Die Energie der Zukunft ist Teil eines hochintelligenten Infrastruktur-Netzwerkes

Konferenz Erneuerbare Energie Kärnten, 2011

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Energy Department, Austrian Institute of Technology (AIT)

Inhalt

- Ausgangssituation – Einbindung Erneuerbarer und Energieeffizienz
- Europa gegen den Klimawandel – der SET Plan
- Globale Aspekte der Einbindung Erneuerbarer Energieträger
  - das europäische Übertragungsnetz
  - Auswirkungen der Einbindung von Windkraft auf das Übertragungsnetz
  - case study Forschung: project proposal *EcoGrid EU*
- Lokale Aspekte der Einbindung Erneuerbarer Energieträger
  - Photovoltaik im elektrischen Verteilnetz
  - „the bottlenecks are local“ – aktive elektrische Verteilnetze
  - case study Forschung: DG DemoNet smart LV grid
- smart cities – Großstädte als Chance
  - globale Entwicklung
  - Maßnahmen und Szenarien für energetisch smarte Städte
  - case study Forschung: SmartHeatNetwork
  - China als living lab
- Zusammenfassung und Ausblick

Driving Forces

- IEA Energy Technology Perspectives 2008:
- ….“..a global **energy technology revolution** is needed….“

- IEA World Energy Outlook 2008:
- ..“…The world`s energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable environmentally, economically and socially……

  What is needed is nothing short of an **energy revolution**….“

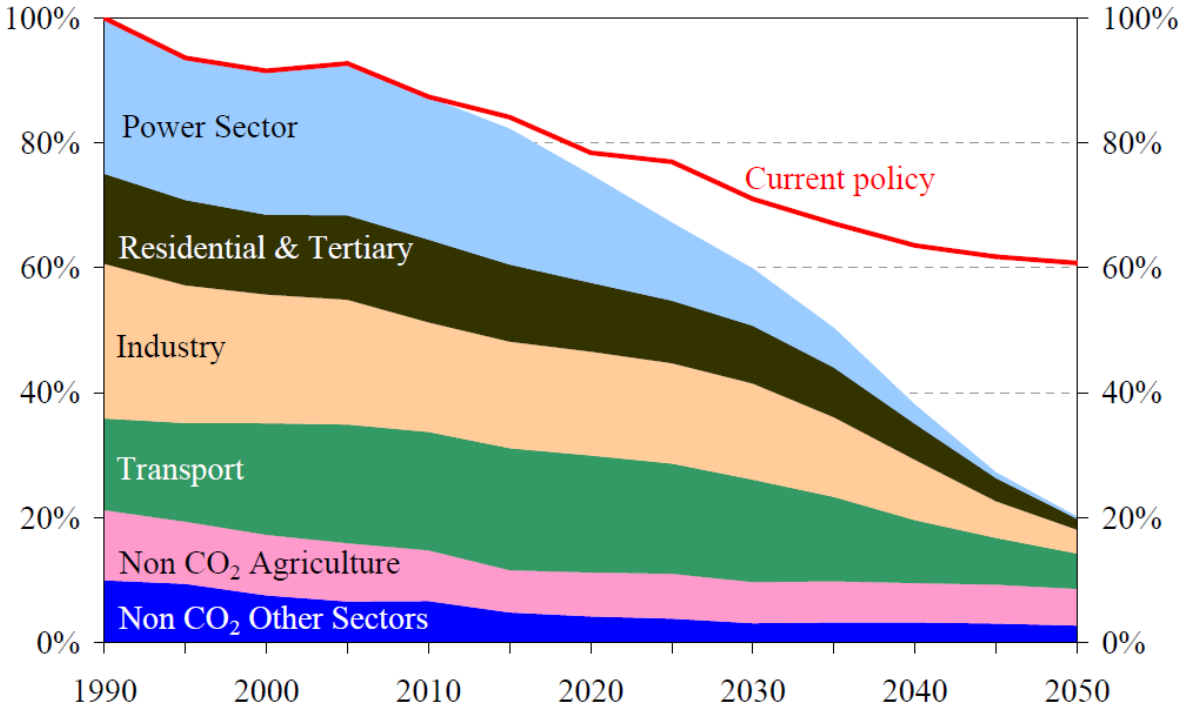
Europe 2020 Strategy and 2050 Roadmap

Climate change and energy – the "20-20-20 targets"

- Reduce GHG-emissions by 20%
- Increase share of renewables in EU energy consumption to 20%
- Achieve an energy-efficiency target of 20%

Roadmap 2050

-80% GHG reduction



What is the SET Plan?

Strategic Energy Technology Plan

- Key instrument of EU for tackling climate change
- Make low-carbon technologies affordable and competitive
- Large scale programs (Industrial Initiatives)
- Technology roadmaps for research and implementation
- Systemic approaches, organisational innovation, sustainable financial schemes, energy policy framework
- EERA (European Energy Research Alliance)

The European Industrial Initiatives
A Roadmap towards 2020

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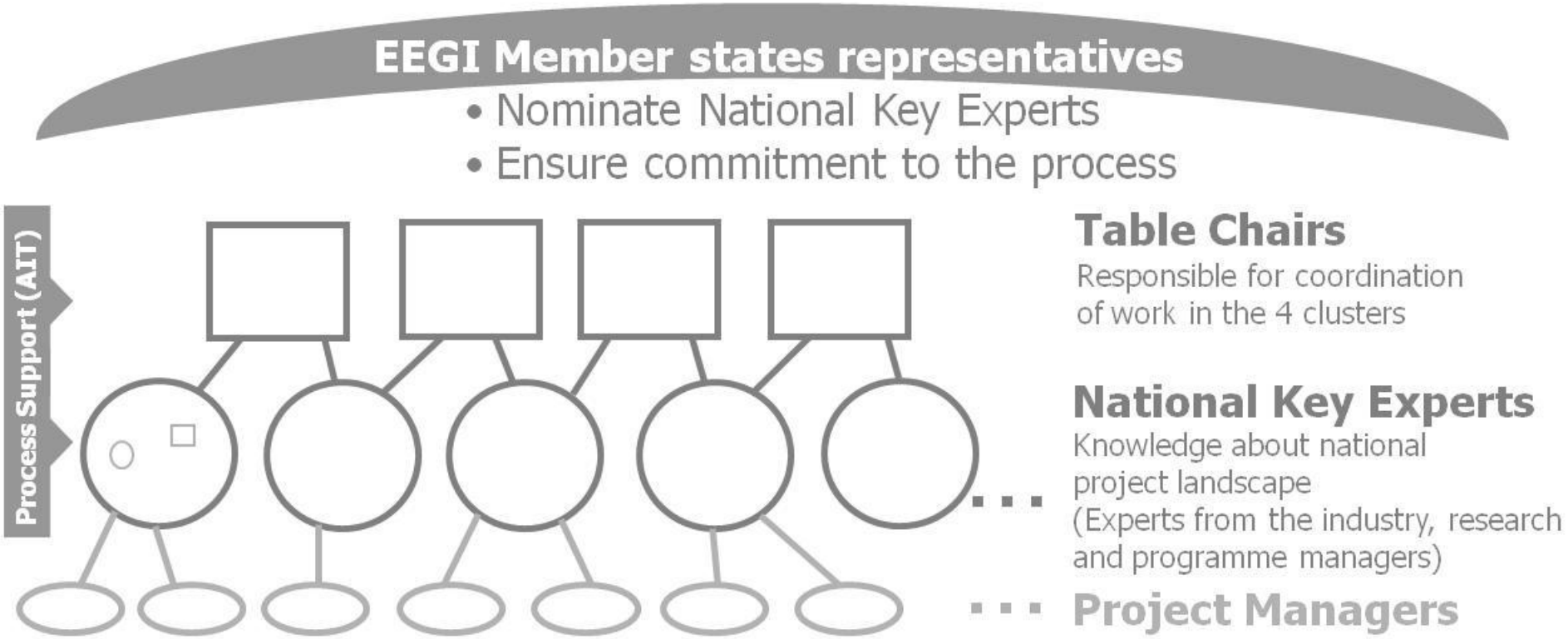
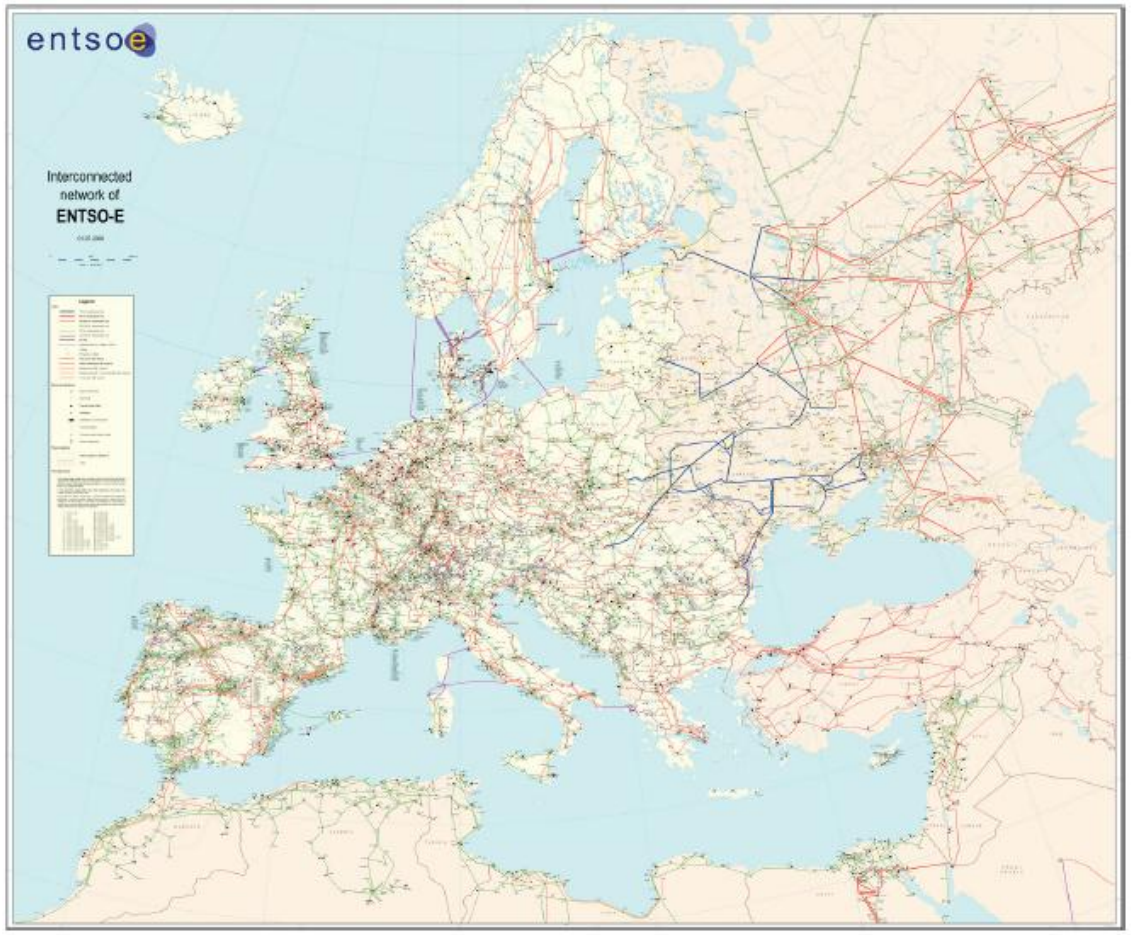
Industrial-Initiative	**€- Investment** R&D, demonstration, early market penetration	**Targets**	**Quantification**
Wind	6 Bln. €	Kosten,, Offshore, Netzintegration; 5-10 Prüfanlagen, 10 Demoprojekte, 5 Prototypen offshore Fundamente	20% of EU electricity consumption
Solar (PV/CSP)	16 Bln. €	PV: 5 Pilotanlagen f. automatisierte Massenfertigung, Demo zentral und dezentral; CSP: 10 Prototyp-Kraftwerke	15% of EU electricity consumption
Electricity Grid	2 Bln. €	Echter Binnenmarkt, Integration volatiler Erzeugung, Management der Wechselbeziehung zw. Lieferanten. und Kunden; 20 Demoprojekte	50% of networks „Smart“
Bioenergy	9 Bln. €	Fortgeschrittene Biokraftstoffe, Biomasse KWK; 30 Demoanlagen	14% of EU energy mix
CO_2 – Capture	13 Bln. €	Demonstration der vollständigen CCS-Kette in industriellem Maßstab	Costs 30-50 EUR/TCO2
Nuclear	7 Bln. €	Generation IV Reaktoren, erste KWK-Reaktoren	First prototypes
Smart Cities Initiative	11 Bln. €	Energy efficiency and renewable energy sources in urban environment, need for smart energy management	5-10 demo- cities

Member States Initiative within the European Electricity Grid Initiative (EEGI) Cooperation Structure – Network of Experts



renewables and the transmission grid I



taken from ENTSO-E ten-year network development plan 2010-2020

renewables and the transmission grid II

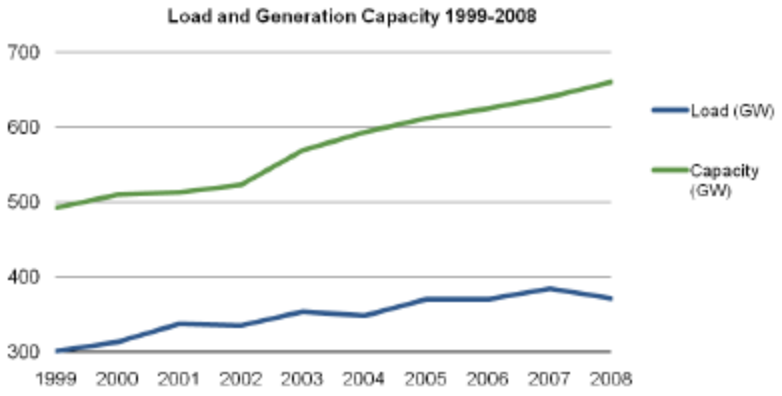
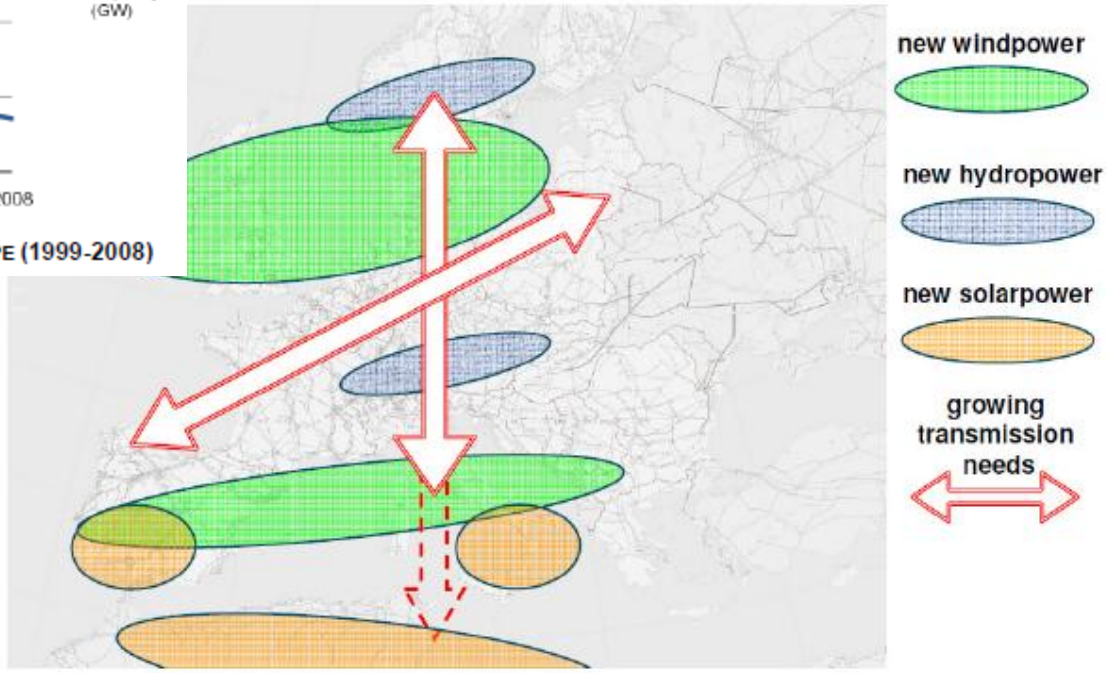


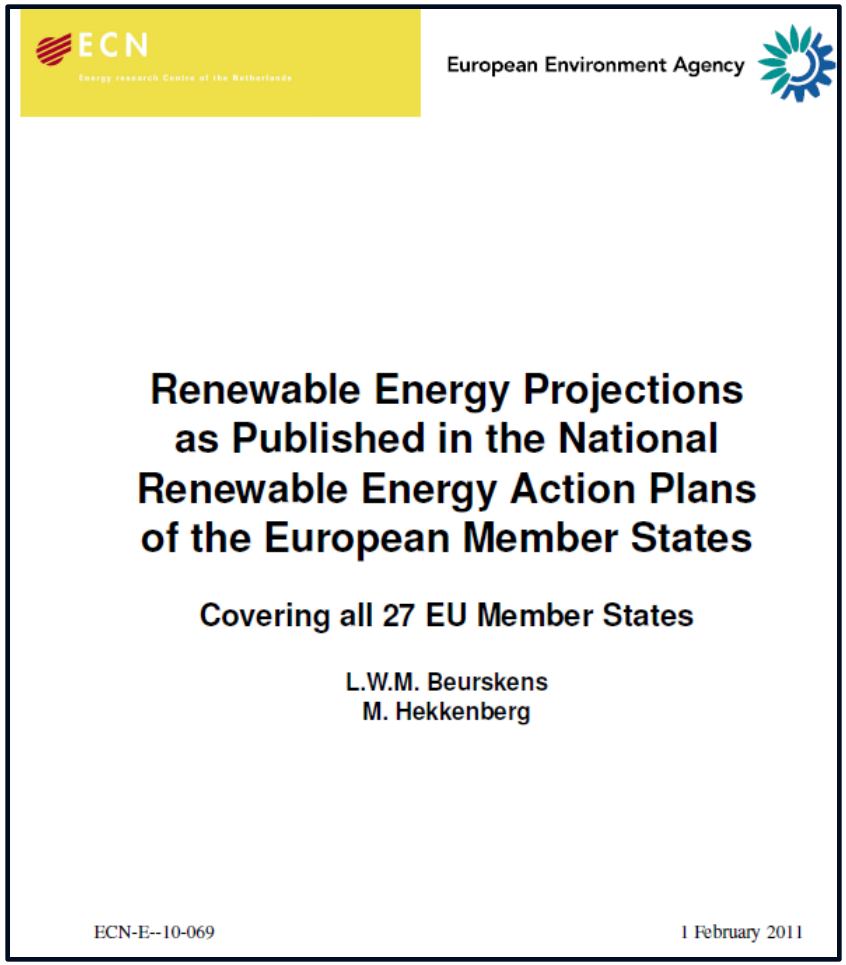
FIG. 12 LOAD AND GENERATION EVOLUTION IN EUROPE (1999-2008)

- load & generation capacity not parallel anymorge
- current system design: grid capacity has to follow generation capacity



taken from ENTSO-E ten-year network development plan 2010-2020

a collection of national Renewable Energy Strategies – the National Renewable Energy Action Plan (NREAP)



ECN
Energy research Centre of the Netherlands

European Environment Agency

Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States

Covering all 27 EU Member States

L.W.M. Beurskens
M. Hekkenberg

ECN-E--10-069

1 February 2011

wind power (according to NREAP)

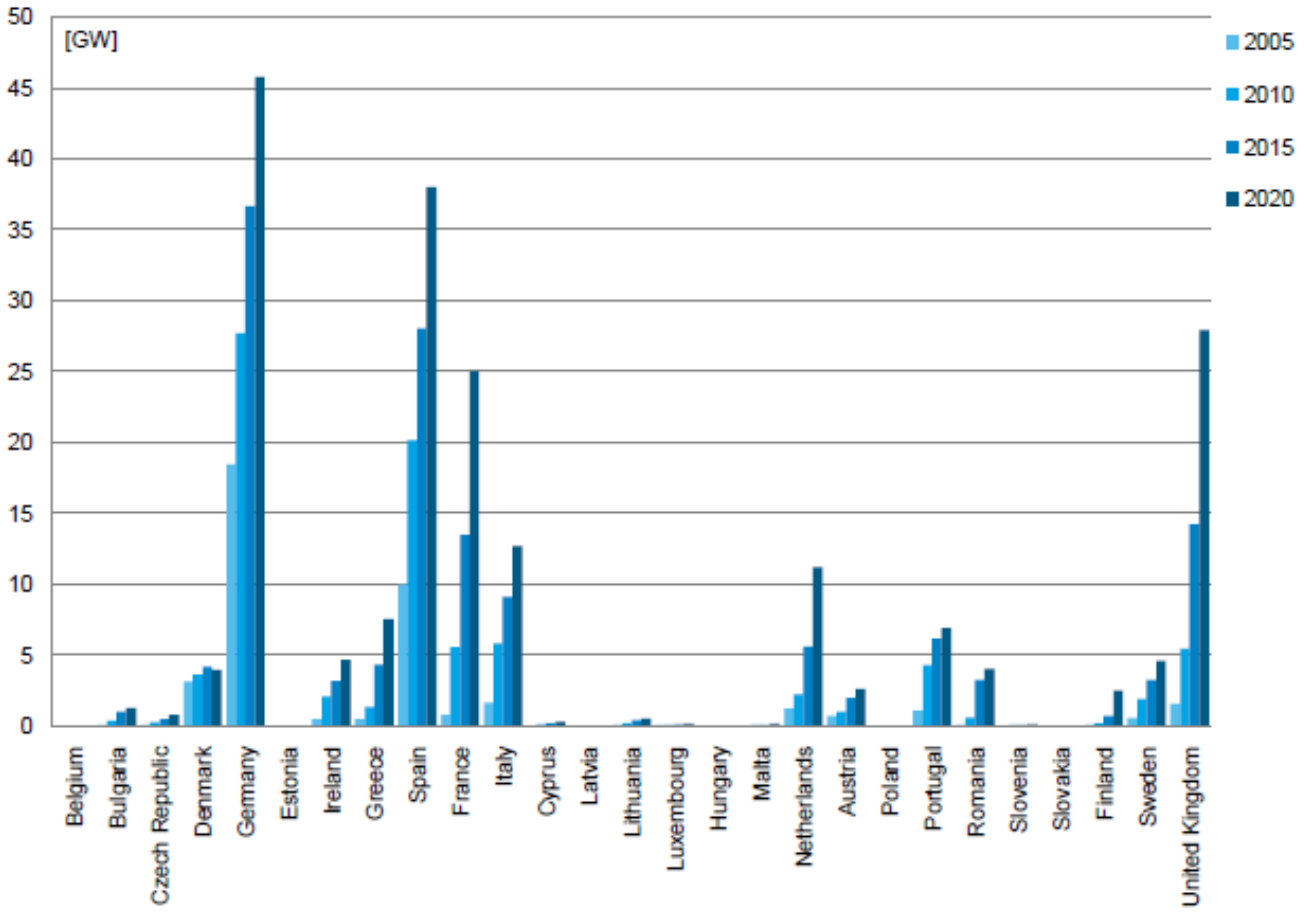


Figure 31: *Projected total wind power electric capacity [GW] for the period 2005 - 2020, including both onshore and offshore wind power*

full operating hours (wind power)

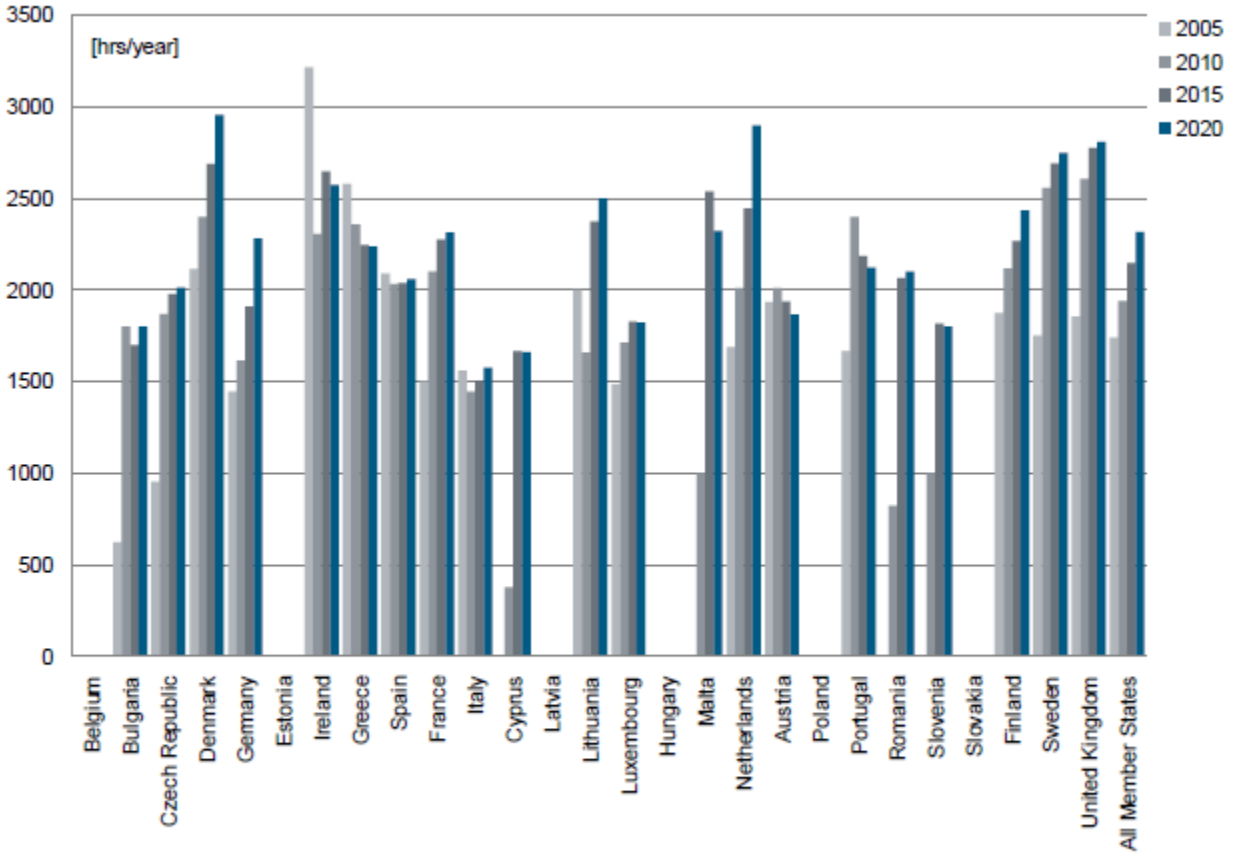
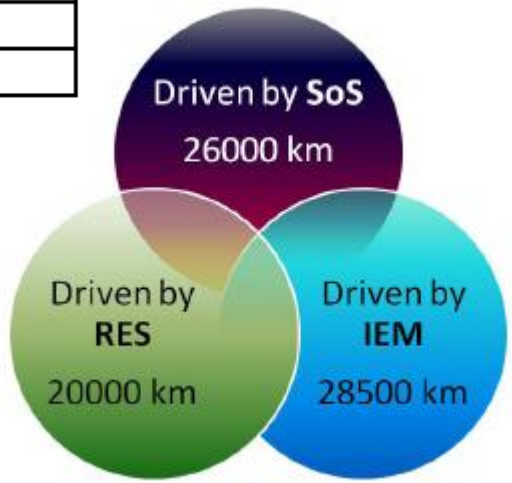


Figure 35: *Calculated average number of full load hours for total wind power [hrs/year] for the period 2005 - 2020*

transmission grid development – ENTSO-E TYNDP

TABLE 9 LENGTH OF NEW AND REFURBISHED POWER LINES UNTIL 2020 (PROJECTS OF EUROPEAN SIGNIFICANCE)

Project tehcnology	Total Length Km	Length of new connections Km	Length of upgraded connections Km
AC	32500	25700	6900
of which >300kV	*29600*	*23200*	*6400*
DC (mainly subsea)	9600	9600	0
TOTAL	**42100**	**35300**	**6900**
of which in mid-term	*18700*		



taken from ENTSO-E ten-year network development plan 2010-2020

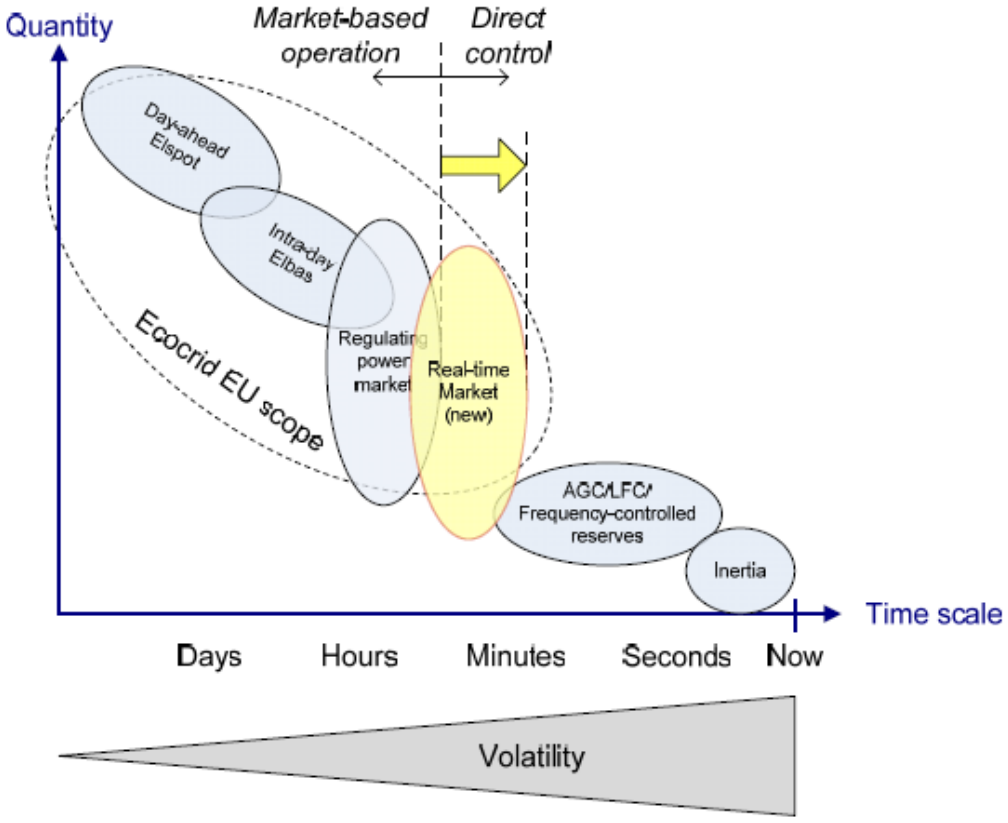
the EcoGrid EU project

- A large scale demonstration of a real-time market place for distributed energy resources
- A demonstration of a *real* power system with more than 50 percent renewable energy
- Preparation for a fast track towards European real-time market operation of RES & DR

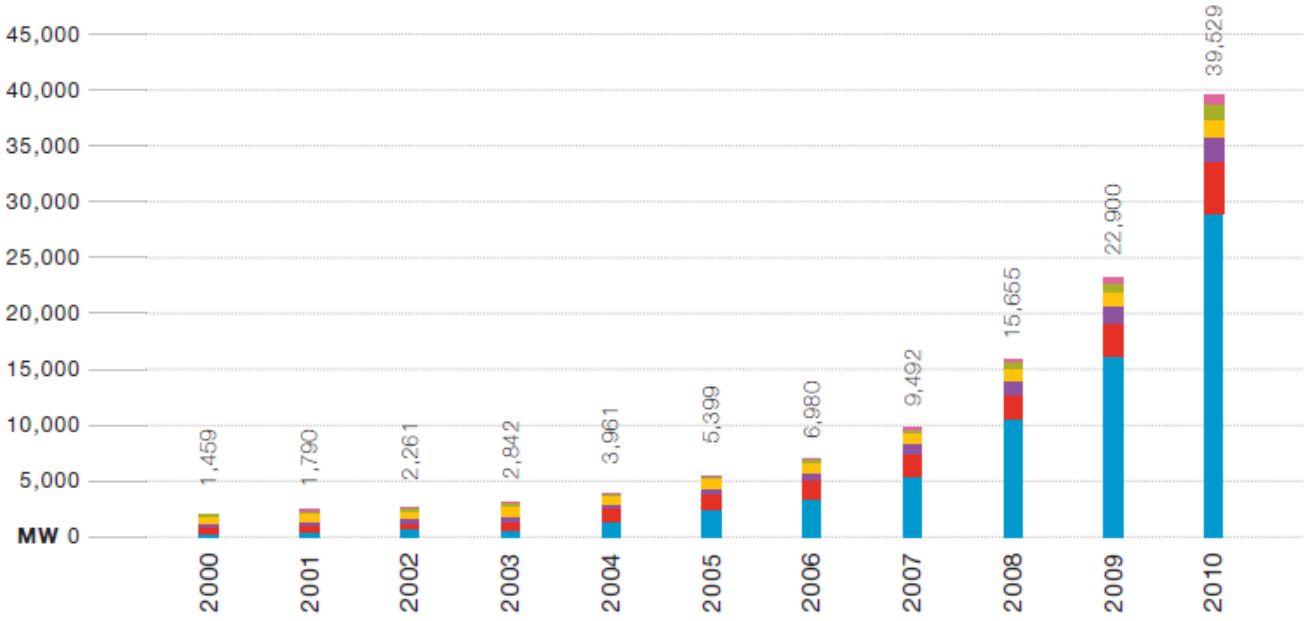
AIT Austrian Institute of Technology – Tomorrow Today · DTU · eandis · ECN · elia · EnCT · Energinet.dk · IBM · labein tecnalia · ORES · Østkraft – energi til gode oplevelser · SIEMENS · SINTEF · TTÜ 1918

the scope of the real-time market within Eco-Grid EU

- The EcoGrid Real-time Market will be an integrated part of the current power markets and supports the need of direct control options on a very short time scale
- An efficient instrument to wide spread adoption of small-scale end-users and prosumers in the power market(s)
- Increasing competition on the power market(s)
  - Small scale end-users can attain economic benefits
  - TSOs get access to alternative balancing resources



Installed PV capacity



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China	19	30	45	55	64	68	80	100	145	373	893
APEC	38	43	49	57	66	80	112	170	466	718	1,191
Rest of the world	758	814	894	971	1,000	1,010	1,128	1,190	1,303	1,427	1,844
North America	146	177	222	287	379	496	645	856	1,205	1,744	2,727
Japan	318	452	637	860	1,132	1,422	1,708	1,919	2,149	2,632	3,622
EU	181	275	414	613	1,319	2,324	3,307	5,257	10,387	16,006	29,252
Total	**1,459**	**1,790**	**2,261**	**2,842**	**3,961**	**5,399**	**6,980**	**9,492**	**15,655**	**22,900**	**39,529**

Germany:
80% in low voltage grids an < 100 kWp

taken from EPIA gobal market outlook for PV until 2015

electricity from solar power (according NREAP)

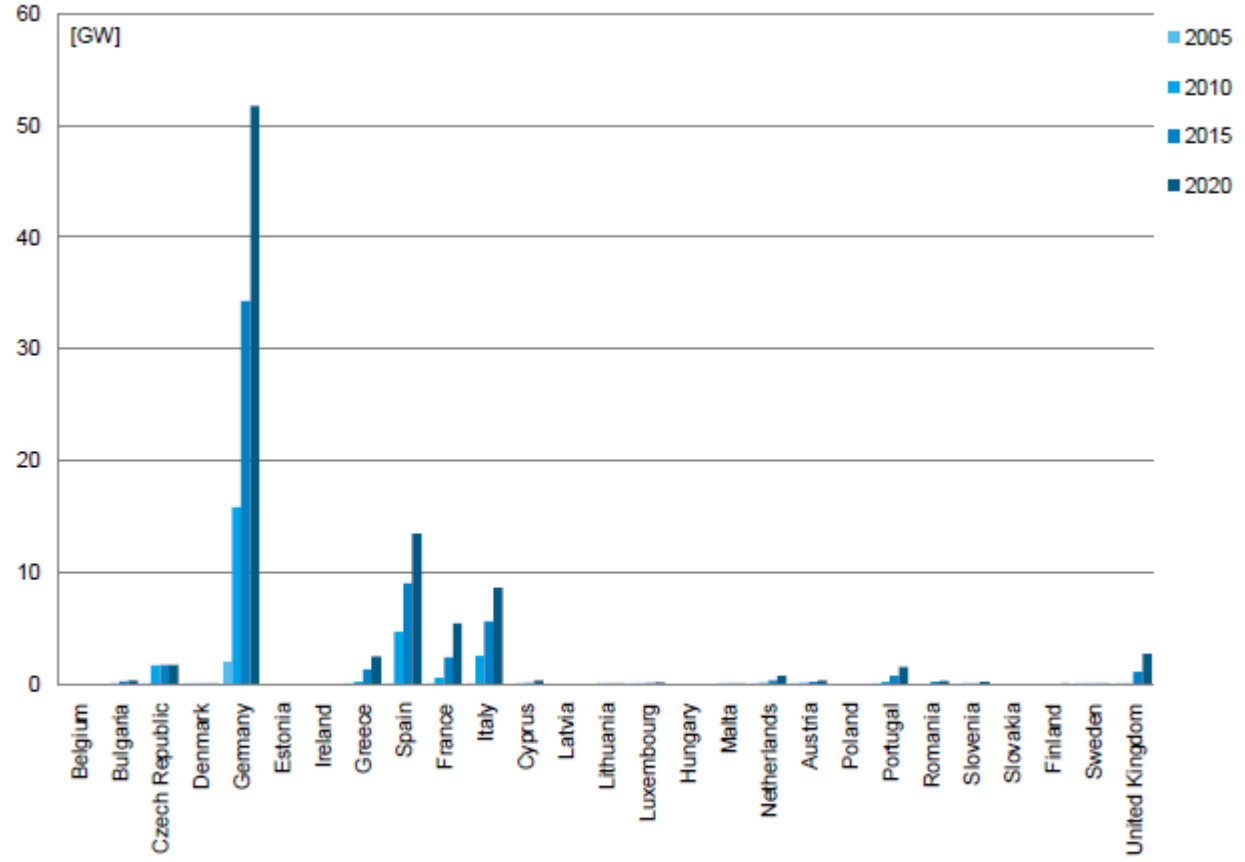
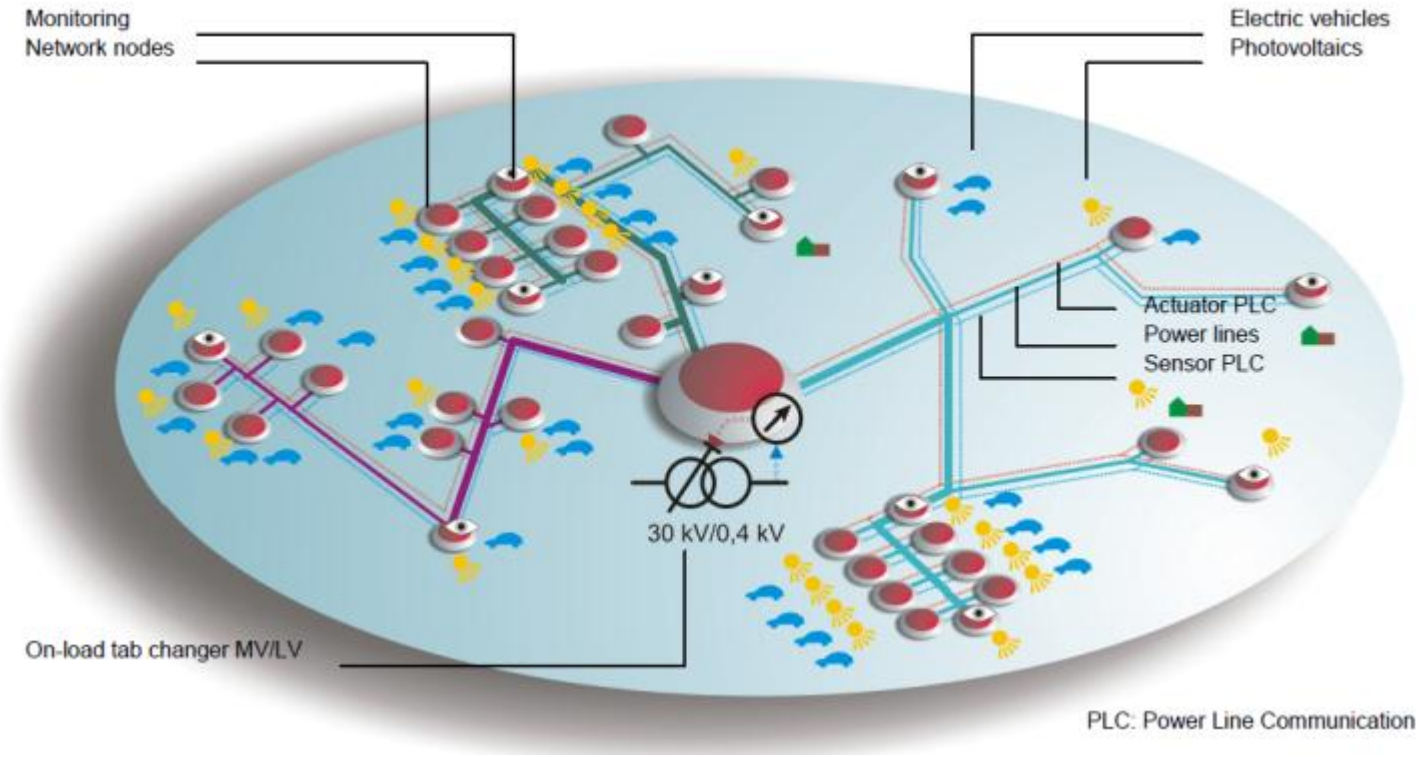


Figure 17: *Projected total solar electric capacity [GW] for the period 2005 - 2020, including photovoltaic (PV) and concentrated solar power (CSP)*

Smart Grid Technologies in three field tests

DG DEMO NET SMART LV GRID



- Monitoring & intelligent probabilistic planning
- Intelligent voltage control at secondary substation
- Active and reactive power control at DG unit
- Demand response: controllable loads – e-mobility

Field test regions and focus

DG DEMO NET SMART LV GRID

- Oberösterreich: Linz AG
  - **Use case "intelligent planning and smart monitoring“** - verification of the **probabilistic planning** method by measurements in a grid with high penetration of PV
- Oberösterreich: Energie AG OÖ
  - **Use case "smart sensing and coordinated generation control“** - testing of the control- and monitoring solutions in a grid with **high penetration of PV** based on smart metering communication infrastructure
- Salzburg: Salzburg AG
  - **Use case "smart sensoring and coordinated load control“** - examination of effectivity of the control- and monitoring solutions in a grid with high penetration of **PV linked with a high penetration of electric vehicles**

Global Challenge - Urbanization

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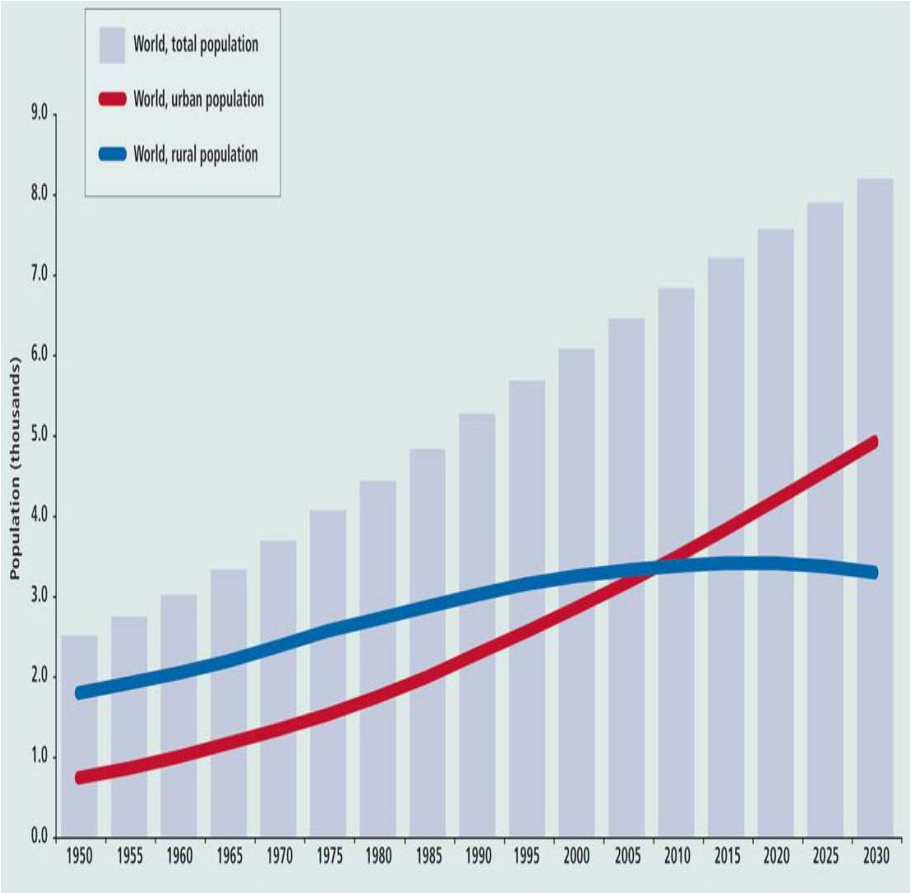
Source: NASA

Urbanization

The Urban & Rural Population 1950 - 2030



- Urbanization worldwide:
  - 2005: 3,2 billion people live in cities (49 % of humankind).
  - 2010: Urban population exceeds rural population
  - 2030: 60% (4.9 billion) of the world's population is projected to be urban
- Urbanization in Europe:
  - Majority of population lives in and around cities

Source: 2005 Revision of the UN World Urbanization Prospects report

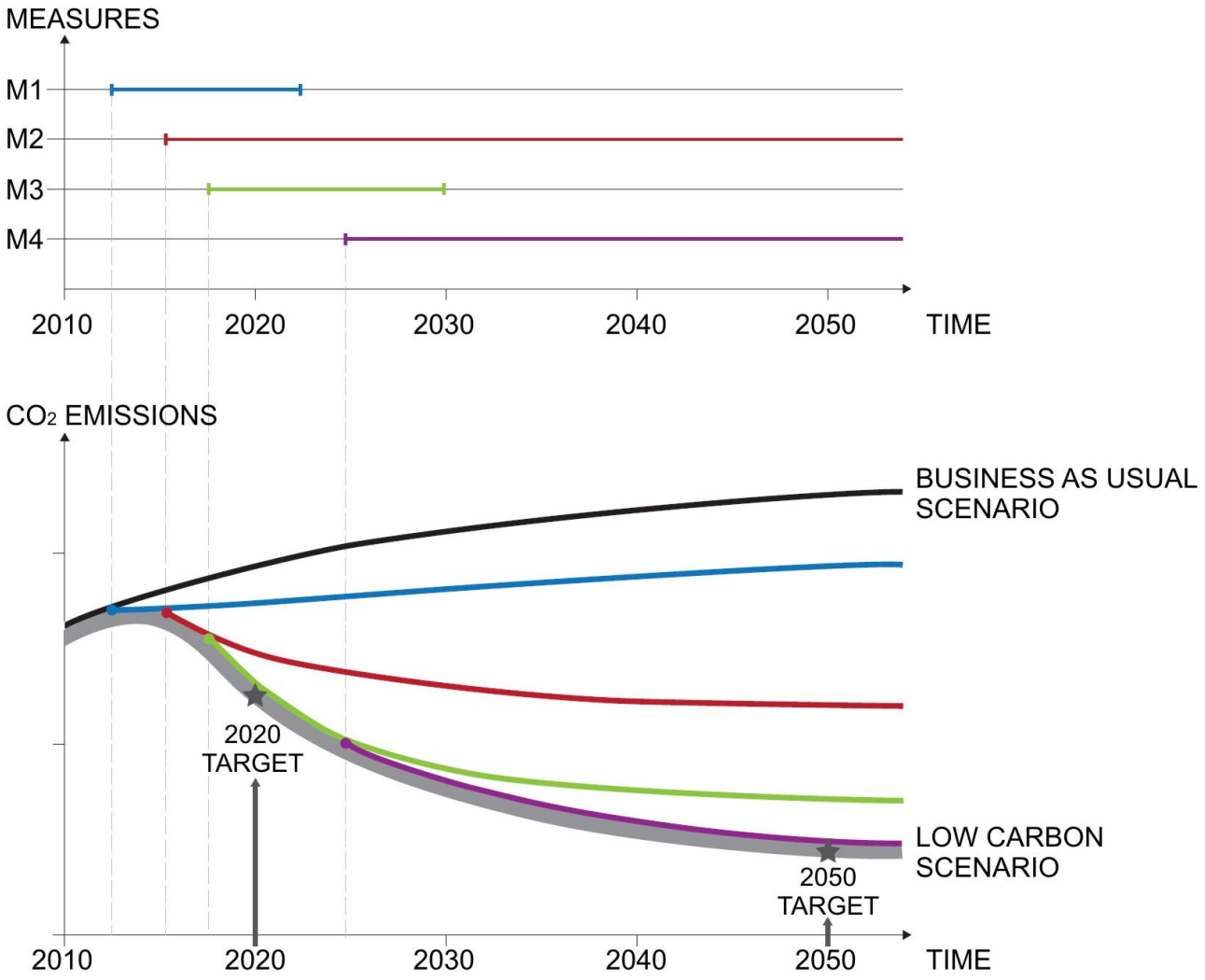
Smart Cities – Areas of research

ICT & Energy Technologies are merging
Intelligent energy management on regional & city level

- **Urban Energy Planning**
- **Smart Energy Networks**
- **Interactive Buildings**
- **Urban Supply Technologies (RES)**
- **Mobility**

- **New Business Models + financial schemes**

Measures towards a Smart City



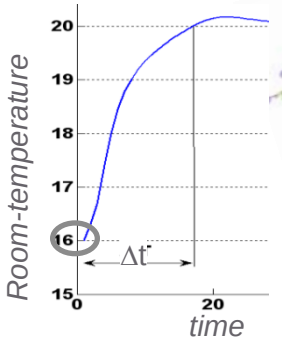
Die Rolle von thermischen Netzwerken in Smart Cities

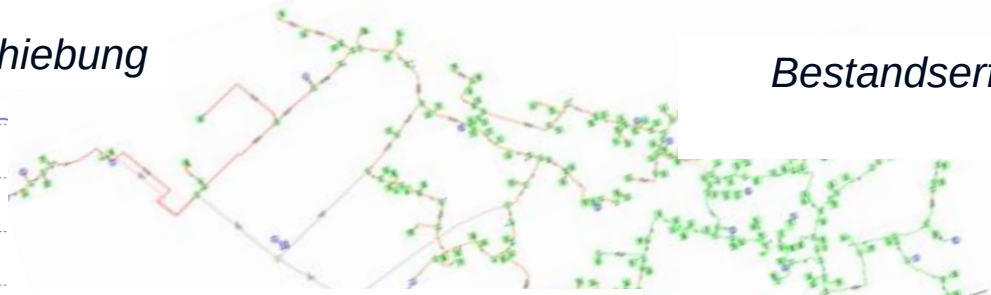
- 69% des Primärenergiebedarfs, rd. 55% für Wärme, entfällt auf städtische Ballungszentren
- Eine intelligente und integrierte leitungsgebundene Wärme- und Kälteversorgung als wichtiger **„Enabler“ der Smart City**
  - kann Wärme / Kälte aus unterschiedlichen (dezentralen) Quellen aufnehmen und verteilen
  - bieten die Möglichkeiten zur Lastverschiebung zwischen Gebäuden
  - reduziert die relativen Spitzenlasten (Zusammenfassung einzelner Verbraucher)
  - kann über dezentrale „Mikro-Netze“ Verbraucher, unterschiedlichste Energiequellen und Speicher auf lokalem Level verbinden
- Aktuelle Entwicklung: **Niedertemperaturfernwärme** (TVL: 30-50°C)
  - Wirtschaftlicher Transport von Wärmeenergie
  - Erhöhung des Potentials erneuerbarer Energieträger

Case Study: SmartHeatNet Project

- National gefördertes Forschungsprojekt (NE2020, 3. AS)
- **Ziel:** Entwicklung von intelligenten Betriebsstrategien und Regelalgorithmen (Versorger- und Abnehmerseitig), Reduktion von Lastspitzen
- **Methode:** Analyse des Ist-Zustandes, Übertragung von Konzepten aus dem Smart Grids Bereich, Evaluierung mittels dynamischer Netzsimulation

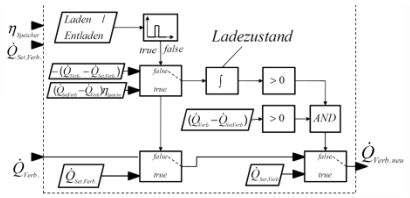
Lastverschiebung



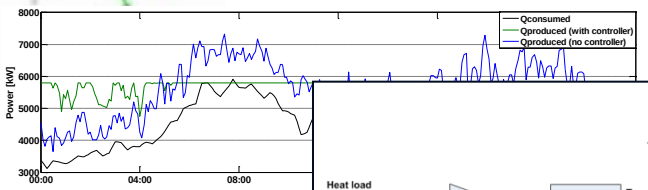


Bestandserfassung, Analyse

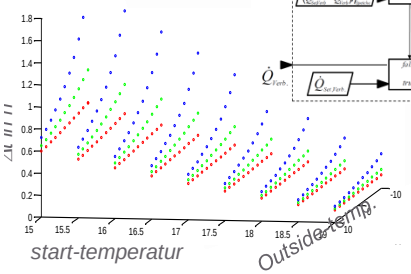
Zentrale/ dezentrale Speicher



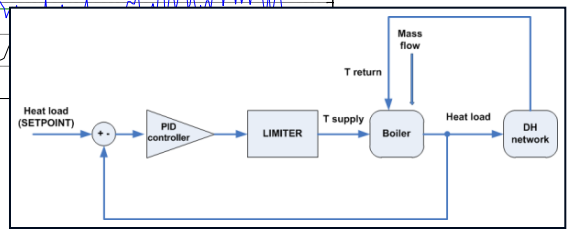
Vorlauftemperatursteuerung



Dynamische Gebäude-simulation



Sozio-ökonomische Faktoren



AIT activities in China

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Why China?

- Emerging market, rapid development
- Urgent need for massive CO2 reductions
- 8 low-carbon cities and 5 provinces

Ambitions:

- Establish win-win situations for Austria and China
- Long-term positioning AIT in China
- China as “living-lab”

City of Nanchang, Joangxi Province

Zusammenfassung

- Die Einhaltung der Klimaziele (z.B. 2 Grad Szenario) erfordert eine radikale Systemänderung was die Einbindung erneuerbarer Energieträger und Energieeffizienz betrifft
- In unserem aktuellen Systemverständnis erfordert vor allem die Einbindung zentraler erneuerbarer Energieträger ein zur installierten Erzeugungskapazität proportionales Wachstum an Übertragungskapazität
- Dezentrale (verbrauchsnahe) Integration von Erneuerbaren erfordert einen Systemumbruch hin zu aktiven elektrischen Verteilnetzen und den damit in Zusammenhang stehenden Technologien
- Neue Marktmodelle und gesamtheitliche Planung von Energiesystemen – z.B. smarte cities – können (und müssen?) die Forderungen der Einbindung erneuerbarer Energien und nach Energieeffizienz erfüllen.

AIT Austrian Institute of Technology

your ingenious partner

Wolfgang Hribernik
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