Smart Grids
- måske større end internettet

også med brændselsceller

HotMEA, 15. juni 2010

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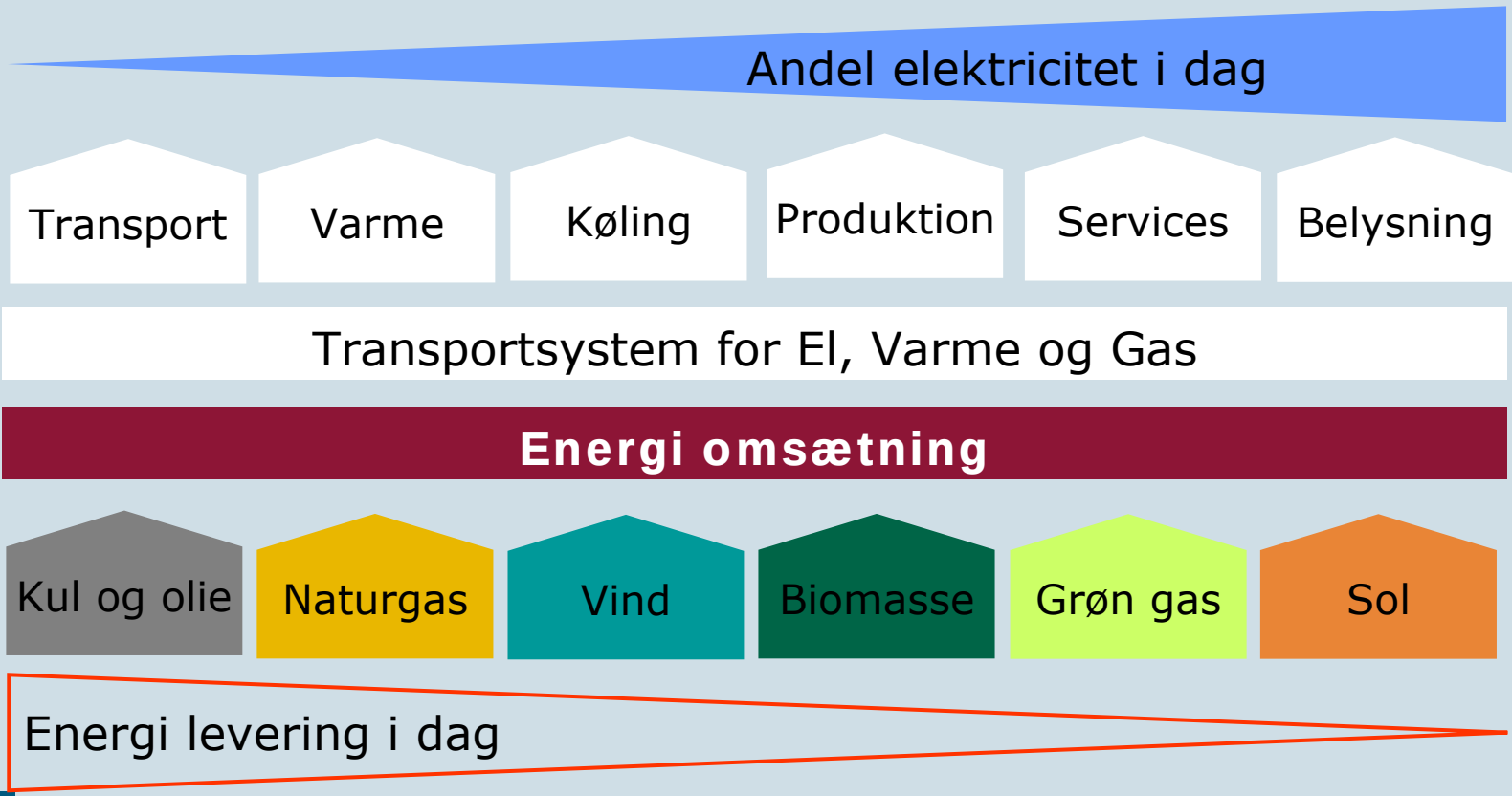
Energisystemer – skal ændres markant

- Sammenhængende energisystemer
- El bliver fremtidens væsentligste energibærer
- Fleksibelt forbrug til at følge fleksibel produktion



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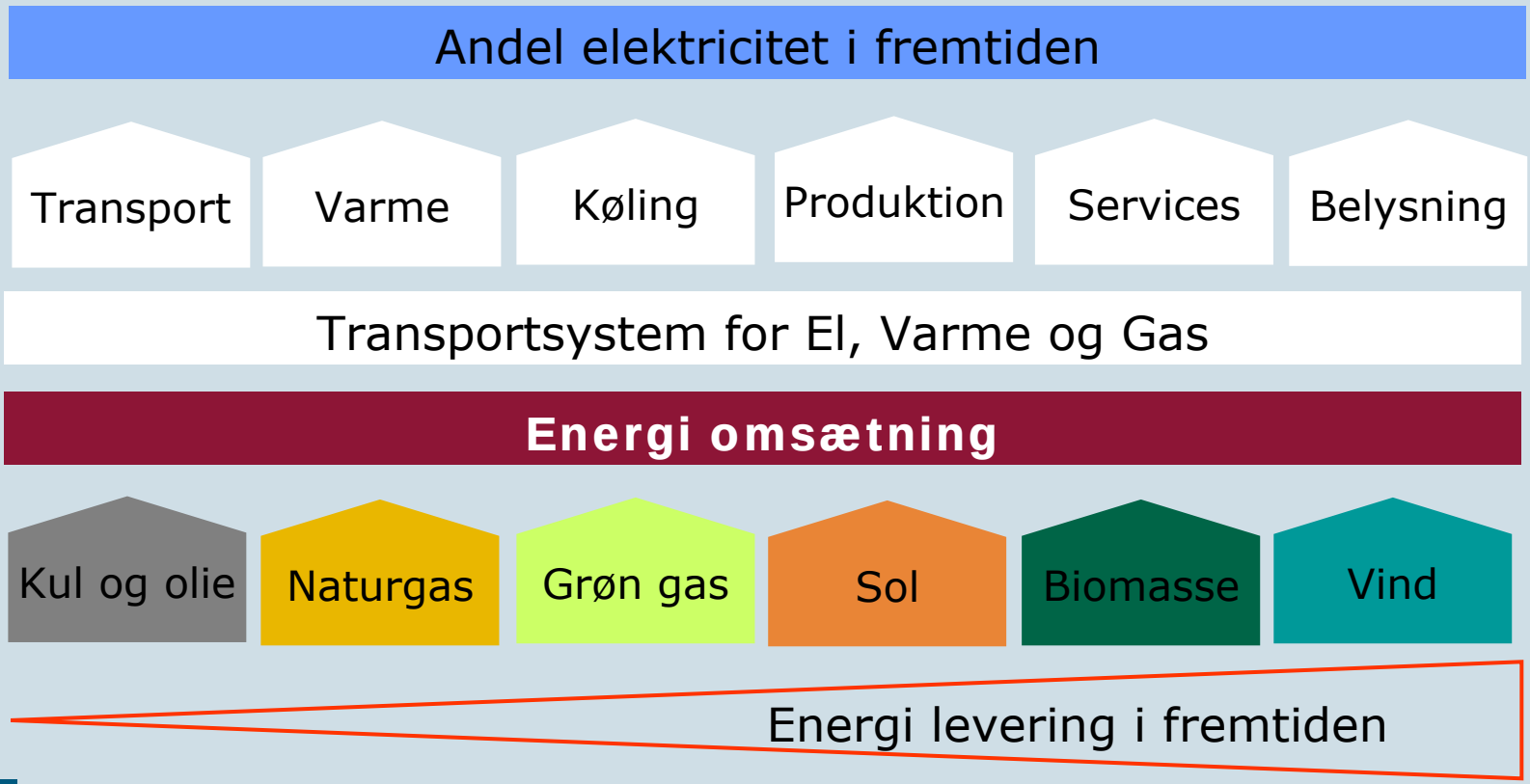
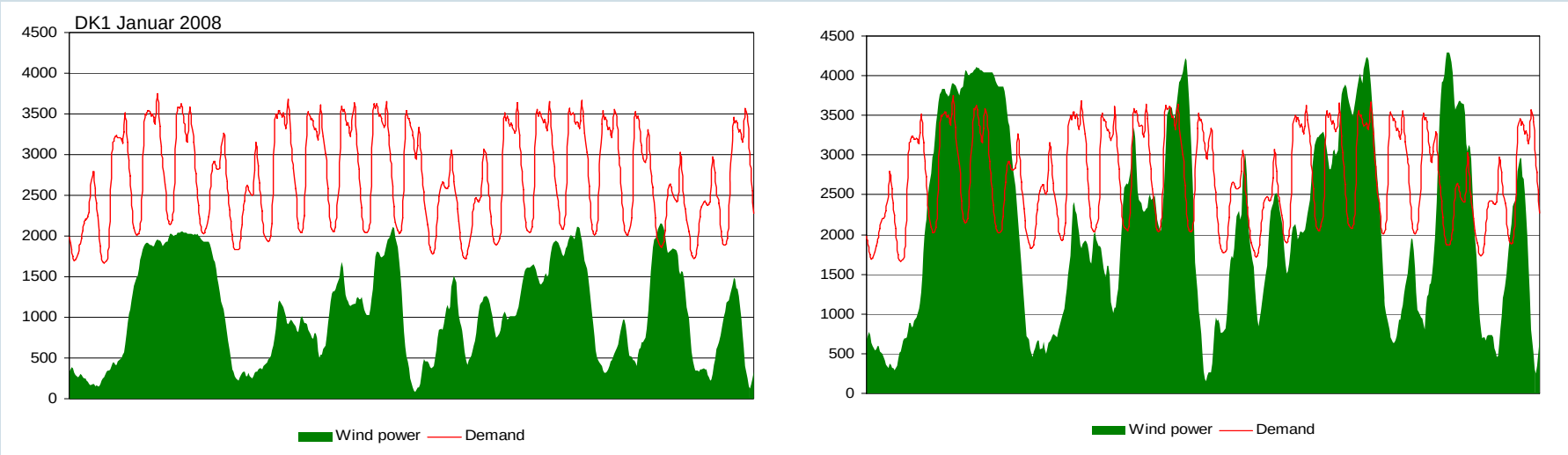


50 % vindkraft i det nuværende elsystem

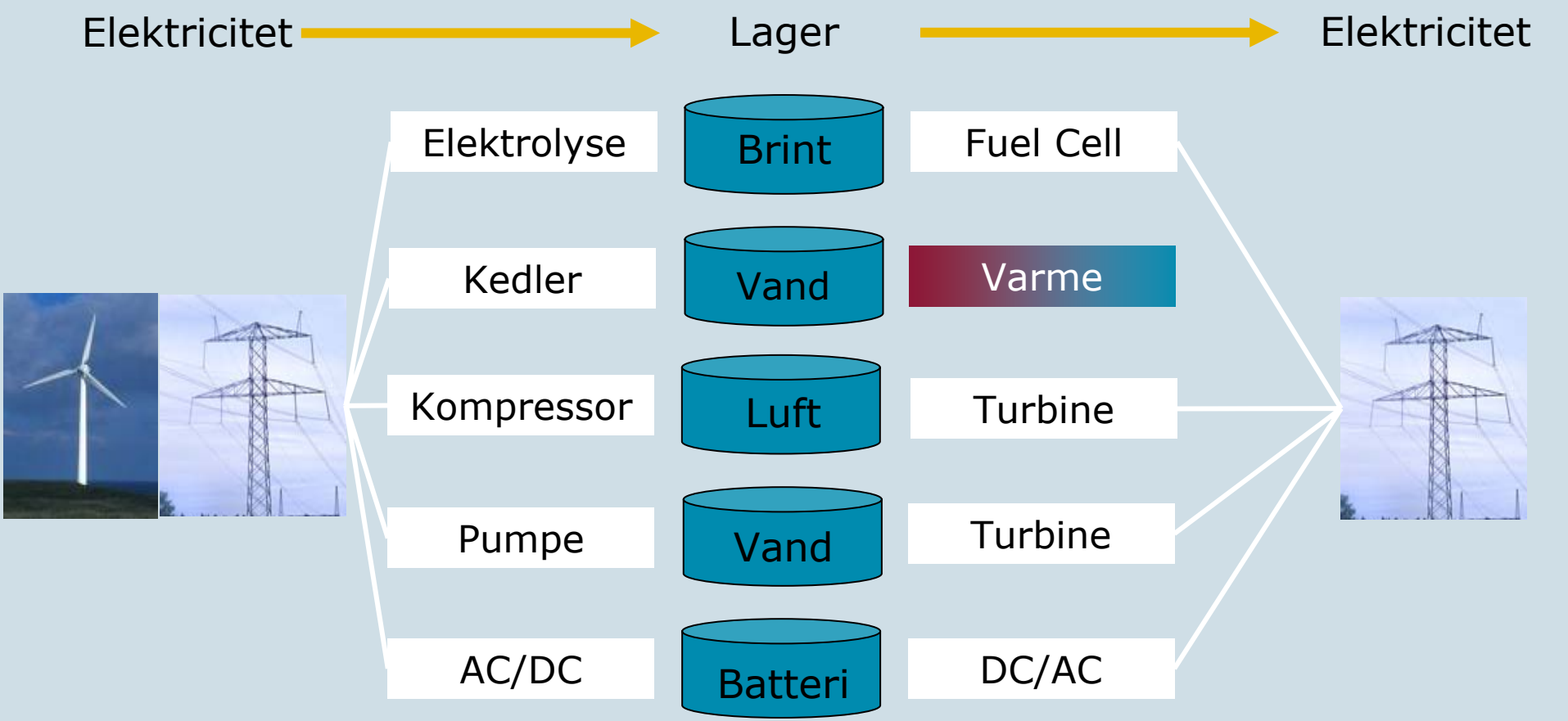


- Fordobling af vindkraft i forhold til i dag. I blæsevejr vil vindkraften overstige det maksimale elforbrug
- Ubalancen mellem vindkraft og forbrug vil variere med mere end 1,5 x det maksimale elforbrug
- Vindmøller må stoppes 1.000 timer om året

Vindkraften kan indpasses effektivt med:

- Robust transmissionsnet med stærke udlandsforbindelser
- Sammenhængende energisystem med stor fleksibilitet
- Intelligent styring – med aktivering af kraftvarmeværker

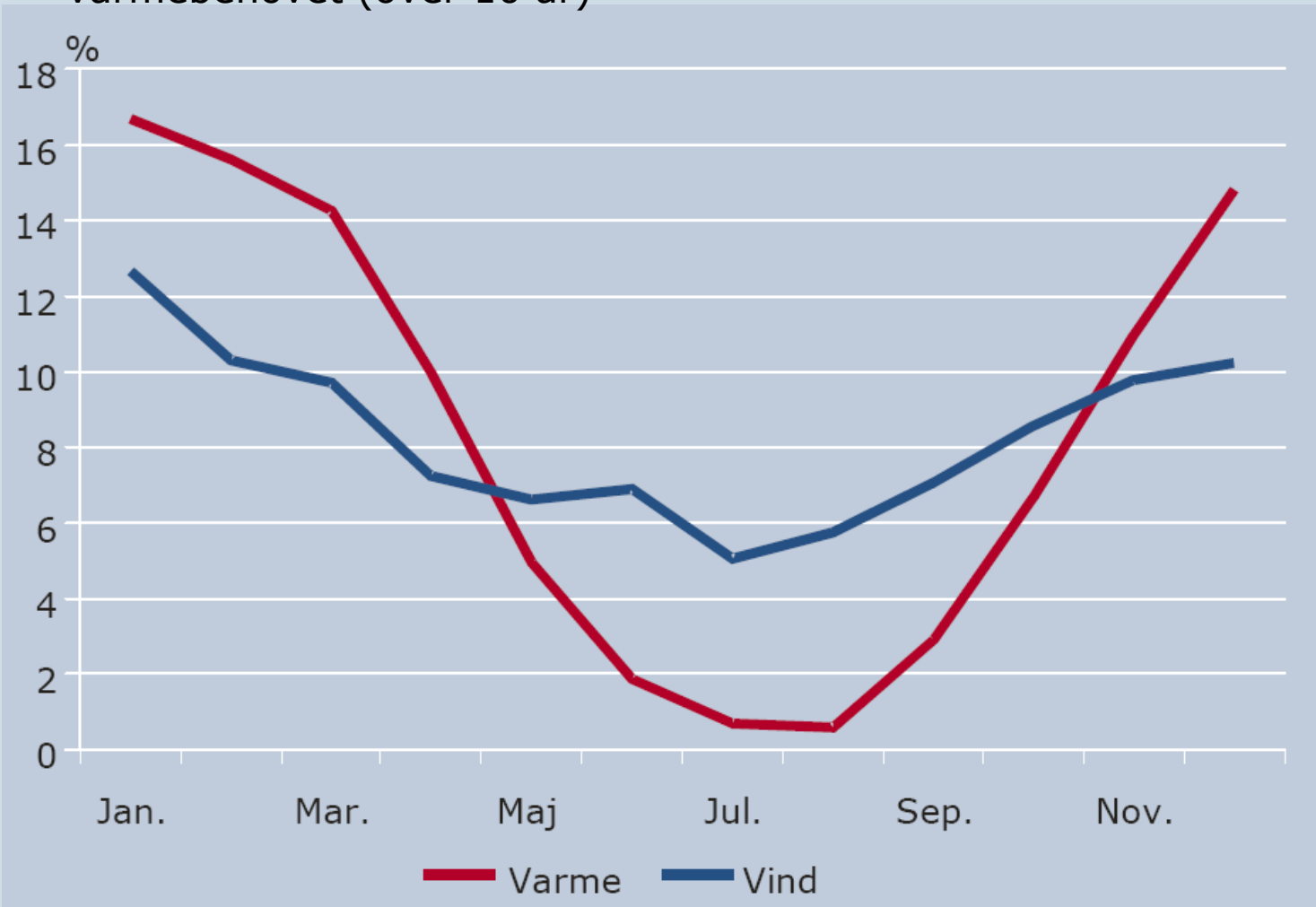
Elektricitet – lagrings muligheder



Fleksibilitet og minimale tab er nøgle specifikationer

Vind til Varme integration

- Årlige gennemsnit vindproduktion sammenholdt med varmebehovet (over 10 år)



Brændselsceller – den fleksible VE omsætter

- Brændselsceller i Smart Grids applikationer
  - Hurtige aktiveringstider (hele elmarkedet)
  - Skal anvende flere forskellige brændsler (fokus på 'grønne gasser')
  - Skal levere el og varme med høj virkningsgrad
  - Skal kobles sammen i VPP løsninger (aggregering)
  - Dimensioneres efter elmarked, ikke efter varmebehov!
- Fremtidig vigtig nøglekomponent
  - Til decentrale løsninger
  - Klar til næste "Skrot dit oliefyr" kampagne
- Lovgivningen går i rigtig retning
  - L162 er vedtaget af et enigt Folketing 4. juni
  - "Elmåler forlæns/baglæns" er nu teknologiuafhængig
  - 6 kW pr husstand eller 6 kW pr 100 kvm offentligt byggeri
- Fortsat stort F&U behov
  - ForskEL og EUDP har brændselsceller som prioriteret teknologi

Hvad er Smart Grids?

Produktionssiden	Smart Grids	Forbrugssiden
Solceller	Elnettet	Smart Houses
Solvarme	Kommunikation	Elbiler
Vindmøller	IT systemer	Varmepumper
Kraftvarmeværker	Markedsplads	Elkedler
Mikro kraftvarme	Afbrydelighed	Fleksibelt forbrug
Geotermi	Elmålere	Erhvervskunder
Bølgekraft	Styring	*Prosumer*
Brændselsceller	Regulering	Gl. elvarme
Biogas		Fjernvarme

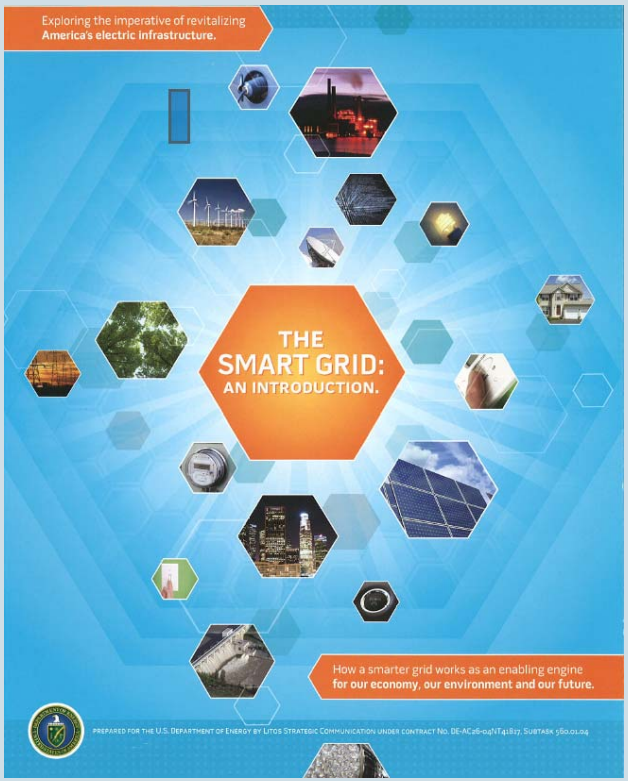
Fremtid med aktivering af alle ressourcer

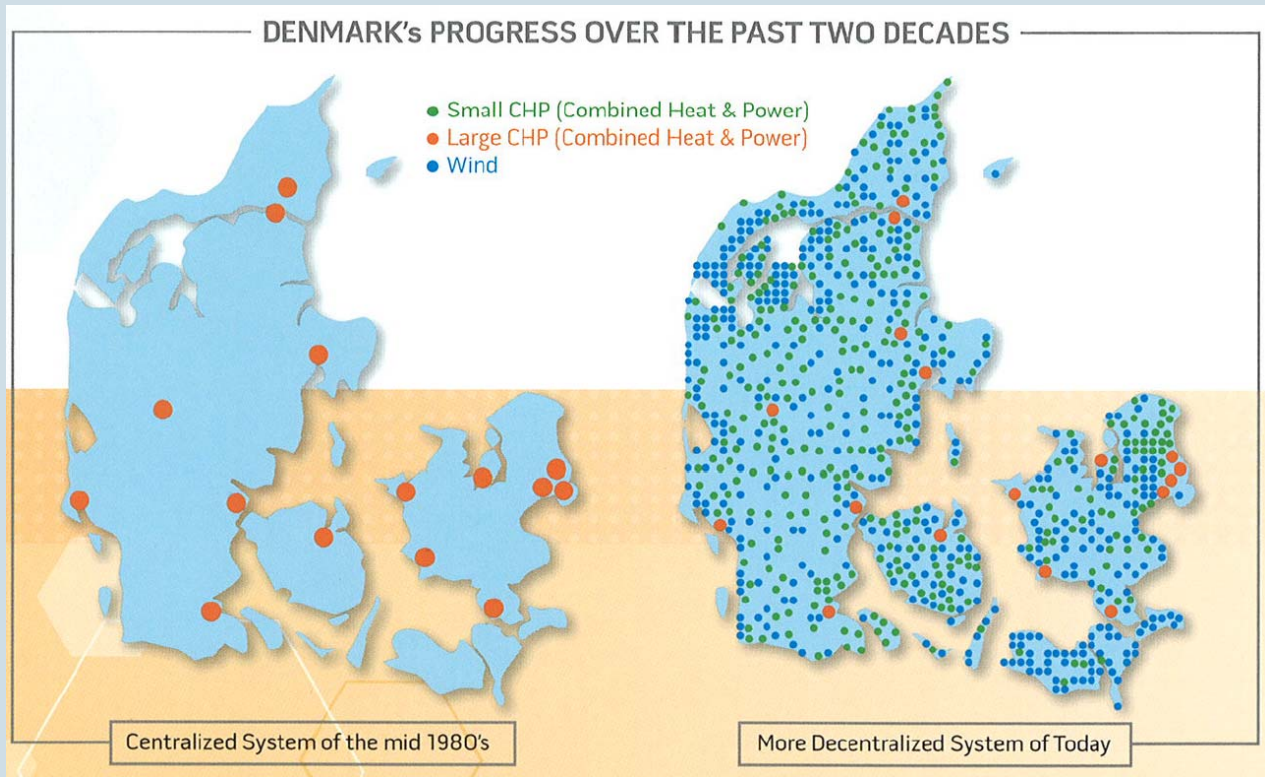
Ny systemarkitektur til aktiv styring af distribuerede ressourcer - produktion og forbrug!

Smart Grids

The American dream

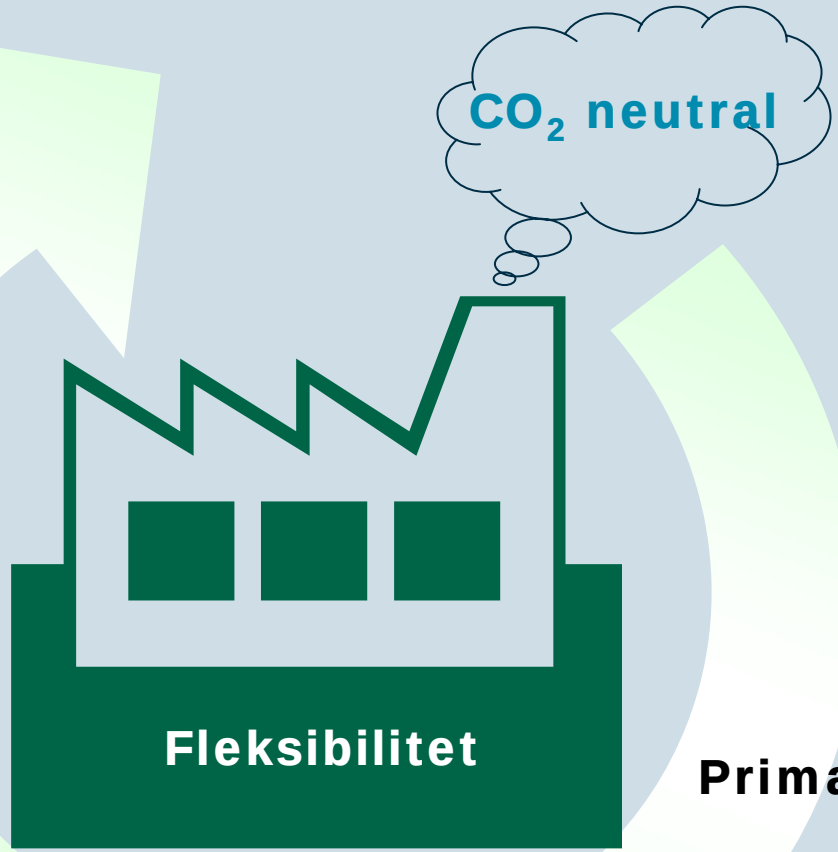
- Smart Grid visionen fra Department Of Energy (DOE)





Finder løsningen i Danmark

Fremtidens *perfekte* energiværk



Geotermi

Solvarme

Biogas

Biomasse

Varmepumper

Prosumer

Generator på nettet

Elpatroner

Fjernkøling

Affald

Fjernvarme

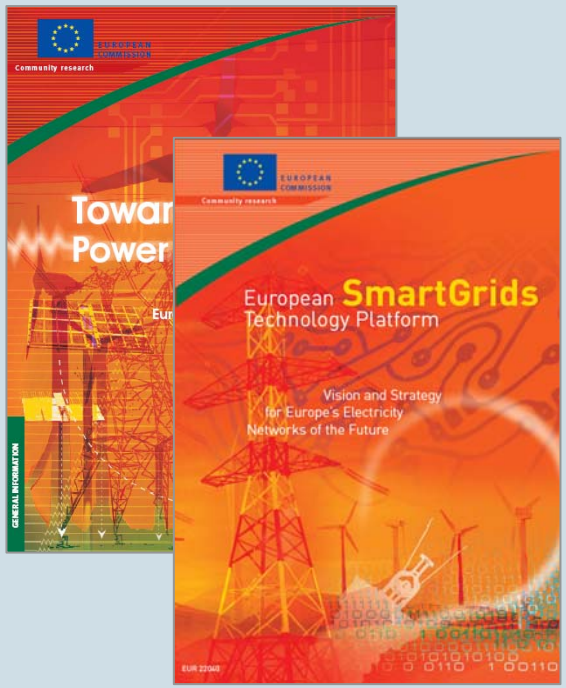
Primær regulering

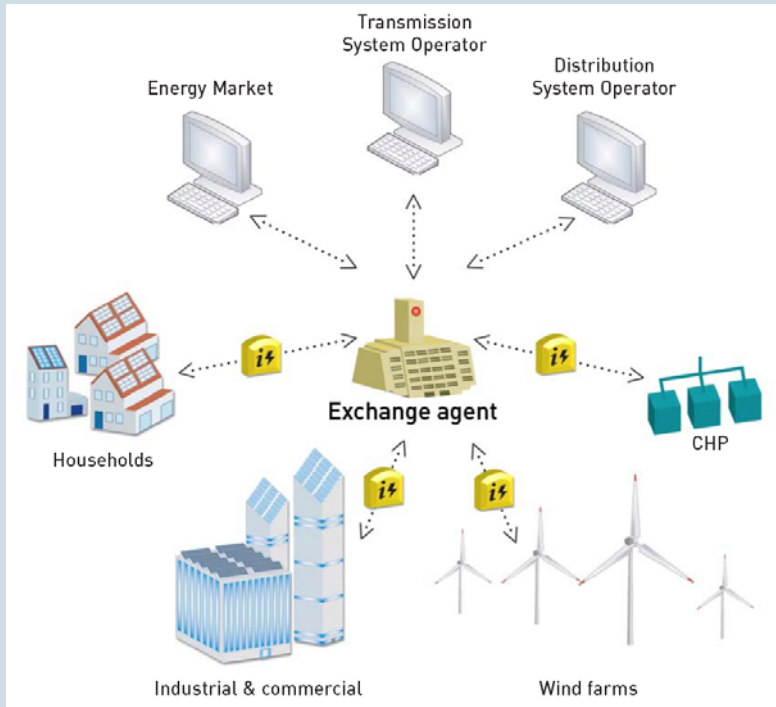
Stor akkumuleringstank

Fuld markedsdeltagelse

Smart Grids visionen fra EU

- Smart Grids er punkt 5 ud af de 7 SET emner
  - Aktiv anvendelse af mange distribuerede produktionsenheder

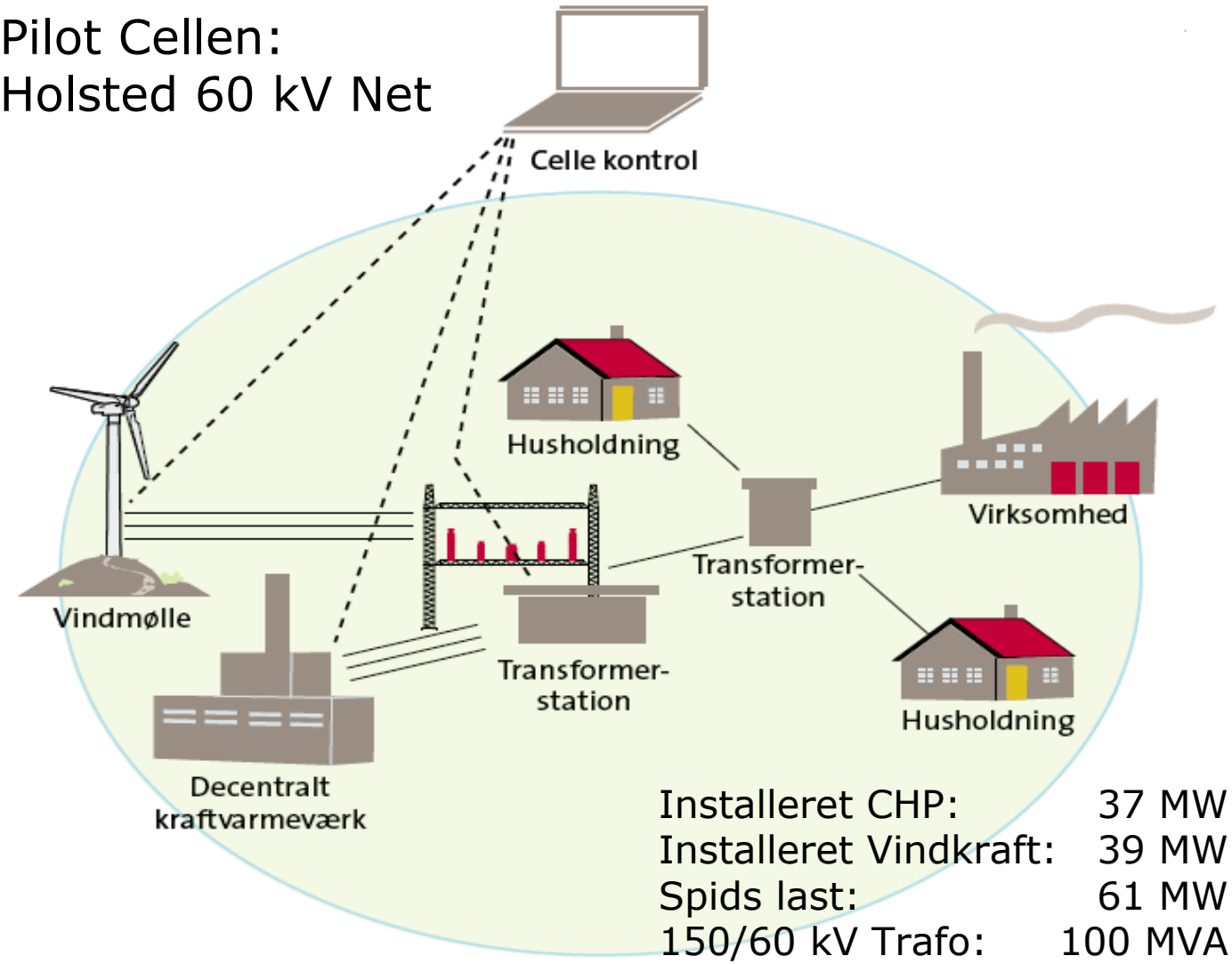




- Aktivering af mange små ***Prosumers*** kræver en ny platform til aggregering af tusinder af enheder og markedsdeltagelse – ved hjælp af agenter.

Celleprojektet – udvikling i verdensklasse

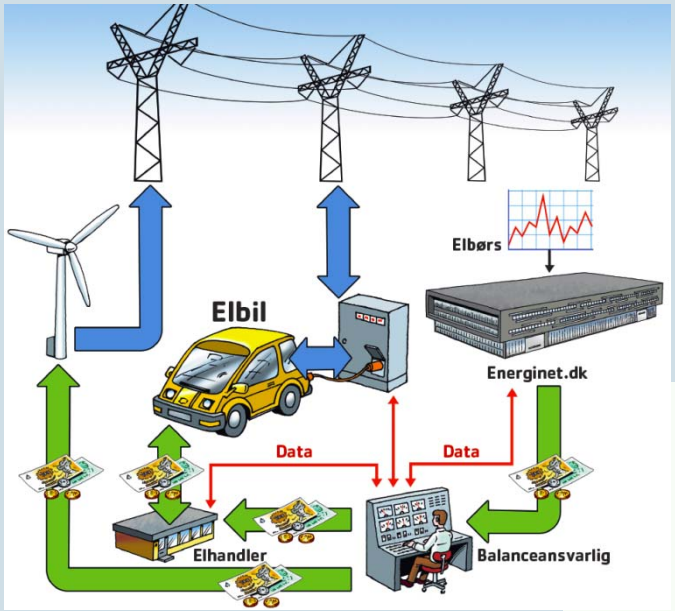
Pilot Cellen:
Holsted 60 kV Net

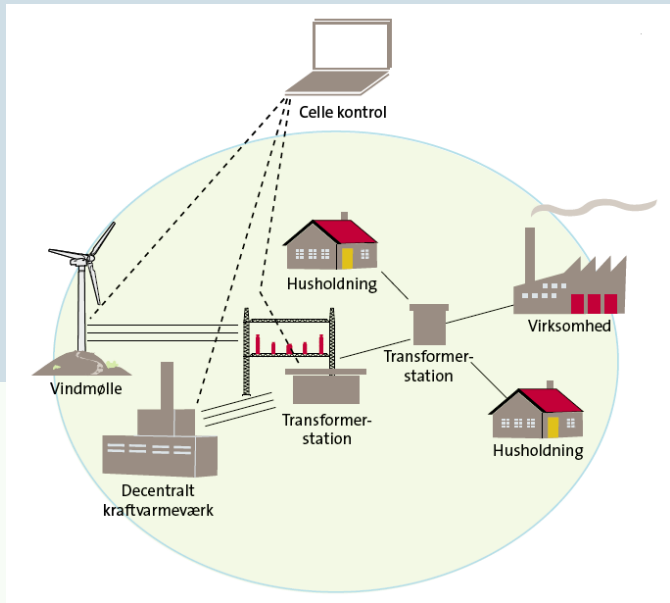


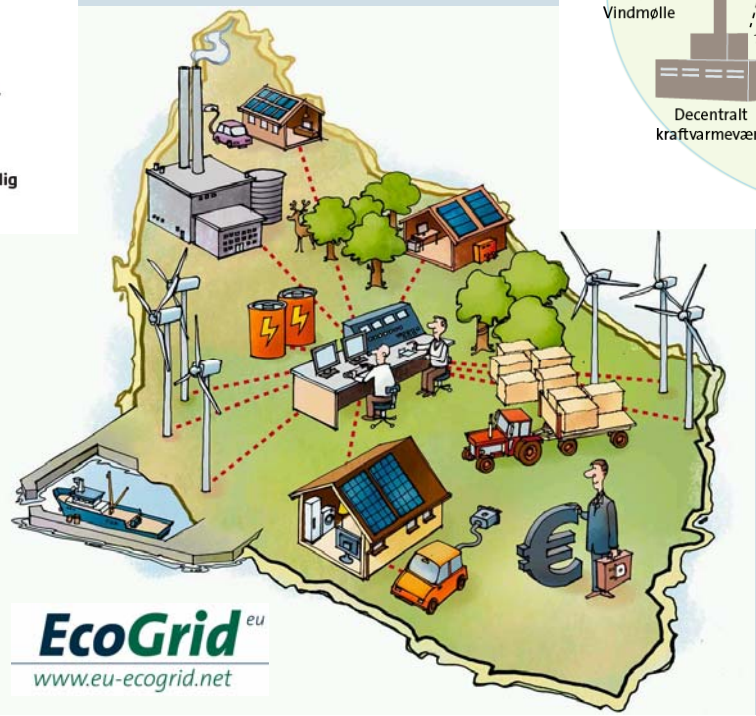
Installeret CHP:	37 MW
Installeret Vindkraft:	39 MW
Spids last:	61 MW
150/60 kV Trafo:	100 MVA

Vindmøller, kraftvarmeanlæg og nyt isenkram

EDISON og Celle kontrol til Bornholm







Bornholm - Energisystemet

Produktionssiden

- Kraftvarme; 88 MW_e & 55 MW_v
- Varmecentraler; 67 MW_v
- VE-brændsel KV og Varme
  - Biomasse; 37 MW_e & 50 MW_v
  - Biogas; 2 MW_e & 3 MW_v
- Vindkraft; 35 stk. = 30 MW
  - 80.300 MWh produktion i 2008
  - 33 % af energibalancen
- Solceller (PV); 7,7 kW_p

Nyt

- Solceller (PV); 1 MW_p
- Vindkraft (nye møller)
- Biogasol (biobrændstoffer)

Forbrugssiden

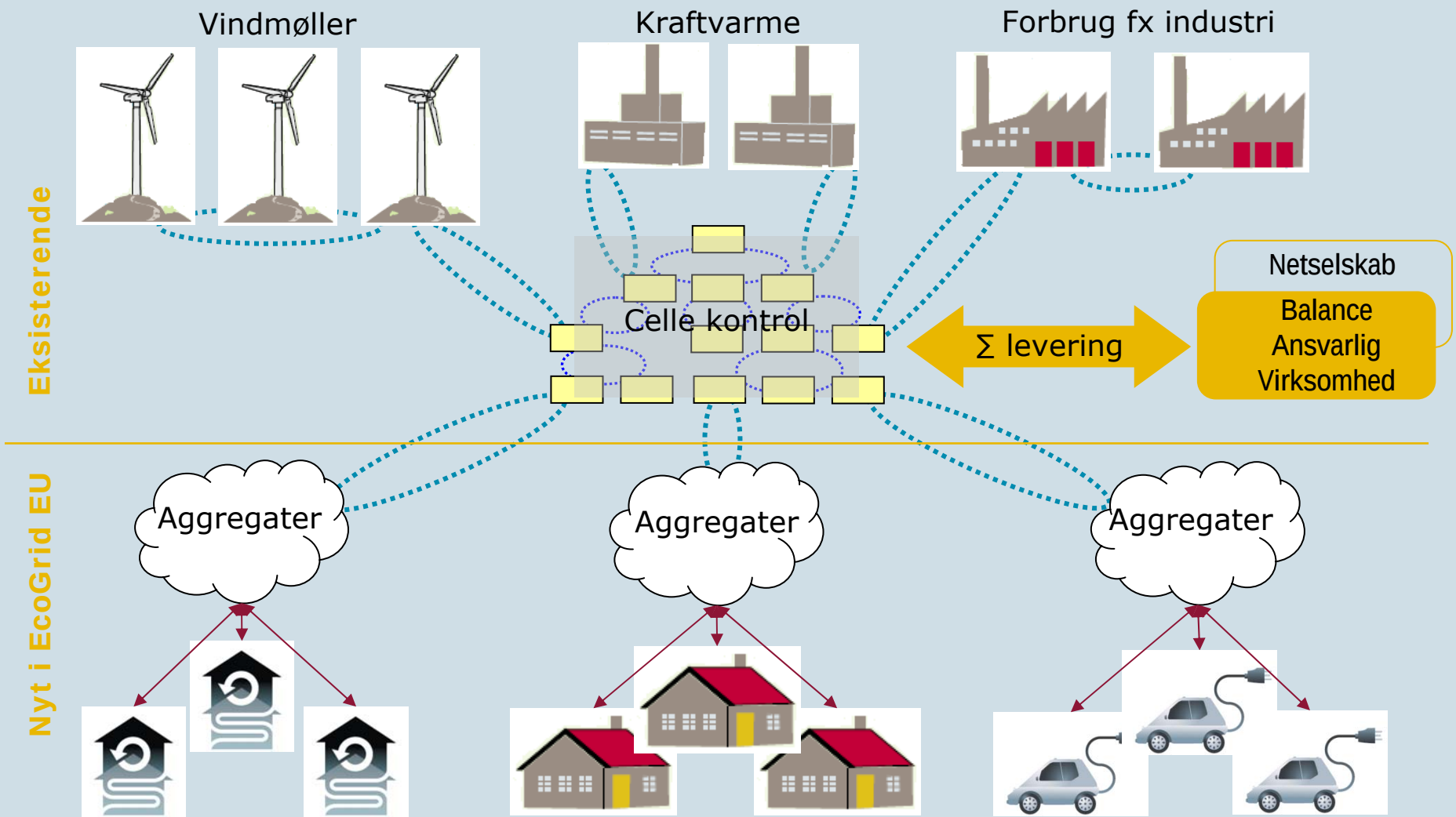
- 28.324 kunder
  - 246.000 MWh årsforbrug i 2008
  - 55 MW_e peakload
- 300 kunder >100.000 kWh/år
- Landbrug, fiskeri, industri, turisme
- Elvarme, 6.266 kunder; 33.000 MWh
- Fj.varme, 7.104 kunder; 205.000 MWh

Nyt

- Elbiler – EDISON projektet
- Varmepumper (ny støtteordning)
- El til fjernvarme
- µCHP fx med brændselsceller

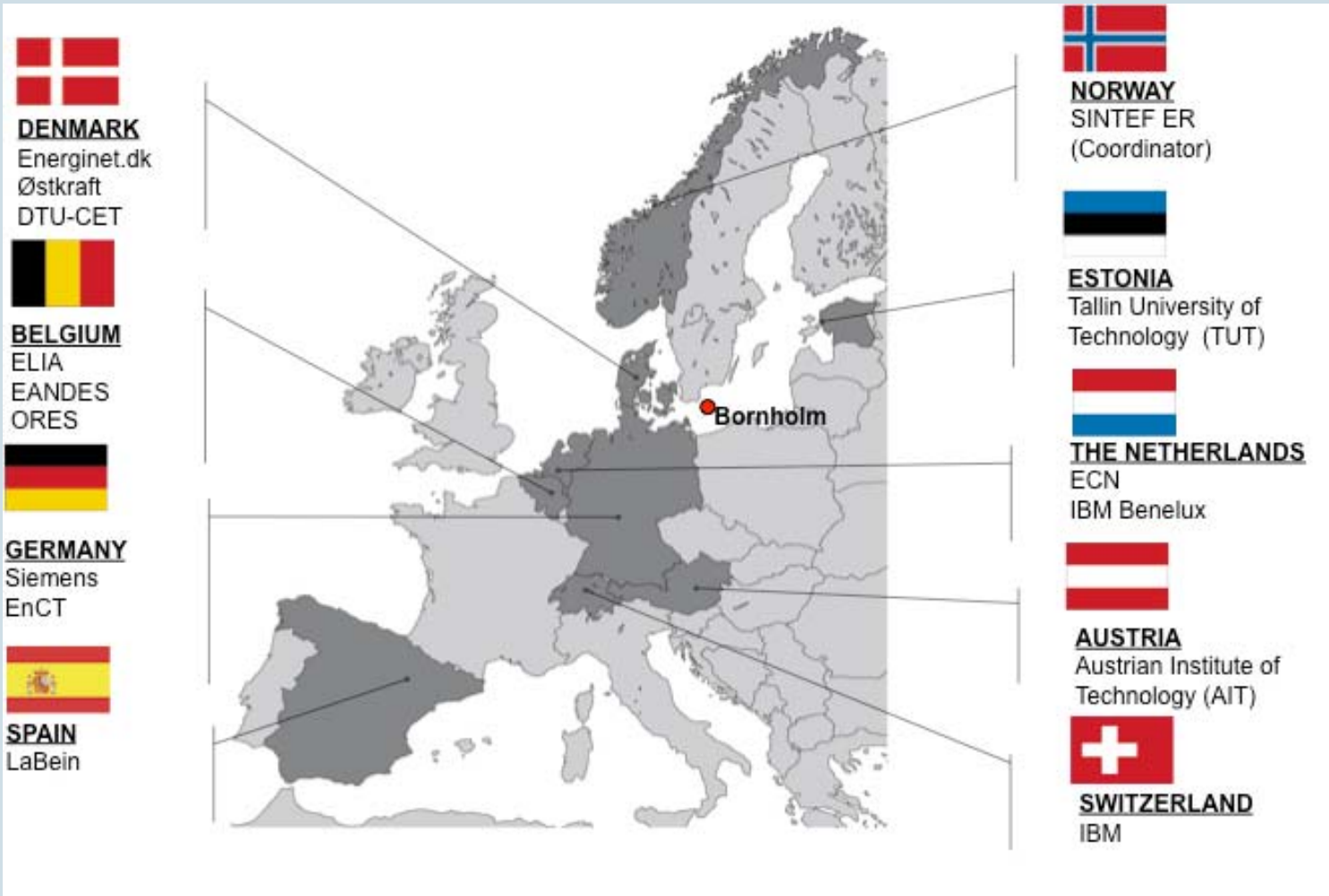
Aktuel andel VE af energiforbruget = ca. 43 % - Målet er at komme op på over 50 %

Celle kontrol skal anvendes i EcoGrid EU



Partnere i EcoGrid EU projektet

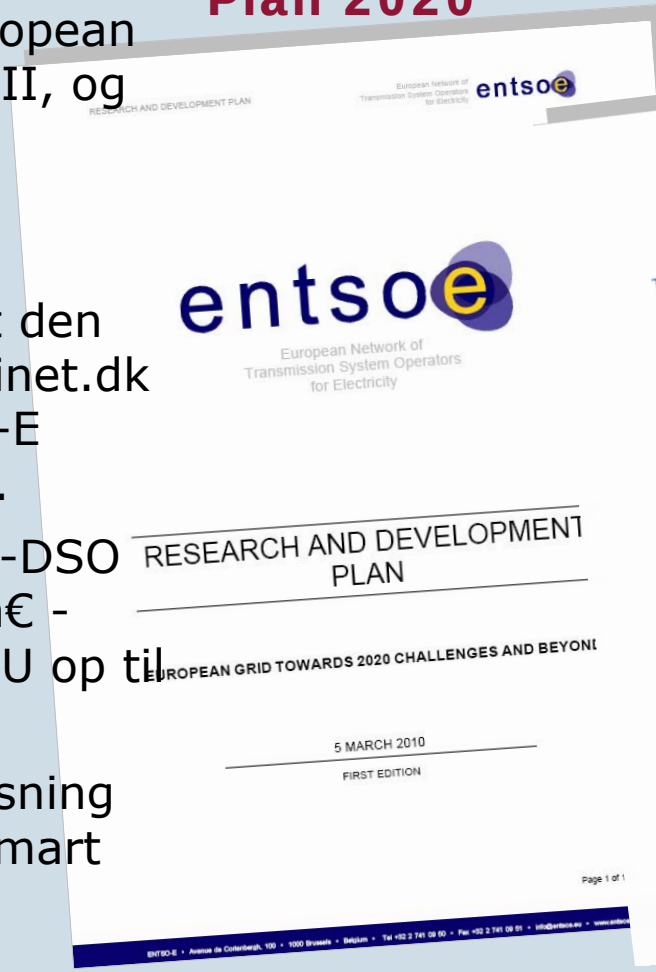
Ansøgning afleveret 4. marts 2010 – besked juni 2010



Smart Grids – Europæisk strategi og Roadmap

- TSO og DSO i ny European Industrial Initiative EII, og samarbejde med Kommissionen
- Administration og finansiering besluttet den 18. maj 2010. Energinet.dk har en af fire ENTSO-E pladser i bestyrelsen.
- Total budget for TSO-DSO Roadmap er 1.990 m€ - forventet støtte fra EU op til 1.200 m€
- Europæisk MEGA satsning og forpligtelse bag Smart Grids

ENTSO-E R&D Plan 2020



TSO+DSO Smart Grids Plan 2010-18

SET-Plan Conference 2010

3th-4th of june 2010, Madrid, Spain

Spanish Presidency of the European Union

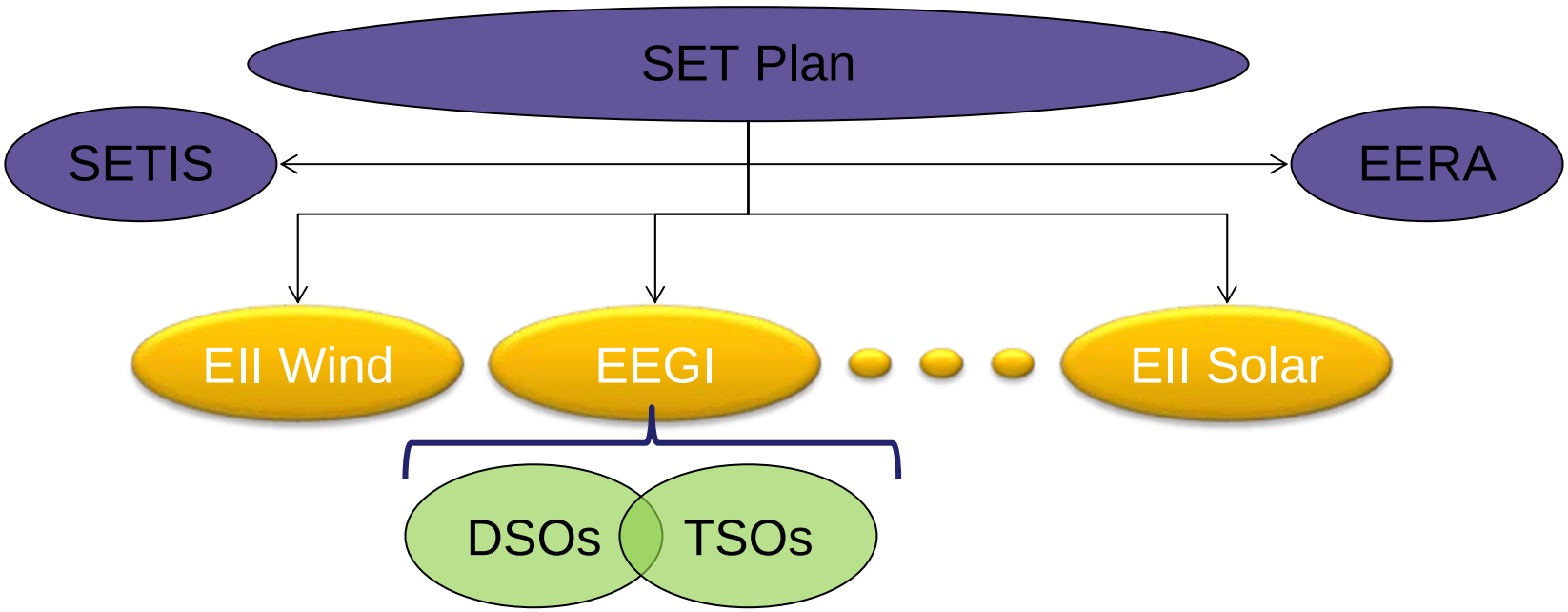
GOBIERNO DE ESPAÑA

MINISTERIO DE CIENCIA E INNOVACIÓN

eu 2010.es

Collaboration framework

In the context of the SET Plan European Electricity Grid Initiative (EEGI) as a common platform for Industry, Grid Operators, Administrations and other relevant stakeholders.



Role and missions of each level

Orientation level

Planning and programming level

Implementation & operational level

STEERING GROUP
EC - chair
all MS and observer countries

- **Assure and endorse the rolling Implementation Plans,**
- **Evaluate progress of the Technology Roadmaps (TR),**
- **Report on the progress of TR to the Council of the EU**

1 ***Proposes Implementation Plan IP***

EEGI

Industry/TP

15 MSs

EC

2 ***Endorses IP & Makes available programming instruments and budgets***

3 ***Implements according to funding rules and procedures***

Activities

EU: Framework Programme
MS: National Programmes
EERA
Industry: co-financing

4 ***Reports on the progress of the actions***

5 ***Reports on the IP progress***

Monitor the technological progress of IP through KPI

6 ***Specific knowledge sharing arrangements***

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EEGI Team – Industry - TSO

- Hubert Lemmens (ELIA)
  – Matthias Luther (Transpower)
- Pierre Bornard (RTE)
  – Vicente Gonzalez (REE)
- Kim Behnke (Energinet.dk)
  – Gerald Kaendler (Amprion)
- Konstantin Staschus (ENTSOE)
  – Angelo Ferrante (Terna)

EEGI Team – Industry - DSO

- Livio Gallo, ENEL Distribution
  – Marco Cotti
- Michele Bellon, ERDF
  – Pierre Mallet
- Javier Villalba, Iberdrola Distribution
  – Miguel Angel Sanchez Fornie
- Jan Peters, ENEXIS
  – Bob Cabbolet

EEGI Team – Industry

- Ronnie Belmans, Smartgrids Platform
  – Pau Rey
- Giuliano Monizza, T&D Europe, ABB
  – Richard Charnah, Areva T&D
- Maher Chebbo, ICT, SAP
  – John Harris, ESMIG, Landis & Gyr
- Hans ten Berge, EURELECTRIC

EEGI Team – Member States

- Austria – Michael Huebner
- Belgium – Stephanie Bonnard, Gerrit Jan Schaeffer, Laurence Polain
- Czech Republic – Frantisek Pazdera
- **Denmark – Hanne Thomassen**
- Finland – Jussi Mäkela (excused)
- France – Sébastien Henry, Axel Strang
- Germany - Ute Roewer
- Italy – Michele De Nigris
- Norway – Jan Ove Gjerde
- Portugal – Joao Peças Lopes (excused)
- Slovenia – Erika Glasencnik, Frank Zlahtic
- Spain - Maria Teresa Velasco Rincón, Ignacio Martin
- Sweden - Svante Söderholm
- Turkey - Ilknur Yilmaz
- UK - John Christie

Smart Grids Model

SMART GRIDS
Functional level

Level 5: Smart Customers

Customers aware and actively participating

Level 4: Smart Energy Management

Management of end-use energy efficiency, aggregation, retail

Level 3: Smart Integration

Renewable energy, DG, electric vehicles, electricity storage and aggregation

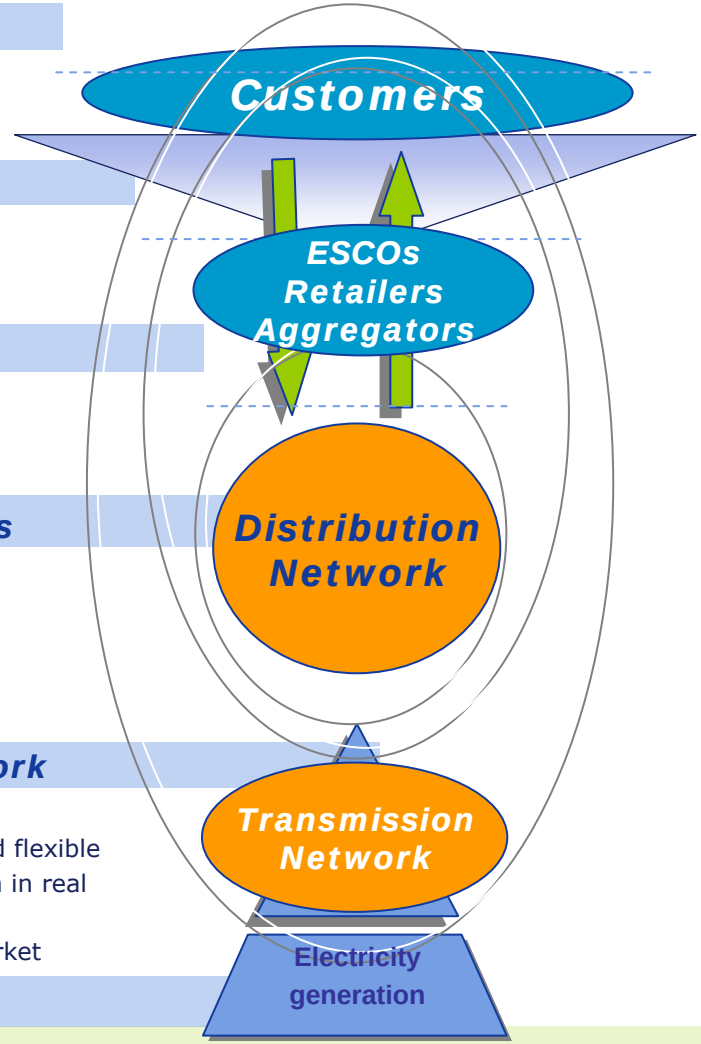
Level 2: Smart distribution network and processes

More automated MV distribution networks with self healing capabilities.
Monitored and controlled LV networks
IT supported monitoring process

Level 1: Smart Pan-European Transmission network

Novel approaches to develop a pan-European grid
Affordable technologies to make the transmission system more clever and flexible
Critical building blocks to operate the interconnected transmission system in real time and reliably
Market simulation techniques to develop a single European electricity market

Level 0: New generation technologies



The 14 Functional Projects on transmission networks

SMART GRIDS MODEL

SMART GRIDS *Functional level*

Level 1: Smart pan-European

Cluster 1: Pan-European Grid architecture
Novel approaches to develop a pan-European Grid

Cluster 2: Power technologies
Affordable technologies to make the transmission system more clever and flexible

Cluster 3: Network management and control
Critical building blocks to operate the interconnected transmission system in real-time and reliably

Cluster 4: Market rules
Market simulation techniques to develop a single European electricity market

Functional projects

- **T1. A toolbox for new network architecture assessment**
- **T2. Tools to analyze the pan-European network expansion options**
- **T14. Innovative approaches to improve the public acceptance of overhead lines**
- **T3. Demonstrations of power technologies for more network flexibility**
- **T4. Demonstrations of power technologies for new architectures**
- **T5. Demonstrations of renewable integration**
- **T6. Tools for pan-European network observability**
- **T7. Tools for coordinated operations with stability margin evaluation**
- **T8. Improved training tools for improved coordination**
- **T9. Tools for pan-European network reliability assessment**
- **T10. Tools for pan-European balancing markets**
- **T11. Advanced tools for congestion management**
- **T12. Tools for renewable market integration of active demand**
- **T13. Tools to study market integration of active demand**

Transmission activities

RD&D Roadmap

Mill EUR

Smart Grids Functionalities	Project	YEAR										Total Costs	2010-2012
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Pan-European Grid Architectures(R&D)	T1		A tool box for new network architecture assessment									19	19
	T2	REALISEGRID		Tools to analyze the pan European network expansion options								21	21
Power Technologies (Demonstration)	T3				Demonstr.of Power technologies for more network flexibility							80	--
	T4				Demonstrations of Power technologies for new archtectures							120	--
	T5	SAFEWIND, WINGRID, IS-POWER, TWENTIES			Demonstration of renewable integration (ct'd)							130	--
Network management and control (R&D)	T6	PEGASE			Tools for a Pan European network observability							12	--
	T7		Tools for coordinated operations with stability margin evaluation									24	24
	T8				Improved training tools for improved coordination							25	--
	T9		Tools for Pan European network reliability assessment									14	14
New market design options (R&D)	T10				Tools for Pan European balancing markets							18	--
	T11				Advanced tools for congestion management							21	--
	T12	OPTIMATE			Tools for renewable market integration							14	--
	T13				Tools to study market integration of active demand							12	--
Pan-European Grid Architectures(R&D)	T14		Innovative approaches to improve the public acceptance of overhead lines									50	30
											Total	560	108

The 12 Functional Projects on distribution networks

SMART GRIDS *Functional level*

SMART GRIDS MODEL

Level 5: Smart Customers
Customers aware and actively participating

Level 4: Smart Energy Management
Management of end-use energy efficiency, aggregation, retail

Level 3: Smart Integration
Renewable energy, DG, electric vehicles, electricity storage and aggregation

Level 2: Smart Distribution network
More automated MV distribution networks with self healing capabilities.
Monitored and controlled LV networks
ICT supported processes

Functional projects

Cluster 1: Integration of smart customers
- **D1. Active Demand Response**
- **D2. Energy Efficiency from integration with Smart Homes**

Cluster 2: Integration of smart metering
- **D3. Metering infrastructure**
- **D4. Smart metering data processing**

Cluster 3: Integration of DER and new uses
- **D5. DSO integration of small DER**
- **D6. System integration of medium DER**
- **D7. Integration of storage in network mgt**
- **D8. Infrastructure to host EV/PHEV**

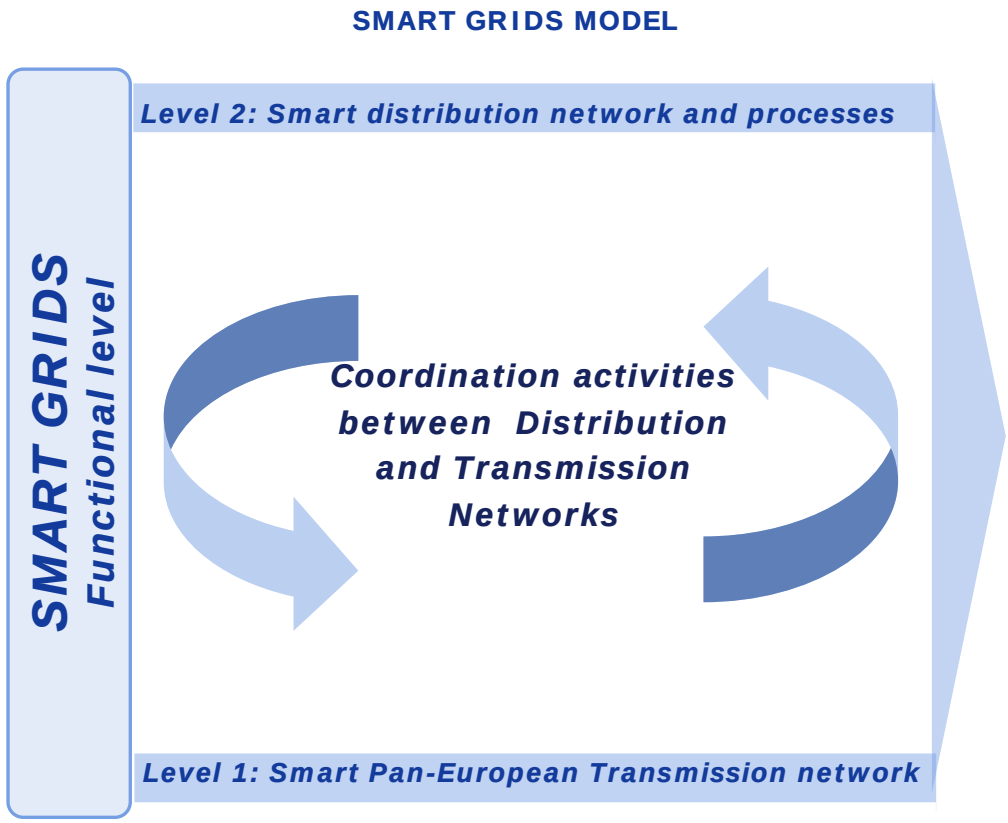
Cluster 4: Smart Distribution Network
- **D9. Monitoring and control of LV network**
- **D10. Automation and control of MV network**
- **D11. Methods and system support**
- **D12. Integrated communication solutions**

Distribution activities *RD&D Roadmap*

Mill EUR

Smart Grids Functionalities	Project	YEAR										Total Costs	2010-2012
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Active Demand Response and integration with Smart Homes	D1	ADDRESS			Active Demand Response							190	--
	D2	BEWARE Smart Homes/Smart Grids			Integration with Smart Homes							120	--
Smart Metering Infrastructure & Data Processing	D3	OPEN METER Existing Deployment			Smart Metering Infrastructure							150	150
	D4	Existing Deployment	Smart Metering Data Processing									20	20
Integration of RES, storage and EV	D5	Active Distribution Network			Integration of small DER							90	90
	D6	Active Distribution Network	Integration of medium DER									150	150
	D7	STORAGE TECHNOLOGY			Integration of storage technologies							60	--
	D8	ELECTRIC VEHICLES			Integration of Electric Vehicles							100	100
Planning, monitoring and control	D9	Active Distribution Network			Monitoring and control of LV networks							100	100
	D10	Active Distribution Network	Automation and Control of MV networks									90	90
	D11		New methods and systems support									80	80
Integrated communication Infrastructure	D12	Active Distribution Network			Integrated Communications Solution							50	50
											Total	1,200	830

The 5 Functional Projects on transmission / distribution networks coordination



Functional projects

- **TD1.** Increased observability of the electric system for network management and control
- **TD2.** The integration of demand side management in TSO operations
- **TD3.** Ancillary services provided by DSOs
- **TD4.** Improved defence and restoration plans
- **TD5.** Joint task force on IT system protocols and standards

Transmission / distribution networks coordination

RD&D Roadmap

Mill EUR

Project	YEAR										Total Costs	2010-2012
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
TD1		Increased observability of the electric system for network management and control									45	18
TD2			The integration of demand side management in TSO operations								70	7
TD3		Ancillary services provided by DSOs									50	10
TD4		Improved defense and restoration plans									45	14
TD5		Joint Task force on IT system protocols and standards									20	19
										Total	230	68

EEGI Program budget - summary

- Total program cost estimation is around **€ 2 bn in 9 years (2010 – 2018)**
- The cost estimation of the **priority actions** that need to **start in 2010-2012** is around **€ 1 bn**

Roadmap	Priority projects costs (€M) Start 2010-12	Other projects costs (€M) Start 2013-	Total costs (€M)
Transm./distrib. coordination	68	162	230
Transmission networks	108	452	560
Distribution networks	830	370	1,200
Total	**1,006**	**984**	**1,990**

- The results are beneficial for the whole European energy value chain, requiring a comprehensive funding **that must involve EC, the Member States, the regulators and industry**.

Tak for opmærksomheden

ENTSO-E involvement in European Electricity Grid Initiative (EEGI)

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Reliable Sustainable Connected

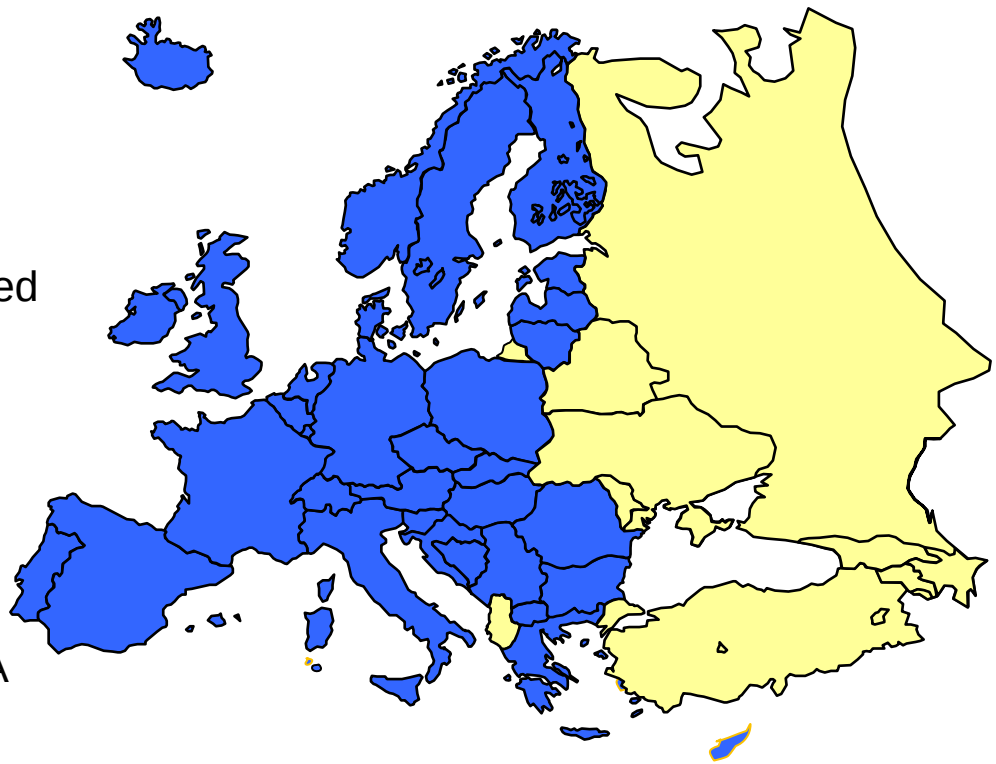
ENTSO-E fully operational since 1 July 2009

Represents 42 TSOs from 34 countries

- 525 million citizens served
- 828 GW generation
- 305,000 km of transmission lines managed by the TSOs
- 3,400 TWh/year demand:
- 400 TWh/year exchanges:

Replaces former TSO organisations: ATSOI, BALTSO, ETSO, NORDEL, UCTE, UKTSOA

Web site: www.entsoe.eu



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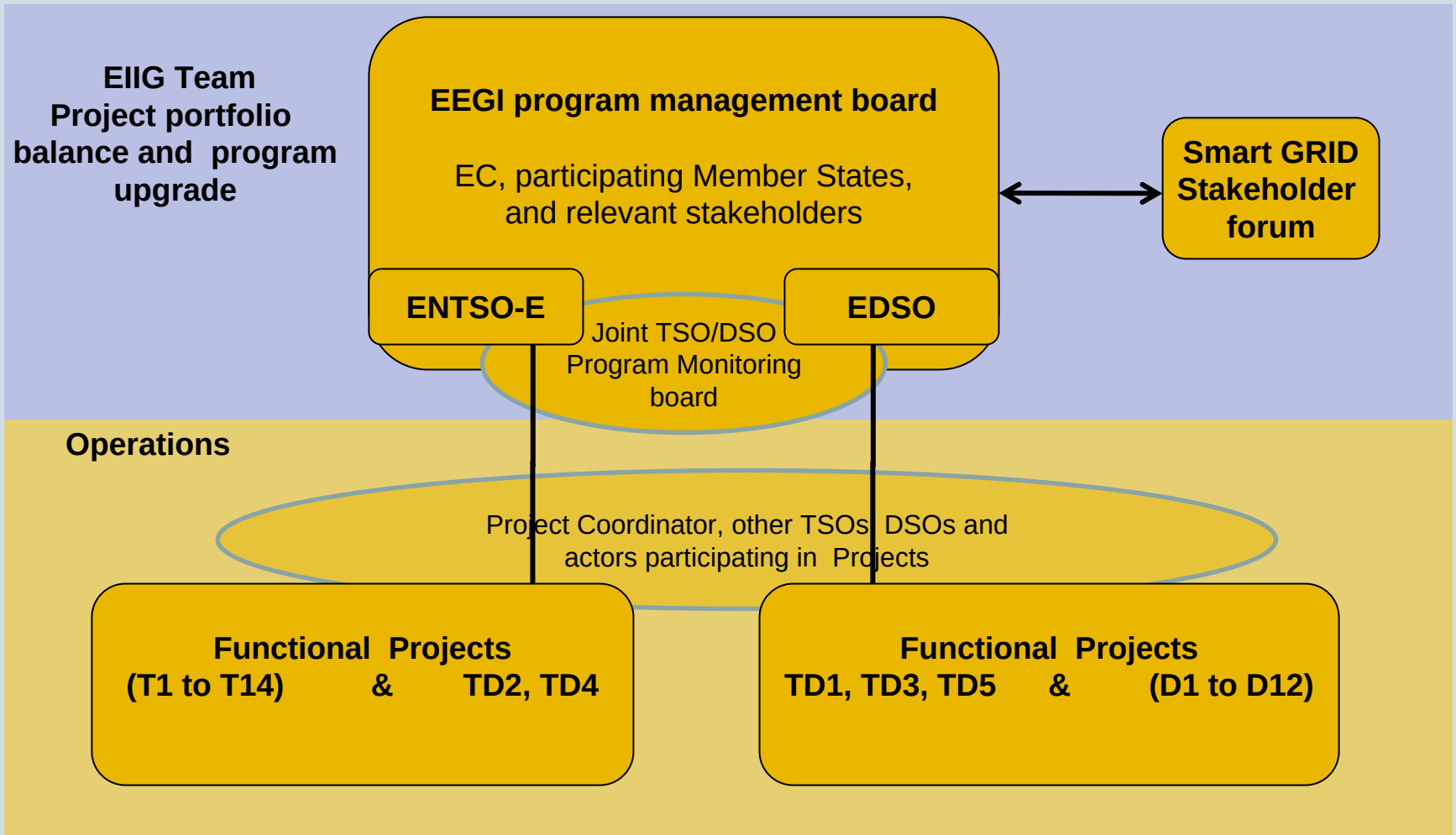
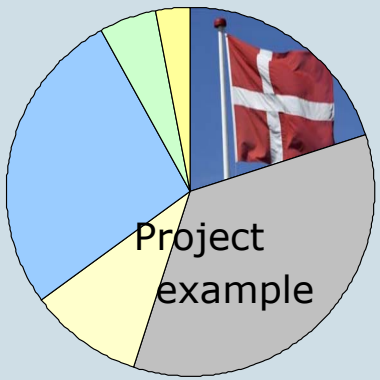
How to Organize the work



How about financing?

- There is no common pot!
- There will be projects. In projects there will be EC funding, National funding, Tariff funding and Self funding from partners.
- FP7 Criteria will be adopted
  - R&D activities are allowed up to 100 % funding
  - Demo activities are allowed up to 50 % funding
  - Dissemination might get up to 25 % funding
  - The normal regulation on State Subsidies doesn't apply!



The Danish part of a project might have several partners

- Energinet.dk, DSO's, Universities, Industries, Energy companies etc.
- Possible EC funding of all partners according to FP 7
- Funding from Member state = EUDP in Denmark
- You must bring some of your own funding
- Access to a larger project with relative small Danish funding