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Evolution of Smart Grid Regulation

Regulations for Smart Grids
1. EVOLUTION OF ENERGY REGULATION
2. EVOLUTION OF SMART GRIDS
3. EVOLUTION OF SMART GRID REGULATION
4. THE CONTROL LOOP PROBLEM
5. FINAL REMARKS
EVOLUTION OF ENERGY REGULATION - HOW

- COST OF SERVICE
- PRICE CAP
- PERFORMANCE / OUTPUT ORIENTED
EVOLUTION OF SMART GRIDS

- SMART METERING
- PILOT PROJECTS
- LARGE-SCALE

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Evolution of Smart Grid Regulation

PARADIGM SHIFT

CONCENTRATION ELECTRICITY GENERATION

PARTICIPATION ELECTRICITY DEMAND

TODAY

TOMORROW
EVOLUTION OF SMART GRID REGULATION

- general remarks post-Paris Agreement

- the European Union case
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TODAY

PRESENT

TRANSITIONS

T 1
T 2
T 3

(GREEN / SMART) FUTURES

FUT A
FUT B
FUT C

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SEVERAL ALTERNATIVE PATHS MAY LEAD TO LOW CARBON ENERGY SYSTEMS.

DIFFERENT PATHS REQUIRE DIFFERENT ROLES BY NETWORK OPERATORS, TRADITIONAL UNDERTAKINGS, DIFFERENT MARKET AGENTS AND REGULATORS.
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INFORMATION

ELECTRICITY  NATURAL GAS  DISTRICT HEATING  OIL  TRANSPORTATION  WASTE  ...

CO₂
CONSISTENCY IS THE KEY:

- ACROSS SECTORS AND LAYERS
- MARKET DESIGN
- MARKET / OPERATION INTERFACE
- REGULATION
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**POLICIES**
- **≤ 1990**: Monopolies
- **1990s**: Competition in generation
- **2007**: Full competition & EU integration
- **2020**: CO₂ reduction, renewables, en. efficiency
- **2050**: Decarbonization

**MARKETS**
- **No market**
- **1990s**: Wholesale & ancillary markets
- **2007**: Wholesale, ancillary & retail markets
- **2020**: Ad-hoc transition solutions
- **2050**: New Electricity Market

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"reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990 as agreed in October 2009 will require a revolution in energy systems, which must start now."

European Council, February 2011
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RENEWABLE GENERATION AS % TOTAL ELECTRICITY GENERATION

- SMALL-SCALE
- MEDIUM-SCALE
- LARGE-SCALE

% vs. Years

- 0.0
- 10.0
- 20.0
- 30.0
- 40.0
- 50.0
- 60.0
- 70.0
- 80.0
- 90.0

1990 2000 2010 2020 2030 2040 2050
Do not try to fix the “renewables problem” in isolation because the transition towards a low-carbon electricity system requires a holistic approach.
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THE "WHO PAYS" (COST / BENEFIT) PROBLEM

REACTIVE APPROACH

EXISTING SYSTEM COSTS

EXTRA ICT COSTS

WHO WILL PAY?
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THE “WHO PAYS” (COST / BENEFIT) PROBLEM

PRO-ACTIVE APPROACH

- AVOIDABLE COSTS
- EXISTING SYSTEM COSTS
- EXTRA ICT COSTS
- AVOIDED COSTS

Who pays the inefficiencies?

How to transform avoidable into avoided costs?
EXAMPLES OF SMART GRID REGULATION:

- MANDATORY ACTIONS (eg. smart meters roll out)
- ENABLES COST RECOVERY (eg. pilot projects, smart meters)
- ENABLES NEW TRANSACTIONS (eg. aggregation, storage, VPP)
- PROVIDES INCENTIVES (eg. energy efficiency)
- … but not yet “NEW REGULATION”
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MARKET COMPLEXITY

LIBERALIZATION

TRANSITION TOWARDS LOW-CARBON

SYSTEM CONTROL COMPLEXITY
THE CONTROL LOOP PROBLEM
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thanks to ICT full control at any level is possible
IC TECHNOLOGIES INTRODUCE THE CONTROL LOOP PROBLEM

THE CONTROL LOOP PROBLEM:

WHO CONTROLS WHAT AND WHO COORDINATES?
1) **How to ensure control at each level?**

Within each layer, different control policies can be implemented, from a highly centralized approach, more or less replicating at each level the current national master/slave hierarchical structure, down to a fully decentralized structure.

2) **How to define the functional interfaces between layers?**

In order to ensure effective coordination of the whole system it is necessary to exchange information between layers and to establish clear communication and control procedures. Protocols must be implemented both for normal and for abnormal operational conditions.

3) **Who is the “controller of the controllers” and “controller of last resort”?**
FINAL REMARKS

- who leads the energy transition?

- which regulation?
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- government
- market agents

energy mix

- regulators
- academics

regulation

- TSO
- DSO
- regulators
- EC

system operation

- market agents
- government
- regulators
- new comers (ICT)

- government
- market agents

market

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WHICH REGULATION?

OLD REGULATION

REGULATION FOR TRANSITION
TRANSIENT REGULATION

NEW REGULATION

TODAY

TRANSITION

LOW CARBON FUTURE
“THANK YOU”