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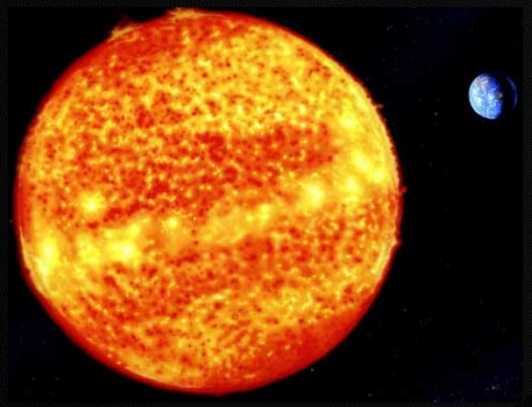

Smart Grid and Energy Market vs. Energy Revolution

J.Partanen, March 2013

COMBATING CLIMATE CHANGE AND ENHANCING ENERGY EFFICIENCY

Emissions = Population x GNP/person x Energy/GNP x Emissions/energy

Efficiency of energy use
Energy efficiency of production processes and equipment
Energy saving

Energy generation
Electricity
Heat
Traffic

INSTRUMENTS OF ENERGY TECHNOLOGY

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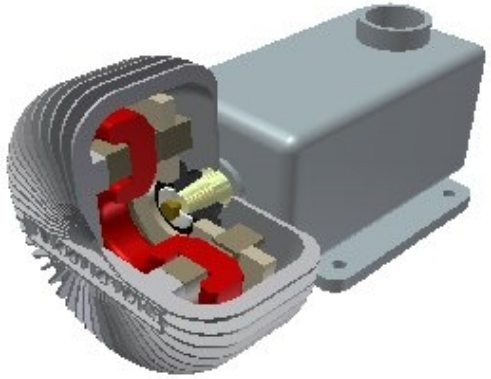
Sufficiency of low-cost energy and machines

Key elements for welfare and growth of society, also in future



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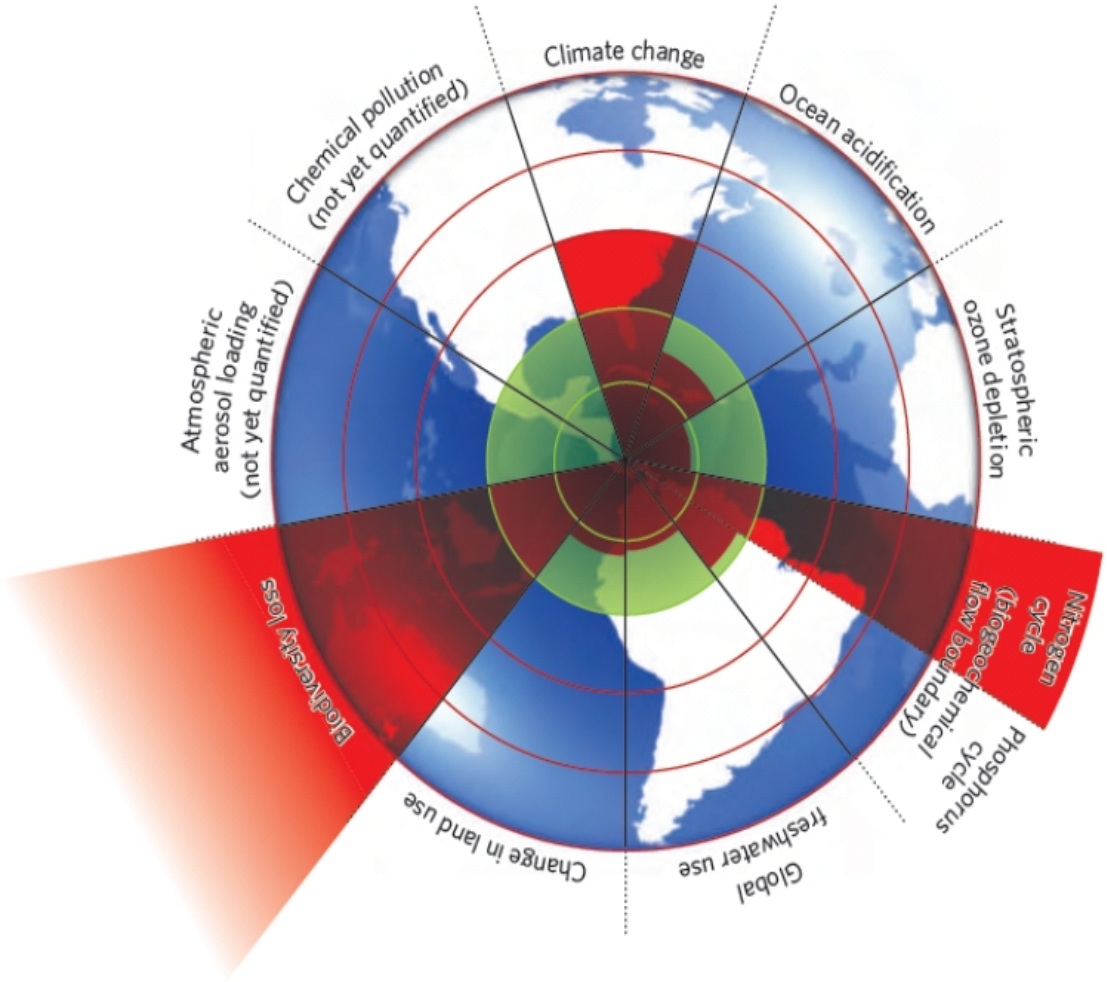
Climate change is not our only problem

- Nine interlinked planetary boundaries have been identified and three of them have already been overstepped

  - Biodiversity loss
  - Nitrogen cycle
  - Climate change

- Crossing certain biophysical thresholds could have disastrous consequences for humanity



* Rockström et al., NATURE, Vol 461|24 September 2009

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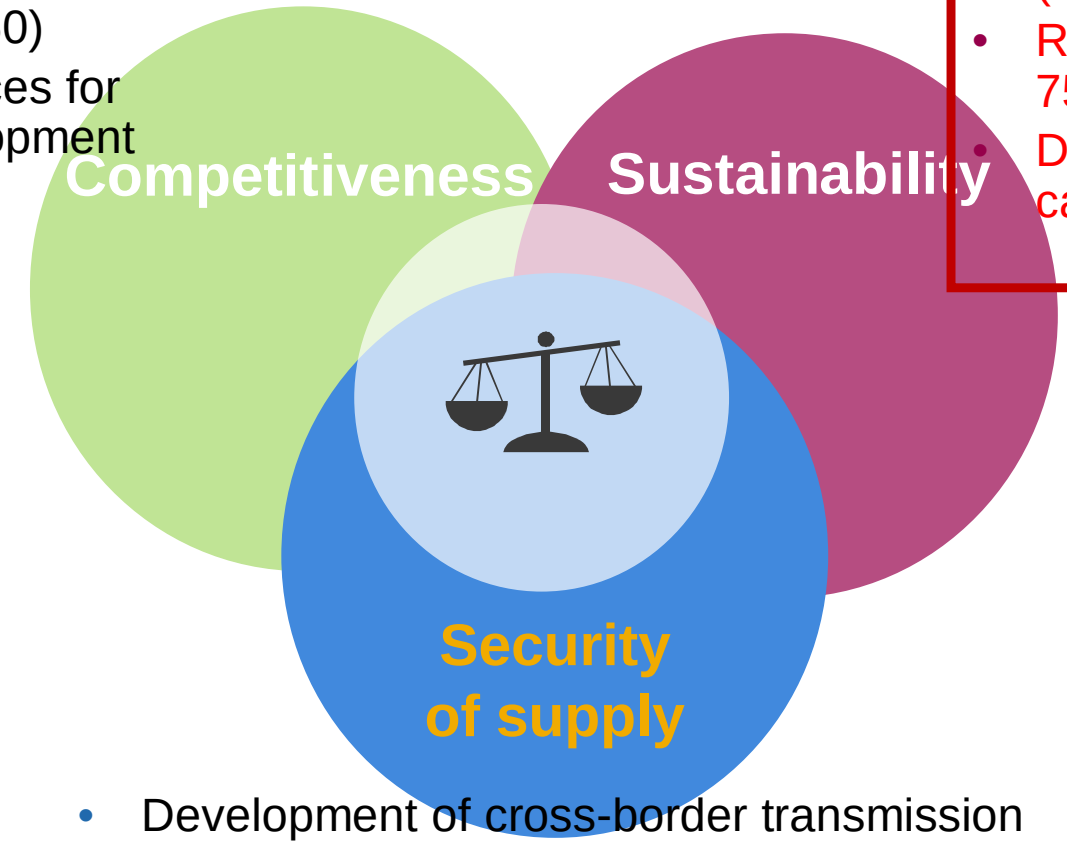
Key EU energy policy objectives by 2020/2050

- Implementation of internal energy markets
- Energy efficiency +20% (2020), 40 % (2050)
- Increased resources for technology development

- Minimum reduction of EU CO_2 emissions 20% (2020), 80 % (2050)
- Renewables 20% (2020), 75 % (2050)
- Development of CO_2 capture and storage



- Development of cross-border transmission
- Increase in own production
- Enhancement of external energy relations

Source: Fortum, J.Keronen

Energy revolution

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Distributed, non-controlled small scale generation; solar, wind, bio

- Distributed ownership, mass production, no emssions
- Intermittent production, power balance problem
- Microgrids, self-sufficiency
- Challenging market problem because of subsidized production. At the same time feed in tariffs have accerelates technical development and innovations ☺

Load monitoring, load control, demand response actions and business models

- Cut of peak powers, power balance management, Reserve power, cost optimization

Energy storages; batteries, electro-chemical conversion

- Short term (hours) and long term (days) balance of power and energy in system with high penetration of renewables

Market models

- Self sufficiency, security of supply
- frakmentation vs. trans-european market
- Market based business vs. subsidized business

Smart Energy Systems

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Energy revolution

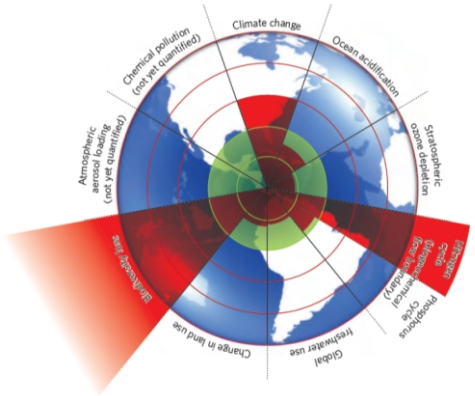
China, India, USA, Europe

- Increased burning of coal in Asia will continue
- Europe; forerunner (flagship) vs. self destruction ?
  - If Europe is not a leader of gang in climate question, what will happen? +3-4 C increase of climate temperature can lead to runaway change (environmental impacts). In that phase then solutions in energy systems will have no impact.
  - It's time to operate now; CO2 market or/and technology development by feed in tariffs?

Shale gas and oil

- Additional time for fossil fuels?
- Low price will lift world economy? More emissions?
- Self-sufficient USA – change in global politics
- Role of energy resources from Russia in Europe ?

Climate change and other boundaries of planet



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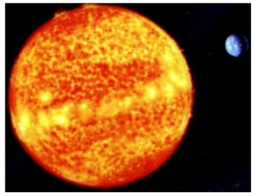
Vision & objectives of SGEM



Objectives of Smart Energy Systems, 2050 +

- improvement of global welfare
- ultimate efficient use of energy
- emission (CO_2, ..) free energy production
- active customer participation in the market
- security of supply

Objectives for Smart Grids and Energy Market

- Energy and capacity efficient use of electricity
- Active customer participation in the electricity market
- Self-sufficiency of resources
- Uninterrupted use of electricity
- Development and operation of electricity system and market in Smart Grid environment

"Power to the people"

The electricity system in 2030 combines a large number of customer-owned generations sites, large centralized-controlled power plants, controllable and mobile loads and energy storages. The technical and economic balance of supply and demand will be based on active customer and producer market participation through grids that function as a market place for the market actors.

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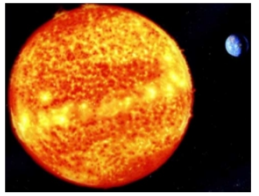
Objectives and actions of SGEM



Objectives for Smart Grids and Energy Market

- Energy and capacity efficient use of electricity
- Active customer participation in the electricity market
- Self-sufficiency of resources
- Uninterrupted use of electricity
- Development and operation of electricity system and market in Smart Grid environment

Actions and activities on the road to the vision

- Market oriented demand response actions
- Easy and flexible grid and market connection for DG
- Market models & customer behaviour
- Estimation models for dynamic loads & generation
- Self-healing networks & microgrids
- Weather proof networks
- Apply of new technologies
- Standardisation
- System level planning methods for grids, market actions and ICT-systems
- Methodology for operation of grids and in market
- Information for decision makers & other stakeholders
- International benchmarking.

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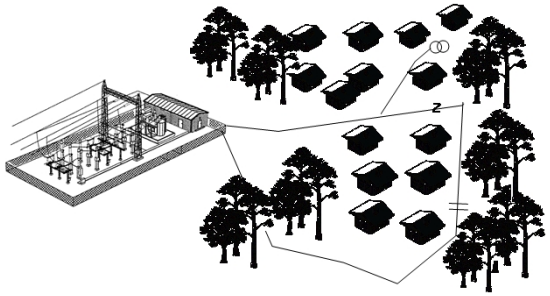
Smart Grids

Enabler for load response, distributed generation and uninterruptable use of electricity

Market players; TSO, DSO, supplier, aggregator



Active monitoring, optimisation and control of energy use and power flows

Information systems

Load information for market players

Grid

Action signals based on optimization against different targets of system players

Actions at the customer gateway

Energy storage

Generation

- Solar, wind, fuel cell, biogas

Loads; controllable, non-controllable

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Energy revolution vs. Smart Grids

	Chances	Challenges/Threats	Solutions
Renewable energy resources	Distributed energy system; geographically and ownership	Power balance with non-controlled production	Demand response. Energy storages
	Mass production of small units	Reasonable market volume	Subsidized market mechanism as a market activator
		Subsidized market mechanism	New technical solutions, distributed generation
		Unefficient operation of traditional power plants	Subsidies?
	Self-sufficiency	Apply of local energy resources	Micro-grids
		Security of supply	Apply of demand response and energy storages as a reserve power capacity
		Easy grid connection (technical, economic) for RES	Standardisation

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Energy revolution vs. Smart Grids

	Chances	Challenges/Threats	Solutions
Security and quality of supply	Power electronics & ICT	Non-controlled subsidized production	European Super Grid
	Energy storages	Grid reliability	Trans-European market mechanisms
	Local generation	Congested grids	Capacity markets
	Demand response	Increased number of major storms	Weather proof grids
		Fragmented energy markets	Self healing grids
			Local distributed generation and energy storages
			Microgrids
		Cost efficient solutions	New technologies, HVDC, LVDC

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Energy revolution vs. Smart Grids

	Chances	Challenges/Threats	Solutions
Competitiveness, Self-sufficiency in Europe	Common Trans-European energy market	Self-sufficiency of nations	Super Grid
	Efficient low cost cleen energy production	Security of supply	
		Unefficient operation of traditional power plants	Trans-European market mechanisms
		Fragmented energy markets	
		Increased use of coal in Asia	Economic technology for clean production
		CO2 market	

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Energy revolution vs. Smart Grids

	Chances	Challenges/Threats	Solutions
Energy efficiency	Reduction of energy use	Unefficient use of system capacity; decrease of transmitted and distributed energy but increased peak powers	Incentives for peak power reduction
	Reduction of CO2 emissions	Efficient use of system capacity	Tariff structures
		Forecasting of demand	Demand response
	Electrical vehicles		Controlled charging systems
		Information of possibilities to efficient energy use	AMR-meters

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Energy revolution vs. Smart Grids

	Chances	Challenges/Threats	Solutions
Active customer in energy market	Efficient use of energy	Non optimal solution from system perspective	Customer driven business models
	Apply of demand response	Business models	Legislation driven market
	Own production of energy	Inefficient use of system capacity	Low cost technology
	Self sufficiency		
	Continuous use of electricity		Microgrids

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Energy revolution vs. Smart Grids

Topic	Goals	Benefits
Demand response	Flexiple control of customer loads (behaviour)	Technical power balance management
	Optimal use of grid and generation capacity	Economic balance settlement
	On-line management of customers through ICT-system	Capacity (peak power) reduction, lower investments
	Customer based generation	Reserve power capacity
	Security of supply	

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Energy revolution vs. Smart Grids

Topic	Goals	Benefits
Energy storages	Flexiple control of customer loads (behaviour) and generation	Technical power balance management
	Optimal use of grid and generation capacity	Economic balance settlement
	Security of supply, short term & long term	Capacity reduction, lower investments
		Security of supply, reserve power
		Reduction CO2 emissions

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Energy revolution vs. Smart Grids
Actions in short term

Topic	Tasks
Management of power balance	New resources for controlled generation, gas & coal & hydro
	Demand response into practise
Demand response	Business models, technology, legistlation, customer behaviour, COI problems to be solved
AMR-meters	Information for customers, energy efficiency
	Integration with network automation functionalities
Electrical vehicles	Smart charging, incentives from government
Energy storages	Feasibility (technical, economic) studies for different apply areas
	Pilot installations

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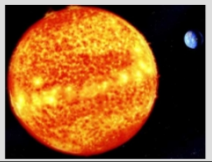
Energy use & energy production
Trends in short and long term

	2015	2030	2050+ 
Energy production	BAU Increased use of renewables	– Peak of burning of oil, coal and biomass has passed – market shares of wind, solar and gas have significantly increased	Solar economy Renewable & clean production De-centralised
Energy market	Regulated, feed-in tariffs, security, bottlenecks	Smart grids, energy storages Efficient use of capacity	Market as for other commodities demand – supply
Energy use	Guidelines, laws, agreements Apply of existing energy saving technology	Innovative energy saving technology and processes	Real energy and material efficient processes, appliances, vehicles and buildings

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Business impact and potential within Smart Grid Concept

Market player	Chances	Challenges	Threats
Producer, basic big scale production	Clean production Regulating production for power balance management	Distributed generation, energy politics	Shorter operation time for basic power plants, low prices for non subsidized production, market rules fragmentary
Retailer	Customer gateway Demand response; Optimization of power purchase and balance energy, reserve power services, energy services for customers	Egg-chicken problem, New business environment, ICT-systems, Time to market ?	Market fragmentary Management of ICT-systems in fragmented market
DSO	Energy storages for peak reduction, Services for distributed generation, Market place at all	Decrease of energy supplied, increase of peak powers, **no possibility** for direct load control	Regulation, rate of return
TSO	Demand response & energy storages in distributed power balance management	Non-controlled production Decrease of energy supplied, increase of peak powers, **no possibility** for direct load control	System security, huge investment needs
Customer	Non-interrupted use of electricity, Own production with reasonable costs Lower costs in long term	Higher prices in short term	No services for energy efficiency