Top Team Energy

Innovation Contract

Smart Grids

Headlines of a public private partnership

December 15th, 2011

Contents

Appendices have bundled in a separate document.

Summary (in Dutch)

Ontwikkeling van Smart Grids: onstuimig, onvermijdelijk, en een groeibriljant
Het thema Smart Grids (SG) is het jonge zusje van de andere thema's in de Topsector Energie; het bestaat pas sinds een paar jaar en het heeft banden met vrijwel alle andere thema's. SG maakt een onstuimige ontwikkeling door en is hard op weg naar grotendeels 'uncharted territory' met nieuwe spelregels, stakeholders die nieuw zijn in (en voor) de energiesector, nieuwe consortia, en nieuwe modaliteiten voor de wijze waarop we met energie om zullen gaan. Ter vergelijking, denk aan de transitie van statische naar dynamische processen, van eenrichtingsverkeer naar tweerichtingsverkeer, van centrale organisatie naar decentrale organisatie, van een enigszins afgeschermde markt naar een open markt, en van een speelveld met een beperkt aantal spelers naar een omgeving met talloze actieve partijen. Dit is een revolutie, 'a paradigm shift'.
Dit verklaart ook waarom de Innovatietafel SG op dit moment waarschijnlijk een minder scherp beeld kan neerzetten met minder duidelijk afgebakende activiteiten dan de meeste andere innovatietafels binnen de Topsector Energie. In 2012 zullen daarom nog een aantal elementen van het voorliggende Innovatiecontract SG moeten worden uitgewerkt, waaronder verdere afstemming met een aantal andere energiethema's.

Wel duidelijk is dat er de afgelopen 2-3 jaar een groot aantal concrete projecten en initiatieven zijn ontwikkeld door een breed spectrum aan bedrijven, kennisinstellingen en overheden. Enkele voorbeelden. PowerMatching City in de wijk Hoogkerk in Groningen is het eerste 'live' demonstratieproject in Europa dat belangstelling en bezoekers trekt vanuit de hele wereld. In 2011 zijn er verschillende consortia gevormd om gezamenlijk proeftuinen voor 'intelligente netten' te ontwikkelen en in 2012-2013 te realiseren. Netbeheer Nederland heeft een Projectgroep Smart Grids. Een 30-tal bedrijven heeft haar krachten gebundeld in Smart Energy Collective. En verschillende regionale initiatieven en samenwerkingsverbanden zijn opgezet, zoals New Energy Business Community (Noord-Nederland), Smart Energy Regions (Noord-Brabant), Smart Energy Technologies & Systems (Twente), en subgroepen van Stichting kiEMT (Gelderland en Overijssel), Amsterdam Innovatie Motor, Rotterdam Climate Initiative en Utrecht Sustainability Institute. Opvallend is dat het MKB vooral in de regionale initiatieven sterk is vertegenwoordigd. Bedrijven uit dit segment hebben de afgelopen twee jaar de eerste innovaties op de markt gebracht.

Ondanks deze veelbelovende experimenten en recente ontwikkelingen, is er tijd nodig om SG uit te laten uitkristalliseren. SG is immers onafwendbaar voor de energiesector en vooral een groeibriljant voor het Nederlandse bedrijfsleven. Tevens bevat het een aantal wetenschappelijke uitdagingen vanwege de 'uncharted territory'.

SG draagt bij aan alle 6 doelstellingen van Topteam Energie
Het Topteam Energie heeft de volgende 6 doelen voor 2020:
- 20% minder CO_2-uitstoot;
- 14% duurzame energie;
- Benutting van het potentieel aan energiebesparing;
- Concurrerende energieprijzen op korte en lange termijn;
- Een versterkte positie van Nederland in essentiële sectoren;
- Sneller meer concurrerend maken van duurzame energieopties.

SG is een cruciaal thema voor het realiseren van de doelen van het Topteam Energie. SG kan tevens beschouwd worden als de spin in het web van de andere thema's binnen de Topsector Energie.

SG levert allereerst een bijdrage aan de eerste, de tweede, de vierde, en – indirect – aan de zesde doelstelling. Grootschalige toepassing van duurzame energiebronnen en de implementatie van honderdduizenden, of zelfs miljoenen, elektrische auto's – inclusief hun kosteneffectieve inpassing in de energie-infrastructuur en in de energiemarkt – is

alleen mogelijk door SG. Zonder SG leiden deze ontwikkelingen tot grotere fluctuaties in aanbod respectievelijk vraag naar energie waardoor grotere prijsfluctuaties ontstaan en hogere onbalansprijzen in de energiemarkt. En zonder SG zijn daardoor ook immense investeringen in verzwaring van de energie-infrastructuur nodig.
Door de introductie van ICT in het energiesysteem ontstaan meer mogelijkheden voor het balanceren van vraag en aanbod en kan de energie-infrastructuur kosteneffectiever worden ontworpen en beheerd. Tevens is daardoor een geringere investering nodig in conventionele energiecentrales, en is een betere benutting van deze centrales en een efficiënter gebruik van de energienetten mogelijk. Dit leidt tot minder CO_2-emissie, meer concurrerende prijzen en het aantrekkelijker maken van (meer) duurzame energie.

SG levert daarnaast een bijdrage aan de derde doelstelling. De inzet van ICT maakt het namelijk mogelijk directe feedback over het energieverbruik te verstrekken aan eindgebruikers. Dit leidt tot een groter bewustzijn van dit verbruik, wat volgens verschillende internationale studies leidt tot 3-10% energiebesparing. En dat leidt eveneens tot minder CO_2-uitstoot en lagere kosten voor energie.

Tot slot levert SG een bijdrage aan de vijfde doelstelling. Er is een enorm potentieel voor SG, al is het een complex thema met vele stakeholders. Nederland is één van de voorlopers in het onderzoek en heeft zich een goede uitgangspositie verworven, mede dankzij de activiteiten van de Taskforce Intelligente Netten die het toenmalige ministerie van Economische Zaken in 2010 heeft ingesteld. Ook de eerder genoemde veelheid aan initiatieven en proeftuinen bieden een aantrekkelijk perspectief voor bedrijven en kennisinstellingen. Dit geldt vooral voor partijen in de ICT sector en consumentenelektronica die zowel aan de thuismarkt maar, dankzij ervaringen uit de proeftuinen, ook op de internationale markt hun producten en diensten zullen aanbieden. Dat leidt tot een versterking van de Nederlandse positie, zowel voor de kennisinstellingen als voor het bedrijfsleven: meer omzet en meer banen.

Concrete doelen van het thema Smart Grids voor 2012-2016

- Reduceren van de kosten van netwerk verzwaringen en kosten voor balancering vanwege de systeemintegratie van duurzame energiebronnen met minimaal 10%, waardoor de kosten van duurzame energie met 1-2% dalen (bovenop de kostendaling dankzij de inspanningen van andere energiethema's);
- Minimaal 10% van de Nederlandse energieconsumenten (eindgebruikers: ca. 700.000) maakt gebruik van Smart Grids technologiën, waaronder slimme meters, Home Energy Management Systems, en slimme apparaten (slimme wasmachine e.d.). Dit kan ook indirect dankzij gebruik van energiemanagement, participatie in 'energy communities', en (slim) laden van elektrische auto's;
- Verlagen van het energiegebruik met minimaal 5% door 'Smart Grid consumenten';
- Kostenreductie van Smart Grids technologieën, zoals meetapparaten en sensoren, op afstand bestuurbare schakelaars, en toepassing van telecommunicatie in de distributienetwerken voor elektriciteit, gas en warmte/koude. Technologieën moeten uiteindelijk zo goedkoop worden, dat het de business case interessant maakt voor partijen die hierin moeten investeren. Dit moet leiden tot een opmaat naar grootschalige toepassing van deze technologieën en daarmee tot een snelle groei van deze markt;
- Verhoging van de betrouwbaarheid van de elektriciteitsvoorziening van minimaal 10% vergeleken met het niveau in 2010;
- Toename van de omzet van de deelnemende Nederlandse bedrijven van minimaal 5x de inzet van overheidsmiddelen in de periode 2012-2016. De 'echte' groei zal pas (kort) na deze periode plaatsvinden;
- Uitbouw en consolidatie van de bestaande top-3 kennispositie in Europa op het gebied van Smart Grids.

Topaanpak SG: 3 subthema's, gebundeld in 1 TKI, en gerichte impulsen

Met de topsector aanpak kan een stevige basis onder de ontwikkeling van SG als kansrijke Nederlandse sector worden gelegd. Allereerst door een beter georganiseerde ‘gouden driehoek’. Daarnaast kan de ontwikkeling van SG worden versterkt en verbreed door projecten te stimuleren die leiden tot ‘opschaalbare’ producten en diensten die ook geëxporteerd kunnen worden. Dit vraagt ook om een impuls aan het kennisfundament om de vele uitdagingen voor SG tijdig op te kunnen lossen. En tot slot door institutionele en sociale innovatie.

Het Innovatiecontract SG bevat drie subthema’s:
1) Diensten en producten (B2C, B2B en C2B). Hierin zijn de volgende programmalijnen benoemd: beïnvloeding van gedrag, intelligente applicaties, energiemanagement, balanceren van het energieaanbod en ‘vraagsturing’, energieopslag en diensten.
2) Virtuele infrastructuur (o.a. ICT), met de programmalijnen: open data, ‘agent systems’, dataverzameling en –analyse, veiligheid en privacy, participatie, en sensortechnologie.
3) Fysieke infrastructuur, onderverdeeld in de programmalijnen: toenemende flexibiliteit, nieuwe componenten, veiligheid/betrouwbaarheid, oplaadpunten voor elektrisch rijden, energieopslag (apparaat, opslag als dienst valt onder sub 1), en smart gas grids.

Deze driedeling is echter niet allesbepalend voor de organisatie van de innovatieketen. Naast technologische vernieuwingen is er immers een hoofdrol weggelegd voor institutionele en sociale innovatie. Maatschappelijke acceptatie, het ontwikkelen van strategieën voor de interventie in het gedrag van eindgebruikers, het ontwerpen van nieuwe marktmodellen en business concepten, en aanpassingen in de wet- en regelgeving zijn noodzakelijke randvoorwaarden voor het succes van SG – en zelfs voor de energietransitie. In de uitwerking in programma’s en projecten zullen de thema’s dus gecombineerd worden.

Alle activiteiten van dit contract worden ondergebracht in één TKI in SG met een regisserende functie. Dit TKI is gericht op krachtenbundeling en versterking van het kennisfundament. Onder meer door gericht demonstratieprojecten aan te sturen, en R&D-programma’s en –projecten te initiëren.

Het thema SG bevindt zich nog in de beginfase van de levenscyclus en zal naar verwachting geen grote overheidsbudgetten vergen. De financiële R&D-inspanningen van de overheid waren de afgelopen jaren ca. €7 miljoen/jaar. Deze inspanningen lijken momenteel – afgezien van de proeftuinen SG, waarvoor een budget van €16 miljoen is gereserveerd voor 2012-2014 – ‘op te drogen’ terwijl in deze fase van de ontwikkeling van SG R&D cruciaal is. Daarvoor is het zo snel mogelijk inrichten van de opvolgers van EOS en IOP heel wenselijk, zo niet noodzakelijk.
Naar de mening van de innovatietafel is de komende jaren een overheidsimpuls nodig van gemiddeld €40 miljoen/jaar om dit gebied te positioneren bij de top van Europa. Voor een deel betreft dit R&D, en deels op de export gerichte demonstratieprojecten.

Preface

The Round Table Innovation Smart Grids (in Dutch: Innovatietafel Intelligente Netten, further "Innovation Team SG") has been established (November 2011) with an assignment from Top Team Energy (in Dutch: Topteam Energie) to prepare a public private innovation contract on the area of smart grids (SG) – smart energy systems (SES). We will shorten SG-SES to SG in this contract.

The Innovation Team SG wants to stress that Smart Grids has not been institutionalised yet. Besides, a major part of the companies in this field of play are coming from outside the energy sector. The team therefore had to create an overview of the recent and planned developments based on the input from very different sources. The first selections in topics with SG has been made, and have been elaborated in this draft Innovation Contract.

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The Innovation Team SG has received many contributions during the set-up of this document. The Innovation Team SG renders special thanks for their ideas and insights to, in alphabetic order:

- Amsterdam Innovatie Motor
- Brainport and Smart Energy Regions
- CWI
- Energy Valley
- Smart Energy Technologies & Systems (SETS)
- Stichting kiEMT
- TU Delft
- TU/e
- University of Groningen
- University of Utrecht
- And many other companies and individuals contributing in discussions and providing ideas.

1 Introduction

Definition

The Innovation Team SG uses the Dutch Taskforce Smart Grids' definition of SG: SG are *innovations in and around energy grids focusing on an affordable, reliable and sustainable energy system in the future* and enabling and enhancing:

- Demand side response from end users;
- Connection and integration of electric transport, RES, DER and storage;
- New products, services and markets;
- Flexibility of the energy system;
- Moderation of investments in infrastructure and generation;
- Reliability of the energy supply.

Scope of SG and links to other energy themes and sectors

The activities in the area of SG under this contract comprise adding ICT to the electricity, gas, heat and cold infrastructures. They further include energy storage, focusing on electricity storage but also paying attention to storage of heat and cold. SG have many links to other energy topics, and other sectors. Therefore a clear demarcation is needed. The scope of this contract *does not include*:

- Energy saving from design and construction in the built environment.
- Solar-PV panels.
- Offshore wind turbines, their physical connection to transmission grids and their integration with NL and EU energy markets.
- Biogas and 'Green Gas'.
- Electric Vehicles.

But there will be a strong link between each of these (energy) applications and SG. As far as one or more of these applications interact with the infrastructure or with each other through the infrastructure or on the energy market they come into the focus of this contract.

ICT is an important topic for SG, this has been tuned with the team of the ICT Roadmap.

Benefits

SG potentially offer a great deal of added value: they contribute to the integration of electricity production in all kinds of places in the grid. In principle, their directing and coordinating capabilities make it possible to optimise energy use throughout the entire energy supply chain. And finally, the application of SG makes the energy system more 'dynamic', improving reliability of supply.

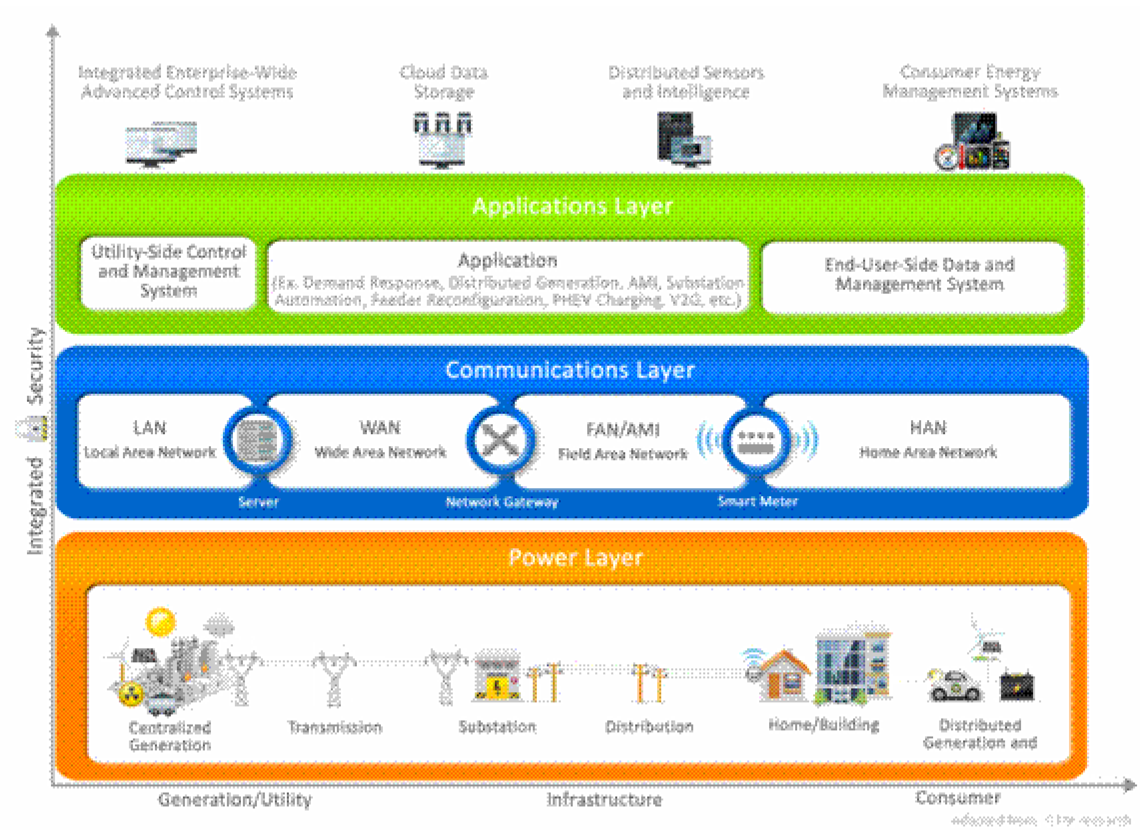
SG strongly contribute to the goals of the Topteam Energy:

- 20% reduction CO2 emissions and 14% renewable energy: SG support integration of renewable energy sources (RES) into the energy system, reducing the cost of this integration and making RES more competetive compared to conventional sources of energy.
- Energy savings: SG lead to increased consumer awareness and energy savings. Studies show that increased awareness can lead to 5%-10% energy savings.
- Competitive prices for energy: SG increase the possibilities of differentiating commercial propositions and conditions for consumers, contributing to a competetive energy market and consumer choice resulting in reductions in energy prices.
- Stronger position of NL enterprises: SG comprise a huge market for ICT and consumer electronics. Due to the advanceness of the SG concept, in many countries development of SG is relatively slow. The Netherlands have taken the lead with the Taskforce Intelligente Netten. Staying in the lead will result in a huge market for Dutch manufacturers selling SG technology internationally.
- Competitive options for renewable energy: SG enable end-users to cash their flexibility in the use of energy, flattening peaks in the power demand, and increasing

consumption when (renewable) energy is readily available. Furthermore, SG offer opportunities for new energy-related services.

Based on this, it is clear that SG will contribute a great deal to the goals of the Topteam Energy.

Schematic reflection
The central point in SG is that the grids need to become more ‘intelligent’. ICT will play a crucial role in the smart grids on multiple levels. Both for the users and in the grid itself. ICT will enable the smart grid to facilitate the much more dynamic transmission and distribution demands in the coming years. The following drawing is a schematic reflection and scope of the SG concept.



It illustrates a separation in layers with respect to ‘applications', 'communication' and 'power’. From left to right is the flow of power from concentrated generation across transmission to substations to distribution to homes and buildings. At all steps in this flow of power communication might be needed. And at all layers ICT components and/or applications will be crucial.

This drawing is a view without the 'separation of concerns' between different parties, that the Innovation Team SG elaborates and emphasizes in this contract. The Innovation Team SG has translated the drawing to three layers as a basis for its focus under this contract:

- Services layer, both B2B, B2C & C2B.
- Virtual infrastructure.
- Physical infrastructure.

Special attention has been paid in this contract to the broad spectrum of stakeholders and their interests, the broad spectrum of parties developing hardware and software for SG and parties for market design, legislation, regulation and standards.

2 Vision and strategy

2.1 Today

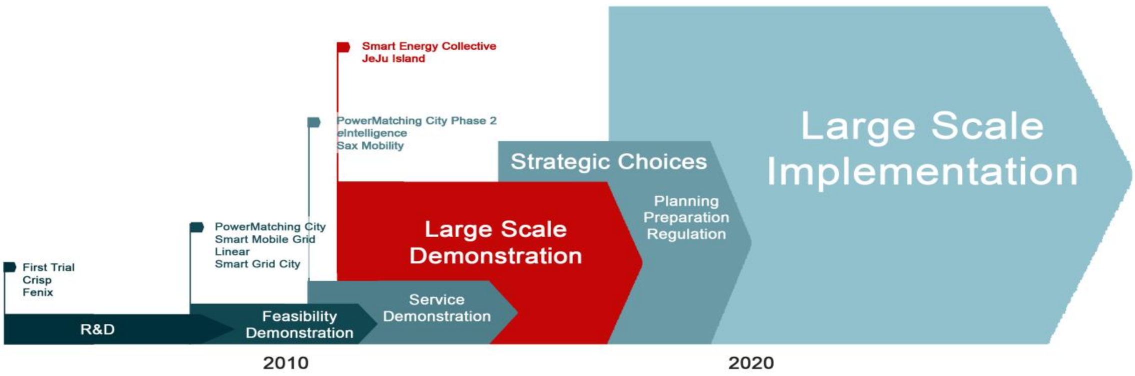
2.1.1 Existing situation

Smart Grids (SG) is the youngest member of the Top Sector Energy and is experiencing an unruly growth. We are entering uncharted territory with new rules, new stakeholders, new consortia and new modes in the way we deal with energy. As an example, think of the transformation of static to dynamic processes, from uni-directional to multi-directional, from uni-source to multi-source, from proprietary to open, and the change from central to distributed processing. Without exaggeration we can call this a paradigm shift.
And it explains why the output of the smart grid table at this moment, cannot be so precise, formalized and defined as is the case for other topics with the Top Sector Energy. Many elements still have to be settled; integration with these other topics is key but complex.

Despite this however, many concrete projects and initiatives have been developed over the last 2-3 years by a broad range of companies, institutions, and governments. Some examples:

- PowerMatcher City is the first 'live' demonstration project in Europa on balancing supply and demand in a smart grid environment and attracs a tremendous interest from all over the world;
- In 2011 multiple consortia have been created to develop pilot fields (proeftuinen) for intelligent networks in the 2012 – 2013 timeframe;
- Netbeheerder Nederland has its project group Smart Grids;
- Some 30 companies are united in the Smart Energy Collective, and;
- Multiple regional initiatives and cooperations are created, e.g. New Energy Business Community (Northern region of the Netherlands), Smart Energy Regions (province of Noord-Brabant), Smart Energy Technologies & Systems (Twente region), groups within Stichting kiEMT (provinces of Gelderland and Overijssel), Amsterdam Innovatie Motor, Rotterdam Climate Initiative and Utrecht Sustainability Institute. It is noticeable that SME has a strong representation in these initiatives which have been contributing to many promising innovations as part of the output.

Despite these promising experiments, smart grids still have to crystallize out. But it is fast growing, inevitable phenomenon that cannot be ignored! The graph below shows the developments in SG.



There is no clear picture yet of the total number of companies active in SG nor in the amount of people working in this field of play. The Netherlands is recognized though as one of the leading countries in Europe, and even in the world[1].

[1] JRC Report on Smart Grids, 2011

2.1.2 Existing activities

Discovery
Under IOP-EMVT, EOS and FP7 RD&D projects have taken place or still take place. The majority of the projects concern basic and industrial research. Some of these projects have been listed in appendix 1. In total about €7 million per year has been funded by the Dutch government in Smart Grids RD&D via these programs.

Demonstrations
June 2011 the government launched a tender for demonstration projects. Nine projects 2012-2014 have been selected (status today), with a total of €16 million funding from the Dutch government. The partners are investing some €80-100 million in these pilot projects, involving industries, offices, glass houses and residential areas both including houses, appartments and shopping areas. Some of these will be designed and established under already existing local, regional or other initiatives. One of these examples is PowerMatching City, a living lab in which 25 households are linked together in a Smart Grid, the first 'real' Smart Grid pilot project in Europe. The houses are equipped with a mix of decentralized energy resources (wind, solar-PV, microCHPs and hybrid heat pumps), energy buffering, smart appliances, smart meters and electric vehicles. Stabilization and optimization of the network is realized by trading energy on a local market based on a real-time price signal using the PowerMatcher concept. This project already received a lot of attention from all over the world. On overview of existing and planned pilot projects can be found in Appendix 1.

Deployment
Until today there is hardly any large-scale and commercial employment of projects in the area of SG except for the roll-out of Smart Meters in several countries. First products are coming to the market though, mainly devices related to energy management.
Early 2011 Alliander and KPN started a new initiative to realize the European Network for Cyber Security (ENCS). This will be a Center of Excellence on cyber security, first focusing on energy and on Smart Grids in particular. Other companies like KEMA, research organisation TNO, and national and local government (The Hague) joined the initiators, by that creating a nice example of public-private partnership in line with the concept of Innovation Contracts.

2.1.3 Existing co operations

Smart Grids is a relatively new topic in the energy business. Nevertheless, almost all regional energy related initiatives have added this topic to their field of play. Furthermore a few new initiatives has started fully focussing on this topic, e.g. Smart Energy Collective, New Energy Business Community, and Smart Energy Technologies & Systems. Within the branch organisation of the grid operators, Netbeheer Nederland, the project group Smart Grids has been installed some 3 years ago.

Regional initiatives
The existing regional initiatives all apply cooperation within the 'golden triangle', i.e. companies (especially SMEs), knowledge institutions (including education on a practical level), and local governments. Some of these initiatives have a strong focus on SG, others have a broader range of activities including SG. A selection of these regional initiatives and co-operations are (see also appendix 2):

- Energy Valley. The triple helix in the Northern Netherlands has expressed its commitment to develop smart grids. Many SME's, large energy companies, governmental parties, high quality educational institutes and financiers defined smart grid as a focus in their strategy. There are many R&D and pilot projects and commercial initiatives currently in progress providing a precious resource of information. Some of and New Energy Business Community. The following partnerships are exemplary for this commitment: 1) the New Energy Business

Community (NEBC), a platform of around 50 SME's focusing on Smart Energy Technology, 2) Sensor Universe, a platform for companies, ranging from small SME's to multinationals, focusing on sensor technology of which Smart Energy Grids is one of the key application fields, 3) Energy Academy EU, a Groningen based knowledge institution founded by the University of Groningen and the Hanze University of Engineering that offers an integral research and education program on the energy topic with a special focus on gas, renewables and (smart) energy grids, 4) Energy Valley, which coordination bureau is actively stimulating Smart Grid projects, 5) the Noordelijke Ontwikkelings Maatschappij (NOM), which focuses on financing (revolving fund of around 100M€) and business development with innovative market parties in the North (Smart Grid companies are one of the five focal points of the NOM), and 6) the Hansa Energy Corridor (HEC), an active partnership on the field of of energy between Northern Netherlands and northwestern Lower Saxony which is aiming to organize a strategic and practical cooperation in energy competence organizations from business and science.

- SETS (Smart Energy Technologies & Systems). SETS is positioned as an 'icon project' within Smart Grids in the 'Twentse Duurzaamheidsagenda', drawn up by the Twente Region existing of 14 municipalities. Smart Grids is regarded to be the linking pin between the topics 'building environment' (lead: Stichting Pioneering), 'energy' (lead: Twence), and 'mobility' (lead: Twente Region). SETS is an expertise centre of industry and knowledge institutes for research and development in small scale energy generation, local storage, usage and energy management in the Twente region. Main goals of the centre are: 1) integration of research in distributed generation, distributed storage, energy transport and energy management in a pre-competitive research and development setting, 2) addressing technical and non-technical issues such as legal, financial, human behaviour, and privacy, 3) support for renewable energy technologies using ICT solutions, 4) show the results of SETS to the general public (make aware of the energy transition), and 5) realising practical and concrete results for the participants. Current partners in SETS are: University of Twente and Saxion Hogescholen (both founding fathers), KEMA, IBM, Alliander, Nedap, Eaton, Twence, Exendis / Alfen, Homa, Locamation, Nulwoning.nl, Tripleco, Stichting Pioneering, LochemEnergie, Stichting kiEMT. SETS is discussing the start of a concrete project with the city of Enschede.
- Brainport and Smart Energy Regions. Smart Energy Regions is the label used by a cluster of companies, knowledge institutes and governmental organisations to combine forces to develop and realize modern concepts of decentralized regional energy solutions. Especially densely populated areas and rapidly growing cities require efficient usage of energy and system level integration of generation, distribution and storage. Smart grids and ICT services will be of major importance to solve the intermittency effects that most sustainable energy sources have and to balance central and decentralized energy generation and use. Our industry is well positioned to take full advantage of these business opportunities in the Energy Sector. In fact, it has the potential to become the driver. The Dutch High Tech industry already plays a global leading role with regard to development of new technologies and materials for communication means, safe and fuel efficient transportation, generation and storage of sustainable energy, energy efficient homes and offices. This industry has an annual turnover of 73 Billion Euro and invests annually 2.2 Billion Euro in R&D. It is very well equipped to achieve breakthrough innovations, because of the 'open innovation' cooperation of all actors: industry, knowledge institutes and governments, at regional, national and international level. Smart Energy Regions combines these forces towards one business proposition for global energy markets. For Noord-Brabant the economic benefits are calculated on a yearly turnover of 4 billion Euro and approximately 15,000 – 25,000 new jobs by 2020. Smart Energy Regions will leverage on and be supported by the EIT KIC InnoEnergy, a top consortium of 6 leading regions selected by the European Commission in the field of sustainable energy.
- Stichting kiEMT. The provinces of Gelderland and Overijssel do have a long history in the energy sector. A growing number of innovative companies have an ideal

starting point in the eastern part of the Netherlands. The region consists of 600,000 people working in this sector, 800 companies with leading companies like TenneT, Alliander, Enexis, and KEMA, 3 universities, 7 high schools, and 9 ROC's specialised in topics like smart grids and smart gas applications, ecosystems of private-public partnerships, and revolving funds of Gelderland (100 M€) and Overijssel (250 M€). Many projects on Smart Grids are already running or about to start. Some examples are: 1) Rijnboog (renovation of part of the Arnhem City Center) which will apply smart heating systems to connect appartments, public buildings, cultural centers, offices, and a shopping area In the region, 2) Second Phase of Smart Power City Apeldoorn (upscaling to 300-400 households) in which micro CHP systems are applied amongst others, and 3) GEN project that will develop new energy concepts for buildings and the built environment.

- Amsterdam Innovatie Motor (AIM). Sustainability is a key element in Amsterdam's policy on innovation in its region. Projects are executed with the Amsterdam Smart City program in which government, companies (especially SME's), and knowledge institutions are working together. Smart Grids is regarded as an important enabler of both energy reduction measures and increasing the use of renewable energy. The Amsterdam Economic Board expects the application of technology in the energy transition arena to be a challenge for the local economy as well as a prerequisite on their innovation agenda. At present three different Smart Grids projects are carried out in this region, i.e. in Osdorp, Almere en op Schiphol. The Amsterdam Science Park will be a kind of a copy of the PowerMatching City project but at a 10-100 times larger scale.
- Utrecht Sustainability Initiative (USI). USI and its founding father Utrecht University (UU) have initiated the Smart Grid System Innovation network to express its interest to participate in the Innovation Contract Smart Grids. This network summarizes the specific smart grid expertise of UU/USI and its partners - specialised knowledge institutes, companies and local governments with the shared ambition to realize successful smart grid systems in urban regions. The focus of the specific expertise of the SGSI network is not the development of technology for smart grids as such. Instead, the core ambition is to accelerate the implementation of smart grid technology in the urban environment. The network develops specific expertise in system innovation factors that are decisive in the implementation process of smart grids, ultimately leading to its success or failure. These make-or-break system innovation factors include consumer's perception and acceptation, value chain optimisation, financial arrangements, policy instruments, institutional conditions, spatial planning and new legal challenges. This expertise will be deployed and amplified in the 2012-2014 project 'Smart Grid: efficiency for all', realizing smart grid systems in the cities of Utrecht and Amersfoort. This project can serve as a flag ship project within the Innovation contract Smart Grids: because of the above described gamma-perspective this flag ship will be of distinct added value with respect to other more technology oriented programmes.

Other projects and initiatives

A wide range of projects from the former R&D programs EOS and IOP could be part of this Innovation Contract. Most of the still running projects however, are in their final stage. Nevertheless we propose to include these in the contract as this most likely is a strong base for the development of our future knowledge on SG. Besides, several of these projects have links to European projects which supports the international cooperation of the knowledge institutions as well as the international expansion of our SG businesses.

Next to these projects other initiatives and projects will be integrated in this contract. A number of these are described in Appendix 3, a selection is mentioned below.

- Smart Energy Collective (SEC), a partnership of 30 key industry players in the Netherlands to jointly develop new Smart Energy products and services in an open innovation environment. The SEC will design and built 5 large-scale pilot projects in industry, offices, and residenstial areas with more than 1,000 participating energy consumers. This initiative will provide the partners a way to keep ahead of the competetion and develop real business in Smart Energy / Smart Grids. Total budget of their pilots is estimated at 60M€ of which more than 90% will come from the participating industries and local partners.

- Smart Energy Market (SEM), is a project to enable bilateral and online consumer-to-consumer energy trade, within (and despite) the current energy legislation framework. On the "SEM" people can buy and sell locally, sustainably generated electricity. This will create emotional value (freedom of choice), societal value (awareness about energy use, and stimulation of sustainable energy), economic value (load optimisation for grid companies amongst others), and energy saving (awareness created by active involvement in energy trade). Budget is about 1M€.
- Tuning Information Architecture for Smart Grids will support companies and others involved in Smart Grids with information about interoperability and standards, and at the end by creating a common base for communication and infrastructure for further deployment of Smart Grids. Budget indication: 2M€.
- Energy Network of Cyber Security (ENCS), already mentioned above. ENCS will be an independent European public-private partnership, open to industry, academia, and governmental organisations within the area of digital critical infrastructure resilience and cyber defense, located in The Hague. ENCS aims to promote and spread cyber security awareness, critical infrastructures, government institutions and business against cyber threats, and to address the blind spots – protect Smart Grids and Industrial Control Systems with innovative products and services. The 4 program lines will be: R&D, Testbed, Information & Knowledge sharing, and Education & Training. Total budget is estimated at about 3M€.

2.2 Vision and ambition

2.2.1 Vision

There is a global drive to drastically reduce CO_2 emissions due to global warming. Besides, there is an European political drive to reduce dependence on (imported) fossil fuels. Increasing environmental and energy awareness in society is resulting in energy savings and the increased use of renewable energy, which for a significant share will be derived from intermittent energy sources such as the wind and sun. Some like the Smart Energy Collective (SEC) expect that within two decades more than 30% of the energy generated in the Netherlands will be derived from renewable, partially decentralized, energy sources.[2]

> *"Expanding and improving Europe's energy networks will be vital for Europe's transition to a low-carbon economy. Smarter distribution grids will be needed to integrate increasing amounts of decentralised generation, electric vehicles and heat pumps into the network and encourage consumers to actively manage their energy demand. This will require additional investment in new infrastructure."*
> Source: Eurelectric, Regulation for Smart Grids, February 2011.
>
> *"Smart Grids and Smart Energy Systems are privileged and, for the future, necessary for which we need action now."*
> Source: Taskforce Intelligent Grids, 1st recommendation in final report, May 2011 [2].

The Taskforce Smart Grids state that new perspectives develop for the electricity supply mainly, although innovations in the gas system as well as in heat and cold infrastructure – in Dutch households twice the energy use compared to electricity – are expected.[3] Some examples are electric vehicles, heat pumps, micro CHPs, smart appliances and energy management as well as energy storage services for both households, offices, glass houses, and industries. A fuel shift is taking place due to an increasing demand for electricity, to a large extent driven by the large-scale introduction of electric transport and space heating by heat pumps. This will cause the consumption of electricity to increase drastically.

[2] Smart Energy Collective, End Report Phase 1, May 2011 (not publicly available).
[3] Taskforce Intelligent Grids, Discussion Document, July 2010 (in Dutch).

Netbeheer Nederland, the Dutch branch organisation of grid operators, and many others are regarding SG as necessary to make the energy transition happen, to offer new services to energy consumers, and to fulfil the future demand for energy transport and distribution.

On the one hand, the abovementioned changes in the currently undifferentiated energy system will lead to the necessity of significantly reinforcing the energy infrastructure (electricity, gas and heat) and the associated higher costs and/or will lead to a significantly less reliable energy system that threatens the energy consumer's freedom of choice and comfort. This is socially undesirable.

On the other hand, these changes also offer opportunities. The energy sector is challenged to be innovative and this will create new markets, services and value chains that will benefit the energy consumer as well as the energy sector.

So, we are searching for a 'new order' in the supply of energy (especially decentralized) that optimally matches the changing social context of the 21st century. The definition of this order is uncertain, because it is unknown what the energy consumers, and specifically the low-volume consumers – which in the Netherlands comprise millions of households, non-residential buildings and small and medium enterprises that collectively account for more than 30% of the total energy consumption – really want in the future. Their engagement and behaviour will have a major impact on the entire energy system.

2.2.2 Ambition

The goal of the companies, institutions and (governmental) organisations participating in this Innovation Contract SG is to become a powerful, effective, competent and innovative sector. More precise:
- Strengthen and further organisaing the cooperation between the 'traditional' energy sector and 'new' players working in ICT, High Tech, telecom, built environment, construction, and automotive industry.
- Utilizing the existing qualities of enterprises (especially SMEs) and trade. As an example, the European market for smart energy applications is €15 billion in 2015.
- Apply open innovation and improve the expansion of our knowledge position by strong interaction between research organisations, enterprises and authorities.

The concrete goals for the 2012-2016 period are:
- Reduction of the investment and operational costs of the reinforcement of the energy grids – especially the power grid – and of the costs for balancing power due to the integration of renewable energy sources. Target: 10% cost reduction, resulting in a (additional) 1-2% cost reduction of these sources.
- At least 10% of the Dutch energy consumers (end-users: about 700,000) is applying SG technologies, e.g. Smart Meters, Home Energy Management Systems, and smart devices like smart washing machines. This could be realized indirectly by making use of energy management systems, participation in 'energy communities', and smart charging of electric vehicles.
- Lower the costs of energy consumption of 'Smart Grid consumers' by at least 5%.
- Cost reduction of SG technologies, such as sensing and measurement devices, remotely controlled switchgear and telecommunications to all levels of the Dutch electricity, gas and heat distribution grids. So far, high costs of SG components is an important barrier for large scale use and confine the technologies to application in very specific situations only. Cost reduction would lead to rapid increase of market size.
- An increase in the reliability of the electricity supply of at least 10% comparing to the 2010 level by applying SG.

- An increase in turnover of the participating Dutch companies in the SG market of at least 5 times the governmental funding in the 2012-2016 period. It is expected though that the serious take-off will be shortly after this period.
- Further expansion and consolidation of the existing top-3 position in R&D in Europa with respect to SG.

2.3 Strategic innovation and long term learning agenda

2.3.1 Opportunities on the market place

With the introduction of smart grids a huge market potential will be created varying from products and services supporting reliablity and affordability of energy to products and services focused on energy comfort for end-users.

At this moment in demonstration projects all stakeholders gain insight into the needs of consumers. In the end, the latter might be motivated to transform into modern, individual 'energy downloaders and uploaders'. This should be subject to the precondition that the overall, differentiated energy system will remain safe, reliable and affordable, and will become more sustainable.

Really offering the energy consumer freedom of choice enables the consumer to independently make an assessment in terms of the costs, volume, location, origin and sustainability of the energy requested and/or supplied by him or her. This provides the companies in the market with greater freedom of choice for delivering customized products and services to the consumer (B2C) and to each other (B2B).

Companies and others executing demonstration projects jointly learn which technological solutions, combined with new products, services and value chains are really desirable for energy consumers, feasible and affordable for the sector, and socially and politically acceptable if these are nationally rolled out in the near or distant future.

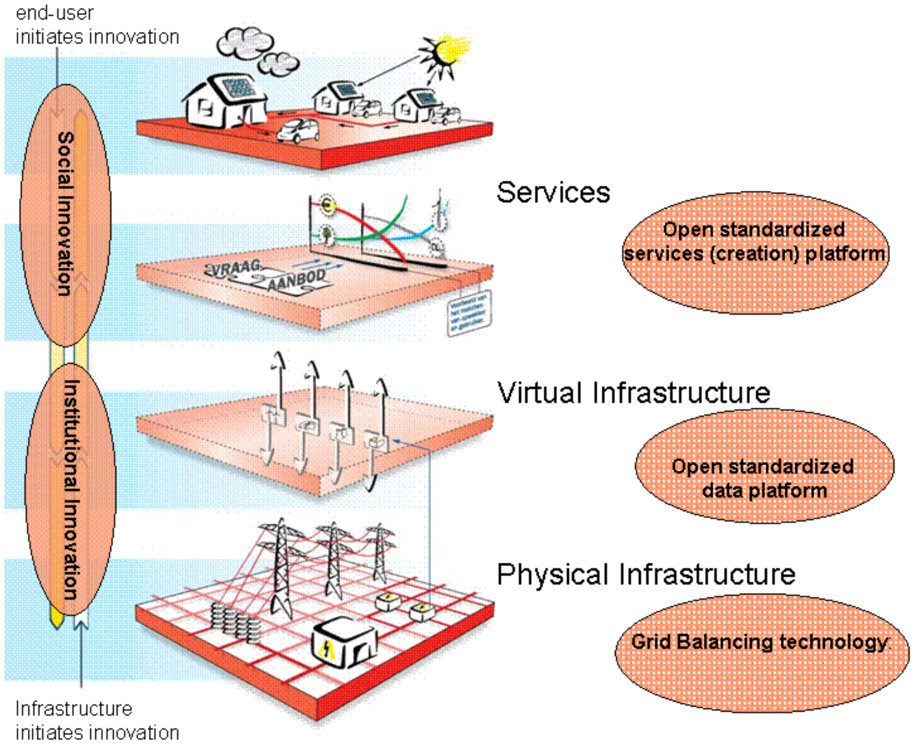
2.3.2 Innovation topics

The realisation of the above described vision and opportunities in the coming years will concern many different technological, commercial, legal and societal aspects. For example, there is little to no room for error in generation and physical distribution of power, and there are commercial, legal and societal issues at stake like 'a fair price and equal access to power markets'. It requires solving an intertwined set of challenges. A seperation of concerns using a reference model combined with institutional and social innovation is a key factor to succes.

Smart Grids and three layers
Within the reference model and its key-concept of separation by using layering & interfacing, we distinguish the following three layers (see also figure beneath):

1. **Services layer, both B2B, B2C & C2B.** A (market)place where on one hand services with respect to generation, transport and distribution of energy and on the other hand energy-comfort services are provided.
2. **Virtual infrastructure.** A representation in terms of (digital) interfaces of the physical infrastructure in cyberspace (also known as 'the cloud'). These interfaces can be used for as well monitoring & control of physical equipment as providing data for the services layer.
3. **Physical infrastructure.** The physical layer comprising the components for generation, transport and distribution of energy. And all physical components are able to communicate about their state and possibilities.

This separation in three layers enables parties to collaborate and co-operate at the service layer with far less understanding of the physical level. For example, market supply and demand services can be constructed 'digitally' using interfaces that are made available at the virtual infrastructure layer.



The interfaces between layers of abstractions are called vertical interfaces, since they form a shield between a higher and lower layer of abstraction from the actual physical grid. Next to vertical interfaces there are also horizontal interfaces. These are interfaces between parties which have to cooperate or want to use services from each other. The challenge for the next decennium is to define the vertical and horizontal interfaces in such a way that solving problems efficiently requires a minimum amount of expertise ('shielding areas of expertise'). For example implementing new and more efficient technology for frequency control (the 50 Hz frequency of the electricity) should interfere as little as possible with implementing new supply and demand market mechanisms on the market. In other words: separation of concerns.

On each layer we defined a set of innovation topics, which will be adressed in chapter 3:
1. Grid balancing technology,
2. Open standardized data platform,
3. Open standardized services (creation) platform.

Smart Gas Grids
Although most attention in Smart Grids is on the electricity part, integration with heat and gas grids and markets, are part of this topic. E.g. the Dutch gas infrastructure is already there for many decades asking for increasing attention to the operations and maintenance of the gas grid. Remote sensing can be applied to develop smart gas grids.

Gas can also be applied as a means of storage to support greater flexibility in the energy supply at local levels. One then should develop a smart coupling of the power grid and the gas grids as well as between the electricity market and gas market.

Smart Grids and institutional and social Innovation
In the transition to a 'new order' in the supply of energy there are all kind of technical challenges to deal with and there are all kind of stakeholders involved. A stakeholder that is becoming more and more important is the end-user (in various roles).

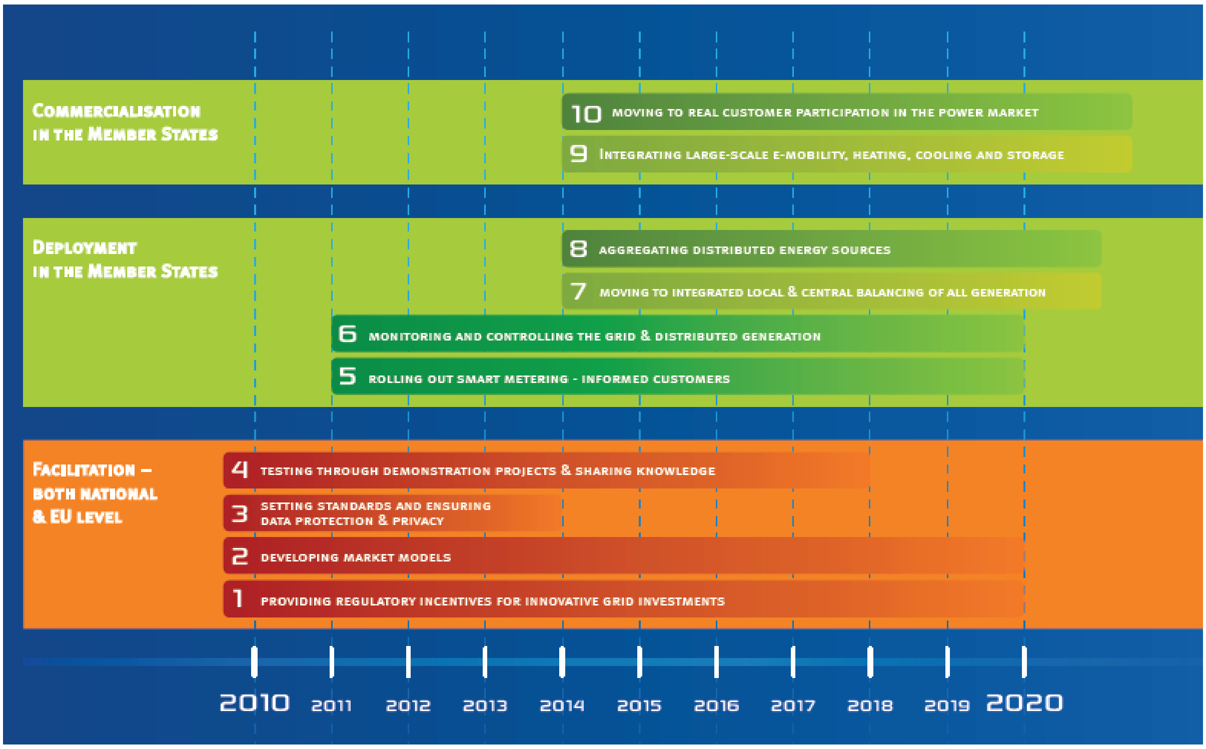
So an additional challenge is to get the end-user involved in such a way that it will play an active role and in that way directly contributes to the energy transition. It means that the end user (perspective) should be involved:
- in technical innovations within smart grids
- in creating (conditions for) smart energy services
- as a guidline for institutional and social innovation.

We defined two sets of innovation topics that link to all of the three layers and will be adressed in chapter 4:
1. Institutional Innovation: with a focus on avoiding regulation barriers.
2. Social Innovation: with a focus on business models and end-user behaviour

2.3.3 International dimension of SG

2.3.3.1 SG development in Europe and the world

SG developments differ from country to country, and even in regions within countries. Several roadmaps or roadmap alike papers have been developed in recent years, by countries like Australia and South Korea, by international organizations like the IEA and the European Technology Platform (ETP), and by companies or organizations of companies like Eurelectric, the International Electrotechnical Commission and – in the Netherlands – Netbeheer Nederland. The different roadmaps have different time lines, use different tangles or place different accents. But also there are some similiarities. The Eurelectric roadmap identifies 10 steps that give a picture of the commonly agreed elements and gives an indication of the speed and sequence of developments (though that differs between countries) in Europe.



Source: Eurelectric, '10 steps to smart grids; Eurelectric DSO's Ten-Year Roadmap for smart grid deployment in Europe, 2011, www.eurelectric.org.

In an overview form the EC[4], the main estimates are given of overall investments in the electrical system and a snapshot of investments already committed for SG development:

- European Union:
  - ⇒ During the period 2010-2020 European investment in SG Technologies will reach € 56.5 billion, with transmission counting 37% of the total amount.
  - ⇒ Also it is suggested that by 2020 almost 240 million smart meters will haven been deployed in Europe.
  - ⇒ Europe requires investments of € 1.5 trillion over 2007-2030 to renew the electrical system from generation to transmission and distribution
- United States:
  - ⇒ Full implementation of SG will require between $ 338 and $ 478 billon over the next 20 years (about 70% for distribution and 10% for consumer systems). These costs are in addition to investments needed to maintain the system en meet electric load growth.
  - ⇒ In 2020 60 million smart meters expected to be in use (now already > 8 million).
  - ⇒ In the US until 2030 $ 560 billion is needed for investments in generating plants and $ 900 billion for transmission and distribution.
- China:
  - ⇒ China plans to invest in the periode 2009-2020 € 423 billion into a nationwide transmission network with € 71 billion dedicated to developing SG technology.
  - ⇒ China is set to roll out 360 million smart meters by 2030 and is investing heavily in more efficient distribution transformers.
- India:
  - ⇒ In India transmission and distribution losses are among the highest in the world (26% of total electricity production). Non technical losses (theft) amount to 50% of these losses. This is an import driver for smart grids, together with increasing energy efficiency and the renewables.
  - ⇒ India has announced massive smart meter roll-out projects with a plan for more than 130 millon smart meters by 2020.
- Brazil:
  - ⇒ In 2010 Brazil invested € 144 million in stimulus funding for SG.
  - ⇒ Planning to replace 63 million electricity meters with smart meters by 2021.
- Australia:
  - ⇒ In 2010 Australia invested € 253 million in stimulus funding for SG.
  - ⇒ State of Victioria plans State-wide roll-out of 2.4 million smart meters by 2013.
- Japan:
  - ⇒ In 2010 Japan invested € 570 million in stimulus funding for SG.

What we see in Europe is that up to now most investments (60%) concern the deployment of smart meters.

When it comes to integration of Distributed Energy Resources and large scale renewables, most investment concern R&D and demonstration.
Also noteworthy is that most projects are lead by DSO's.
In Europe there are very few larger-scale demonstrations yet, involving a high number of sites and real communities. Such large scale demonstrations are needed to prove the up-scaling and reliability of technical, market and regulatory solutions, and to better understand their social impact.

The JRC-study indicates as attention points for the future (also identified in het Eurelectric Roadmap):

- Regulation that leads to platforms for the provision of services, service-based business models and a fair sharing of costs and benefits.
- Interoperability, data protection and data security.
- Consumer engagement (and segmentation of consumers).

[4] European Commission, Joint Research Centre, Institute for Energy, 'Smart Grid projects in Europe: lessons learned and current developments', 2011

2.3.3.2 European policy

Until recent EU-policy on SG mainly focused on R&D. For a large part this was operationalised in energy(grid) projects under FP5, FP6 and FP7. And co-ordination between R&D-programmes of Member States took place in the ERA-Net SG, that started in 2008 (chaired by the Dutch Agency). Meanwhile the Energy Technology Platform SG (chaired by Dutch KEMA, former CEO Pier Nabuurs) published a Vision (2006), a Strategic Research Agenda (2007) and a Strategic Deployment Agenda (2008). In 2008 the Strategic Energy Technology Plan (SET-Plan) started and appointed SG as one of the central themes.
In 2009 the EC installed a SG Taskforce with the task to advice the Commission on policy and regulatory directions in Europe. The policy conclusions that resulted from this European taskforce were published in a communication on SG (april 2011), and regulatory consequences in het Infrastructure Package and the (concept) Energy Efficiency Directive. Main subjects are:

- regulation on standards, interoperability, privacy and security (mainly concerning smart meters);
- regulation on system services of DSO’s and dynamic tariffs.

2.3.3.3 Pre-commercial public procurement

Pre-commercial public procurement is an approach for procuring R&D services. The public sector in the EU is faced with important social challenges, not limited to the world of energy. Addressing such challenges require new and innovative solutions. Some of the required improvements are so deeply technologically demanding that either no commercial stable solution yet exists on the market, or existing solutions exhibit shortcomings which require new R&D. This will be specifically the case for Intelligent networks, a fast developing sector, with many new stakeholders and consortia, entering uncharted areas. Most likely this will lead to the creation of new Intellectual Property Management.
By developing forward looking procurement strategies including R&D procurement to develop new solutions that address these challenges, the public sector can have a significant impact on the mid to long-term efficiency and effectiveness of public services as well as on the innovation performance and the competiveness of European industry. Thus, by acting as technologically demanding first buyers of new R&D, public procurers can drive innovation from the demand side.
Developing a strong European home market for innovative products and services for smart grids is key for Europe to create growth and jobs – quickly evolving from R&D to markets.

2.3.3.4 Dutch position in international context

Dutch companies are active in industrial networks that give attention to SG, but often these networks are based on existing industrial structures.
In international context, typical smart grid networks, especial industry networks, are very young. Globally oriented organisations, like the US-based Gridwise Alliance, that embraces different types of industry are still rare. Members are often multinational companies. Dutch companies that are active in these typical smart grid networks are mainly KEMA and Alliander.

The Netherlands is in different ways present in the European and global governmental networks. Also these networks, like the International Smart Grid Action Network (ISGAN) that started in 2011, are still in development.

An trade strategy for the Netherlands on SG should be based on succesfull demonstrations in the Netherlands. So at this moment only starting points can be given for such a strategy. Attention points concerning such an international strategy are:

- The Netherlands is not the home-country for the major global players in the field of SG like IBM, CISCO, Siemens, LG or Samsung, but some of these companies have positions and activities in the Netherlands and are interested and participating in projects in the Netherlands;
- A typical strong asset of Dutch companies is the ability to work creatively together with other companies and combine services and products. This is particularly relevant in the field of smart grids where 'the new order' with smart energy systems and (virtual) smart energy communities demand these qualities.
- Dutch demonstration projects can have the function of steppping stone to trade missions where coalitions of comapnies use the projects as reference for their business. The Dutch TWA-network could have an important facilitating role in preparing these missions and building networks.
- In the IPIN demonstration projects the focus was on products and services for the Dutch situation. The export position could be strengthened through developing new demonstration projects that have a more international focus.

This trade strategy can use longer running co-operations between regions in NL and neighbouring countries such as:

- Hansa Energy Corridor (HEC): a joint regional development between the Northern Netherlands and northwestern Lower Saxony on the field of energy. One of the actions of HEC is the formation of the Energy Academy: bundling all energy related research at the RUG and Hanze University of Applied Sciences in one integral research facility. SG are one of the eight energy related topics on the HEC-agenda.
- Co-operation between south east of the Netherlands and North Rhine Westphalia.
- Co-operation between Dutch parties and regions and parties in Belgium.

2.3.4 Human capital agenda

The Innovation Team SG intends to align its agenda on the area of human capital with an agenda to be developed for the energy branche by the Topteam Energy in order to meet the challenges on the area of engineering, construction, operation and maintenance of SG hard- and software.

2.3.5 Legislation and regulation

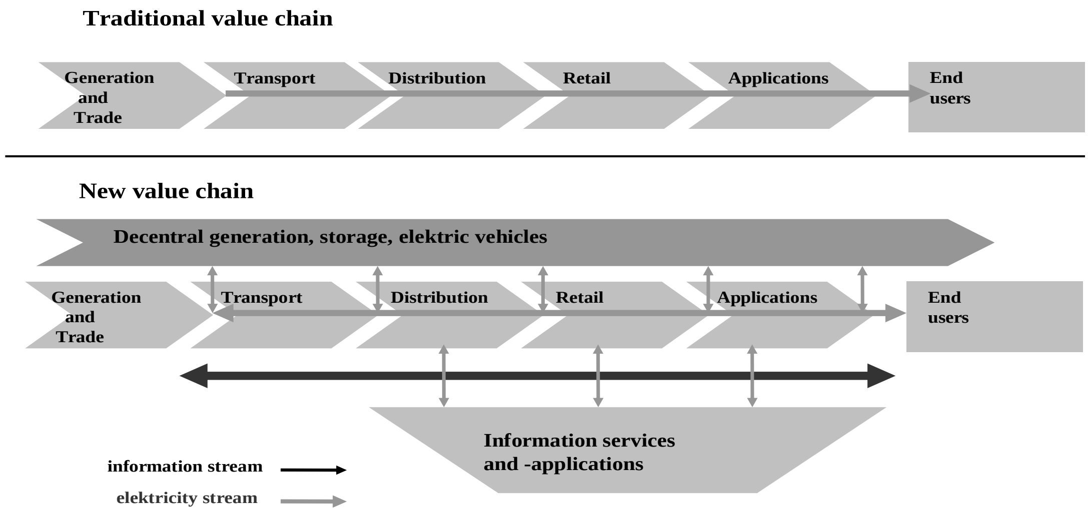
The domain of the energy infrastructure is heavily regulated, because of the monopoly character of this sector. Regulation concerns amongst others:

- Market models with the definition of the monopoly and allowed market activities of TSO’s and DSO’s;
- Investments in and exploitation of networks (including innovation);
- Tariffs for transport and distribution.

Smart grids lead to an new value chain (see figure below) with the need for regulation that facilitates:

- platforms for the provision of services;
- service-based business models;
- a fair sharing of costs and benefits.

Smart grids: a new value chain



Adjustments in regulation are probably inevitable in the light of this new value chain to overcome split incentives:

- For energy communities to have a business case;
- For using prosumers in maintaining system balance;
- For using decentral generation to enlarge system reliability;
- For using electric vehicles as storage opportunity;
- For optimizing (saving on) investments in energy infrastructure.

The Dutch smart grid demonstration projects that are running in 2012-2014 allow for experiments with this kind of regulation and offer opportunities to learn about regulatory solutions.

Relevant questions in this dimension are:

- How to realise more integral energy solutions (electricity-gas-heat) in balancing local supply and demand with the lowest costs?
- How does regulation affect the decisions tot implement smart alternatives for enlarging netcapacity like storage, decentral generation and demand response?
- What new ancillary services are needed for DSO's?
- What kind of new dynamic tariffs (for energydelivery and transport) are needed to realize system benefits?
- How does this lead to new roles, responsibilities and market models?

Different research methods (questionnaires, simulations, monitoring, gaming) can be useful.

3 Activities and layers

Goal of this document is to develop new technologies, new tools, new services, new business cases, and stimulating governance structures by using smart grids as a vehicle for innovation. As energy infrastructures and systems increasingly interconnect and are increasingly interchangeable, new possibilities for services become viable, that could never have developed in dedicated infrastructures. To reap the fruits of such integration, made possible by SG, a new market design is needed and current barriers for innovation need to be removed. Most importantly new roles, new stakes, new responsibilities and tasks need to be defined for incumbent and for new players in this market.

This theme transcends the borders and compartments of the physical infrastructures and energy carriers (gas, electricity, thermal), and it crosses boundaries in law and regulation, service provision, and governmental decision making. The integrated approach leads to a cross sectoral vision encompassing all energy systems.

An important starting point is the need to develop energy-neutral cities or parts of cities, offices and industrial areas. This has clear priority for many national and regional governments, as well as for many private entrepreneurs, housing agencies, owners, consumer organisations and a large group of active citizens. It concerns new areas as well as renovation and redesign of existing areas and buildings (the European and nationally acclaimed "smart city concept").

SG are considered to be the crucial link to obtain a energy-neutral cities. By reconciling the activities, energy sources and energy flows within such area or network, the systems energy consumption will decrease. A smart energy community will thus contribute to an important extent to the energy goals of The Netherlands.

The role of citizens, SMEs and larger companies is crucial. Their behavior will determine the energy consumption, but also in increasing extent the energy conversion, supply and trade.

3.1 Products and services (B2B & B2C & C2B)

As energy infrastructures and systems increasingly interconnect and are increasingly interchangeable, new possibilities for products and services become viable. Possibilities that would never develop in dedicated infrastructures.

In fact some of these products and services are basically required to operate a smart energy infrastructure. The more distributed production becomes common the more products and services are needed to keep the energy system healthy and stable.

We recognize six development areas which can be grouped in different logical programming lines:

1. Influencing behaviour,
2. Intelligent appliances,
3. Energy management,
4. Load balancing and demand side management,
5. Energy storage and power conversion and
6. Services.

3.1.1 Programme lines

Influencing behaviour

The awareness of people regarding energy consumption and personal CO_2 footprint is growing. Like mobility people tend to have a generic way of moving, working and related implicit energy consumption. From the mobility arena lessons are learned to change

peoples' behaviour by providing information and price based incentives. The energy consumption behaviour of an individual or company is most of the time unknown:
- consumption isn't monitored on a regular basis;
- price information is only provided on the yearly bill.

The effect is that people aren't confronted with their behaviour using direct feedback. Individuals or management are ignorant - they have no incentive to save energy and no information to support them.

Product developers and service providers have recognised this aspect and are willing to invest in energy monitoring solutions which provide direct feedback in terms of:
- information about energy usage and suggestions to lower consumption;
- the effect of the behaviour in terms of their CO_2 footprint;
- the effect of the behaviour in terms of cost spending and cost reductions.

Intelligent appliances
Changes in behaviour can be encouraged by providing the ability to monitor and control appliances in and around the house of the resident (or the office of a company). This includes interfaces with appliances which consume or produce energy.

Monitoring

The monitoring function allows the resident to make informed decisions in how to make better use of the existing equipment to lower energy consumption. This is the first step in gaining awareness.

Control

Secondly the appliances or equipment must be controlled (if technically feasible) to optimize energy production or demand.

Both aspects can be addressed by technical standards which aren't available yet. Currently a lot of different interfaces exist and no real standard is available. This holds back the development of new products and related services.

Intelligent appliances involve all equipment which consumes or produces energy including dishwashers, washing machines, dryers, heat pumps and central heating. Developing intelligent appliances will have impact on the whole value chain: systems, products, processes and the installation and maintenance of systems and products.
As a result many opportunities for a lot of businesses, not only product developers or service providers will arise.
Furthermore, integration of different intelligent appliances will create opportunities to provide comfort for residents. The availability of an integrated domotica platform including energy management features is beneficial to people and will result in increased acceptance and willingness to invest.

Energy management
Energy management systems will control the consumption and production of energy on behalf of a resident or company. These systems will provide parameters to the user to actively control the energy use by predetermined goals or objectives: cost saving, energy saving etc.

Energy management systems will provide the portal to the resident to use valid and actual data and the ability to modify the behaviour on user specific objectives. This will involve modern technologies like touch screens, iPads and web technology.

Load balancing and demand side management
Distributed energy generation and increased use of renewable, intermittent energy sources such as solar (photovoltaic) and wind result in unpredictability and lack of control over the supply of electricity at various levels in the grid, down to the household level.

Consequently there is an increasing risk of mismatch between instantaneous supply and demand levels. Also, electricity demand shows clear peaks during the day, which can often not be followed by even conventional electricity generation.

Therefore management and control of the demand side is required. This is often referred to as peak-shaving, or load-balancing. Dynamic pricing mechanisms, in combination with collaborative autonomous electricity producing and consuming nodes are considered a promising and scalable approach to this problem. Such nodes can for example be smart appliances, smart PV panels, micro-CHPs and electrical vehicles.

If technically feasible decentral production units can also be used for balancing services, even combined with storage installations.

All of this requires definition of detailed architectures, as well as definition of interfaces and protocols. Security, transaction management and pricing schemes need to be addressed as well. Obviously this creates interesting opportunities for new products and services.

Energy storage and power conversion

As described in the previous chapter the power usage will increase and challenges arise to control the grid in having controlled demand response or to provide services to consume decentralized production into the grid. Energy demand and decentralized energy generation should be balanced and it is evident that storage of energy plays an important role in getting this balance. Energy storage can be provided in various corners of the smart grid arena. This includes:

- local storage via batteries in home;
- local storage in residential areas;
- storage via electric vehicles;
- energy storage via 'smart water[5]';

Efficient power conversion is necessary to convert, store and use the energy at the appropriate time. Loss of energy during the conversion should be kept to a minimum.

Services

Service providers will use the technologies and systems as described in the aforementioned paragraphs to provide new services. These services may include B2C and B2B services:

- Consulting
  - Provide services to companies and residents to optimize energy use.
  - Provide highly professional knowledge about tariff models and cost structures to companies interested in pricing of balancing services.
- Science
  - Develop knew market models for the future smart grid infrastructure.
  - Conduct scientific research to new product concepts and control and optimization techniques.
- Energy management
  - Provide services including energy management systems to inform residents or companies, influence behaviour and optimize energy use by using intelligent equipment.
- Maintenance services
  - Being able to control and monitor appliances opens a new world of opportunities for maintainers (or owners) of equipment. For example housing cooperatives.

The ability to provide energy management to residents and companies will provide new kinds of services when a certain footprint is established. Being able to monitor and control a large number of households or companies by using dynamic pricing provides

[5] Control timing of boilers and 'plan' the power consumption.

new possibilities to control the energy demand and decentralized generation within the grid on a large scale. New service providers will provide these services to:
1. get lower prices for their customers (residents) using APX;
2. be able to provide services to network operators to support balancing the grid;
3. be able to provide services to energy suppliers to provide dynamic pricing schemes.

3.2 Virtual infrastructure

3.2.1 Programme lines

One of the main purposes to create the layer that we call the virtual infrastructure or interface layer is to achieve independency between the service layer and the physical layer. A change in one of these two layers will be unnoticed by the other one. The open interfaces in the virtual infrastructure will facilitate this.

In more detail the function of these interfaces is to provide uniform and standardized interfaces with respect to:
1. functionality for the use of resources (e.g. power metering).
2. functionality for the state ('health') of the physical infrastructure and its components.
3. functionality for the control of physical components within the grid and components/devices connected to the grid. Note that for key components that could have a large impact in grid operation very secure and strict access management is required and that this 'part of the cloud' might only be accessible (even physically) to a strict subset.
4. functionality for balancing supply and demand on energy market (at different time scales).

An important aspect of the virtual infrastructure is that the real infrastructure can be monitored and controlled at the level of the virtual infrastructure, but that the physical infrastructure does not rely on the virtual infrastructure. If – by whatever cause or through whatever reasons – the link between the virtual and physical infrastructure is severed, the physical infrastructure will revert to a default and secure autonomous mode of operation.

Another important aspect of the virtual infrastructure is its distributed nature. There will be no central 'ICT-platform' in the Netherlands to which the entire smart grid, its devices, sensors and displays will be connected. Instead there will be many different ICT-platforms distributed throughout data centres or 'local computational and communication hubs'. This (large) network of nodes will communicate through the vertical interfaces over the so called Energy Internet - a (possibly large) variety of communication technologies, enabling parties to make their own choices with respect to realizing their part of the virtual infrastructure. Also note that the exposure of (technological) components in and connected to the grid depends on the extent to which owning and/or controlling parties want to expose monitoring & control interfaces of their components to others. The more impact a component has on the performance of the smart grid, the more restrictions there are with respect to access to that component.

To give some concrete examples of this we can think of:
- Meshed RF: the technology that will enable the mutual communication between devices and the communication between devices and appliances so that no additional infrastructure or services will be necessary.
- Smart Grid protocols: An open protocol that facilitates interoperability between e.g. the components within a Local Area Network (at home, within a company or between buildings in an area).

The link with the ICT roadmap
Because of the connecting role of the Virtual infrastrucure layer in our three-layer model we describe in this section the link with the ICT roadmap.

As mentioned earlier ICT will touch all aspects of SG. It will be used for constructing services using the interfaces at the virtual infrastructure layer. But at the same it time will also be used for billing services at the services layer. Finally, high-speed communication technology can be needed for processes at the physical infrastructure layer.

The most prominent innovations will be the application of existing ICT concepts in the smart grid domains, less on totally new ICT concepts. There are however several aspects mentioned in the ICT roadmap that already require special attention. To name a few:

- Open data; the possibility to have a general access to all the data that is generated and reuse it. As Mrs Kroes stated in Binnenlands Bestuur, December 12, 2011, "open data is a gold mine".
- Agent systems; in the world of complex event processing and event stream processing agent systems will be crucial to detect defects and anomalies and initiate actions on that. But also for billing systems SW agents will be crucial.
- Data mining and analytics; extracting relevant information from huge amounts of data.
- Security and privacy, identity management; one of the preconditions for a successful implementation of smart grids. The paradox between the right to privacy and collecting data for smart grids applications.
- Participation; user generated context and data, the link to social networks, the way to communicate to the users.
- Sensor techniques, storage and conversion; typical aspects on the physical layer where ICT will be an enabler.

3.3 Physical infrastructure

3.3.1 Programme lines

Apart from ICT developments the physical grid also faces challenges.

1) Increasing flexibility
Accommodation of new distributed technologies requires higher flexibility of the grid. A grid that used to be a passive set of components, for the major part. At least at neighbourhood level. Two way energy flows pose new requirements on grid operation and protection practices.

There are three main action lines to follow for achieving this flexibility. These are:

a) instrumentation and sensoring;
b) data interpretation;
c) automation/actuation.

Up until now automation was restricted to substation level. Due to the decrease in costs for ICT it now becomes interesting to explore the possibilities of high quality sensoring into the far ends of the grid. Sensor costs still have to come down for actual widespread deployment. But we have to start with this learning curve. In order to do this successfully sensoring will first be applied in niche situations and later on be rolled out.

Since the regional part of the grid has never been instrumented in a structural way there is a lot to learn and explore on the new data that becomes available once new parts of the grid will be instrumented. What data do we actually need to effectively support decision making on a higher level? Both for short term actions like fault detection and repair as well as for long term activities like diagnostics for asset management and maintenance.

Finally, based on new decision support possibilities new actuators can be deployed in the grid that will enable us to perform remote operation and eventually automate it.

Technologies are mostly available. It is a matter a starting to use them in order to build knowledge on these new possibilities and significantly bring down their costs.

2) New components

New components will increase the more efficient use of the grid. Such developments include super conducting cables, intelligent transformers, FACTS to control energy flows, and current limiters. Significant cost reductions are required to make these technologies feasible and will be achieved through this contract.

3) Security; cyber and physical are interdependent

Increased use of ICT introduces increased vulnerability. Awareness on cyber security has grown considerably in the past couple of years.

An aspect that has not yet enjoyed so much attention is the interdependence of physical and cyber security. The penetration of ICT and network based components in all parts of the grid makes these components vulnerable for global events and threats. Local components influenced by global threats.

And conversely, local access to sites and/or components might introduce effects on a much larger scale. Physical access to a site will no longer be a local issue.

4) Electric vehicles (EVs), charging points

The advent of EVs seems to take on substantially in the next years. Today our industry expects some 4 million Evs in Europe by 2020. Although by 2020 the market share is still expected to be quite modest, our industry is seriously preparing the uptake of e-mobility in Europe[6].

The success of EVs in European markets largely depends on the availability of adequate infrastructures offering convenient solutions for the customer. This is the main focus of electrical and electronic equipment manufacturers that are providing the essential link between the e-vehicle and the electricity grid.

As opposed to other alternative technologies for green mobility, the basic infrastructure for charging EV's is already available in the electric grid even though this infrastructure still needs some adaptations to be prepared for mass deployment of EVs.

From the very beginning the design of appropriate charging infrastructures for EVs needs to be adapted to the following key requirements:

1. Highest requirements for safety.
   Charging points in buildings are a fully-fledged element of the electrical installation. As present EU regulations for electrical installations in buildings have brought electric safety to a very high level they must not be undermined by the introduction of e-vehicles.
2. Managed charging processes (smart charging) as a general rule.
   Charging an EV is like feeding any other electrical load for the grids but EV charging needs to be managed. A proper load management is necessary to ease stress on the electricity grids. A proper energy management accompanied by economic incentives is recommended to entice customers to charge when "greenest" and cheapest electricity is available.
3. Infrastructure availability according to the development of usage pattern over time.
   According to current experiments and surveys, daily distances amount to less than 100km and the majority of charging (90%) is expected to be done at home and at work as well as in parking (shopping, train stations etc.). This suggests that low and semi-rapid power charging would satisfy most of the charging needs for the years to come. But also speed charging for specific applications.

5) Energy storage

Energy storage is a very diverse technology area. Applications in the grid include local grid balancing. Indispensable in situations of capacity shortage. The real value of storage can be captured with the appropriate business models in place and a market structure

[6] Source: Orgalime position paper, Nov 21, 2011; http://www.orgalime.org/Pdf/PP_Integrating_e-vehicles_into_modern_%20infrastructures_Nov11.pdf

that defines relationship with the capacity market amongst others. And costs need to be reduced in order to make application viable.
EASE (European Association on Storage of Energy) – the Netherlands is represented in the board by Jillis Raadschelders (KEMA) - has links to other branch organisations in the US and Canada. These organisations too see the need for demonstration projects, simulation tools, business models, market development, and technical improvements aiming on cost reduction mainly but also on safety, and higher energy density.

6) Smart Gas Grids

Although some of the following items might be better positioned in one of the other subthemes, it has been decided to bundle the smart gas grid items in this section:

1. Create smartness in the decentralised grid to enable the integration of new gasses including biogas, to improve the monitoring of the ageing grid, and to facilitate the development of new services (both for technical and commercial reasons).
2. Develop knowledge on the opportunities and restrictions of applying various energy sources in the decentralised energy system. Especially gas-to-power and power-to-gas and research on new integration strategies are regarded to be of great interest.
3. The use of storage capacity and the flexibility of the gas grid to effectively integrate dsitributed generation.
4. Introduction of new efficient application of gas like hybrid transportion, hybrid heat pumps, and micro CHP.

See also appendix 4.

4 Social innovation

4.1.1 Programming Lines

In the transition to a 'new order' in the supply of energy and the deployment of smart grids (SG) there are all kind of technical challenges to deal with and there are all kind of stakeholders involved. A stakeholder that is becoming more and more important is the end user:

- as a citizen in the decision making process regarding large-scale (elements of) SG roll-out;
- as a consumer (household or company) of energy with a growing demand for smart energy (comfort) services;
- as stakeholder (household, company or community) in the local matching process of supply and demand;
- as a prosumer of local production of energy.

So an additional challenge is to get the end user involved in such a way that she or he will play an active role and in that way directly contributes to the energy transition. It means that the end user, or at least the end user perspective, should be reflected in

- in the technical design of a SG;
- in creating (conditions for) smart energy services;
- as a guidline for institutional and social innovation.

Beyond the focus on technical innovations at each of the three layers we address in this chapter the institutional and social innovation aspects which link to all three layers. The mentioned innovation topics are in line with the roadmaps of the EU/JRC study and Netbeheer Nederland.

Institutional Innovation

As mentioned in the section Regulation in chapter three smart grids lead to an new value chain with the need for adjusted regulation and legislation that facilitates:

- platforms for the provision of services,
- service-based business models and
- a fair sharing of costs and benefits.

The main issue is how to remove bottlenecks or barriers on one hand and to give incentives to the various stakeholders on the other hand.

Subjects that should be adressed are:

- Interconnection and interchangeability of energy infrastructures:
    - The question arises where one network ends and the other one begins. How are networks regulated and how are the mutual dependence and interchangeability dealt with in the regulatory regime?
    - An important aspect in this respect is the tariff-based regulation of the Dutch networks. What tariff structure properly reflects the integration of networks and communities in smart grids?
    - How can the daily operations of het networks be reconciled in an increasing interconnected system?
    - How do mutual dependencies of networks influence the design and maintenance decisions in individual networks?
- Roles, functions and responsibilities assigned to the various market parties, including households and network companies. What new ancillary services are needed for DSO's?
- Pricing, regulation and coordination of the balancing services as delivered by prosumers (citizens and industry).

Social Innovation
With the end user in mind we have chosen to focus on the innovation topics business modelling and end user engagement/behaviour. There are however other topics that should not be forgotten like customer interaction and (product/service) usability, open innovation in the new valuechain and organisational innovation (including the effectiveness of the deployment of an ever more scarce workforce).

Stakeholders will base any decision for investment in energy activities on large, or small, or simple or complicated business models. However, there is a clear lack of appropriate business models and scenarios for smart energy community development, especially when the new services concern interconnected energy systems. More concrete we think of:

- Macro economic business models;
- Cost-benefit analyses;
- New Valuechains and role models;
- Cross sectcor business models.

To achieve more end user engagement it is important know what are his or her drivers and to te know the drivers one should first research te different types of behaviour. A complex factor is the fact that “sustainable behaviour” is a collective term for very different kinds of behaviour: from turning of the light while leaving a room to buying a solar PV system. Each type of behaviour requires a different approach and intervention to adjust the behaviour to certain circumstances. In today’s smart grid pilots the interventions are focussed on (display of) information about the use and the conservation of energy. This is certainly nessecary but is only one of the many possible interventions and adressing onlt a few types of behaviour and drivers. Therefore more research and pilot experience is needed to discover which intervention at which moment for which group of end-users results in effective behaviour.

5 Structure and governance

Many initiatives already started, but hardly institutionalised
One can divide the various initiatives regarding SG in the Netherlands as follows[7]:

- Pilot projects and other projects or initiatives, mostly at local level;
- Initiatives and cooperations between companies, universities and other research organisations, and governments on a regional level;
- Other projects including the ones funded with former RD&D programs like EOS and IOP EMVT as well as European funded projects (FP7), projects and initiatives from Dutch grid operators, and from other companies and organizations.

Although most of these projects and initiatives cover all three layers many of the individual companies, institutions and organizations involved have their focus on only one of the layers, or on either social innovation or institutional innovation. Joining their expertises enables realisation of 'real' SG pilots or projects. It therefore also makes sense to create **one TKI** (Topconsortium voor Kennis & Innovatie, Top Consortium supporting Knowledge & Innovation) for SG. Within this TKI it is proposed to make use of the existing cooperations and larger initiatives to structure the SG research as well as the SG business. The research program will be organised along the three layers, i.e. 1) physical infrastructure, 2) virtual infrastructure and 3) services (B2B, B2C and C2B). As a cross-section special attention should be given to non-technical topics like regulation, new business models, and social sciences regarding end-user engagement and their behaviour. This has been divided into social innovation and institutional innovation.

Pilot projects
The first recommendation of the Taskforce Intelligent Grids[8] was to start pilot projects. In june 2011 the government launched under its Innovation Program Intelligent Networks (IPIN) a tender. Nine demonstration projects 2012-2014 have been selected (status today). These projects involve industries, offices, glass houses and residential areas both including houses, appartments and shopping areas, see also appendix 1.

In addition the Taskforce proposed to organise a platform with the ambassadors of these pilot projects to create optimal learning (recommendation no.8 in their final report, May 2011). The Innovation Team SG has transferred this suggestion into the recommendation to create one TKI for Smart Grids. All selected pilot projects as well as pilot projects that are initiated without support from IPIN are therefore part of this Innovation Contract Smart Grids.

Regional initiatives
The Innovation Team SG strongly supports further developments and strengthening of regional initiatives as these already apply the ideas of cooperation within the 'golden triangle', i.e. companies (especially SMEs), research organisations (including education on a practical level), and local governments. Although SG includes energy systems on the transmission grid (both on a national and European level) most of the near future activities will be on the distribution grid, and, thus involves regional interaction. It is therefore proposed to include the SG activities in these regions in this Innovation Contract Smart Grids. See appendix 1 for a list of projects and initiatives.

Other projects and initiatives
A wide range of projects from the former R&D programs EOS and IOP could be part of this Innovation Contract. Most of the still running projects however, are in their final stage. Nevertheless we propose to include these in the contract as this most likely is a strong base for the development of our future knowledge on SG. Besides, several of these projects have links to European projects which supports the international

[7] An overview of these initiatives including the companies, institutions and (governmental) organisations can be found in Appendix 1.
[8] Taskforce Intelligente Netten, Op weg naar intelligente netten in Nederland – Discussiedocument, July 2010.

cooperation of the research organisations as well as the international expansion of our SG businesses.
Next to these projects other initiatives and projects will be integrated in this contract, see also a number of these in appendix 1 and 3. A selection has been presented in section 2.1.

Structure
The development from research to commercial products, tools, and services in general can be visualised, see Figure 5.1. The picture expresses that companies will join consortia with researchers amongst others but will hardly request for scientific or applied research directly. One should also expect that results of scientific research mainly will be absorbed by research organisations, and to a lesser extend by companies. It also shows that questions for research more likely will come from consortia in the pilot projects rather than from individual companies.

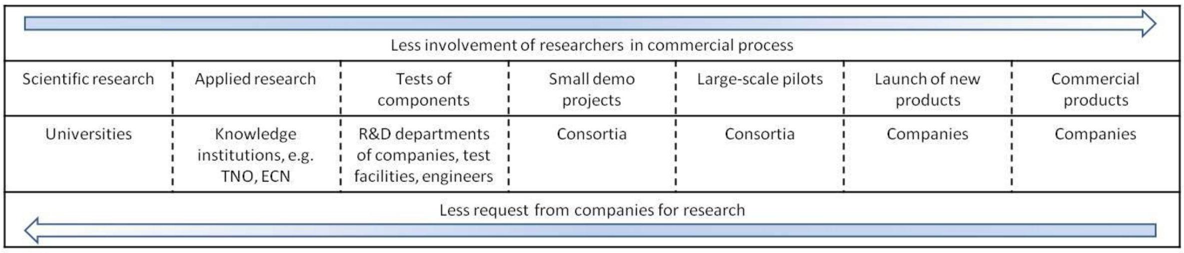


Figure 5.1 Development of scientific research to commercial products, tools and services.

Based on the above the TKI can be organised along the three layers, and include all the projects and initiatives as shown in Figure 5.2.

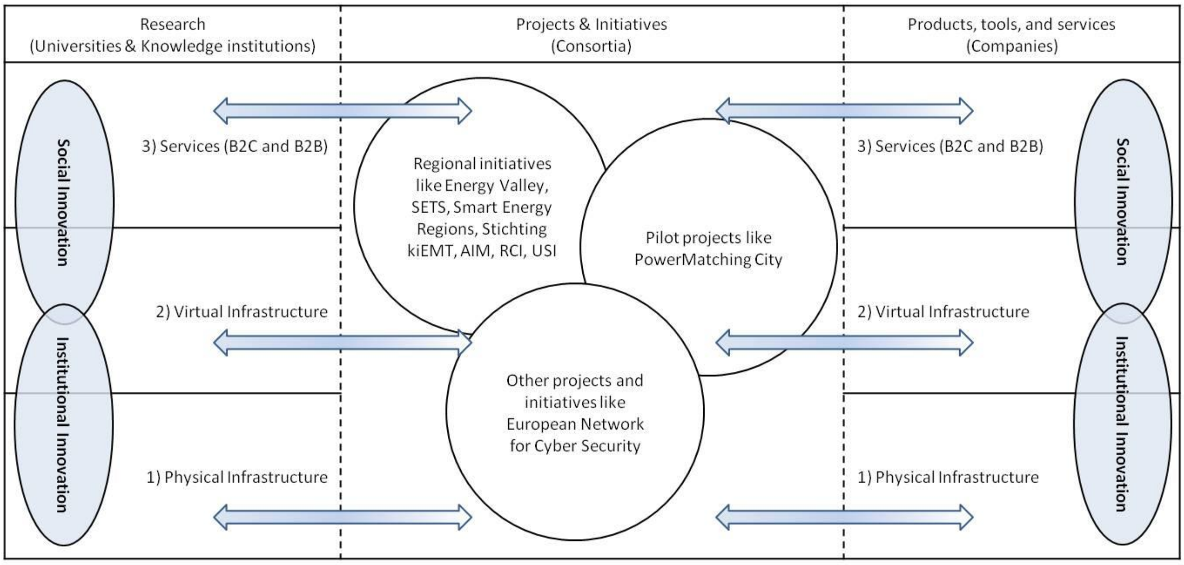


Figure 5.2 Structure of TKI Smart Grids.

Researchers on the left-hand side of the value chain most likely will focus their SG activities in one of the three layers or on activities related to either social innovation or institutional innovation. The same ‘specialisation’ holds for many companies and organisations at the right-hand side of this scheme. The regional initiatives as well as the pilot projects integrate all these layers whereas other projects like the European Network for Cyber Security focuse on a specific topic. In all these examples companies, research organisations, and/or governments organise themselves into consortia.
Next to the interaction within these consortia an exchange of knowledge and experience takes place between researchers themselves, researchers and companies, and between companies.

Governance

The structure of the TKI SG might be complex due to the many stakeholders involved, including many parties who are relatively new to the energy business, and the broad range of topics being part of the Smart Grids. It is recommended to start with the existing initiatives and to create governance for the group of pilot projects first. Next step is to create the governance for the new TKI SG. This will need quite some attention in 2012 as SG has not been institutionalised yet.

Further steps and a plan to realize the TKI has to be determined in Q1-2012. It will be ensured that the interests of companies active in SG are optimally incorporated in the TKI and will be in the lead of the allocation of scientific activities in order to guarantee that the TKI serves the goal of increased business and creation of jobs in the SG field.

6 Financial aspects

6.1 Financial frameworks

As SG is still in its early stage of the lifecycle budget requirements from the government are expected to be relatively modest in the first years of the 2012-2016 period. Over the past few years the governmental funding of R&D has been about €7 million per year. Except for the subsidy of the SG pilot projects of €16 million in the 2012-2014 timeframe the other governmental funding for research is hardly zero. This causes a serious gap in knowledge development while this is crucial for SG in this stage especially as the Netherlands has positioned itself very well in this emerging energy theme.
The Innovation Team SG urgently recommend to set-up the successor of the former EOS and IOP program in order to start creating new knowledge that should create the basis for new business in the last years of the 2012-2016 period.

According to the Innovation Team SG an annual impulse of €40 million of governmental funding for RD&D in SG is needed to position – or keep positioning – the Netherlands at the top of Europe in this business. No clear distinction between the three subthemes have been yet. Ditto for the division between 'discovery', 'development', and 'deployment' although the amount of money for 'development' most likely might need the biggest share of that. Further details will be provided early 2012.

The following budgets will be available from companies, institutions and organisations participating in the Innovation Contract SG in the period 2012-2014:

- Investments from the DNO's budgets. About €75 million in distributed automation, smart cable guards, data management, etc (this is about 2% of the DNO's total annual investments: 2% x €1.2 billion Euro x 3 years);
- Investments in RD&D projects and programs from local and regional initiatives outside the pilot projects funded within the IPIN program. This will be tens of millions of Euros, and maybe even €75 million (no final figure yet). The Smart Energy Collective and its local partners and participants will invest about €60 million, for which only €4 million will be funded by the Dutch government. Budgets of other pilot projects will be several million Euro each;
- Other RD&D investements from participants. Only a few projects have been defined yet counting up to some €5-10 million. No clear total figure is available yet;
- R&D program from TNO, ECN, and universities. This will be some €2.5 million from TNO and ECN, and about €5-10 million from the universities. Final figure has to be determined early 2012.

On top of the investments abovementioned, other private investments are already planned for the coming years. The Innovation Team SG proposes to add these activities to the Innovation Contract SG. We are not sure though whether these investments can be regarded as part of the investements from the participating companies:

- Pilot projects. About €50-60 million of which the government will already fund €16 million from their IPIN program. This investment is without the investment from the Smart Energy Collective that has been mentioned in the second bullet above;
- Investments in Smart Meters. In this period some 500,000 smart meters will be installed at a figure of about €80-100 per meter, resulting in €40-50 million.

For the 2012-2014 period the total investments of the participants then will be at least about €150-200 million plus another about €100 million in co-funded SG pilot projects and Smart Meters.

During 2015-2016 these figures are expected to increase despite the limited budgets in the final stage of most pilot projects. There are two main reasons for that. First, the increase in investments of companies as a series of commercial products and services will become available in the market place creating a cash flow for new investments in innovations comparable with the innovation process of the telecom industry in the late

1990s. Secondly, the Smart Meter roll-out will take of seriously with about 1 million meters installed annually resulting in about 80 mio Euro per year.

6.2 Current support from parties

The Innovation Team SG has received many contributions from universities, companies and cooperations already. Besides, members of this team have been in close contact with spokesman of many companies, a number of universities and research organisations, and directors and secretaries of regional initiatives. The results have been integrated in this Innovation Contract SG.
Next to this a large number of people have been informed about the Innovation Contract SG by Email in which team members asked to reply if their companies, institution or organisation is willing to become a partner in this contract, i.e. partner in the TKI SG. The table below shows a current overview of parties having expressed their willingness to further deploy co-operation within this public private partnership. Notably, the Email has been sent less than a week before the deadline of December 15th, 2011.

Universities and research organisations	CWI, ECN, Hanzehogeschool Groningen, KUN, NWO, RUG, TNO, TU/e, TUD, Twente University, UU, Vito
Companies and branch organisations	Alfen, Alliander, APX-ENDEX, Chess, Cofely, Cogas, DNWB (Delta) DOET, Early minute, Eaton, Elspec, Eneco, Energy art consulting, Energie van nu, Enexis, Essent, Flexicator, GEN, Greenchoice, Heijmans, Heliox, IBM, Imtech, iNRG, KEMA, Kropman Installatietechniek, Mansveld, Mastervolt, Neways, NOM, NXP, Philips, Plugwise, Priva, Prodrive, Proxenergy, Rendo, Smart Dutch, Smit Transformatoren, Sogeti, Stedin, Unica Ecopower, Technolution, TenneT, and, Fedet-FME, EMVT, Netbeheer Nederland, Smart Energy Collective
Local and regional initiatives (this includes several local and regional governments)	Amsterdam Innovatie Motor, Brainport Region, Energy Valley, Rotterdam Climate Initiative, Smart Energy Regions (and Brainport), Smart Energy Technologies & Systems (SETS), Stiching kiEMT, Utrecht Sustainability Institute.

The Innovation Team SG will organise individual meetings and workshops in January and first week of February, 2012. One large meeting is planned on February 8, 2012, for which especially SMEs will be invited. As SG is hardly institutionalised at this moment it might take a few months to organise full commitment from companies, especially to fix concrete figures for their contribution to the Innovation Contract SG. The year 2012 should also be used to establish the formal aspects of the TKI SG, including staffing.

Abbreviations

AgNL	NL Agency (Agentschap NL)
APX-ENDEX	Owner and operater of energy exchange market.
B2B	Products and/or services traded between one enterprise/business and another.
B2C	Products and/or services sold by an enterprise/business to (a) consumer(s).
C2B	Products and/or services sold by (a) consumer(s) to an enterprise/business.
CHP	Combined Heat and Power
DER	Distributed Energy Resources.
DSO	Distribution System Operator.
ELI	Dutch Ministry of economic affairs, agriculture and innovation.
EMVT	Elektro Magnetische Vermogens Techniek (Electro Magnetic Power Engineering).
ENARD	IA: Electricity Networks Analysis, Research and Development.
EOS	Energie Onderzoek Strategie (Energy Research Strategy), NL program for energy RD&D.
ETP	European Technology Platform for smart grids.
FACT	Flexible Alternating Current Transmission System.
FP	Framework Program, EU RD&D funding mechanism.
IA	Implementing Agreement within the framework of the IEA.
ICT	Information and Communication Technology.
IEA	International Energy Agency.
IEC	International Electrotechnical Commission
IOP	Innovatiegerichte Onderzoeks Programmas, the Dutch program to encourage innovations.
IPIN	Innovation Programme Intelligent Networks (from ELI Ministry, executed by AgNL)
ISGAN	IA: International smart grids action network.
JRC	Joint Research Centre under European Commission
R&D	Research and Development
RD&D	Research, Development and Demonstrations
RES	Renewable Energy Sources.
SES	Smart Energy Systems
SG	Smart Grids
TKI	Top consortium for knowledge and innovation (Topconsortium voor Kennis & Innovatie)
TSO	Transmission System Operator.
VPP	Virtual Power Plant