

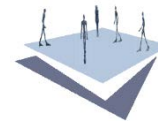
Governance of smart grids

Accelerating the implementation of smart grid technologies

Imke Lammers/Maarten Arentsen

University of Twente, The Netherlands

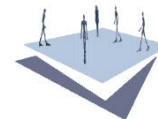
University of Twente



UNIVERSITY OF TWENTE. 

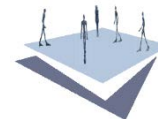
Governance

- governance refers to ordering of actors, their decisions, activities and interactions in specific societal domains.



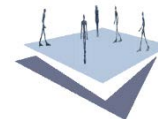
Problems smart grid from a governance perspective

- Emerging phenomenon, no consolidated understanding
- No clear location/positioning in the energy system
- Emerging and diversified types of technologies
- Too many stakeholders in certain settings
- Long and inefficient decision making



Ideal model as benchmark for improvement decision making

- Analogy engineering sciences
 - Problem
 - modelling logical optimal solution with mathematics
 - Design, test and scale technology
- Social world is not only ruled by logic of problem solving
 - Use ideal “model” as benchmark to improve decision making

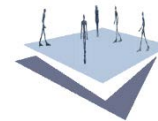


Emerging phenomenon

Flow	Direction	Media
Electrons	Bidirectional between producer and producer/end user and between producer/end user and neighbors	Production, grid and control technology, end-user devices and decisions
Information	Bidirectional between grid operator/producer and producer/end user and between producer/end user and neighbor	Technology and agency
Money	Bidirectional between producer and producer/end user and between producer/end user and neighbor	Agency
Rights	Conditional end user right of electricity supply, real-time control of end-user appliances under the agreed conditions Peer-to-peer electricity supply.	Multiple negotiated contracts End user – supplier End user – system operator End user/peer - peer

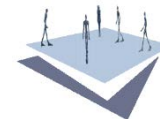
Sm
sen
res
con
pro
eco
Sour

e
oth

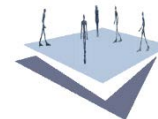
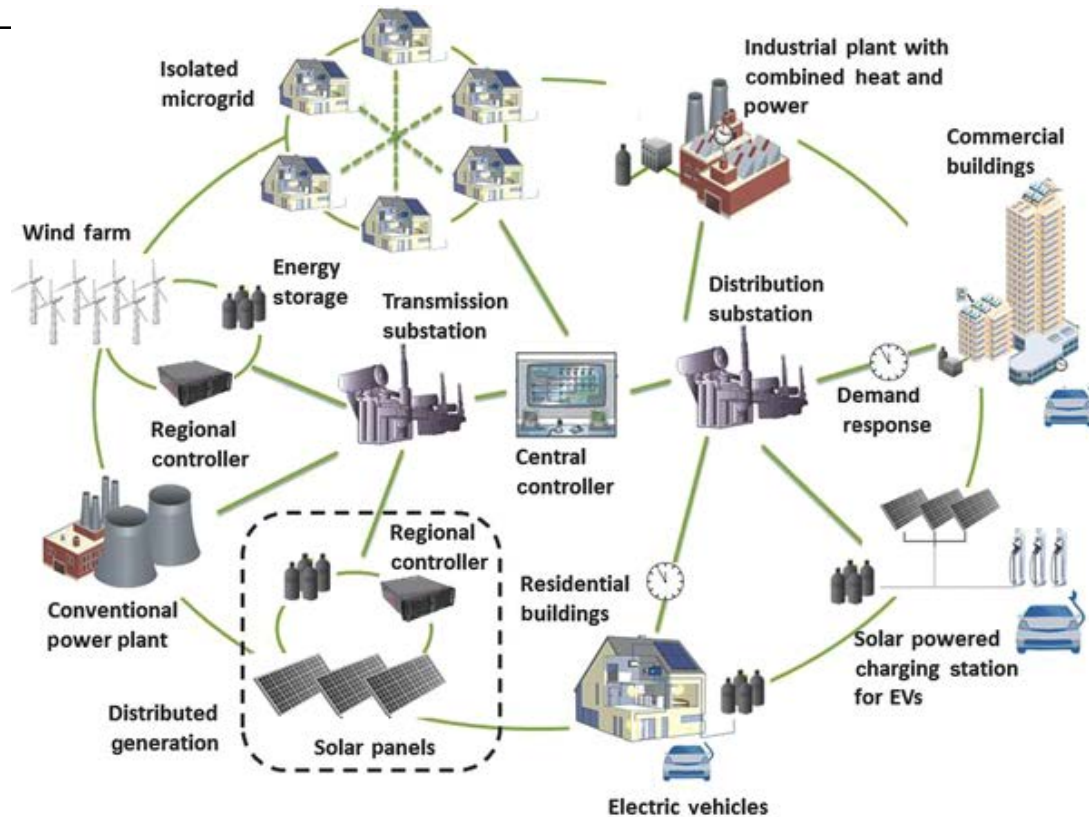


NED1 Power Matching City II

Project Application	NED1	NED2
Smart Network Management	●	
Smart Metering		
Integration of DER		●
Smart Customer/Home	⊗	⊗
Integration of Large Scale RES		
Aggregation		
EV and V2G Applications		
Contribution to Policy Goal		
Peak Load Reduction	✓	✓
Energy Saving	✓	✓
CO2 Reduction	✓	✓
Electricity Loss Reduction		
Reliability Improvement	✓	✓
Increased Consumer Participation	✓	✓
Additional Demand Side Management		
Additional DER		
Additional RES		
Transfer Capacity Btw DSO and TSO		
Interconnection Capacity		



Lack of positioning



Too many stakeholders

Stakeholder	Main SmartGrids system needs and roles
Consumers Copy	Consumption of energy products and services. This is the end-user of electricity. Categories of consumers are residentials, households, and communities. As consumers we also consider SMEs, industries and electricity-intensive industries. A specific example of a consumer category is the set of users with specialized mobility requirements for hybrid or pure electric vehicles. These users need mobility interfaces with quality and security of supply of the electricity system.
Prosumers	Consumers with the additional role of self-provided (owned) electricity generation and/or storage for private, daily life needs, comfort and SME business needs.
Energy Retailers	Selling energy and other (related) services and products to consumers. Retailers will develop consumer oriented programmes and offerings.
Aggregators	Broking energy on behalf of a group or groups of prosumers
Energy Service Companies (ESCOs)	Provision of a broad range of comprehensive energy solutions, including designs and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply and risk management.
Electric Appliance users	The use of electrical appliances at consumer sites for daily life and business needs will increase due to substitution of (fossil based) space heating requirements. The users will be required to interface their needs with quality and security of supply needs of the electricity system.
Electric Vehicle users	A hybrid or pure electric vehicle is a specialized electricity consumer with mobility requirements. The users will be required to interface mobility needs with quality and security of supply needs of the electricity system.
Generators	Large scale centralized generation including wind farms.
Distributed Generators	Small- and medium-scale generation of mainly renewable based electricity either for third party consumers or for own consumption.
Storage Providers	Delivery of storage products and services, including their maintenance and operation thereby shifting electricity and energy consumption in time either for third parties or own purposes.

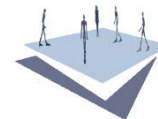
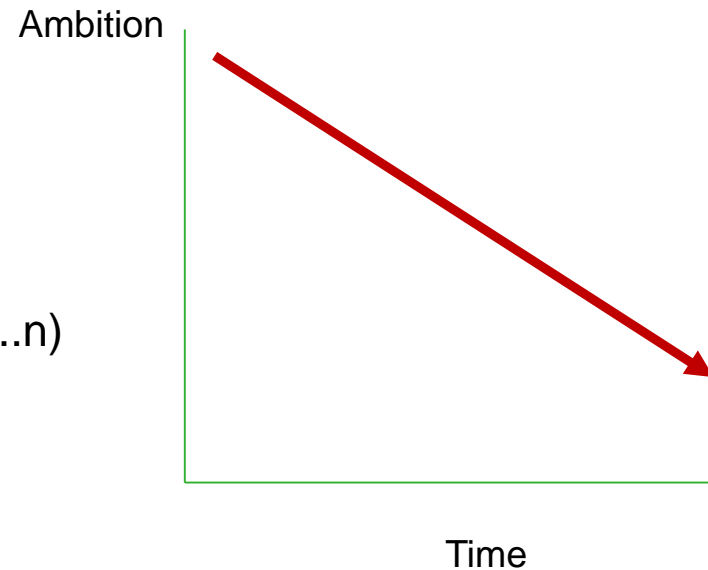
Copy

Ancillary Service Providers	Provision of services such as Power Balancing, Voltage Profile Support, Frequency and Time and Blackstart
ICT equipment and systems providers	Sales of Information and Communication Technology (ICT System) products and services.
Telecommunications providers	Provision of telecommunication services, based on dedicated or public infrastructure
Data processing service providers	Provision of data processing services respecting consumer privacy
Energy Equipment & Systems Manufacturers	Sales of Electro-technology (System) products and services.
Distribution System Operators (DSOs)	Provision of services for secure, efficient and sustainable operation of electricity distribution systems. Legal obligation of a high quality, secure planning, operation and maintenance of the distribution grid.
Transmission System Operators (TSOs)	Provision of services for a secure, efficient and sustainable operation of transmission system. Legal obligation of a high quality, secure planning, operation and maintenance of the transmission grid.
Wholesale Electricity Market Traders	Provision of market based prices for products and services by liquid electricity markets.
Policy makers, Regulators	Setup and control of natural monopoly requirements and for highly effective electricity markets.
Electricity Market Operators	Operators of market places for energy and other energy products and services

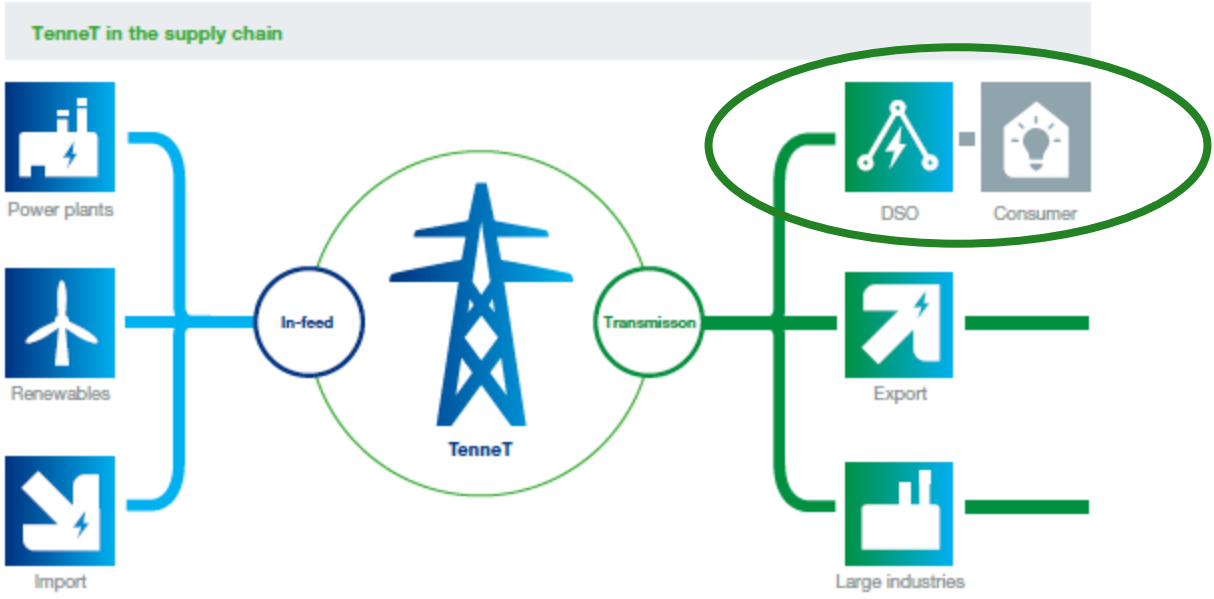


Inefficient decision making: example residential planning NL

- Broad invitation to stakeholders
- Brainstorm options
- Scenario's
- Adjustment idea and ambition (1.....n)
- Feasibility studies/cost calculations
- Searching for money
- Political decision making (1.....n)
- Formal procedures/objections
- Investments
- Implementation



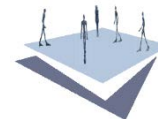
Step 1: Setting: Residential energy planning



Medium and low parts of the grid
End consumer appliances

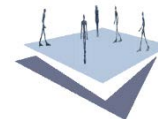
Step 2: Starting with the right questions in the right order

1. Who is the owner of the problem?
2. Who is going to pay?
3. What is the budget?
4. What technology can we buy that is currently on the market?
5. Who should be involved?
 - Legal perspective (responsibility and obligations)
 - Technological perspective (technical realization)
 - Financial perspective (arrangements with financial institutions)
 - Societal perspective (acceptance)



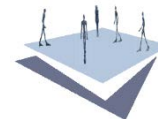
Step 3: Architecture decision making process

- Set of participants
 - The positions
 - The set of allowable actions
 - The potential outcomes
 - The level of control over choice
 - The information available
 - The costs and benefits of actions and outcomes
- Who
 - Boundary rule: who participates
 - Position rule: establish positions
 - How
 - Authority rule: actions assigned to positions and participants
 - Aggregation rule: level of control exercised in a position
 - Information rule: information processing and how its influences knowledge-contingencies
 - What
 - Payoff rule: division of costs and benefits of outcomes
 - Scope rule: potential outcomes that can be delimited



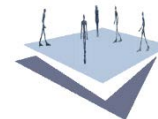
Arrangement for design and implementing smart grid technologies

1. Who is the owner of the problem?
 2. Who is going to pay?
 3. What is the budget?
 4. What technology can we buy that is currently on the market?
 5. Who should be involved?
 - Legal perspective (responsibility and obligations)
 - Technological perspective (technical realization)
 - Financial perspective (arrangements with financial institutions)
 - Societal perspective (acceptance)
- Who
 - Boundary rule: who participates
 - Position rule: establish positions
 - How
 - Authority rule: actions assigned to positions and participants
 - Aggregation rule: level of control exercised in a position
 - Information rule: information processing and how its influences knowledge-contingencies
 - What
 - Payoff rule: division of costs and benefits of outcomes
 - Scope rule: potential outcomes that can be delimited



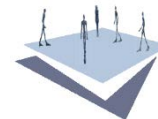
Step 4: Design of the smart grid: content wise

- Technology and system integration
- Organisation and management
- Finance and business model
- User profiles and training
- Monitoring and maintenance



Step 5: Implementation

- Democracy: Political legitimation
- Legal obligations: license to operate
- User training
- Implementation, testing and approving technology
- User feedback and improvement



Step 6 Operation

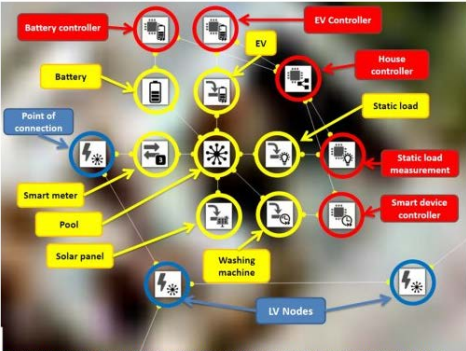


Figure 1: Various elements indicating the appliances in a house and their controllers.

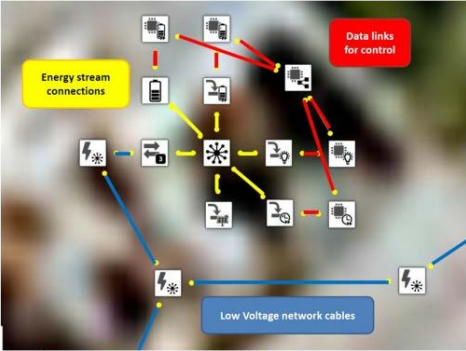
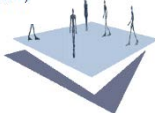
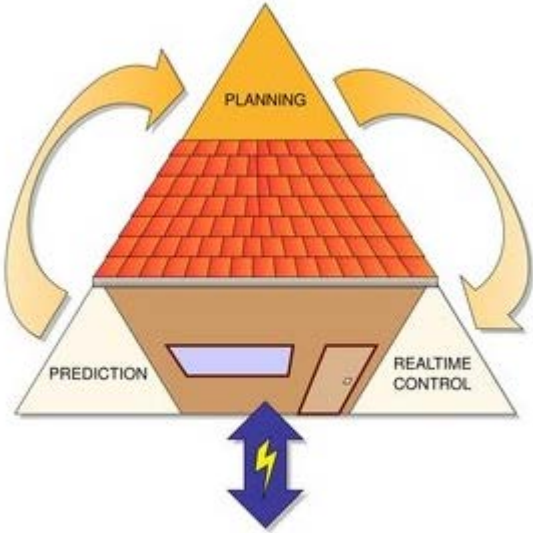


Figure 2: The various connections made in and between houses.



Figure 3: An overview of the model of a neighbourhood in Lochem, both with (bottom) and without (top) an overlaid map.



Conclusion: Benchmark

- Broad invitation to stakeholders
 - Brainstorm options
 - Scenario's
 - Adjustment (1.....n)
 - Feasibility studies/cost calculations
 - Searching for money
 - Political decision making (1.....n)
 - Formal procedures/objections
 - Investments
 - Implementation
- Step 1: Decide setting
 - Step 2: Ask right questions
 - Step 3: Architecture decision making
 - Step 4: Design smart grid
 - Step 5: Implement design
 - Step 6: Operate

