



Open your mind. LUT.  
Lappeenranta University of Technology

# Drivers and requirements for Smart Grids based on development of overall regulation of energy market

**Kaisa Tahvanainen**

**Institute of LUT Energy**

Energy Technology | Electrical Engineering | Environment Technology

# WP 1.1 Significance of electricity and Smart Grids

## Task 1.1.4 Development of overall regulation



---

**sgem**

Smart Grids and Energy Markets

---

Deliverable 1.1.9 Drivers and requirements  
for Smart Grids based on development of  
overall regulation of energy market

# Regulation hierarchy on Smart Grids (SG)



Open your mind. LUT.  
Lappeenranta University of Technology

## EU legislation

- Directives, regulations, communications
- Policy papers

## National legislation

- Implementation of EU legislation
- National regulations

## Economic regulation of DSOs

- Economic framework for electricity distribution operation

## Technical regulation

- Standards, directives
- National smart grid platforms

## Industry regulation

- Industry recommendations, guidelines

DSO = (electricity) distribution system operators

# European Energy policy



Open your mind. LUT.  
Lappeenranta University of Technology

- **Sustainability** - to actively combat climate change by promoting renewable energy sources and energy efficiency
  - reduce greenhouse gas emissions by 20%, to increase the share of renewable energy to 20% and to make a 20% improvement in energy efficiency
- **Competitiveness** - to improve the efficiency of the European energy grid by creating a truly competitive internal energy market;
- **Security of supply** - to better coordinate the EU's supply of and demand for energy within an international context.



# European Energy 2020 strategy



Open your mind. LUT.  
Lappeenranta University of Technology

- 1) Priority 1: Achieving an energy-efficient Europe**
  - Action 1: Tapping into the biggest energy-saving potential — buildings and transport
  - Action 2: Reinforcing industrial competitiveness by making industry more efficient
  - Action 3: Reinforcing efficiency in energy supply
  - Action 4: Making the most of National Energy Efficiency Action Plans
- 2) Priority 2: Building a pan-European integrated energy market**
  - Action 1: Timely and accurate implementation of the internal market legislation
  - Action 2: Establishing a blueprint of the European infrastructure for 2020-2030
  - Action 3: Streamlining permit procedures and market rules for infrastructure developments
  - Action 4: Providing the right financing framework
- 3) Priority 3: Empowering consumers and achieving the highest level of safety and security**
  - Action 1: Making energy policy more consumer-friendly
  - Action 2: Continuous improvement in safety and security
- 4) Priority 4: Extending Europe's leadership in energy technology and innovation**
  - Action 1: Implementing the SET Plan without delay
  - Action 2: The Commission will be launching four new large-scale European projects
  - Action 3: Ensuring long-term EU technological competitiveness
- 5) Strengthening the external dimension of the EU energy market**
  - Action 1: Integrating energy markets and regulatory frameworks with our neighbours
  - Action 2: Establishing privileged partnerships with key partners
  - Action 3: Promoting the global role of the EU for a future of low-carbon energy
  - Action 4: Promoting legally binding nuclear-safety, security and non-proliferation standards worldwide

# Relevant EU-legislation



Open your mind. LUT.  
Lappeenranta University of Technology

## Electricity market directive [2009/72/EC](#)

- Introduces common rules for the generation, transmission, distribution and supply of electricity. Lays down universal service obligations and consumer rights, and clarifies competition requirements.
- All countries must have independent electricity regulators for electricity. They shall ensure competitive, secure and environmentally sustainable internal markets in electricity and gas and shall not take instructions from the government. Among others they shall help to achieve the development of systems that are in line with general energy policy objectives, energy efficiency as well as the integration of large and small-scale production of electricity from renewable energy sources and distributed generation. The regulator shall also facilitate access to the network for new generation capacity and remove barriers of electricity from renewable energy sources.
- More harmonization of technical standards
- Member States should encourage the modernisation of distribution networks, such as through the introduction of smart grids, which should be built in a way that encourages decentralised generation and energy efficiency.
- EU countries can impose on electricity companies public service obligations (PSO) relating to security of supply, quality and price of supplies and environmental protection, including energy efficiency, energy from renewable sources and climate protection.
- Countries shall ensure the implementation of intelligent electricity systems for consumers, but the implementation is subject to an assessment of which form(s) of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution.
- In order to promote energy efficiency, Member States or the regulatory authority shall strongly recommend that electricity undertakings optimise the use of electricity, for example by providing energy management services, developing innovative pricing formulas, or introducing intelligent metering systems or smart grids, where appropriate.
- Rules for regulation of DSOs

# Relevant EU-legislation



Open your mind. LUT.  
Lappeenranta University of Technology

## Directive on energy end-use efficiency and energy services [2006/32/EC](#)

- The purpose is to make the end use of energy more economic and efficient by:
  - establishing indicative targets, incentives and the institutional, financial and legal frameworks needed to eliminate market barriers and imperfections which prevent efficient end use of energy
  - creating the conditions for the development and promotion of a market for energy services and for the delivery of energy-saving programmes.
- Need to improve the availability and quality of information on energy consumption and on available energy efficient technologies and techniques.
- The use of advanced metering systems to improve energy efficiency awareness and to inform the customers better about their own consumption

# Relevant EU legislation



Open your mind. LUT.  
Lappeenranta University of Technology

Regulation (EC) [No 714/2009](#) on conditions for access to the network for cross-border exchanges in electricity

Regulation (EC) [No 713/2009](#) on establishing an Agency for the Cooperation of Energy Regulators

- Establishing an Agency for the Cooperation of Energy Regulators (ACER)
- Complements and coordinates the work of National Regulatory Authorities
- Participates in creating the of European network rules
- Monitors and reports on the internal electricity markets to the Commission

# Relevant EU-legislation



## [COM\(2010\) 677](#) Energy infrastructure package

- Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network
- Commission defines priority corridors to develop electricity, gas and oil infrastructure enabling to reach our 2020 targets, improve security of supply and market integration and to start planning our long-term network of electricity highways and carbon-dioxide transportation

## [COM\(2006\) 545](#) Action Plan for Energy Efficiency (2007-12)

- The Action Plan includes measures to improve the energy performance of products, buildings and services, to improve the yield of energy production and distribution, to reduce the impact of transport on energy consumption, to facilitate financing and investments in the sector, to encourage and consolidate rational energy consumption behaviour and to step up international action on energy efficiency.



# Relevant EU-legislation

## Promotion of the use of energy from renewable sources, directive [2009/28/EC](#)

- National sectoral targets for renewable sources in final consumption (20-20-20 goal) and in transport (at least 10 %)
- National renewable energy action plans
- Building the necessary infrastructures for energy from renewable sources in the transport sector

## Security of supply directive [2005/89/EC](#)

- Establishes measures aimed at safeguarding security of electricity supply so as to ensure the proper functioning of the EU internal market for electricity, an adequate level of interconnection between Member States, an adequate level of generation capacity and balance between supply and demand.
- Member countries have to facilitate the development of new generation capacity, or encourage energy conservation and technology for demand management in real time

## CCS (Carbon dioxide capture and geological storage) directive [2009/31/EC](#)

## ETS (Emissions trading scheme) directive [2009/29/EC](#)

# EU initiatives and programmes



Open your mind. LUT.  
Lappeenranta University of Technology

- Smart Grid Task Force

- The mission of the Task Force Smart Grids to advise the Commission on policy and regulatory directions at European level and to coordinate the first steps towards the implementation of Smart Grids under the provision of the Third Energy Package.
- Timetable: Common vision (June 2010), Recommendations for strategy and regulation (January 2011), Roadmap (May 2011)
- Expert groups: Functionalities for Smart Grids (EG 1), Regulatory recommendations for data safety, data handling and data protection (EG 2), Roles and responsibilities of actors involved in the Smart Grids deployment (EG 3)

- Strategic Energy Technologies Plan (SET-Plan)

- Strategic plan to accelerate the development and deployment of cost-effective low carbon technologies

- The Roadmap 2050 project

- An initiative of the European Climate Foundation (ECF)
- In July 2009, the leaders of the European Union and the G8 announced an objective to reduce greenhouse gas emissions by at least 80% below 1990 levels by 2050.
- A practical guide to a prosperous, low-carbon Europe, a discussion of the feasibility and challenges of realizing an 80% greenhouse gases reduction objective for Europe, including urgent policy imperatives over the coming five years.

# Initiatives and programmes



Open your mind. LUT.  
Lappeenranta University of Technology

- [The European Electricity Grid Initiative \(EEGI\)](#)
  - European Industrial Initiatives under the Strategic Energy Technology Plan (SET-Plan)
  - Focuses on system innovation rather than on technology innovation, and addresses the challenge of integrating new technologies under real life working conditions and validating the results.
  - Roadmap 2010-18 & implementation plan 2010-12
- [International Renewable Energy Agency IRENA](#)
  - Objective to promote the widespread and increased adoption as well as the sustainable use of all forms of renewable energy

# EU Policy Developments

1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 ...UP TO 2020 ...UP TO 2030 ...UP TO 2040 ...UP TO 2050



1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 ...UP TO 2020 ...UP TO 2030 ...UP TO 2040 ...UP TO 2050

Source: ERGEG. 2009. Position Paper on Smart Grids

# Finnish legislation



Open your mind. LUT.  
Lappeenranta University of Technology

## Electricity market act [386/1995](#)

- Purpose is to ensure preconditions for an efficiently functioning electricity market so as to secure the sufficient supply of high-standard electricity at reasonable prices.
- Promoting electricity efficiency and conservation in business operations in companies operating in electricity markets as well as in those of their customers.
- Obligation to deliver electricity and develop and maintain electricity networks
- Guidelines for economic regulation of DSOs
- Standard compensations for interruptions longer than 12 hours to affected end-customers

## Subsidies for renewable energy sources act [1396/2010](#) (in Finnish)

## Energy efficiency services act [1211/2009](#)

- Companies operating in energy markets are obligated to promote efficient and cost-effective energy use in their customers' operation
- Concerns electricity retailers and distributors.
- Billing based on actual consumption at least three times per year
- Report on energy usage annually to customers



# Finnish legislation

Council of state decree on renewable electricity production subsidies [1397/2010](#) (in Finnish)

Council of state decree [65/2009](#) on electricity markets (in Finnish)

- Distribution tariff for energy production in distribution network (maximum average annual tariff 0.07 snt/kWh)

Council of state decree on electricity delivery settlement and measurement ([66/2009](#)) (in Finnish)

- DSOs are responsible for arranging measurements in a way that promotes efficient and cost-effective electricity use and enables utilising the control of electricity usage.
- Measurement services can be done by the DSO or a service provider
- Measurement must be done hourly (and read once a day) and the measuring equipment has to be remotely readable
- The measurement equipment and system must enable remote reading, load control and register interruptions
- Measurement data must be provided to the customers upon request
- 80 % of the meters must be able to meter hourly and be remotely readable by 2013

# Industry regulations Finland



## Finnish Energy Industries: Criteria for security of supply (proposal)

- City: max interruption time 1 hour/a, no short (< 3 min.) interruptions
- Urban areas: max interruption time 3 hours/a, max 10 pc. short interruptions
- Rural areas: max interruption time 6 hours/a, max 60 pc. short interruptions

## Finnish Energy Industries: Recommendation for connecting microgeneration to distribution network, [YA9:09](#)

- Connection fee should not include network reinforcements payments

## Finnish Energy Industries: [Principles for hourly metering](#)

- Guidelines for the implementation of hourly metering
- Aims to harmonise industry practices
- Characteristics of equipment and systems

# Regulation drivers

- EU climate and energy policies expect member countries to develop their networks to be more active
- Efficiency of energy and network resources
- Quality of network service, security of supply
- Customer service
- Policy decisions on opening European electricity markets
- Mitigation of climate change, promoting renewables, environmental concern
- Technical development



# Changes in DSO operation



Open your mind. LUT.  
Lappeenranta University of Technology

- Smart grids are key to reducing carbon emissions, improving energy efficiency. Networks will change during the next 10-20 years by:
  - Facilitating higher penetration of renewable energy generation (intermittent low-carbon generation e.g. wind, solar)
  - Facilitating distributed generation (e.g. small windmill or micro-CHP plants)
  - Facilitating energy storages
  - Helping consumers to participate more effectively
    - in the market by using their energy more efficiently (e.g. through smart metering) and by allowing consumers to act as producers selling back their excess electricity (e.g. CHP or plug-in electrical vehicles)
- Changes will have effect on:
  - Quality requirement
  - Operational cost
  - Network reinforcements
  - Ancillary services
- New operators enter into business
  - Aggregators, small-scale power producers, ...

**DSO regulation regime intergrates policies into electricity distribution business**

# Potential impacts of SG on DSO operation



Open your mind. LUT.  
Lappeenranta University of Technology

- Disadvantages:
  - Increased costs (e.g. network integration costs for DG connections, network upgrading, installation costs)
  - Decreased energy distribution (DER) → decreased revenue
  - Stranded cost
  - Possibility to guarantee service quality
- Benefits:
  - Ancillary services
  - Demand response mechanisms
  - Distribution capacity cost deferral (DER)
  - Reduced losses (DER)
  - DER may increase service quality
  - Smart metering benefits (for customers, DSO, retailer); increased information enables e.g. optimizing existing networks with emerging demand-response technology

# Regulation of DSOs



Open your mind. LUT.  
Lappeenranta University of Technology

- DSOs are natural monopolies and regulated in order to prevent possible misuse of the monopoly position
- Typical regulation methods are price cap or revenue cap frameworks, often ex-ante approaches, revisions typically between 3 and 5 years.
- Rate of return regulation provides a reasonable return on asset base.
- Regulated revenue for DSO generally consist of
  - Return for the regulatory asset base (the network assets)
  - Depreciations
  - Operational expenditure (costs of using the network, losses, cost of ancillary services, operational and maintenance costs)
  - Certain costs can be 'pass through', they are simply reimbursed ex-post.
- Incentive schemes for cost efficiency and quality of service improvements are common

# Regulatory barriers and missing incentives



Open your mind. LUT.  
Lappeenranta University of Technology

- Major challenges are identified (ERGEG 2009):
  - Incentives for innovation
  - Enable DNOs to identify and prioritise SG solutions that can meet the network users' needs
  - Removing barriers for efficient SG
  - sub-optimal rate of return and regulatory instability are hindering investments (Eurelectric 2011).
- Many regulatory regimes encourage cost efficiency targets which can hinder R&D or smart grid pilot projects (Eurelectric 2011).
- Defining the difference between regulated services and competitive services and the roles and responsibilities of different market players.
- Regulatory framework should enable the integration of new services in the network and grid user participation
- Data protection issues
- Regulations for interoperability of technology in order to give equal access to new players in the new market

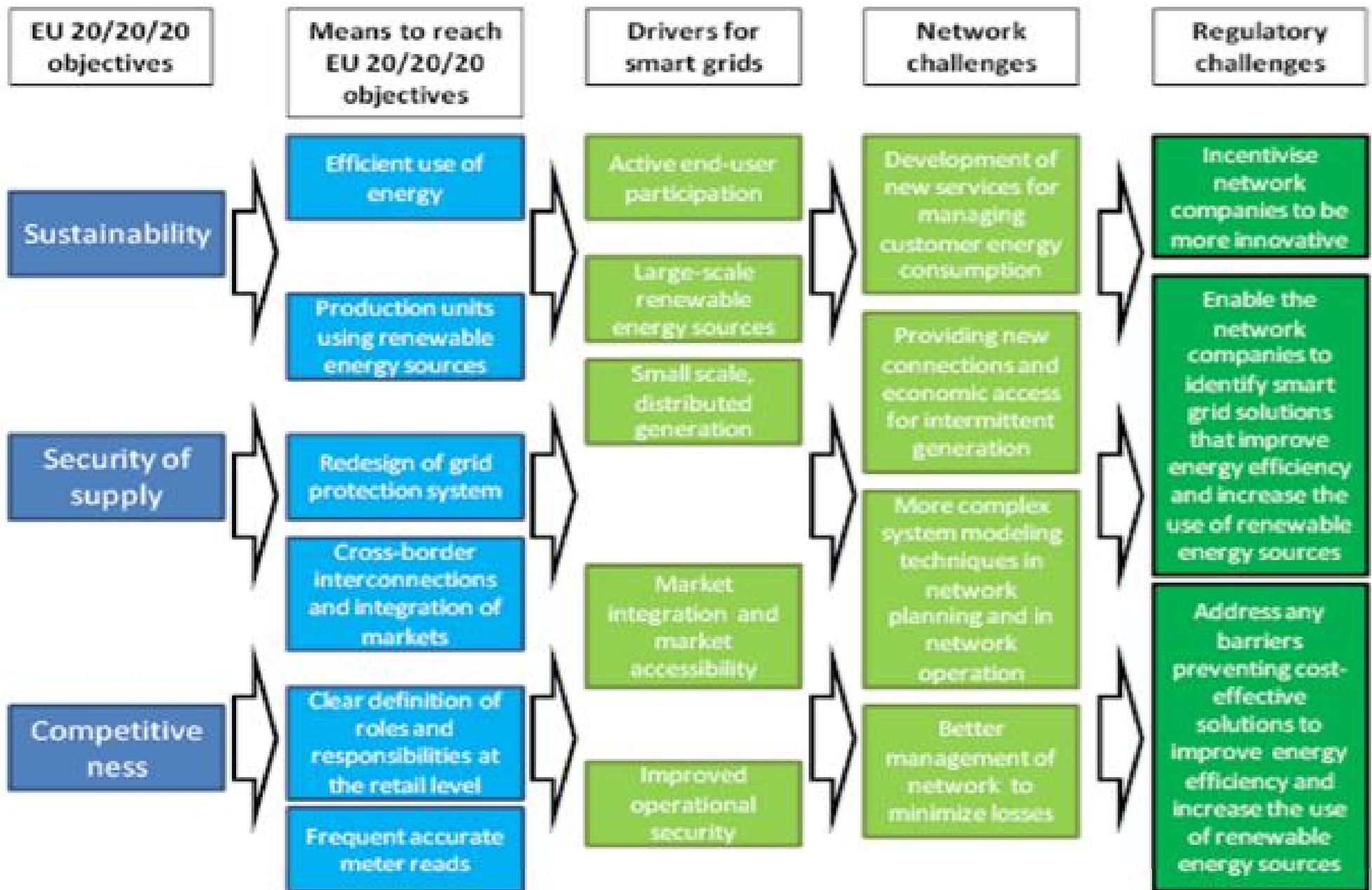


Figure 3-1. Implications of EU's 20/20/20 objectives to electricity distribution network regulation.

# Development needs for economic regulation



Open your mind. LUT.  
Lappeenranta University of Technology

- Cost/benefit analysis should be performed prior to setting any regulations on SG (input information: effects and benefits of SG)
  - Neutralizing the negative impacts of SG for the DSO?
  - Sharing the possible extra cost fairly among the stakeholders of the SG?
- SG needs can be implemented by setting revenue drivers or minimum requirements
- Modifications to tariff structure to signal grid users (e.g. capacity tariff €/kW)

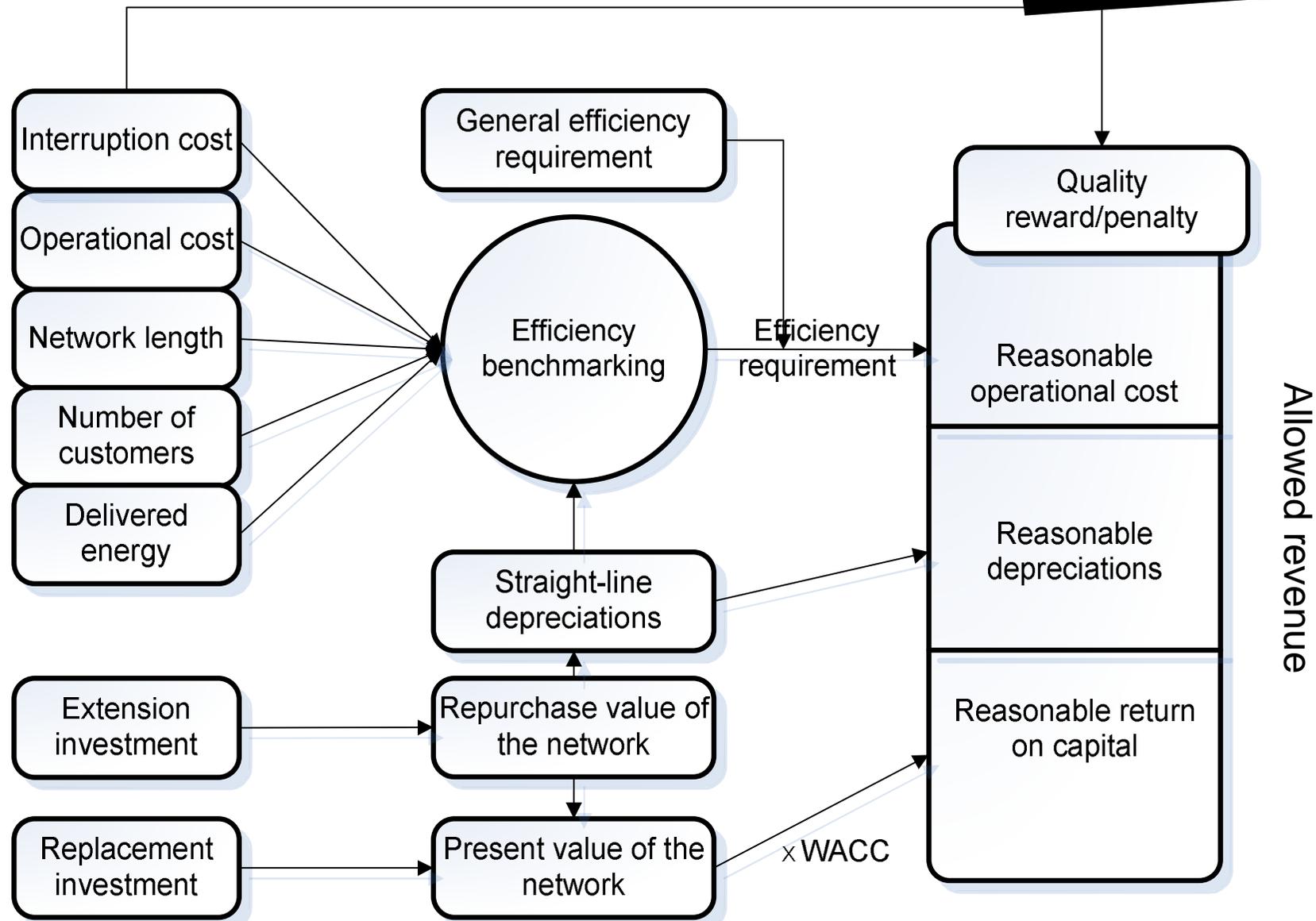
# Economic regulation of the Finnish DSOs



Open your mind. LUT.  
Lappeenranta University of Technology

- Goal: Reasonable end-customer prices and sufficient quality of electricity supply
- Regulation carried out by the Energy Market Authority
- Regulation period 2008–2011; methodology introduced beforehand, decisions on reasonableness of pricing at the end of period.
  - Regulation focuses on reasonableness of rate of return. Rate of return determined for the present value of the network.
  - Regulation sets also reasonable opex and straight-line depreciations
  - Incentives to reduce operating cost and to improve quality of electricity supply.

# Economic regulation of the Finnish DSOs 2008-2011



# Smart grids and regulation in Finland 2008-2011



Open your mind. LUT.  
Lappeenranta University of Technology

- Smart grid investments (including AMR meters) are included in the regulatory asset base on their current replacement value at standard cost defined by the regulator
- Efficiency requirement targeted at operational cost
  - Pilot and R&D cost are under efficiency target
- DSO is responsible for smart meter roll-out
- Recognised development needs for SG in regulation in economic regulation:
  - Increasing opex allowance to account for new responsibilities
  - Acknowledging quality issues caused by DER and DG

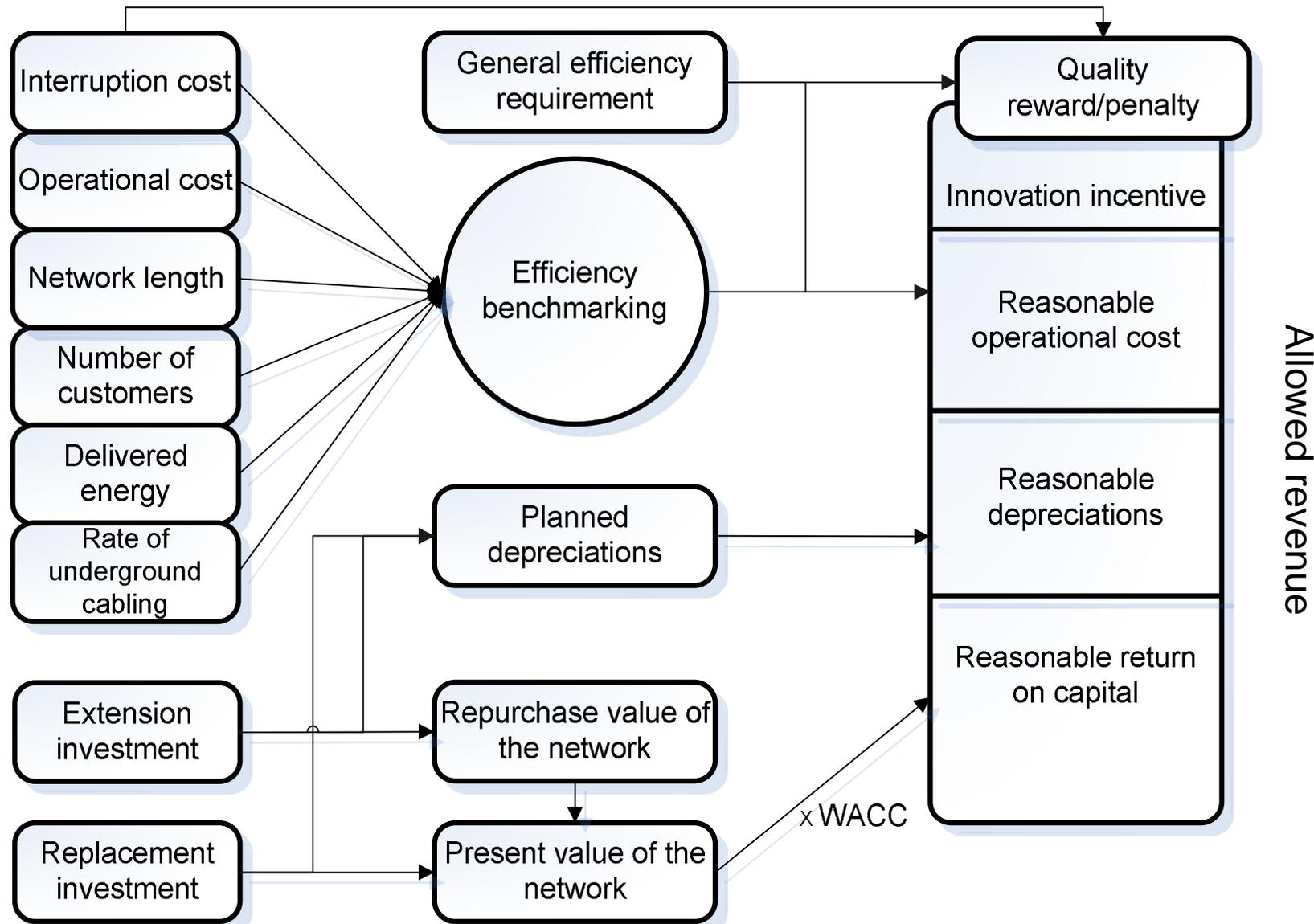
# Proposal for DSO regulation in Finland 2012-2015



Open your mind. LUT.  
Lappeenranta University of Technology

- The role of the quality incentive increased (maximum effect 20 % of the allowed return, before 10 %)
- Innovation incentive:
  - Added operational cost for AMR metering (5 €/meter)
  - R&D costs amounting up to 1 % of the allowed return
- Incentive to reduce operating costs. Opex includes among others:
  - standard compensations for interruptions longer than 12 h,
  - half of the cost of energy losses
- Reasonable depreciations determined as planned depreciations

# Proposal for DSO regulation in Finland 2012-2015



# References



Open your mind. LUT.  
Lappeenranta University of Technology

- Eurelectric. 2011. Regulation for Smart Grids. Available online: [http://www2.eurelectric.org/DocShareNoFrame/Docs/1/DJEPIDCCPHPAALBKHGMKEODAHAYDYDSOY6SCYD1HYO4C/Eurelectric/docs/DLS/eurelectric\\_report\\_on\\_Reg\\_for\\_SG\\_FINAL-2011-030-0131-01-E.pdf](http://www2.eurelectric.org/DocShareNoFrame/Docs/1/DJEPIDCCPHPAALBKHGMKEODAHAYDYDSOY6SCYD1HYO4C/Eurelectric/docs/DLS/eurelectric_report_on_Reg_for_SG_FINAL-2011-030-0131-01-E.pdf)
- ERGEG. 2009. Position Paper on Smart Grids. [http://www.energy-regulators.eu/portal/page/portal/EER\\_HOME/EER\\_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/Smart%20Grids/CD/E09-EQS-30-04\\_SmartGrids\\_10%20Dec%202009.pdf](http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/Smart%20Grids/CD/E09-EQS-30-04_SmartGrids_10%20Dec%202009.pdf)
- Meeus, L., Saguan, M., Glachant, J.-M., Belmans, R. 2010. SMART REGULATION FOR SMART GRIDS. EUI Working Papers RSCAS 2010/45
- de Joode, J., Jansen, J.C., van der Welle, A.J., Scheepers, M.J.J. 2009 Increasing penetration of renewable and distributed electricity generation and the need for different network regulation. Energy Policy 37, 2907–2915.
- Niesten, E. 2010. Network investments and the integration of distributed generation: Regulatory recommendations for the Dutch electricity industry. Energy Policy; 38; 4355–4362.



# Open your mind. LUT.

Lappeenranta **University of Technology**