessels have been able to fuel LNG at Moerdijk. Currently the bunkering of ships is done from LNG trucks. LNG as a marine fuel has become an attractive alternative for customers looking for cleaner fuel in their mix at a competitive cost level.

The EU TEN-T (Trans European Network – Transportation) provided the consortium 'RealNG' with a grant under the 'Motorways of the Seas' initiative. The consortium was formed by Shell Western LNG, GNS Shipping and Containership Ltd Oy (Finnland), Chemgas Shipping (NL), Stichting STC Group (training and educational tools), Port of Rotterdam and Hansestadt Lübeck Port Authority. Chemgas and GNS are shipowners who have chosen to make long-term investments into LNG propelled vessels. Chemgas will build two LPG carrier vessels and GNS is building a fleet of four short sea container ships. Shell Western LNG is building a bunker vessel. In 2017 all ships are planned to be in operation. The Port of Lübeck is Germany's largest Baltic Sea port and an important link to the entire Baltic region for maritime operators. The Port of Rotterdam will further develop its LNG infrastructure to enable an end-to-end commercial bunker supply chain. Other important initiatives supported by TEN-T are for example the 'LNG Masterplan for Rhine-Main-Danube'.

Policymakers have formulated stimulating policies, supported by platforms for LNG to develop infrastructure and vehicles, since the transition needs investments in both areas (chicken-and-egg problem)

LNG for transportation



The governments have adopted various stick and carrot policies that support the adoption of LNG over oil-based alternatives. These policies have contributed to the development of LNG vessels, vehicles and infrastructure. EU policy on SOx and NOx emissions have spurred national governments to adopt various measures favouring use of cleaner fuels and Green Deals supporting the conversion of ships, vessels and trucks to LNG.

Countries involved

Germany and the Netherlands, Baltic region

A national start…

The national LNG platform ('National LNG Platform') is the body that connects industry and government. The platform started in 2012 to develop the Dutch LNG chain for transport under the umbrella of a so-called 'Green Deal'. The goal of this Deal is to realise 50 inland ships, 50 short sea vessels and 500 trucks by 2015. Part of the Green Deal is the Rhine and Wadden area. Denmark, Germany and the Netherlands are working together to improve the sustainability of the Wadden Sea area which is a United Nations protected area. The goal is to build an LNG infrastructure and fleet (mainly ferries and fishing). One of the initiators is the Energy Valley, the public-private cooperation of the Northern Provinces of the Netherlands.

Following from the national energy agreement ('Energie Akkoord') in 2013, the Dutch ministry of Infrastructure and the Environment (IenM) developed a sustainable fuels vision ('Duurzame Brandstoffenvisie', published June 2014) in close cooperation with industry, knowledge institutes and NGOs. The goal of the fuels vision is to reduce the CO_2 emissions from transport with 60% by 2050 and with 17% by 2030 as the intermediate target. The emission reduction refers to tank-to-wheel and tank-to-propeller respectively. The CO_2 reduction from LNG is in the order of 10-20% compared to diesel fuel or gasoil, and realised in the heavy duty sector where alternatives are less available.

…but international cooperation was needed to solve the chicken-and-egg problem

One of the main reasons for government intervention in the LNG market is the chicken-and-egg problem. No filling stations means no vehicles – and vice versa. Infrastructure and customers need to go hand in hand and market trust at both sides is needed to invest. For this reason, the national and EU governments formulated various policies to support the roll-out of LNG in the Wadden area (*please refer to the next page for an international policy coordination example that (also) stimulated the use of LNG*).

Since there is a great deal of cross-border (both shipping and road) transportation activity between Germany and the Netherlands, these two countries were quick to coordinate policies. In Germany two LNG platforms have been installed: one specifically for road transport (under formation) and the second one for maritime transport in Hamburg. They have been in close liaison with the Dutch platform as some Dutch members are also members of one of the German platforms.

The Tønder Declaration for protection and management of the Wadden Sea is a clear example of policy coordination in practice, that drives the need for small-scale LNG

Box: Wadden Sea 'Tønder Declaration', an example of policy coordination

The Wadden Sea 'Tønder Declaration' is a clear example of alignment of cross-border policies. This was the 12th Trilateral Governmental Conference on the Protection of the Wadden Sea, agreed upon in Tønder, 5 February 2014. Preparation and coordination have been done by the Common Wadden Sea Secretariat in Wilhelmshaven, Danish, German and Dutch NGOs and Governmental bodies. The declaration encompasses the Wadden Sea World heritage strategy 2014-2020, consisting of chapters on sustainable tourism, flyway cooperation (bird populations), ecosystem management, sustainable fisheries, energy, CO_2 neutrality and climate change adaption and maritime safety and prevention of pollution from shipping. Furthermore, the declaration contains policies for monitoring and assessment, science cooperation, Wadden Sea forum on clean shipping and shipping safety, international cooperation (Korea and Suffolk-UK tidal flats regions) and communication and education.

The declaration was signed by Mikkel Aarø-Hansen, Deputy Permanent Secretary, Ministry of the Environment, Kingdom of Denmark, Sharon Dijksma, Ministry of Economic Affairs, Kingdom of the Netherlands and Rita Schwarzelühr-Sutter, Parliamentary State Secretary, Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Federal Republic of Germany.

Source: Energy Valley

Building blocks and synergies for success – the Wadden Sea case

There are a number of LNG projects in which policy cooperation by national governments played a crucial role. The Wadden Sea 'Tønder Declaration', for example, can be seen as good practice policy coordination that stimulated the development of LNG. Three countries – i.e. Denmark, Germany and the Netherlands – declared the Wadden Sea (UN World Heritage Site since 2009) a single ecological entity in 2010. In February 2014 they reaffirmed this status in the 'Tønder Declaration'. In this declaration, the countries also agreed to test and implement the alternative marine fuels LNG, fuel cells and H_2 where possible with the purpose to reduce local emissions and protect the environment from risks.

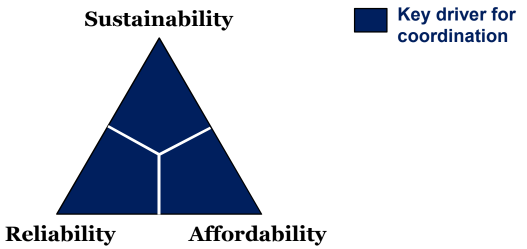
The governments issued the declaration after a trilateral governmental council meeting supported by Energy Valley, a Dutch foundation where the government cooperates with market parties. As a result of this cooperation, AG-Ems shipping company has applied for EU TEN-T funding for LNG retrofitted their ferryboat MS Ostfriesland. This project was carried out in close cooperation with organisations such as the German and Dutch port authorities, the Dutch LNG Platform and the German Maritime LNG Platform. Since June 2015, the MS Ostfriesland is LNG fuelled, sailing Emden – Eemshaven – island Borkum.

The three Governments involved paved the way through the Council Meeting and Declaration for LNG usage. The ECA regulations following per 1st January 2015, made a clear case for alternative fuels in the ECA region. The TEN-T programmed "Motorways of the Seas" co-funds infrastructural investment in dedicated trans-European networks, MS Ostfriesland being the first. Rederij Doeksen in Harlingen will build two new bi-fuel LNG ferries, co-funded by a grant of the 'Waddenfonds'.

Why stimulate the use of LNG? The transition to LNG was mainly driven by environmental considerations, but can contribute to all energy policy goals

Tackling the Trilemma

LNG contributed to all aspects of the policy Trilemma



The natural gas reserves are large and widely spread across the globe, which reduces geopolitical risks. The widespread availability also helps to keep the market competitive.

Additionally, LNG is a cleaner fuel with lower SOx and NOx emissions than transport alternatives such as heavy fuel oil or even petrol.

All the elements of the policy trilemma have featured in policymakers' consideration around LNG.

Impact on reliability

The supply of LNG is well organised, GATE can be sourced from different suppliers and in general the global natural gas reserves are significantly higher than oil reserves. The global reserves of natural gas are large: at the current level of consumption 200-250 years. The natural gas reserves are widely spread across the globe, which reduces geopolitical risk.

Impact on sustainability

LNG is cleaner and more quiet vis-à-vis oil-based alternatives. It represents a reduction of CO_2 emissions by 15%, and of NOx and particulates by 90% for road transport and 20-25% and 80-90% respectively for shipping. In addition, LNG engines emit less noise, which is important for deliveries to cities. Bio-LNG, climate neutral by definition, will enhance the sustainability leg of the trilemma even further.

Impact on affordability

The upfront investment in LNG trucks and ships is high compared to diesel/gasoil. However, the fuel is cheaper and this turns it to lower total-costs-of-ownership and, therefore, into a positive business case for LNG. The payback period for retrofitting a truck to LNG is 2.5-5 years depending on the type of vehicle and assumptions on usage (www.nationaallngplatform.nl).

Government intervention in LNG is essential to solve the 'chicken-and-egg' challenge

From oil to LNG in the transportation sector

- Lessons learned -

1. **Stable (fiscal) policies are needed**. The transition from oil products to LNG in transport is largely driven by the total cost of ownership. The upfront investment is high and needs to be recovered by a lower fuel price. Because fuel tax, i.e. excise duty, plays an important role in the fuel price, the tax regime can steer the fuel mix in the market. The challenge is to continue stabile policies. Uncertainty in this respect can lead to reluctance to invest.
2. **Policy makers and market parties must work together.** The LNG staircase is built on Public Private Partnerships, thereby shortening the lines between parties, also cross border with Germany. Policy coordination can be successful in markets provided there are clear goals that serve both policies as well as commercial interests, that therefore take the full supply and demand chain into account and last but not least public co-funding to stimulate private investments.
3. **Fast developments are possible when the market outlook is there.** As a general direction, synergies and critical mass have proven to be important to further develop both the demand and the supply side of the market. GATE, the receiving LNG terminal in Rotterdam, was opened in 2012. It has taken around four years to realise break bulk facilities (to fuel the small-scale LNG market), which will go into operation in 2016. This facility will enhance the supply chain and will push the wider distribution and usage of LNG.

From oil to LNG in the transportation sector

- Key success factors-

1. **Aligned government policy**. One of the main reasons for government intervention in the LNG market is the chicken-and-egg problem. This issue was at the heart of the formulation of the Green Deal on LNG. No filling stations means no vehicles – and vice versa. Infrastructure and customers need to go hand in hand and market trust at both sides is needed to invest. For this reason, the national and EU governments formulated various policies to support the roll-out of LNG in the Wadden area. These policy visions drove the development of LNG.
2. **Match with local capabilities (synergies)**. The Netherlands has a long-standing relationship with natural gas: domestic production and consumption, and large trading volumes internationally. The GATE LNG-terminal was a logical extension of the Dutch gas business meant to take in natural gas from the sea side, store and to import this into the grid.
3. **Wide benefits to be gained.** The environmental benefits regard both local air quality as well as greenhouse gas (GHG) emissions, which is not obvious as in other cases there is a trade-off between cleanliness and CO_2. furthermore, specifically for trucks that supply stores in cities, the reduction in noise emissions is important since this opens up longer access slots ('venstertijden') for entering the city. Last but not least, there is the outlook towards green or bio LNG. This Liquid Bio Methane (LBM) is produced from biomass and therefore 'climate neutral' in its usage.

Priorities for future coordination lie in breaking the chicken-and-egg dilemma in new European markets

The future of coordination for the use of LNG in transportation:

Continue to implement LNG for shipping and unlock the potential in new European markets…

The implementation of the EU Clean Power Directive for Transport will develop the market for LNG as a result of creating the infrastructure and thereby breaking the 'chicken-and-egg' dilemma. In particular, the LNG for shipping will benefit from the TEN-T subsidies to support the investment in LNG refuelling facilities in all core ports. Based on this Directive, new cores need to be developed in Germany, France and Southern Europe, outside the existing LNG infrastructure hubs in The Netherlands, the UK, and Spain. Where necessary, this development needs to be supported with further government intervention to break the chicken-and-egg dilemma.

Groningen Seaports NV and Niedersachsen Ports GmbH& Co. KG, wish to develop a joint fit for purpose of LNG infrastructure in the Dutch-German cross-border Ems-Dollart/Eems-Dollard region. In order to achieve this goal, both Port authorities joined forces in order to become: an established core port region, a single cross-border port region and eligible for European Union funding.

The programme INTERREG Deutschland-Nederland will give body to the Eems-Dollard regional ambitions. It is planned as a 3-year programme starting end 2015.

…use LNG in other transportation markets…

The Dutch Ministry of Infrastructure and the Environment has commissioned a feasibility study regarding the financial case for 'Vergroening regionale spoorlijnen' (greening of regional railways, May 2014), i.e. a transition from diesel towards electrification or LNG. The payback period and internal rate of return turns out to be positive for LNG vis-à-vis electrification and a bigger environmental impact can be realised in the longer term by using LBM (Liquid Bio Methane).

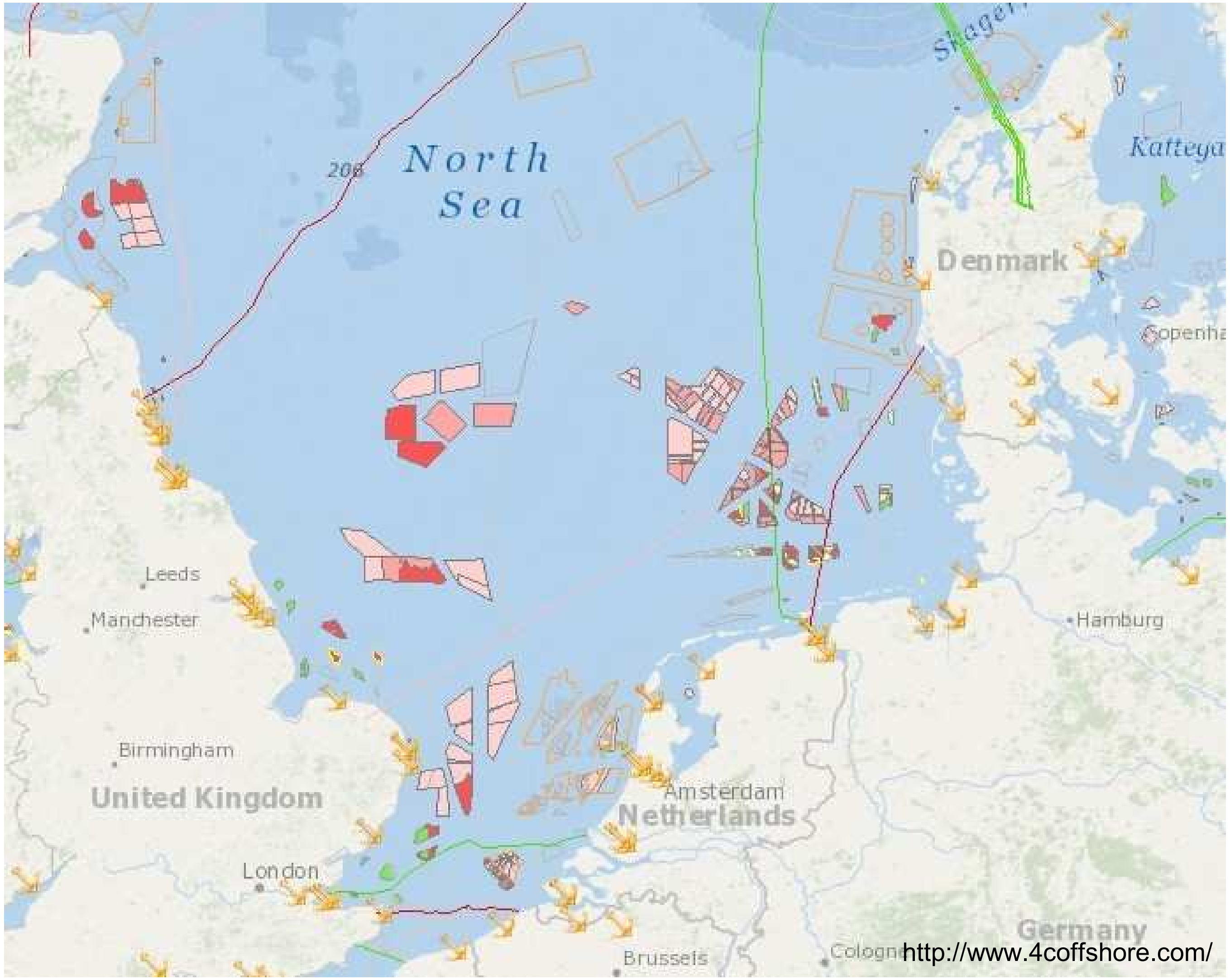
… and move towards a biobased alternative

In selected markets, LBM can make its entrance under the umbrella of the Directive as well because it displaces oil (reduces import dependency), creates jobs and is considered carbon neutral. The Green Gas Foundation strives for bio-based LNG from manure and agro products. The first process step is to produce biogas ,to be liquefied to LBM thereafter. Companies such as FrieslandCampina and Harvestaff initiate LBM projects. The road transport segment will be the most promising because of the economical value of the so-called 'bio tickets' to meet the EU bio fuels obligation (since 2007, originated from the EU Renewable Energy Directive – RED).

Sources

- Nationaal LNG Platform, 2012 onwards, http://www.nationaallngplatform.nl/
- GATE LNG terminal, http://gate.nl/
- Scheepvaartsector Noord-Nederland, inventarisatie door E&E Advies, november 2012
- LNG in het hele Waddengebied, Dagblad van het Noorden, 17 april 2013
- Feasibility study LNG terminal Eemshaven – A quick scan Part 1 Groningen, July 9th 2013
- Masterplan LNG Energy Valley "BIG in small scale LNG...", September 2013
- LNG and Wadden Sea, Energy Valley, 2014 http://www.energyvalley.nl/
- 12th Trilateral Governmental Conference on the Protection of the Wadden Sea (Tønder Declaration), 5 February 2014
- Vergroening regionale spoorlijnen, First Dutch, mei 2014
- Deelrapport Brandstoftafel Scheepvaart, Visie Duurzame Brandstoffenmix, Min. IenM, mei 2014
- LNG in Germany: Liquefied Natural Gas and RenewableMethane in Heavy-Duty Road Transport, September 2014
- LNG for trucks and ships: fact analysis. Review of pollutant and GHG emissions, TNO, February 2015
- Ein Jahr Maritime LNG Plattform – Positive Bilanz der nationalen Initiative für eine sauberere Schifffahrt, June 2015
- Towards an LNG ready Ems-Dollart / Eems-Dollard Region, Niedersaksen Ports/Groningen Sea Ports (undated)
- Projectconcept in het kader van het programma INTERREG Deutschland-Nederland, LNG pilots, augustus 2015
- Agreement between ministries and Foundation LNG TR&D, Harbour Company Rotterdam, Energy Valley Foundation (2015), Green Deal LNG: Rijn en Wadden
- EC Directive 2012/33/EU
- EC (2015), Emissions from Maritime Transport, http://ec.europa.eu/environment/air/transport/ships.htm
- LNG in het zware transport, Energie Dialoog Nederland (EDN), september 2015

Case 5: Offshore grid in the North Sea



The realisation of an integrated offshore grid infrastructure is a cost saving opportunity in the further development of offshore wind power in the North Sea

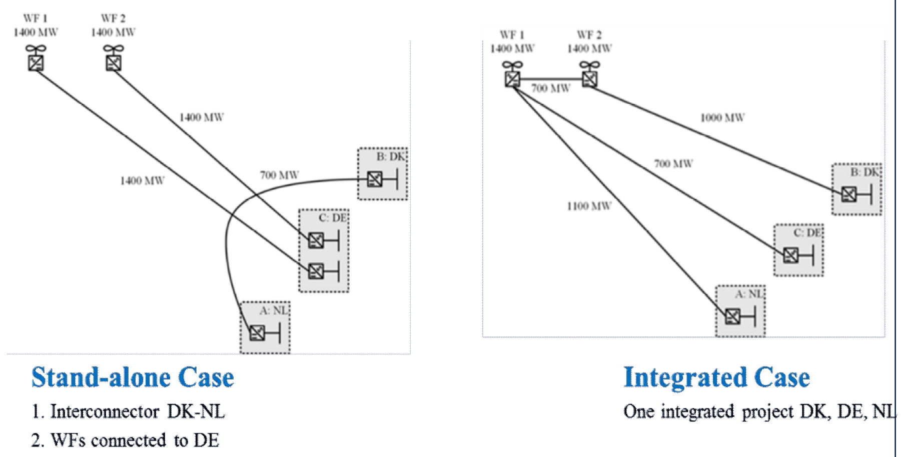
Introduction offshore wind grids

Scenario studies indicate that offshore wind can play a prominent role in contributing to the EU's medium and long-term electricity supply. The Dutch energy agreement (its pathway towards 16% renewable energy in 2023) relies heavily on offshore wind.

However, upon take-off of offshore wind in the Northern Seas, dedicated near-shore locations that can command sufficient public acceptance will become short in supply. Wind farms further offshore are more expensive to develop but when connected to an offshore grid fewer cables would have to make landfall and shorter cable lengths are needed. Also, opportunities for energy trading/exchanges between Member States through the offshore infrastructure have a positive effect on the business case for these wind farms.

A crucial facilitating factor for the take-off of offshore wind is the realisation of integrated offshore grid infrastructures. Therefore, upon the availability of advanced transmission technology, foreseen early in the 2020s, offshore grid infrastructures will increasingly have to encompass 'hybrid components', i.e. components combining the transmission of electricity traded cross-border and the evacuation of electricity from offshore wind farms (*please refer to the figure*). Apart from technological issues, this poses huge regulatory challenges. These challenges have to be tackled. Hence, the case of offshore wind is a potent driver for the accelerated transition of European electricity markets towards the aspired Internal Energy Market for electricity. The realisation of the required offshore grid infrastructure implies high investment costs. Rolling it out in a cost-effective way from a global (cross-border regional or rather EU) perspective would seem to be a political must and requires coordinated policy at an European level.

Stand-alone and integrated offshore grids



The figure above shows two cases; a base case in which wind farms are connected to Germany (DE) and there is an interconnector between Netherlands (NL) and Denmark (DK) and an integrated case where the wind farms are part of an offshore grid with connections to DE, DK and NL.

Focus of this case study

This case study focuses on the investment financing issue: who should pay for offshore grid projects, i.e. what cross-border cost allocation (CBCA) mechanism to apply, ensuring full cost recovery?

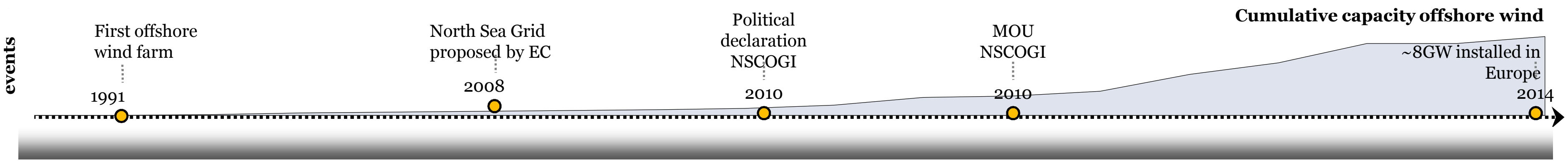
Offshore wind capacity is rapidly increasing. A north sea grid could help to realise renewable targets in a more cost-effective way, but to date this is not realized

Evolution of policy coordination for the North Sea Grid

The current approach to network connection of offshore wind farms in the exclusive economic zone of a Member State is to simply construct a radial connection line from the wind farm (hub) concerned to the nearest feasible point of interconnection with its onshore transmission network. In 2010, ten countries surrounding the North Seas have signed a Memorandum of Understanding (MoU) on the The North Seas Countries' Offshore Grid Initiative (NSCOGI). NSCOGI is the responsible body that evaluates and facilitates coordinated development of a possible offshore grid that maximises the efficient and economic use of those renewable sources and infrastructure investments. In the MoU, the participating countries set up three working groups that have been asked to come up with solutions of various issues: (1) grid implementation, (2) market and regulation, and (3) permissions and planning. Until now the main activity of NSCOGI has been the coordination of studies concerning the North sea grid, which has not yet resulted in new policies.

The working group on grid implementation has issued a first report in 2012 presenting the net benefits of cases for German Bight, UK-Benelux, UK-Norway, amounting to total net benefits of €2.3bn, mainly driven by the benefits to interconnecting the various markets. The second working group has considered options for allocating costs among actors so that all parties are incentivised to support infrastructure with a net societal benefit.

International events



Phase

National Development	North Sea countries start cooperation	Call for EU coordination

Policy focus

National Development

The first offshore wind farm was inaugurated in 1991 in Vindeby, Denmark, developed by DONG Energy . Until 2001, the growth of offshore wind was irregular and mainly depended on a handful of small near-shore projects in Danish and Dutch waters featuring wind turbines with a capacity of less than 1 MW. Due to a lack of adequate national support schemes and high costs, the business case for offshore wind was mostly negative.

Policies were not coordinated – countries developed their own national solutions for connecting offshore wind farms

North Sea countries start cooperation

By the end of 2010, 2,946 MW of offshore wind capacity in 45 wind farms spread across nine countries were feeding an estimated 10.6 TWh of electricity into the European grid. The 883 MW installed in 2010 represented 9.5% of the annual European wind energy market.

The importance of a North Sea grid was identified by the EU; political declarations and MOUs were signed which resulted in increased attention and a number a research projects.

Call for EU coordination

In 2014, 1.483 megawatts of new offshore wind capacity came online in Europe. Bringing the total at 8,045 MW. Overall, 408 new offshore wind turbines in nine wind farms and one demonstration project were fully grid connected at the end of 2014.

Currently, no regulatory arrangements exist to incentivise investment in and facilitate trading across Offshore grids. EU officials , national MPs and NGOs state that the Grid should get priority during the Dutch EU Presidency of 2016.

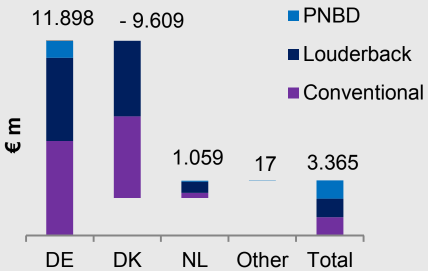
A fair welfare distribution must be present in order for countries to collaborate in realising an offshore grid. Currently benefits and costs are not allocated accordingly. New arrangements are needed to allocate costs and benefits

Within the recent **NorthSeaGrid project (NSG)** two wind farm hubs in the German EEZ were investigated that will connect wind farms to Germany, Denmark and The Netherlands.

Countries involved

Germany, Denmark, The Netherlands.

Allocation of net benefits (NSG project)



A new approach to allocating costs and benefits

Interconnectors combined with offshore grid connection infrastructure have a positive net benefit to society. The take-off of cross-country offshore network development is hampered by regulatory uncertainty and especially regulatory “white spots”. In this respect, one of the key regulatory issues that need to be urgently addressed is the allocation of the costs and benefits between the countries involved.

Conventionally, connection costs for offshore farms are attributed to the home country transmission grid. Project costs and congestion income are split equally between hosting countries through their respective TSOs. Alternative cross-border cost allocation (CBCA) methods considered in the NSG project are:

- **Positive Net Benefit Differential**: cost allocation among countries in line with differential net benefit compared to the base case and compensation of negative/low net benefit differentials; and
- **Louderback**: allocating to countries the directly attributable costs, adding the indirect – i.e. common – costs proportionate to the difference between stand-alone and direct cost.

The cost and benefit impacts of the distinct cross-border cost allocation methods should not only be considered at country level, but also at stakeholder level. The NSG project has pioneered an approach to do so. The CBCA method to be adopted should yield an acceptable net benefit distribution among, at least, hosting countries. Countries involved need to agree ex-ante on a transparent and robust approach for net-benefit determination and the cost compensation rule among affected/hosting countries.

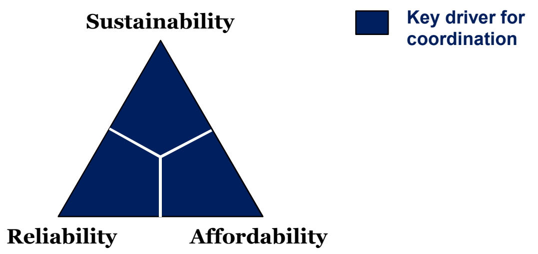
The German Bight case study within the NSG project confirms that notably, but not only, Germany has a lot to gain from the take-off of an integrated, meshed offshore transmission grid. The study results suggest that the Louderback and the Conventional method give (in this case) rise to highly unbalanced outcomes as regards to the distribution of net benefits among countries and across stakeholders. These methods are, therefore, considered less suited to providing guidance for a cross-border cost allocation of integrated offshore infrastructure projects.

Anticipating on the installation of hybrid assets, the offshore grid Cross-Border Cost Allocation issue can only be dealt with in a globally cost-effective way when addressed concurrently with convergence and ultimate harmonisation of other relevant regulatory issues. These include coordinated support schemes, integrated cross-border electricity markets, notably in the balancing market and intra-day time frames, as well as similar use of system charging and harmonised congestion management regimes.

An integrated offshore grid enables the development of wind power, which contributes to the sustainability of our power system

Tackling the Trilemma

All aspects of the policy dilemma drive the push towards a offshore grid



In the case of the North Sea Grid, The North Seas Countries' Offshore Grid initiative (NSCOGI) was formed as the responsible body to evaluate and facilitate coordinated development of a possible offshore grid that maximises the efficient and economic use of those renewable sources and infrastructure investments.

Impact on sustainability
Wind power has a positive effect on GHG emission reduction and local/regional pollutant emissions.

Impact on affordability
To date, offshore wind is a relatively high-cost emerging technology. Through technology learning and technology-specific R&D, there is quite some cost-reduction potential. Connection to an offshore grid will have a positive effect on the business case for offshore wind since this should enable the wind farm to deliver electricity to the country where the electricity prices are the highest.

Impact on reliability
There is quite some confusion on the contribution of offshore wind to reliability. Opponents state that it is intermittent, hence should have a quite low score on this count. In fact, under the latest technology, offshore wind can achieve load factors topping 50% and it tends to have highest production in the autumn and winter months. Hence it needs relatively modest short-term and seasonal flexibility back-up services and can provide significant system services under a reformed electricity market design.

Regulatory coordination and suitable cross-border cost-benefit allocation mechanisms are key for the development of an offshore grid

How to approach offshore wind in the North Sea..

- Key success factors -

1. A **fair and for all connected countries profitable cost and benefit allocation** is a key success factor to create the will and possibilities for cross-border cooperation.
2. **Coordination of legislation and policies** in the connected countries is crucial to provide a level playing field and reduce risks for developers and investors.

The short history already provides meaningful insights

- Lessons learned -

1. Integrated offshore grid solutions involve two or more countries. Bilateral or multilateral **collaboration mechanisms** involving governments, wind farm developers, transmission system operators and regulators may help to bring about such projects earlier.
2. **Cross-border projects** may be beneficial overall but, without proper CBCA mechanisms, their benefits **are likely to be distributed asymmetrically** between the countries concerned. This raises the question of suitable cross-border cost benefit allocation mechanisms to bring all participating countries on board. We recommend using Positive Net Benefit Differential methods as a starting point for negotiations on the financial closure of investments in cross-border (integrated) offshore infrastructures.
3. On the regulatory side, if **all EU regulations** and network codes already in place and under development were and will be transposed into **national regulation**, several barriers could be mitigated. Special attention is required by the European Commission and ACER (Agency for the Cooperation of Energy Regulators) to speed up this process. National support systems for renewables could also be redesigned to facilitate the realisation of integrated offshore grid solutions. To this end, renewable generators could receive the remuneration of the country in which it is located, regardless of which country the electricity produced is flowing into. This ensures a high degree of certainty for investors in renewable energy projects. Monetary compensation mechanisms between the countries involved should be set up to ensure a fair distribution of the costs between the countries involved. Additional compensation mechanisms could be set up between the countries involved to ensure that the electricity produced is counted towards the national target of the country that funds the support.
4. At least between the countries involved but preferably **at regional and** even better (eventually) at **EU level, close coordination of offshore network development is a mus**t. In order to facilitate **the choice of the socioeconomically optimal solutions**, this should be led by the National Regulatory Agencies concerned with close involvement of ACER and in close consultation with all stakeholders.

Substantial future policy coordination is required to achieve cost-effective integration of offshore wind parks into the grid

Future of coordination:

1. Policy coordination could help to assure that the right regulatory framework conditions are in place to enable offshore grids. These coordinated relevant regulations can **level the playing field** among (hosting) countries for investors in offshore wind farms and should **ensure positive business cases** for investors. A **combination of bottom-up coordination of policies between like-minded neighbouring states and regulatory convergence at an EU-wide level** could help to move towards an encompassing joint solution.
2. Policy coordination is also key to virtually **fully integrate electricity markets**, also in the intra-day and balancing time frames, whilst their planning and oversight of offshore wind and grid infrastructure needs to be closely coordinated. **Properly filling the legal voids for implementing integrated offshore infrastructures** would appear to be a matter of high urgency.
3. Integrated cases where wind farms are connected to an offshore grid are generally cheaper to build and operate. Therefore, the development of a North Sea grid can play an important role for **cost-effective achievement of medium- and long-term climate and energy targets** and requires realisation of integrated infrastructure projects as soon as the technology needed is mature (expected early 2020s).
4. This can only be realised when (at least) the countries hosting such infrastructures:
   - Adopt a **joint planning approach** based on a joint strategic vision as to the desirable interconnector capacity and locations of prospective wind parks;
   - **Align support schemes** and electricity market designs; and
   - **Jointly design and implement legislative solutions and governance structures** making this possible.
5. Analysis of **cross-border allocation of costs and benefits** of integrated projects is instrumental in clarifying the impacts of policy/regulatory changes needed.
6. Our main recommendation is to apply a **CBCA method that yields a non-negative or rather a significant positive incremental net benefit for each hosting country** of an integrated offshore infrastructure project as pivotal point of departure for negotiations between the national regulatory agencies concerned aimed to arrive at financial closure. Moreover, it is recommended to also assess the welfare impacts of the integrated project under consideration to stakeholders in each of the hosting countries.

Sources

- DeDecker, J., Kreuzkamp, P., Joseph, P. (2013): NORTHSEAGRID Project Introduction. PPT presentation at EWEA conference. Frankfurt. 21 November 2013.
- A. Flament, P.Joseph (3E); G. Gerdes, L. Rehfeldt (Deutsche WindGuard); A. Behrens, A. Dimitrova, F. Genoese (CEPS); I. Gajic, M. Jafar, N. Tidemand, Y. Yang (DNV GL); J. Jansen, F. Nieuwenhout, K. Veum (ECN); I. Konstantelos, D. Pudjianto, G. Strbac (Imperial College Consultants) **(2014):** Final report of the Northseagrid project
- Jansen, J., van der Welle, A., Nieuwenhout, F., Kraan, C., Dalla Longa, F., Veum, K. (2015): Alternative cross-border cost allocation methods for sharing benefits and costs of integrated offshore grid infrastructures. Work Package 5, NorthSeaGrid Project.
- http://www.ewea.org/statistics/offshore/
- The North Seas Countries' Offshore Grid Initiative (2014) NSCOGI 2013/2014 progress report
- Strbac, G., Moreno, R., Konstantelos, I., Pudjanto, D., Aunedi, M. (2014). Strategic Development of North Sea Grid Infrastructure to Facilitate Least-Cost Decarbonsiation. Imperial College London / E3G. London.
- SER (2013) Energieakkoord voor duurzame groei

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