TenneT response to the Green Paper
A 2030 framework for climate and energy policies

About TenneT

TenneT is Europe's first cross-border electricity grid operator. With approximately 20,000 kilometres of (extra) high-voltage lines and 35 million end-users in the Netherlands and Germany, we rank among the top five grid operators in Europe. Our focus is to develop a Northwest European energy market and to facilitate the integration of renewable energy into system and grid development.

TenneT's core tasks are laid down in Dutch and German legislation. Our operations, performance and reporting processes are supervised by regulatory authorities.

Our core tasks are:

Transmission services

TenneT transmits electricity via the high-voltage grid in the Netherlands and large parts of Germany. We connect producers to the regional grids which supply electricity to consumers.

System services

TenneT operates and develops systems that manage and maintain the balance between electricity supply and demand.

TenneT
Taking power further

Introduction

The transition to a low-carbon environment and the pursuit of renewable energy targets implies a change of the generation landscape. The intermittent characteristics of mainly wind and solar power pose challenges in operating the present electricity system. This circumstance in tandem with decentralised production sites makes challenges different in terms of pace and time.

The investment cycles for energy infrastructures are long. Therefore, a debate on future European climate and energy policy should be conducted now to assure the well-timed development of grids. Investors want certainty and reduced regulatory risks before embarking on investments. Coordinated grid and generation planning is also advisable to ensure anticipatory grid investments to be in line with future generation market developments.

TenneT is a company with experience of integrating renewable energy sources in the grids in the Netherlands and Germany. This puts the company in a good position to share its experience. The Green Paper calls for consultation on a set of questions such as whether or not targets should be in place and how they should be set. These conditions are a given for TenneT in its role as a TSO. TenneT is a facilitator to the market and we will focus our response therefore on the questions concerning security of supply in relation to the operational security and grid development. In chapter I we will address the Green Paper questions related to security of supply. In chapter II we will reply to questions on lessons learned from the 2020 framework .

Our response should be read in conjunction with the joint TSO response via ENTSO-E, which TenneT fully endorses. In addition to this, we feel the need to apply as a cross-border TSO on what challenges are ahead of us and what framework is needed in order to allow for the safe passage to a sustainable energy future that we all committed to.

Chapter I: Security of Supply

This chapter answers the following question of the Green Paper:

How can the EU best improve security of energy supply internally by ensuring the full and effective functioning of the internal energy market (e.g. through the development of necessary interconnections), and externally by diversifying energy supply routes?

TenneT will answer this question of the Green Paper in three sections:

1) System requirements for increasing feed-in from renewable energy sources
2) Market instruments for providing system stability
3) Regulatory provisions for building the required transmission infrastructure

TenneT has identified a number of system requirements that need to be met to support ongoing integration of the European electricity market and to maintain the high level of security of supply required by European society. These are explained in article 1). Article 2) then explains how system requirements can be met by adequate market instruments, article 3) gives an overview on complementary regulatory measures to further facilitate the transition process.

1. System requirements for increasing feed-in from renewable energy sources

This section of our response discusses system requirements that should be factored into the preparation of a roadmap for European energy and climate policies in 2030.

Various national policies have been put in place in accordance with EU regulations to stimulate the feed-in from Renewable energy sources (RES). This has resulted in recent years in a reduction of production from conventional generation, as RES with low marginal costs endanger the business case of conventional power plants. As the funding of the system for operational security is based on conventional generation, however, the new characteristics of new electricity producers have already created and will continue to create new challenges for the system. Besides the cost factor, this situation stems also from the circumstance that renewable energy sources (like wind and solar) fluctuate by nature. There are times when the sun does not shine and the wind does not blow. Notwithstanding the envisaged contribution to attainment of European policy goals, TenneT wishes to share its views on how generation and infrastructure assets in the power system interact and how this translates into system requirements given the increasing share of RES.

TenneT recommends taking into account the following system requirements because they will also have to be met in a future system with an increasingly large share of renewable generation:

1. adequate generation to meet demand at all times
2. sufficient inertia which is essential for a stable frequency in the system

3. flexibility for balancing and ramp speed for compensating for fluctuating production
4. sufficient means of voltage control
5. controllability of generators in the event of major disturbances

These requirements are discussed below.

1. Generation adequacy

There always needs to be sufficient production capacity to meet the demand for electricity among European households and companies. The generation capacity to provide this production is and will remain a concern at times when the sun does not shine and the wind does not blow. Solutions can be found by increasing the flexibility of demand for electricity and for storage capacity. However, a sound level of dispatchable backup capacity will always be needed.

2. Inertia from rotating mass

Large frequency deviations might cause unplanned interruptions in electricity deliveries. Frequency deviations can be caused by a loss of generation (a generator, an importing HVDC link/interconnector), a loss of load ('reduction of demand') and normal variations in low-down generator output. To keep the frequency stable, the system requires a certain amount of inertia. The lower the system inertia, the more difficult it is for the grid frequency to respond to abrupt changes in generation and load patterns. New generator technologies like photovoltaic solar power or modern wind turbines are unlikely to contribute to system inertia.[1] There is a need for further research into the effects and possible solutions.

3. Balancing and ramp speed

The production and demand of electricity in an electricity system have to be in balance with each other every instant in order to keep the frequency stable. In a traditional system, conventional production is rapidly adjustable in response to fluctuating consumption levels. Forecasts of supply (production) and demand (consumption) have always been fairly predictable. With the increase in renewable energy, however, this balancing act has become more challenging. The production of electricity from wind and solar sources can diverge from forecasts and the low marginal production costs for wind and solar provide a strong economic incentive to accommodate production from those sources.

Even if there is less deviation from forecasts in the future, the system will still require flexibility. At times when there is an increase in sunshine, it will be necessary rapidly to switch down ('ramp down') other kinds of generation. Conversely, when clouds block out the sun, it will be necessary to ramp up.[2] One of the big challenges of energy transition is to ensure the permanent availability of sufficient flexibility to avoid balancing problems. As used in this context, flexibility means the ability to adjust electricity production or consumption rapidly.

[1] The inertia in the system is the stability of the rotating energy mass. Photovoltaic solar power does not contribute to the inertia and modern wind turbines rarely do.
[2] A similar pattern applies to wind energy.

The flexibility required for system stability is obtainable from dispatchable thermal power plants (where gas is typically more flexible than coal), adjustable renewable energy production, energy storage and demand response. Additional infrastructure that allows an interchange of flexibility between regions and countries is highly conducive to assuring system stability.

4. Voltage control

Maintaining an adequate voltage level is imperative to deliver the power required by loads through transmission lines. TSOs assure voltage support by locally injecting or withdrawing reactive power from the system. Since reactive power does not travel very far, TSOs usually need to ensure that reactive power is produced near the place where it is needed for voltage control. Traditionally, generators coordinated by TSOs and distributed throughout the grid have played a major role in providing the required amount of reactive power locally. A generator's effect on the voltage level decreases if it is farther away.

The rapidity of energy transition is changing generation locations and altering production patterns. This poses substantial operational challenges in terms of keeping the voltage within safe boundaries, particularly because conventional generators are less available to deliver support. It is vitally necessary to possess sufficient means of voltage control either through conventional generators, RES or additional investments in specific kinds of equipment (such as inductors and capacitors).

5. Controllability

Strong coordination with Distribution System Operators (DSO) is a prerequisite for direct monitoring and, if necessary, influencing the generation of RES on all grid levels as soon as system security is jeopardized.

Conclusion regarding system requirements for operating the grid in a low-carbon environment

The increasing renewable energy sources and the decreasing conventional generation will make a growing proportion of the available generation highly volatile by its nature and because the generation locations and the consumption centres are farther apart.

These effects necessitate having a strong grid infrastructure capable of physically bridging the distance between supply and demand and also necessitate having sufficient ancillary services ('those services necessary to support the transmission of electric power') to assure uninterrupted balancing and safe voltage levels in the power system under all conditions. Ancillary services need to be available at the right time at the right place. Meeting this requirement is a matter of concern now that conventional power plants, which currently play a major role in providing the services, will be less available. When determining climate and energy policies for the future, we recommend giving due consideration to the following matters below:

TenneT recommends:

- **system stability urges to consider all aspects of the integrated power system when drawing the roadmap for an increasing share of RES;**
- **appropriate connection requirements for all generation resources to meet the targets for controllability and ancillary services support.**

2. Market instruments for providing system stability

This section explains how proper market mechanisms and a sound definition of the roles and responsibilities of market parties can help in meeting the aforementioned system requirements and thereby contribute to an cost-effective integration of renewable energy sources. We will also demonstrate that temporary reversible measures might have to be taken to assure a safe transition to a low-carbon economy.

a) Market model/Market design

TenneT believes that market parties have an important role in leveraging sufficient flexibility on a cost-effective manner. All parties and all technologies need to be invited to input their flexibility into the system. Used in this market context 'invited' means utilising the most cost-effective sources of flexibility with the best business case. A precondition for this approach is that suppliers of flexibility must be able to capitalise on the value of a scarce product.

Prices must reflect a fair value, however. Essential steps in our opinion are to expose all market participants to price signals and the quarter-hour trading of products and to accept greater price volatility. Developing suitable pricing mechanisms for flexibility will present a challenge but is inevitable in our view.

In a low-carbon energy environment it is advisable for renewable sources to play a role in delivering to the grid the services that are currently delivered by conventional generators, namely ancillary services for balancing, re-dispatch and voltage control. It is prudent to avoid priority dispatch and (economic) incentives at times when low demand causes negative prices. Retaining priority dispatch for individual power resources will distort market outcomes, unduly raise the price of grid expansion and increase the day-to-day complexity of operating the grid securely.

TenneT recommends that short-term policy measures in the transitional period should leave sufficient scope for temporary targeted measures that can be reversed to ensure security of supply. Where the need for them can be properly justified, temporary measures like the interim contracting of generation reserves should be accepted as a way of achieving the goal of a low-carbon European electricity market at the desired high pace. Temporary measures of this kind might prove necessary to overcome transmission bottlenecks, provide voltage support and maintain or perhaps even increase the required level of system flexibility. The underlying market distortions that currently exist need to be eliminated before giving consideration to making alterations to policies.

TenneT recommends:

- **harmonising the role of RES producers in the system and giving them equal responsibilities, including responsibility for balancing;**
- **eliminating thresholds for alternatives for flexibility like storage and demand response and developing an appropriate pricing mechanism for flexibility;**
- **stimulating innovation in storage and demand side response, but without creating an unlevel playing field for current suppliers of ancillary services;**
- **allowing temporary measures like the interim contracting of generation reserves in the transitional period;**
- **expose all market participants to price signals and the quarter-hour trading of products.**

b) Market integration as a cost-efficient tool for successfully integrating renewables

The amount of additionally required infrastructure will be set at an economically sound level by optimising the utilisation of the existing grid, notably across borders. This makes it a powerful tool for integrating electricity markets while maintaining cost efficiency. Market integration by establishing sophisticated market-based solutions for congestion management will allow optimum allocation of interconnections in a zonal market design, taking into account the competitiveness of generation and demand in each zone.

A fully integrated European electricity market will help to safeguard the desired high level of security of supply when integrating RES. As it allows the pooling of liquidity, it will mitigate the overall system impact of local volatile feed-in from renewables by spreading it within the entire interconnected system (i.e. increasing the scale of the area in which you can improve balancing with increased fluctuating power from wind and solar). Further integration of markets, including balancing markets, will be an important step towards optimising the use of flexibility across borders.

TenneT recommends:

- **further market integration in order to contribute to optimum use of infrastructure, generation assets and flexibility.**

c) Infrastructure to unlock flexibility

While striving for advanced pan-European congestion management is imperative for the integration of electricity markets, building sufficient interconnection capacity will be an equally important ingredient for achieving an economically sound degree of price convergence and for properly managing an increasing feed-in from intermittent renewable energy sources. Infrastructure that unlocks existing flexibility will provide in many cases a cost-efficient alternative to adding more flexibility to the system. The most promising example is the unlocking of the storage capacity of existing hydropower. In combination with harmonised balancing systems, additional cross border infrastructure will play an important role in bringing about cost-efficient integration. It is highly advisable to make a socio-economic cost/benefit analysis of the use of interconnection capacity for balancing purposes in harmonised systems.

TenneT recommends:

- **further integration of balancing markets by harmonising the overall rules for balancing markets and the incentives to remain balanced.**

3. Regulatory provisions for building the required transmission infrastructure

This section addresses two preconditions for building the required infrastructure, namely a sound and coherent regulatory regime and better coordination between grid and generation development

The decarbonisation policy of the European Union and individual Member States will require a large volume of investment and the construction of grids to transport renewable energy sources from their production location (sometimes offshore) to the consumption centres. The European Network of Transmission System Operators for Electricity (ENTSO-E) identified in its Ten Year Network Development Plan (TYNDP 2012) the need to invest €104 billion in electricity infrastructure projects of pan-European significance. To ensure that these essential investments are made, TenneT recommends the following:

a) More coherence between the regulatory regimes in Europe

The national regulatory regimes of Member States define the conditions for infrastructure investments ('regulated via network tariffs'). On the one hand, the aim of national regulation is to prevent over-investment by the TSO. On the other hand, the regulatory framework should provide sufficient investment incentives and sufficient return on equity to allow the investments to materialise. The goal of European climate and energy policy is to facilitate European market integration and energy transition. Therefore, it is essential for different TSOs operating under different regulatory regimes to be able to jointly finance and invest in the different infrastructures.[3].

Given the specifics and conditions of national regimes, TenneT questions whether the sum of the national regulations and their interference will allow sufficient and timely investment in essential cross-border infrastructure.

TenneT recommends:

- **In the light of the enormous investment volumes, TenneT recommends greater Europe-wide coordination of the investment framework with appropriate investment incentives, while keeping competence at national level;**

b) Planning: More coordination between grid and generation

While fully endorsing the goals of liberalisation of the energy market and the core principles of the

[3] See for more information the Florence School of Regulation's report: Glachant e.o. (2013), Incentives for investments: Comparing EU electricity TSO regulatory regimes, Florence School of Regulation, European University Institute

Third Energy Package, TenneT sees a need for better coordination between generation development and grid development. This is one of the lessons learned in Germany in recent years. Investment coordination should focus on the impact on the market and on adequate planning and should give due consideration to system requirements for security of supply as mentioned above. Means towards coordination could be location signals in the form of market-based incentives for investors or coordinated planning at national, regional or European level. Successful coordination will be conducive to a cost-effective power system, taking into account costs for generation, infrastructure and system support to ensure that infrastructure is in place on time and anticipatory grid investments are in line with future market developments.

TenneT recommends:

- **Coordination between grid and generation development in order to ensure anticipatory grid investments to be in line with future market generation developments.**

Chapter II: Lessons learned from the 2020 framework

This section addresses the Green Paper's question about coordination of energy policy (1) and inconsistencies in current targets and security of supply indicators (2).

1) Better coordination of energy policies at national level and between national vs. European policy levels

Which lessons from the 2020 framework and the present state of the EU energy system are most important when designing policies for 2030?

Are changes necessary to other policy instruments and how they interact with one another, including between the EU and national levels?

One of the main lessons learned from developments over the past years is the necessity of ensuring that existing EU policies are coherent with each other and coherent with the national policies. This is especially true in the context of RES targets and respective support schemes for their implementation, where we see room for improvement in ensuring security of supply and increasing cost-efficiency from a socio-economic point of view.

A clear example in our business is the planned COBRACable which is developed to interconnect the Netherlands and Denmark. Future offshore grid scenarios and possible economic optimization of infrastructure argued that directly connecting German offshore wind farms to the cable could be beneficial. As the CORBACable is a point to point interconnector with the technical possibility to connect a wind farm, an economic study was conducted to test the possibilities. It proved not to be positive for the overall COBRACable business case at this point in time as national support schemes in Germany are not applicable in this particular situation. This has further been researched in Twenties from the European Committee project using also a "three legged solution" as the success of such grid developments is strongly correlated to national regulatory regimes and licensing procedures[4].

TenneT strongly recommends avoiding unilateral measures and initiatives and advocates greater coordination of targets and support schemes across Europe. Perpetuation of uncoordinated RES schemes will distort market functioning and European market integration and will cause suboptimal pricing of electricity. Given an overall amount of costs equaling 17 billion euro to stimulate renewables in 2012 in Germany, it can be observed that the public opinion in Germany is characterized by an increasing concern about the recent and future cost development. Therefore, TenneT's advice is to investigate and possibly establish common guidelines and criteria that determine which support scheme is appropriate to particular market conditions and circumstances, so as to ensure the most economic outcome. Better coordination among EU Member States will ultimately help to avoid

4 Twenties: Reframing planning and permitting for offshore interconnectors. Report will be available as of mid-autumn at

fragmentation of the internal energy market, will increase stability and might lower costs. It will also provide the framework needed for investors and the required grid development.

We also urge strong stakeholder involvement before policies are adopted (including national policies). Individual policies obviously have different implications and affect different stakeholders very differently. However, there are rare cases when adopted policies have very fundamental consequences for stakeholders and affect them in the core of their operations. TenneT is convinced that political decisions that have a raft of implications need to be the subject of proper consultation with affected stakeholders to assure a cost-efficient transition, accompanied by a set of temporary measures if deemed necessary.

TenneT recommends:

- **avoiding unilateral measures and initiatives**
- **better coordination of targets and support schemes across Europe**
- **investigate and possibly establish common guidelines and criteria to determine which support scheme is appropriate to particular market conditions and circumstances**
- **assuring early stakeholder involvement**

2) Inconsistencies in the current 2020 targets and definition of security of supply indicators

Have there been inconsistencies in the current 2020 targets and if so how can the coherence of potential 2030 targets be better ensured?

How should progress be assessed for other aspects of EU energy policy, such as security of supply, which may not be captured by the headline targets?

Europe's energy and climate policy is built on three pillars: sustainability, security of supply and competitiveness. After the experience with the 2020 framework, there is a need to discuss for the 2030 framework how potentially conflicting targets can be made compatible with each other in a changing generation landscape. This applies especially to the triad of sustainability and security of supply and competitiveness that must be kept in balance. Given current developments it is all the more important to demonstrate how a growing RES feed-in financed via retail price increasing subsidies can be reconciled with resulting intermittent flows that endanger the security of supply.
In TenneT's view, the European Commission rightly states in its Green Paper that:

> *"The management challenges linked to the introduction of renewables, including dealing with the variable supply of certain renewables (e.g. wind and solar) were also not fully considered and the impact of a large number of national support schemes for renewables on market integration was underestimated"*

Viewed from our perspective, the matter of security of supply appears to have been underestimated in previous policies and therefore requires greater attention when defining future energy and climate policies. An increasing level of Renewable Energy Sources in Europe's energy mix and the volatile characteristics of RES (wind + solar) have created a need for additional measures to safeguard security of supply, as demonstrated by the sharp rise in the re-dispatch necessary in Germany over the past few years and the increasing challenges to keep the voltage level within safe boundaries. It is essential to take into account the impact on the availability of sufficient generation capacity to meet demand and on the means for meeting the system requirements mentioned in chapter 1.

Past discussions on security of supply have tended to focus on fuel security. In our view, the adequacy of generation and infrastructure and operational reliability are matters of equal importance. The Green Paper concedes that “there may also be a need for additional indicators that more directly capture these objectives”. Our advice is to initiate such discussions at an early stage and to find a European consensus. This is especially true as an appropriate level for security of supply is absolutely essential for the functioning and competitiveness of an economy, while establishing indicators is particularly important in order to enable monitoring.

TenneT recommends:

- **Attention for security of supply in future energy and climate policies**

Conclusions

The transition towards a sustainable European energy sector will be characterized by a major share of fluctuating renewables in the overall energy mix, thus posing significant challenges for the secure operation of the transmission system.

To maintain security of supply when there is also a large volume of renewables in the mix, we must give due consideration to the system requirements. Different forms of generation have different ways of contributing to generation adequacy, inertia, voltage control, balancing, ramping and controllability. For reasons of system stability it is crucial to consider all aspects of the integrated power system when drawing the roadmap for future European climate and energy policies.

To ensure the availability of sufficient flexibility for balancing and ramping, it will be a challenge to develop appropriate pricing mechanisms for flexibility services, but we believe this step is inevitable. We further recommend coordinated support schemes that pave the way for common agreement on which support scheme best fits a particular market condition and under which circumstances.

For an efficient and robust future electricity system, we believe it is essential to maximise the potential of market integration projects. By consequence this means that future markets must be played

according to the same rules. The reasoning underlying the existence of priority dispatch schemes needs to be reviewed in order to strengthen security of supply and avoid distortion of market outcomes.

Nevertheless, some transitional measures such as interim contracting of generation resources might be necessary to deal effectively with local specifics in the meantime. This might require specific short-term measures for voltage support, congestion management and measures for injecting into the power system the flexibility required to cope with the volatile nature of renewables.

Increasing the share of renewables will ultimately be accompanied by greater uncertainty on the supply side, making it necessary to consider further integration of cross-border balancing markets.

We can maintain security of supply only if we are willing to make significant investments in the grid infrastructure. Adequate planning of the required infrastructure should be supported by implementing mechanisms that allow a more synchronised development of grid and generation assets. To manage upcoming infrastructure projects successfully, we need to create an investment-friendly environment. This will require regulatory certainty and future policies that promote the coherence of individual regulatory regimes beyond national borders so as to handle cross-border projects effectively.