Thema: KIVI – Smart Grids and Smart Homes, March 17, 2016

12.30 - 13.30 uur Registration and Welcome coffee

13.30 - 13.45 uur Welcome and Introduction by Wolter Lemstra TUDelft
Dept. Technology, Policy and Management, and CMI, Aalborg University

13.45 - 14.15 uur Opening keynote by Erik ten Elshof, Ministry of Economic Affairs,
Member of the Management Team of the department Energy and Innovation

14.15 - 14.45 uur Smart Grids by Prof. Dr. Ir. Han Slootweg TU Eindhoven,
Dept. Electrical Engineering and Enexis

14.45 - 15.15 uur Coffee/Tea Break

15.15 - 15.45 uur Smart Home by Drs. Paul Hermans, AurumEurope, EnWire and TU Delft,
Dept. Technology, Policy and Management

15.45 - 16.30 uur Panel discussion faciltated by Wolter Lemstra with panel members
16.30 - 16.40 uur Concluding remarks and next steps

16.40 - 18.00 uur Networking event in the PUB hosted by KIVI-Electrotechniek,
Location Dept. Electrical Engineering, Mathematics and Informatics, Mekelweg 4, Delft

KIVI Engineering Society

TU Delft

Smart Grids & Smart Homes
- where the twain will meet -

KIVI-E and ETV
2016-03-17

17 maart 2016

KIVI Engineering Society

Delft University of Technology

Agenda

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KIVI Engineering Society

TUDelft

Personal introduction

Industry Experience:
- Philips Telecommunications
- AT&T
- Lucent Technologies
  - VP Strategy & Business Development, EMEA

“The role of DSOs in a Smart Grid environment”

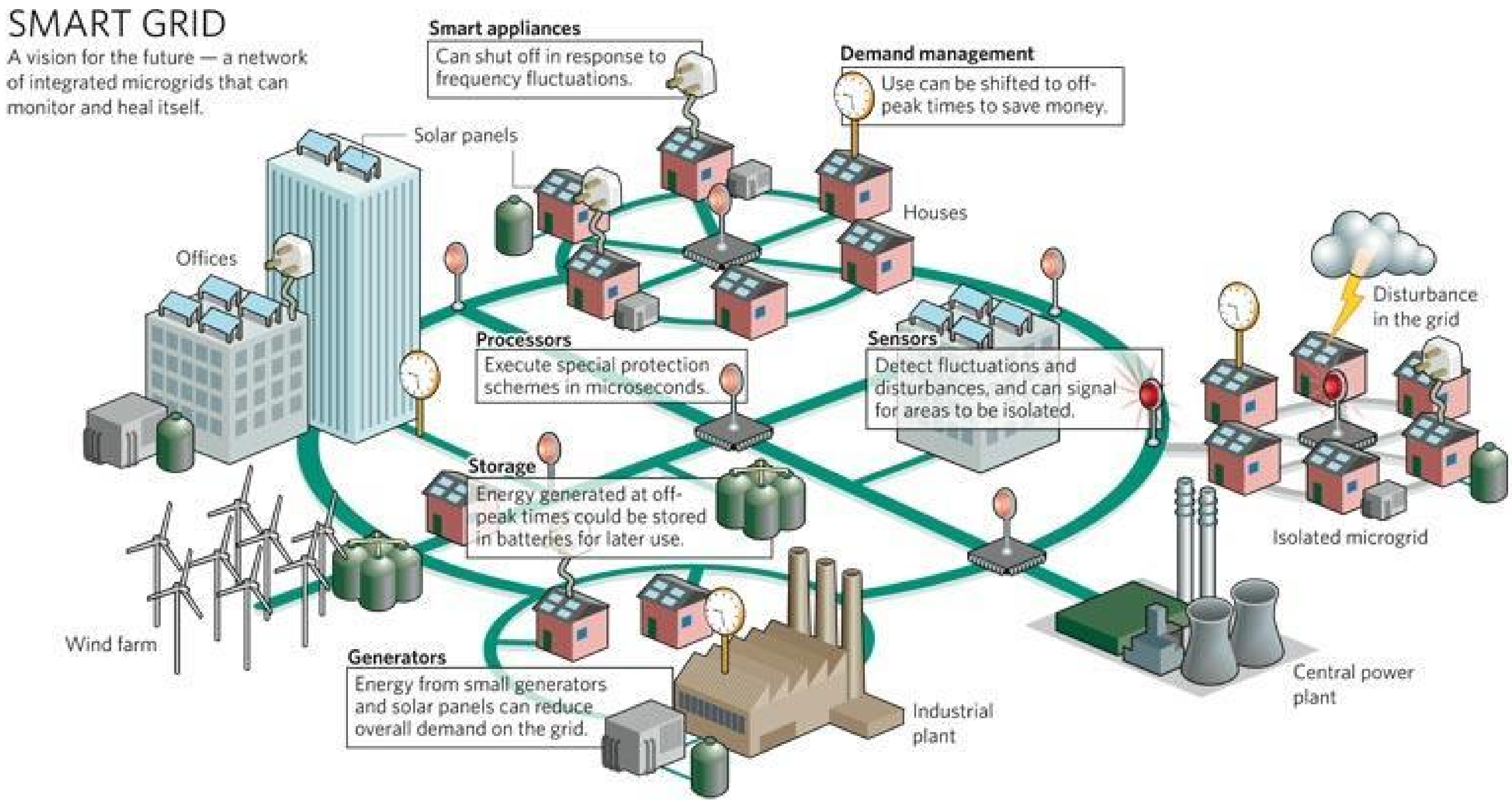
Client: European Commission, DG ENER

Final report

Amsterdam/Rotterdam, 23 April 2014

Education:
- TUDelft EE - Telecom
- TUDelft TPM - Telecom
  - Economics of Infrastructures
  - Domains: Energy – Electricity, Gas, Oil
    Telecommunications; Water; Transport

One integrated network – self healing?



KIVI Engineering Society

TU Delft

Producer

Grids

Smart

€ €

Cloud

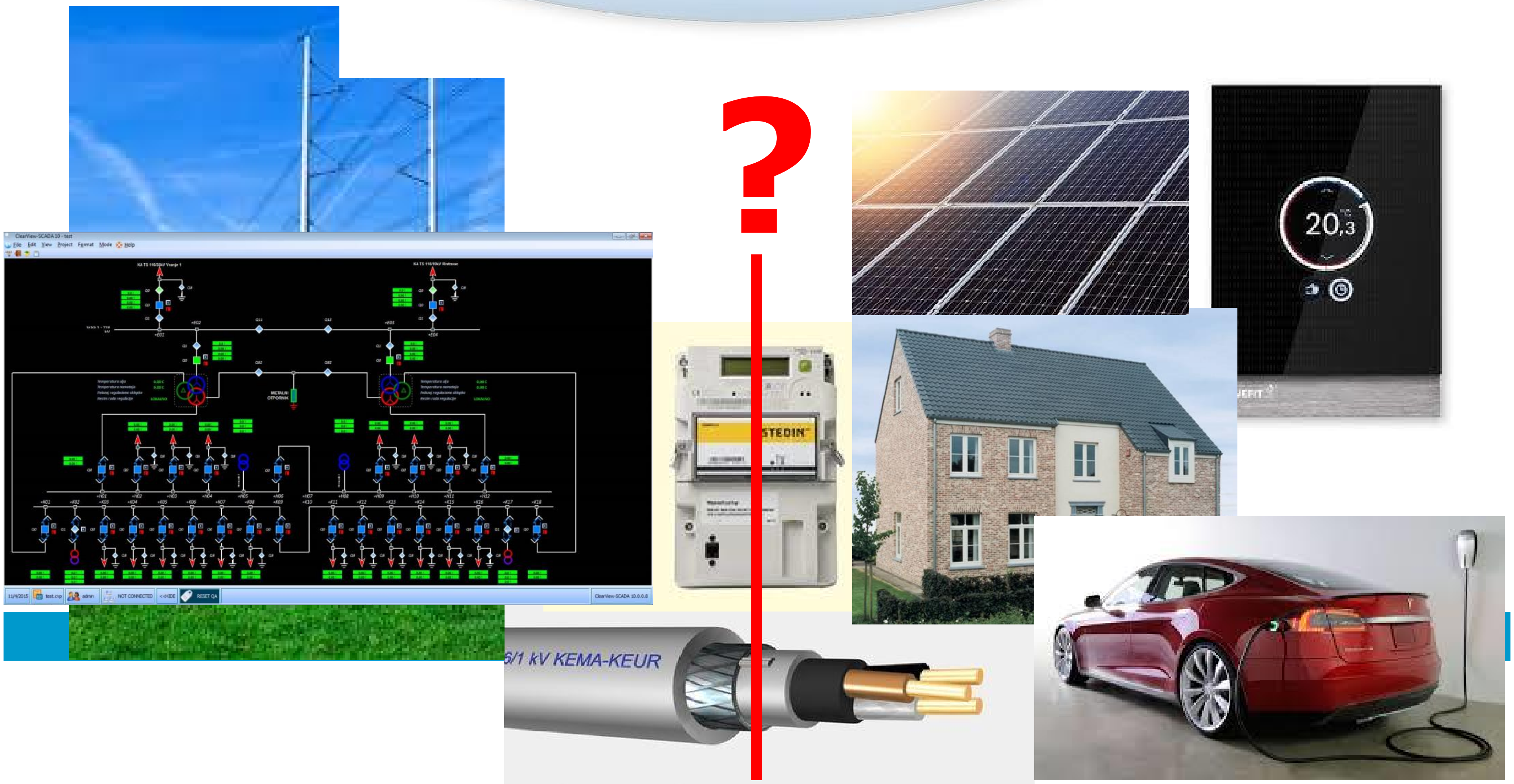
~

Prosumer

Consumer

Homes

Smart



Smart Grids

Market: Emergent/Design?

Cloud

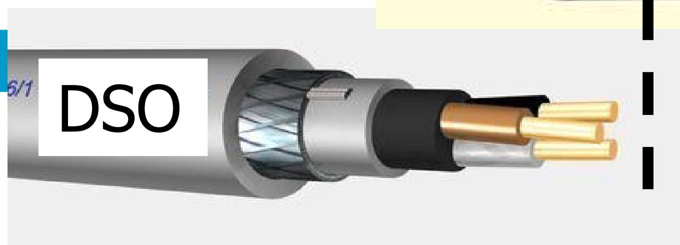
Tariffs => ACM

Smart Quarter/City

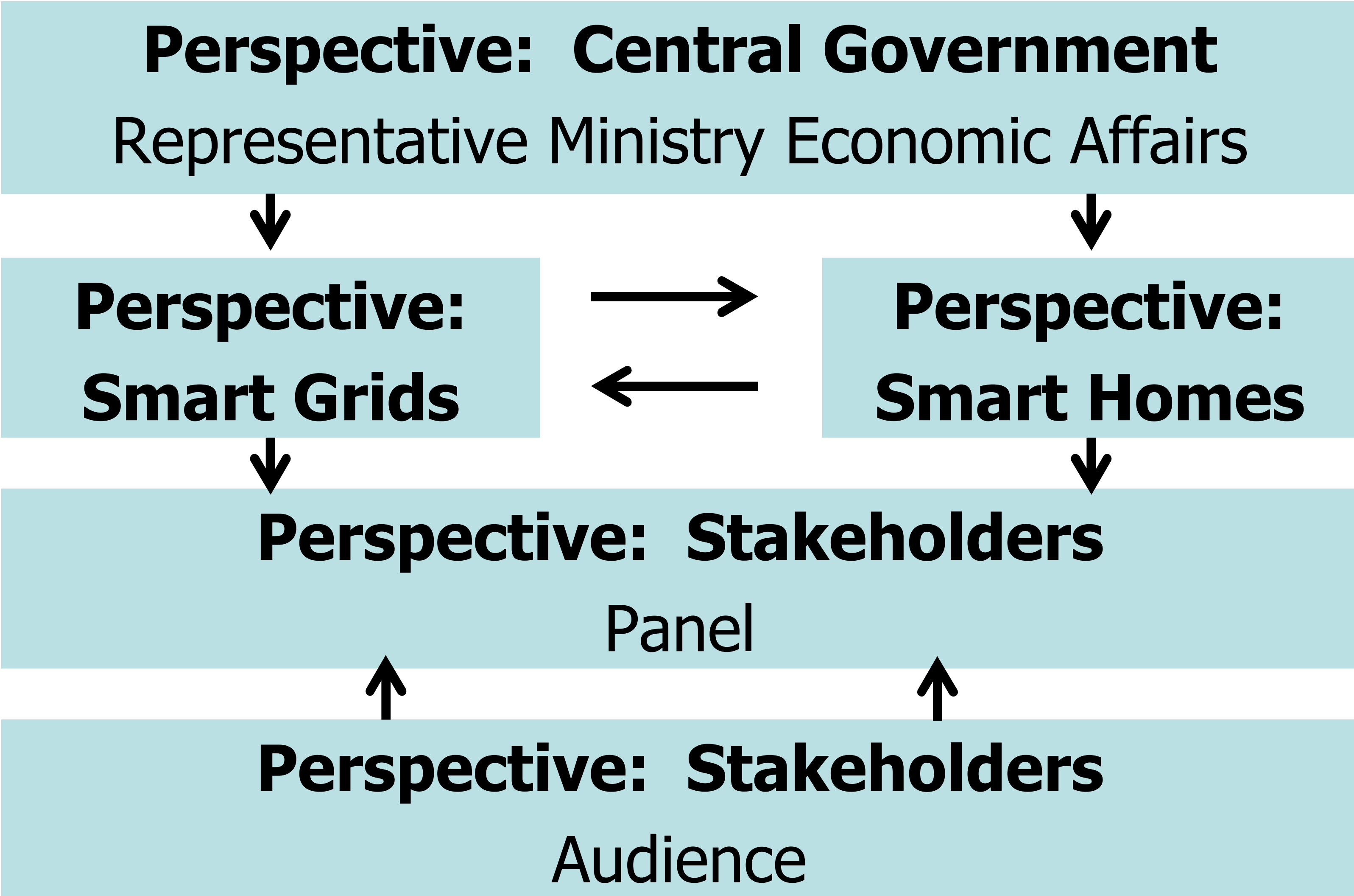
Contracts

Contracts?

Contracts



Contracts


Perspective: Central Government
Representative Ministry Economic Affairs
Perspective: Smart Grids
Perspective: Smart Homes
Perspective: Stakeholders
Panel
Perspective: Stakeholders
Audience

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Ministry of Economic Affairs

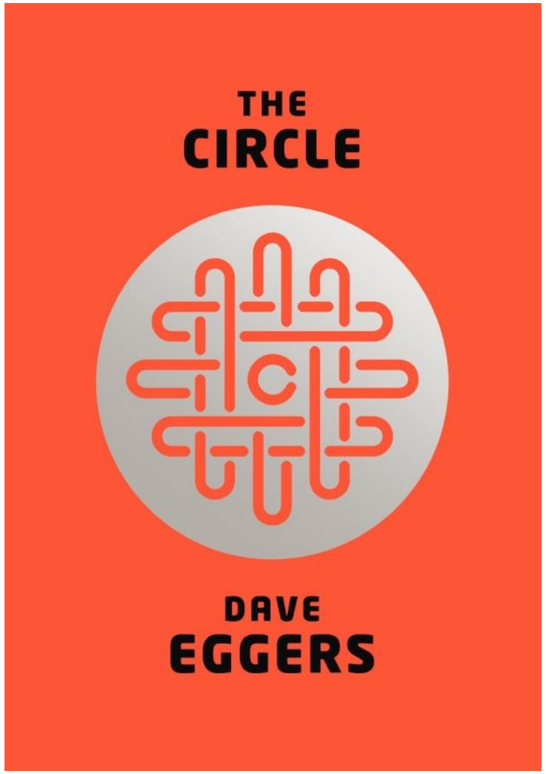
Smart grids & Smart homes

The (energy) policy context

Erik ten Elshof
Energy Markets & Innovation

KIVI symposium
17 March 2016


MARC ELSBERG
BLACK
OUT
MORGEN IS HET TE LAAT...
THRILLER

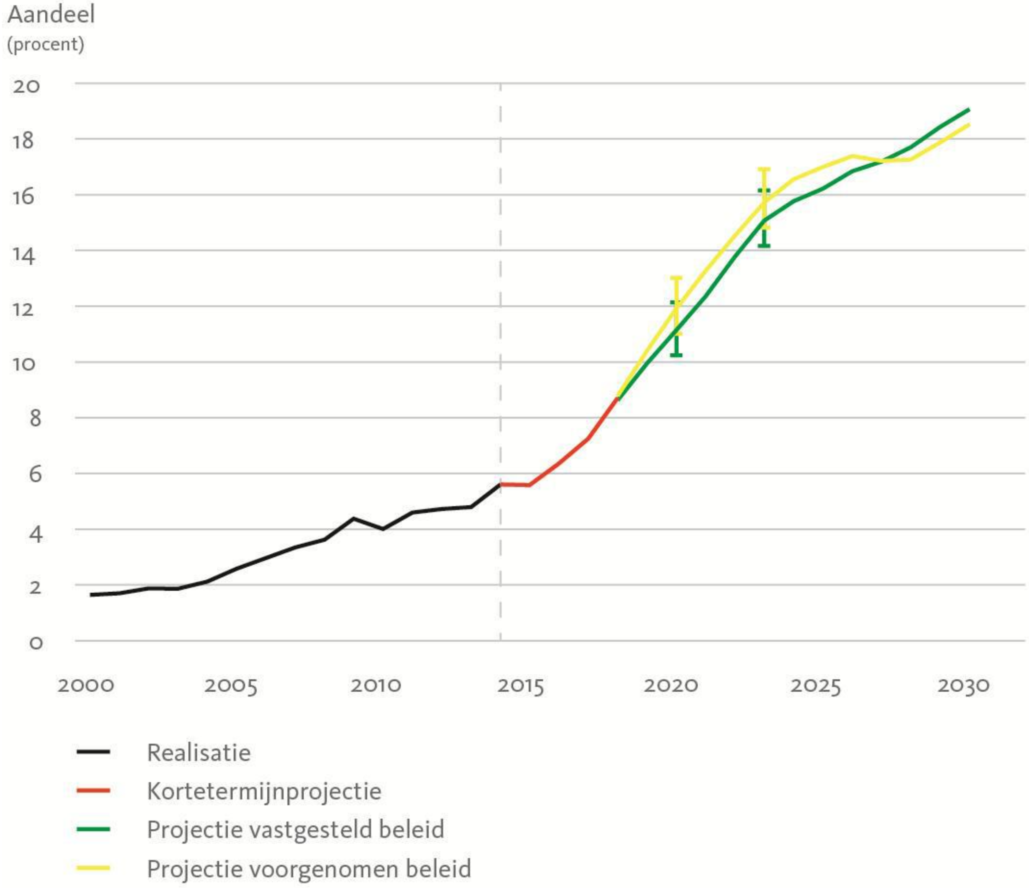

THE
CIRCLE
DAVE
EGGERS


Ministerie van Economische Zaken
Energierapport
Transitie naar duurzaam

Energy Agreement 2013:
setting the transition in motion

Results

Rapid deployment of renewables up to 2023



Bron: ECN, PBL, CBS en RVO, 2015

Energy Report 2016: long term vision

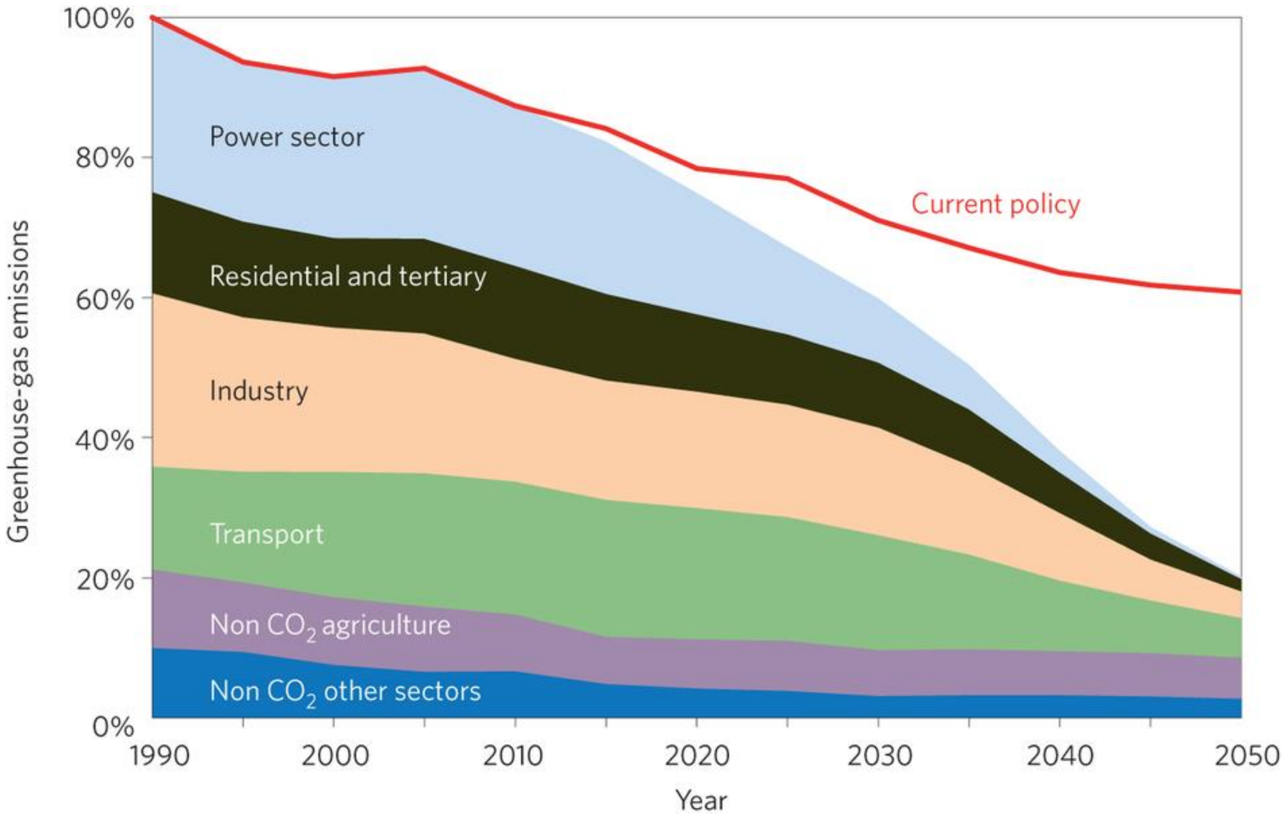
Towards a low-carbon economy that is safe, reliable and affordable

1. Focus on reducing CO_2

- European and international policy
- Firm target but adaptable policies
- Keeping all abatement options on the table

EC Roadmap for moving to a low carbon economy in 2050

EU GHG emissions towards an 80% domestic reduction compared to 1990



2. Innovation and economic opportunities

- New markets for businesses
- Strengthening structure of Dutch economy
- Healthy climate for entrepreneurship and innovation
- International cooperation

3. Energy as part of public space

- Transition affects landscape and spatial planning
- Early involvement of all stakeholders
- Clear roles on all levels

The choices we make

Å Single target of CO_2 reduction; adaptable policy alternatives and giving direction to private investment

Å No new coal power plants

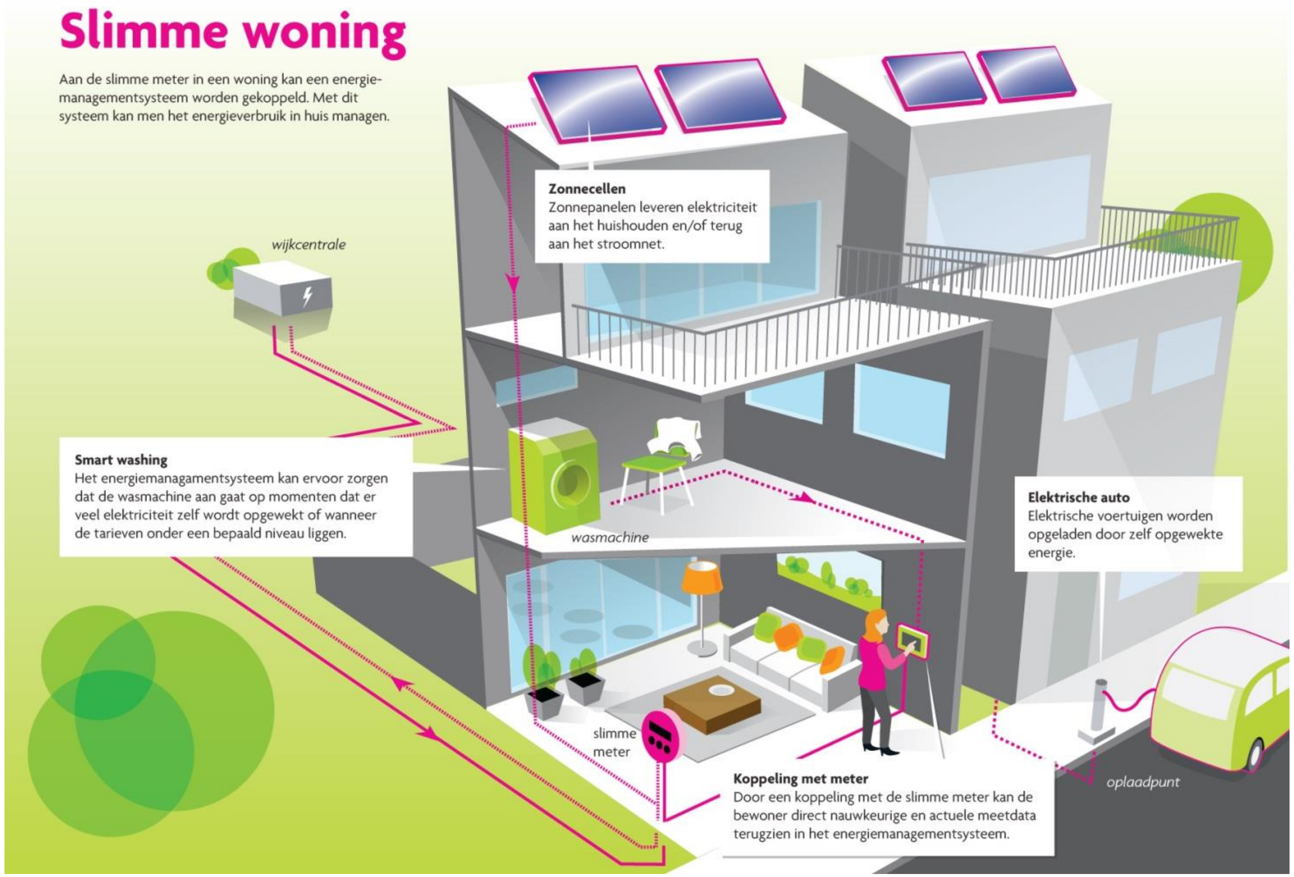
Å Use gas only where alternatives are scarce; reduce use of gas in low temperature heating

Å In the end no room for companies that are not willing to contribute to the needed change

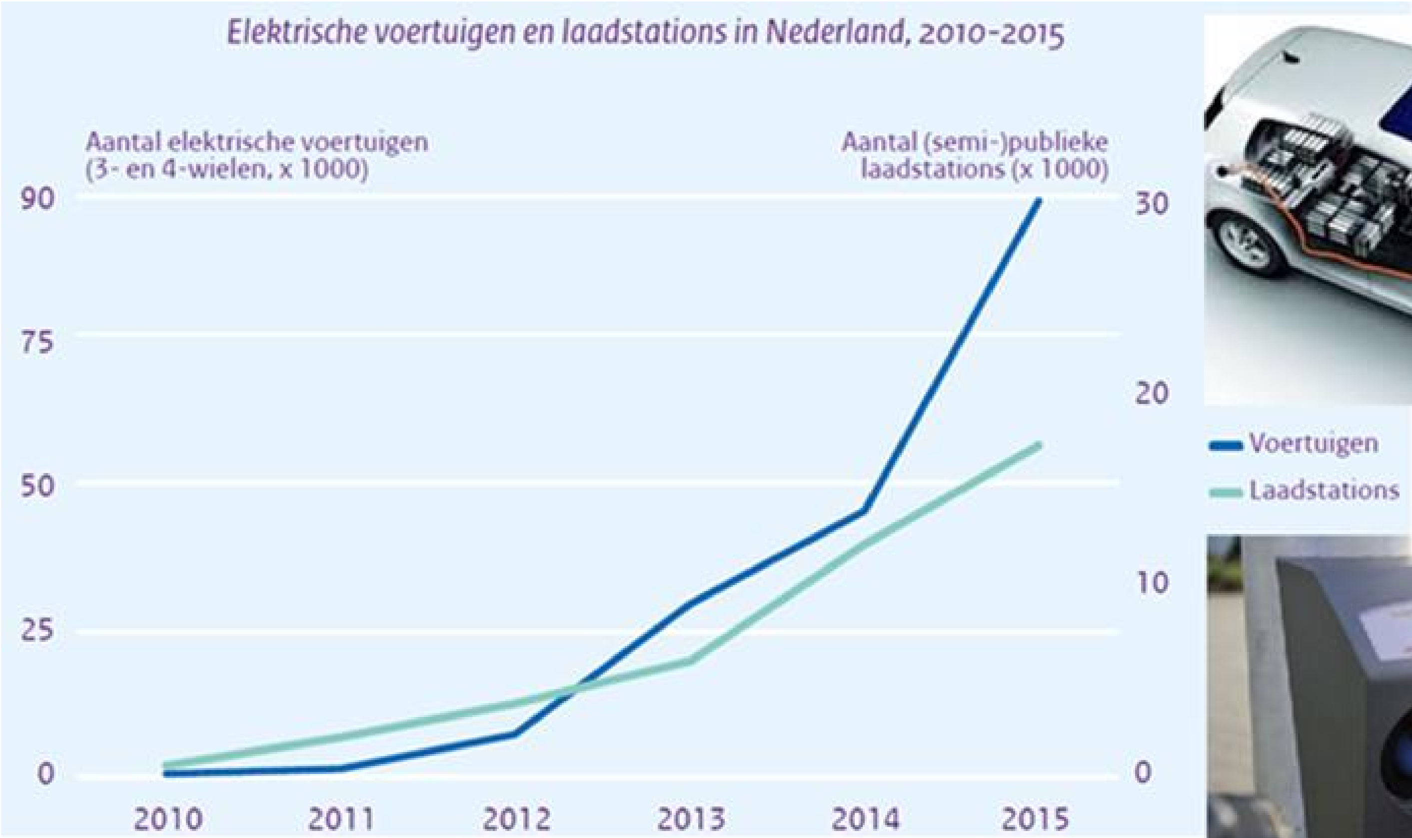
Å Local decision making on solutions for heating

Spatial heating: transition is already happening!

Electricity system: transition is already happening!



Transportation: transition is already happening!

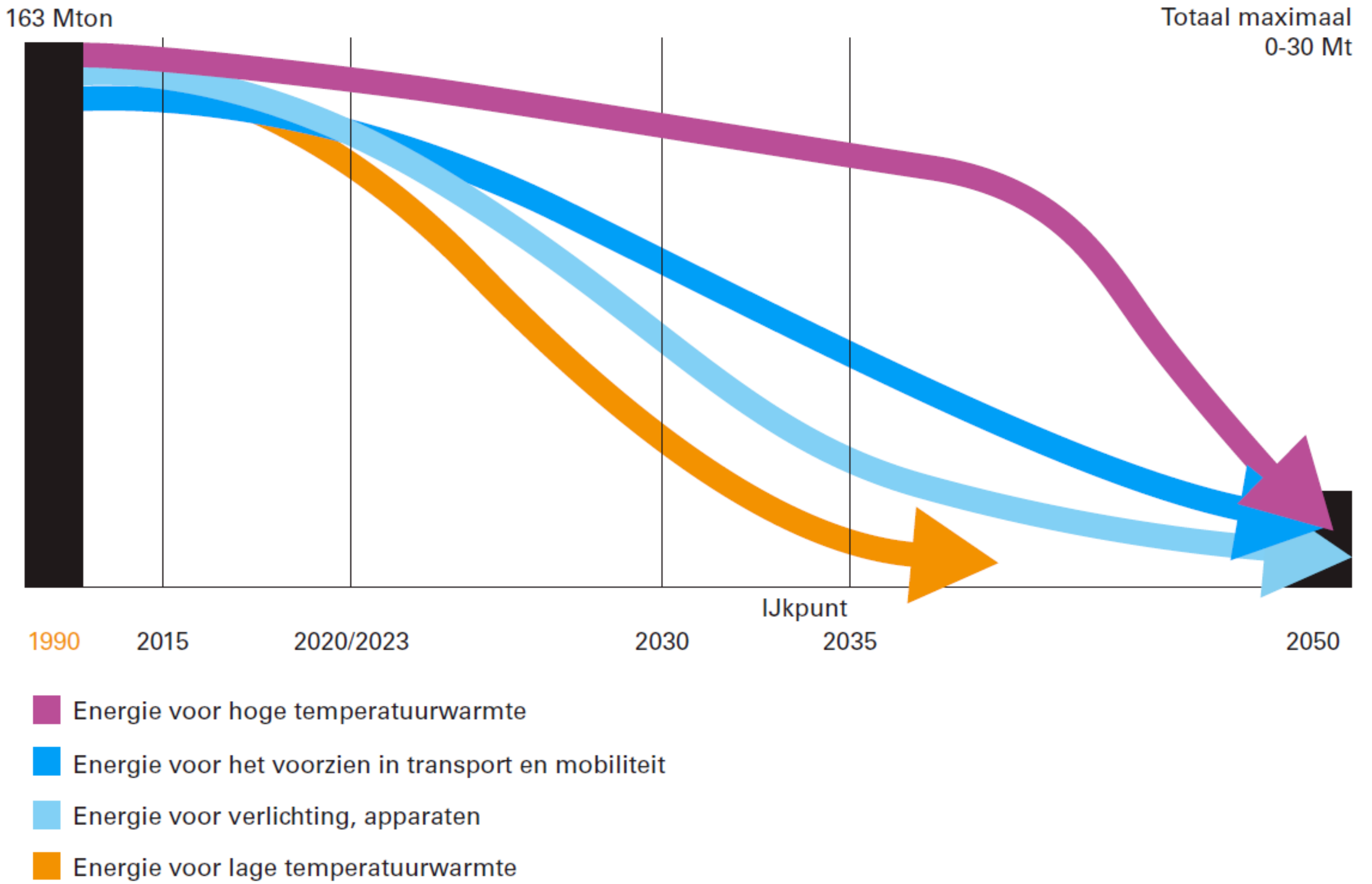


Industrial heating: transition is already happening!

Tata Steel

Empyro

Different transition speed for each function



Bron: RLI, 2015

THINK

GLOBAL,

ACT LOCAL.

AND ACT

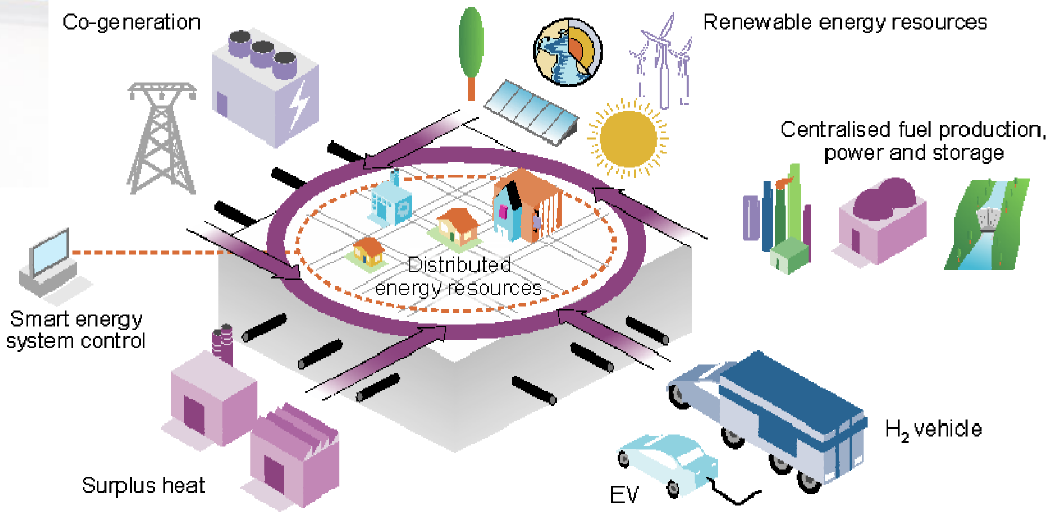
GLOBAL

TOO.

The trek to the cities

Accelerating Technology Development

Connectivity and Networking



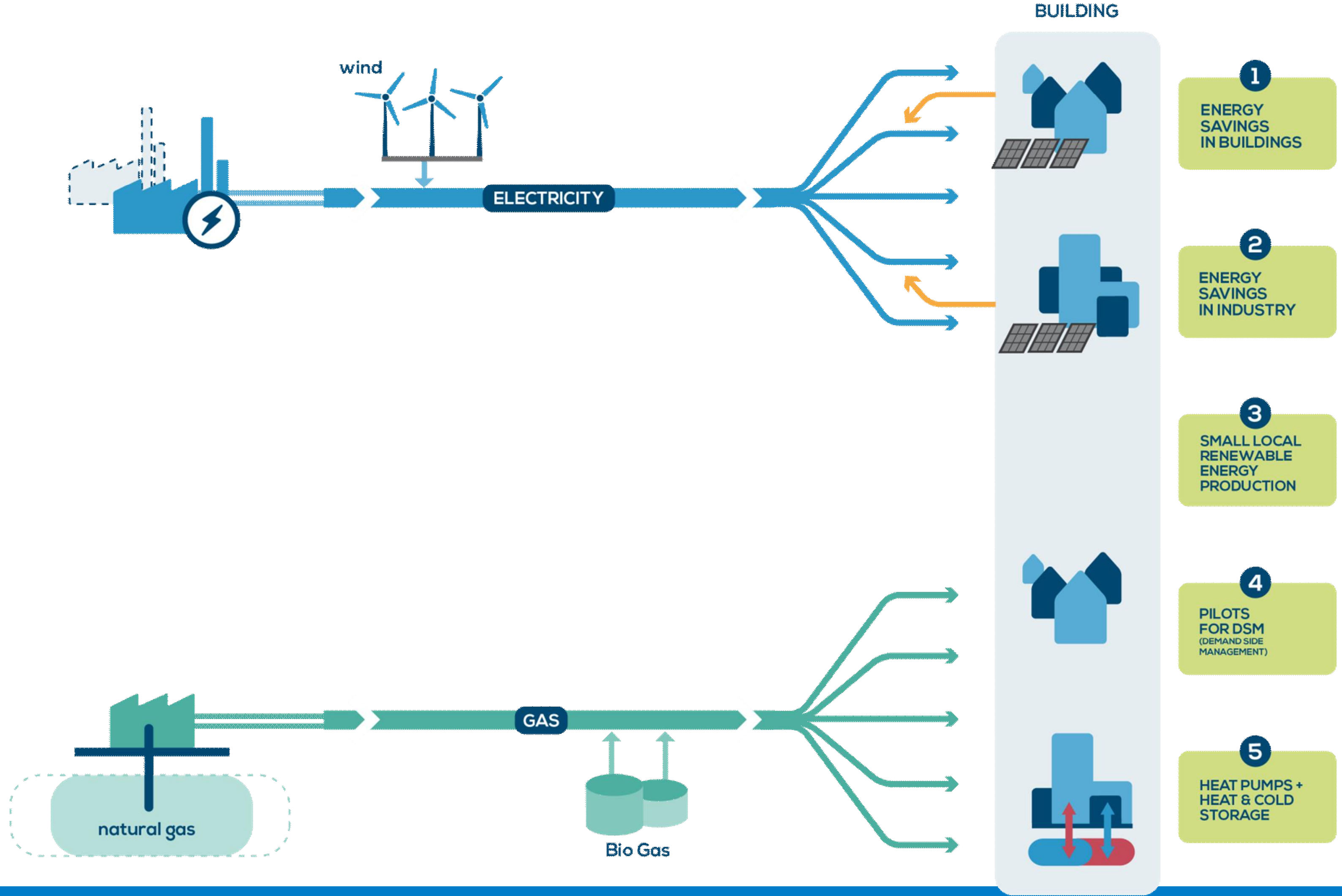
Scaling up smart grids

2016

TOPSECTOR ENERGIE
Empowering the new economy

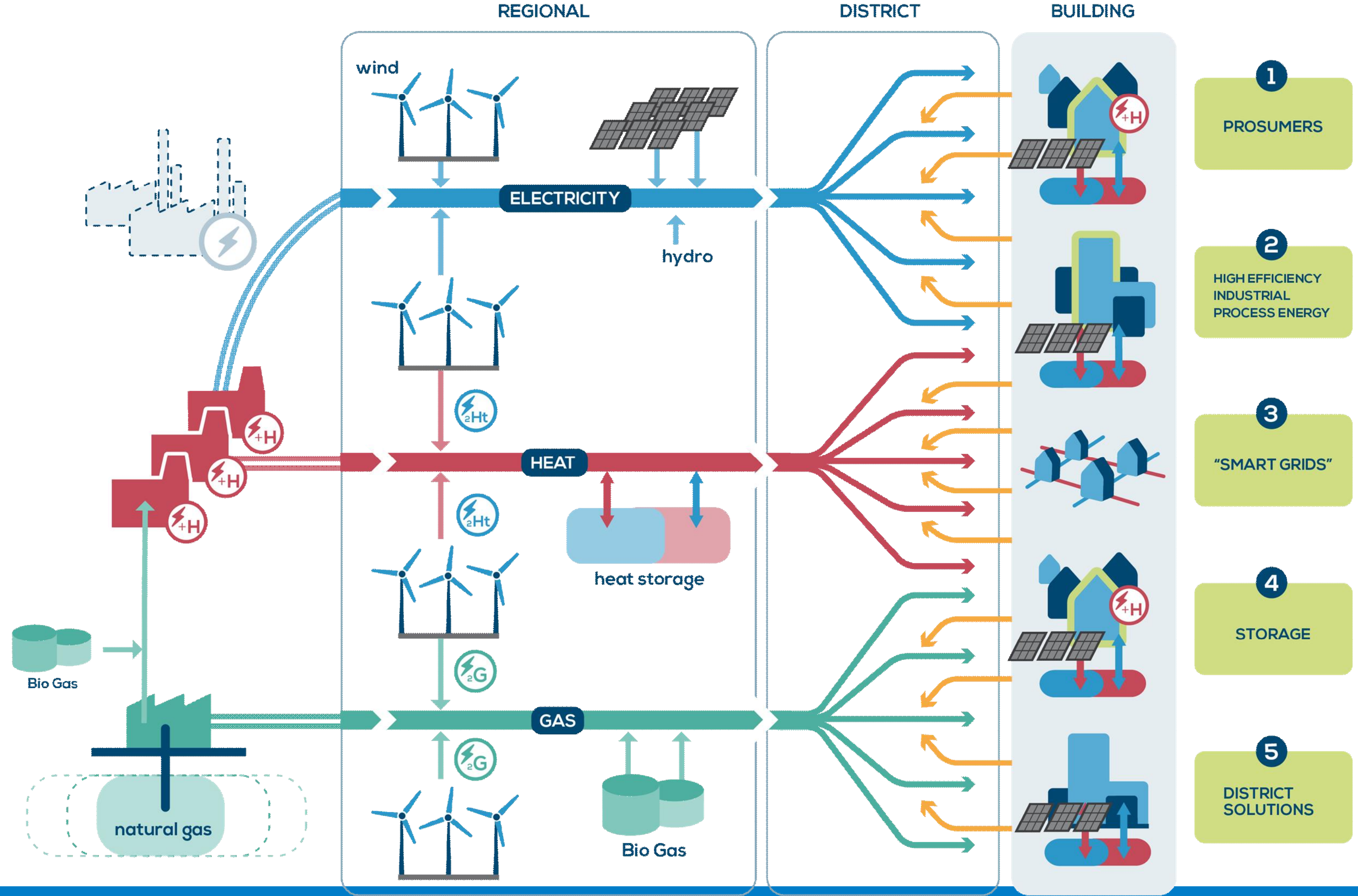
The way our energy supply is organised é

Centralisation today



The way our energy system is organised é

Glocalisation in future



Follow up: the Energy Dialogue

- From vision to actions: April – June 2016 dialogue with society
- Focus on 2023-2030-2050
- Deliverable end 2016: Energy Policy Agenda including societal actors
- Attention for: safety, affordability, reliability, security and economic opportunity

Meedenken en meedoen

Å Nu:
www.rijksoverheid.nl/doe-mee/lopende-projecten/energie-duurzaam-2050

Vanaf **7 april** (start dialoog):
www.mijnenergie2050.nl

Bijdragen aan **innovaties** smart grids:
Stichting TKI Urban Energy
Arthur van Schendelstraat 550
3511 MH Utrecht
Telefoonnummer: 030-747 00 27
Email: info@tki-urbanenergy.nl

Questions to address in the Energy Dialogue

Space heating (built environment)

Å How to accelerate energy renovations of current building stock?

Å How to ensure that local decisions add up to national and European targets?

Process heating (industry)

Å How to decarbonize industry exposed to international competition?

Å What should the agenda for innovation entail? How to bring this forward?

Questions to address in the Energy Dialogue

Energy for transport & mobility

- How to decarbonize the international transportation system?
- What is needed to decarbonize personal mobility?
- What role can battery packs play in the electricity system?

Electricity for power, lightening and ICT

- How to improve the flexibility of the electricity system such that it can accommodate high shares of intermittent energy sources?
- How to improve integration of functions with electricity?
- What market models are suitable for this transition?

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Smart Grids

Enabler for the future energy supply

Prof.dr.ir. Han Slootweg
Delft, March 17th, 2016

Technische Universiteit Eindhoven
University of Technology

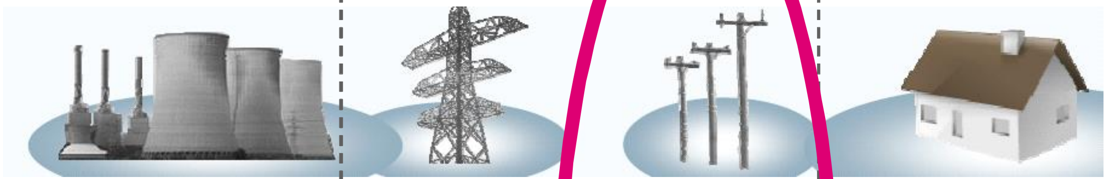
ENEXIS

Agenda

- Enexis as DSO
- Electrical power system
- Energy transition
- Smart Grids as an enabler
- Challenges and next steps

Organisation of the Dutch energy sector

	Liberalized	Regulated		Liberalized	



	Produc-tion	Trans-port	Distri-bution	Supply	Related businesses
Electricity	Large scale generation: Delta, Eletrabel, Eneco, E.ON, Essent, Nuon Other decentralised generation Import	Operator 110 ï 380kV: TenneT Import & export	Enexis , Alliander, Endinet, Rendo, Stedin, Westland Energie, Delta Netwerkbeheer, Cogas, etc.	Delta, Dong, Electrabel, Eneco, E.ON Benelux, Essent (RWE), Nuon (Vattenfall), NEM, etc.	Enexis Other parties, such as Installation companies
Gas	Maatschap Groningen: a co-operation between the State, Shell and ExxonMobil	Operator HP grid (40-60 bar) Gas Transport Services (GTS) Import & export Enexis , Delta (Zebra HD leiding)	Enexis , Alliander, Endinet, Rendo, Stedin, Westland Energie, Delta Netwerkbeheer, Cogas, etc	Delta, Dong, Electrabel, Eneco, E.ON Benelux, Essent (RWE), Nuon (Vattenfall), NEM, etc.	Enexis Other parties, such as Installation companies

TU/e Technische Universiteit Eindhoven University of Technology

ENEXIS

Facts and figures Enexis

Employees:
App. 4.300

Branches:
12, mainly in East-NL

Turnover (2015):
1.353 MEURO

Profit after taxation:
223 MEURO

TU/e Technische Universiteit Eindhoven University of Technology ENEXIS

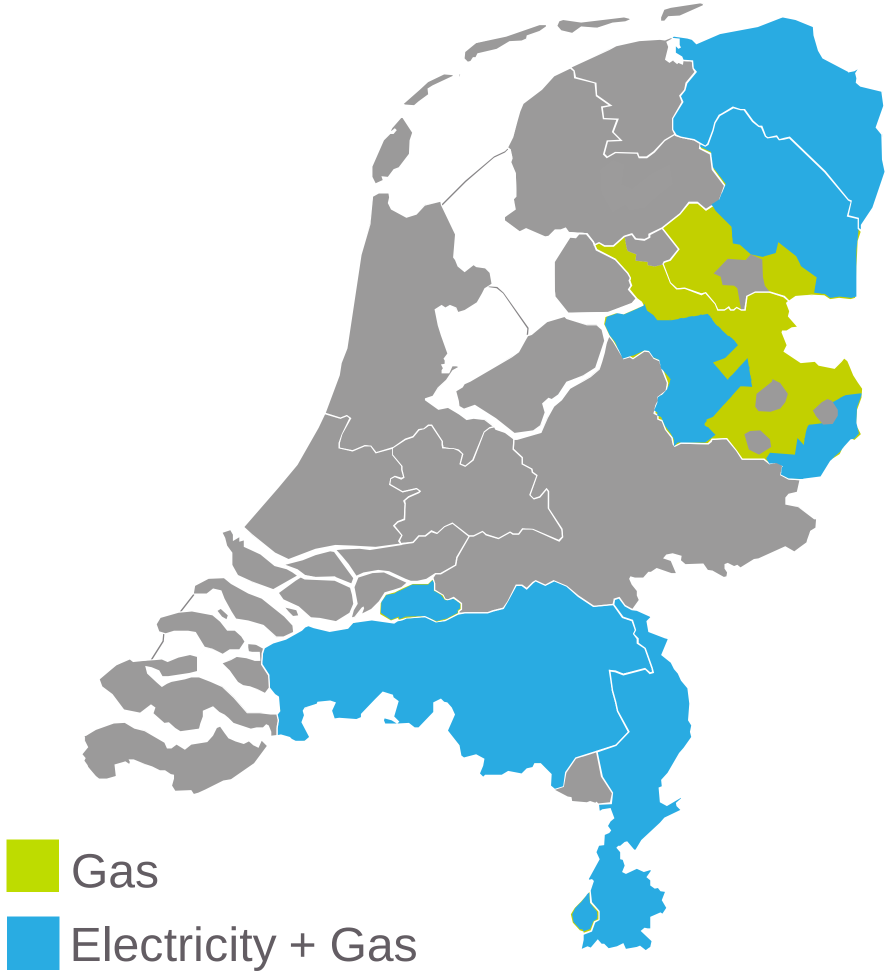
Facts and figures Enexis

Electricity:

- ◆2,7M connections
- ◆148,000 km MV / LV grid
- ◆53,000 stations

Gas:

- ◆2,1M connections
- ◆45,000 km grid 0.03-8 bar
- ◆25,000 stations



Activities DNOs - Enexis

- Realization of network connections for new energy producers and consumers
- Expanding networks for connecting construction areas and for meeting changing requirements of existing/connected consumers (i.e. load growth or connection of distributed generators)
- Replacement of grid components at end of technical life
- Inspection (including gas leakage detection) and maintenance (periodic and condition based) of grid components
- Outage restoration
- Collection and distribution of measurement data
- Reconstructions of gas and electricity due to third party construction activities (buildings, roads, etc.)
- Non-regulated activities, such as rental of MV/LV transformers and MV switchgear

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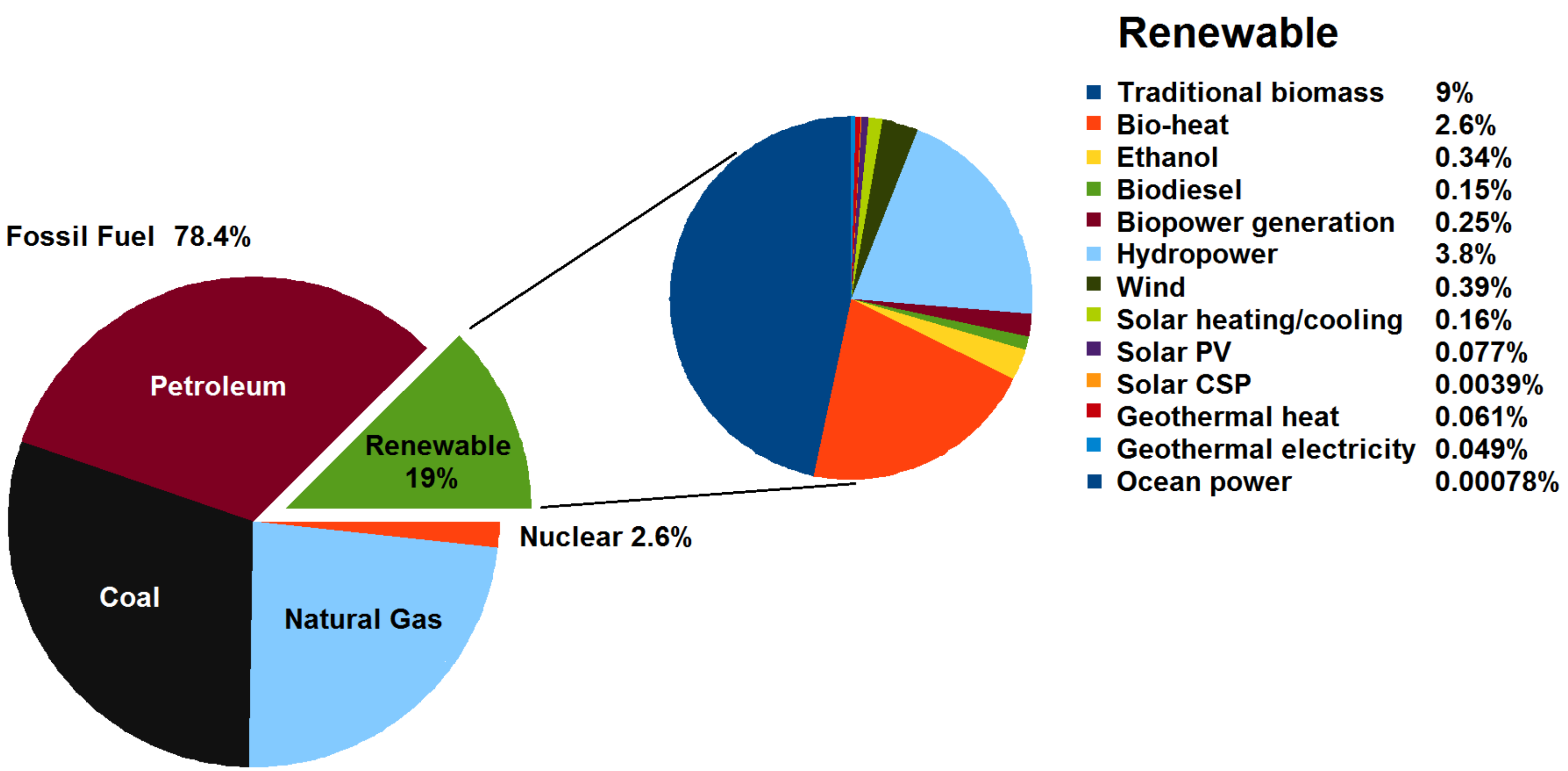
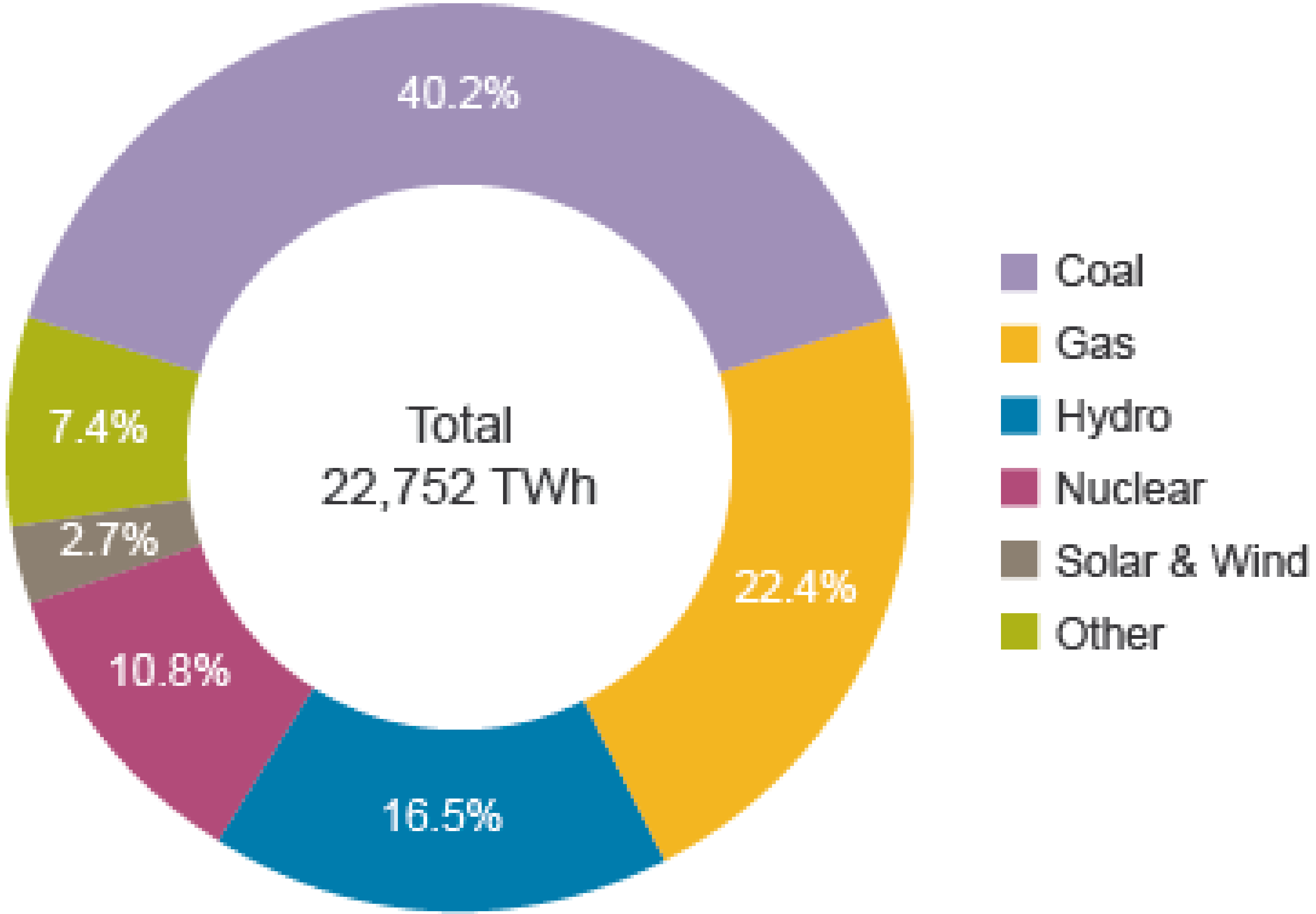
Energy consumption by primary energy source - world



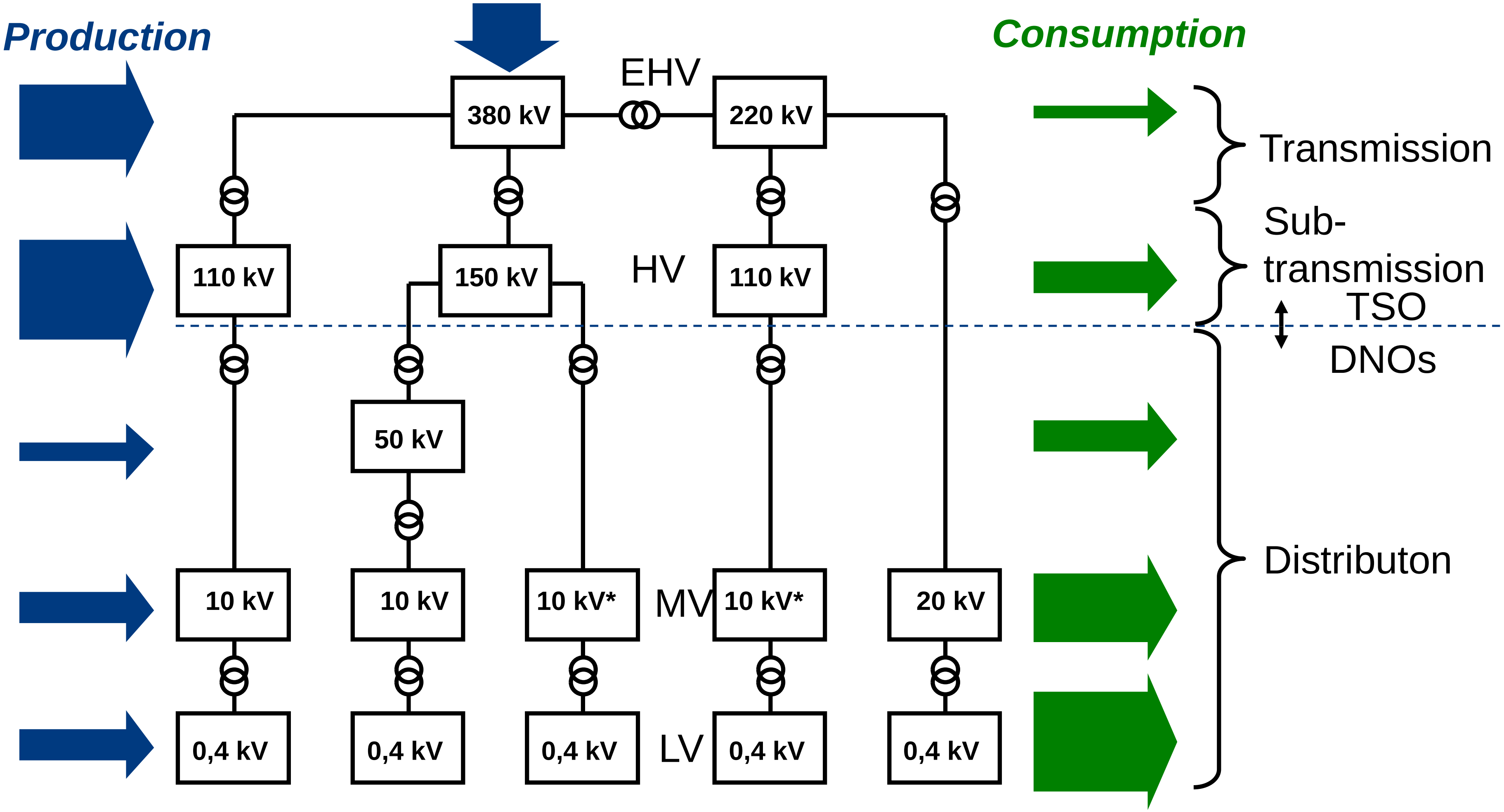
Electricity generation by primary energy source - world



Electric power system in the 20th century

- Large generators have higher efficiency than smaller ones ï most electricity generated in large scale power plants
- Electricity flow mainly ñtop-downò
- Electricity can not be stored cost effectively in large quantities, i.e. at ñutility scaleò
- Supply of and demand for electricity must be continuously balanced
- At present, most consumption is time-critical and inflexible
- Supply and demand are balanced by adjusting supply to demand
- Rotating masses in generators act as a buffer between supply and demand
- Grid frequency reflects the extent to which a balance between supply and demand exists
- In the longer term, demand is followed by committing and stopping power plants

Electric power system in the 20th century



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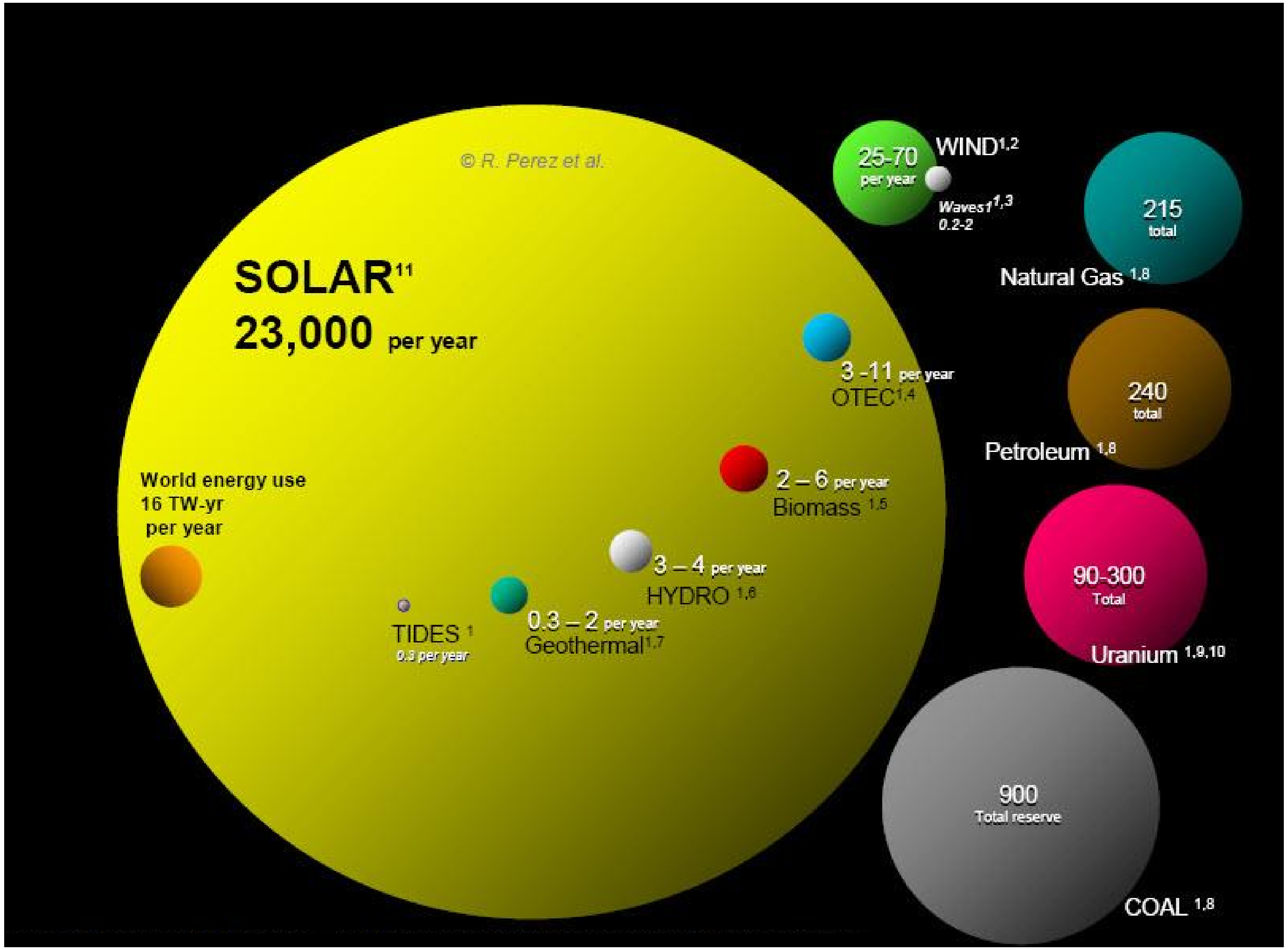
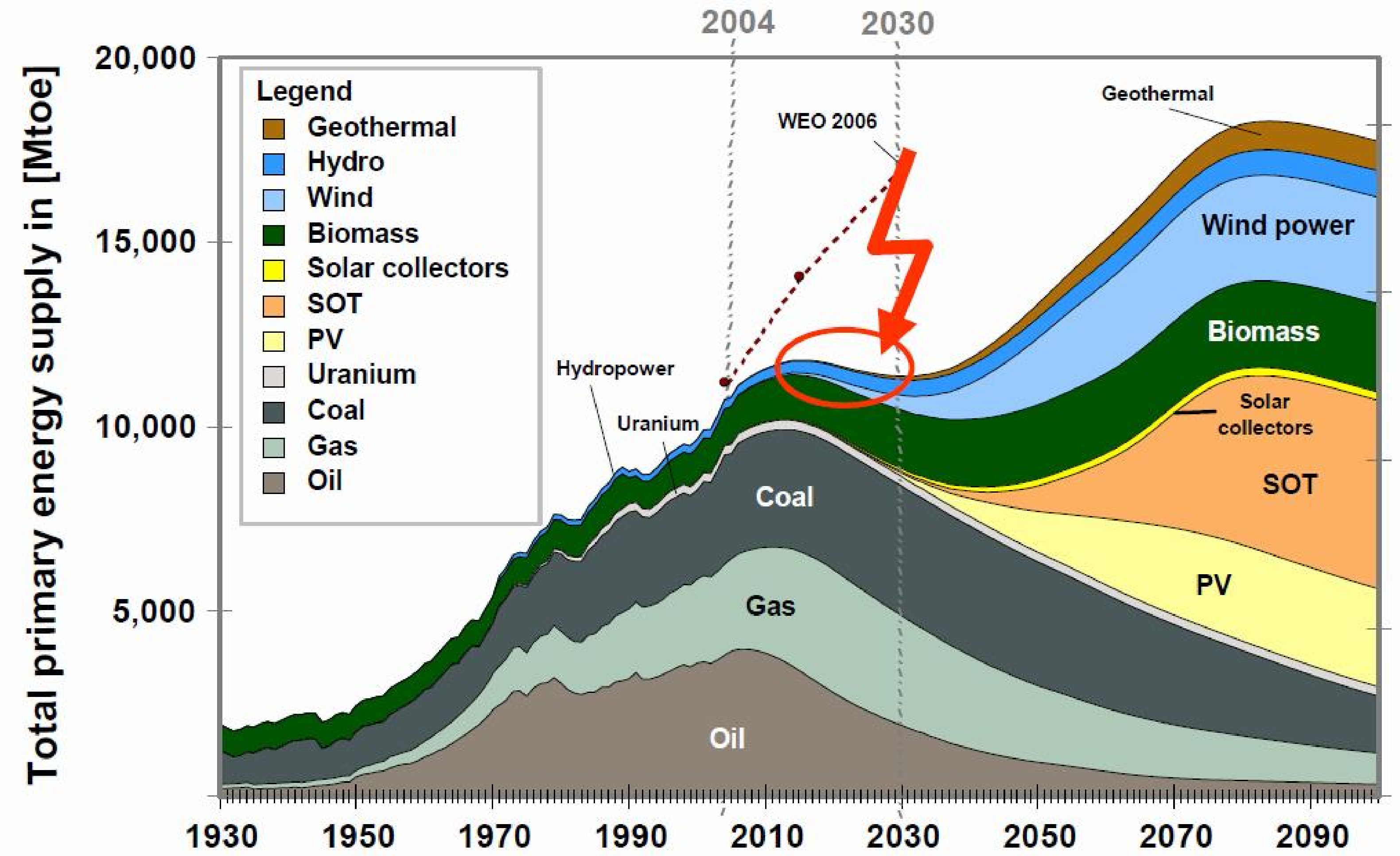
Sustainable energy abundantly available…



TU/e Technische Universiteit Eindhoven University of Technology ENEXIS

…but transition takes time!



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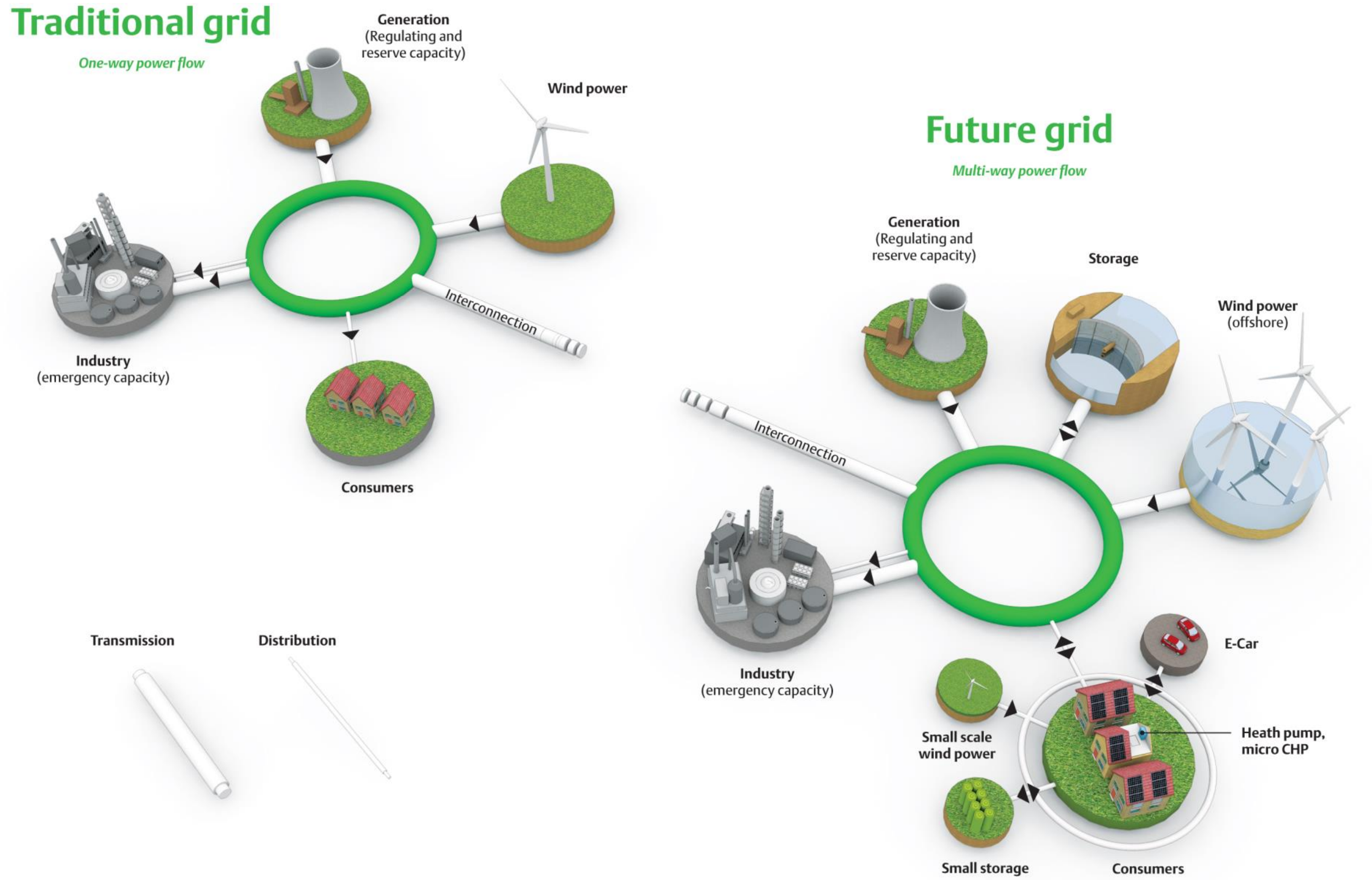
ENEXIS

Consequences of the energy transition

- Contribution of electricity will increase
  - Most technologies for sustainable energy generation produce electricity
  - Increased energy efficiency leads to substitution of gas and liquid fuels by electricity
- Scale of electricity/energy production will decrease
  - Make use of waste heat produced by thermal electricity production (difficult to transport)
  - Low energy density of renewable energy sources
- Controllability of electricity/energy production will decrease
- Amount of flexible consumption will increase
  - Electrification of less time critical applications such as mobility and heating

20th vs 21st century power system



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ENEXIS

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Increasing information exchange in a sustainable energy supply

Increasing information exchange is required in the future electrical power system compared with the present electrical power system, because:

- Generation becomes distributed, uncertain and uncontrollable
- Load becomes increasingly flexible, and this flexibility ȓbehind the meteròmust be mobilized for optimal operation of the power system,
- Balancing supply and demand becomes more complex because of reduced controllability of generation, increased flexiliblity of load and storage facilities
- More advanced tariff schemes will be implemented and new commercial propositions will be offered
- New actors, such as energy cooperations and local microgrids are expected to enter the market
- Grid operators may want or need to discriminate between time-critical and flexible consumption during peak loads or exceptional circumstances

Smart Grids – enabler for the increasing information exchange

A Smart Grid is:

- An electricity network with technologies that make available information on the energy flows in the network
- and the state of its components
- and that allow control of energy flows in order to support the energy transition efficiently

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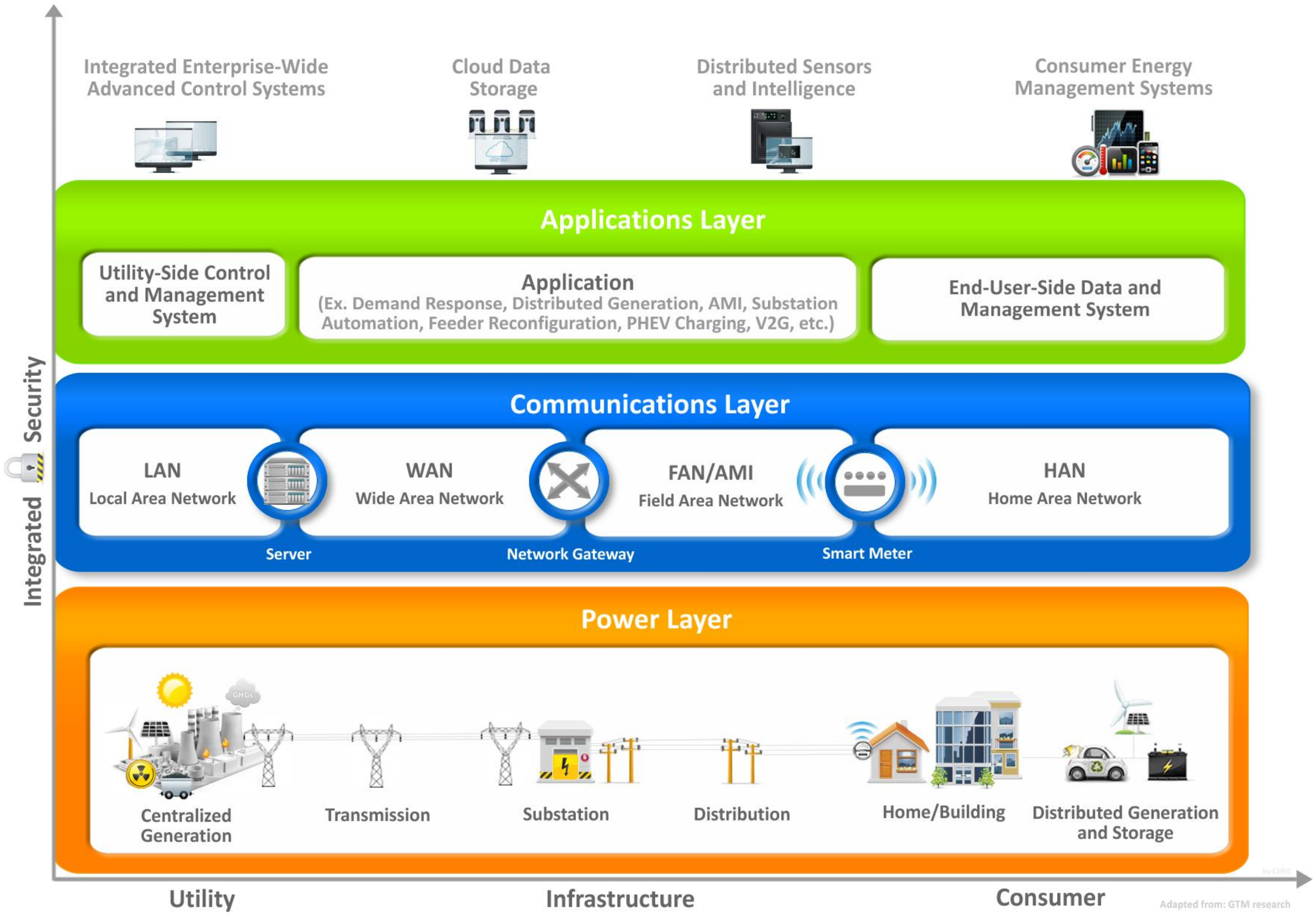
ENEXIS

Smart Grid Architecture

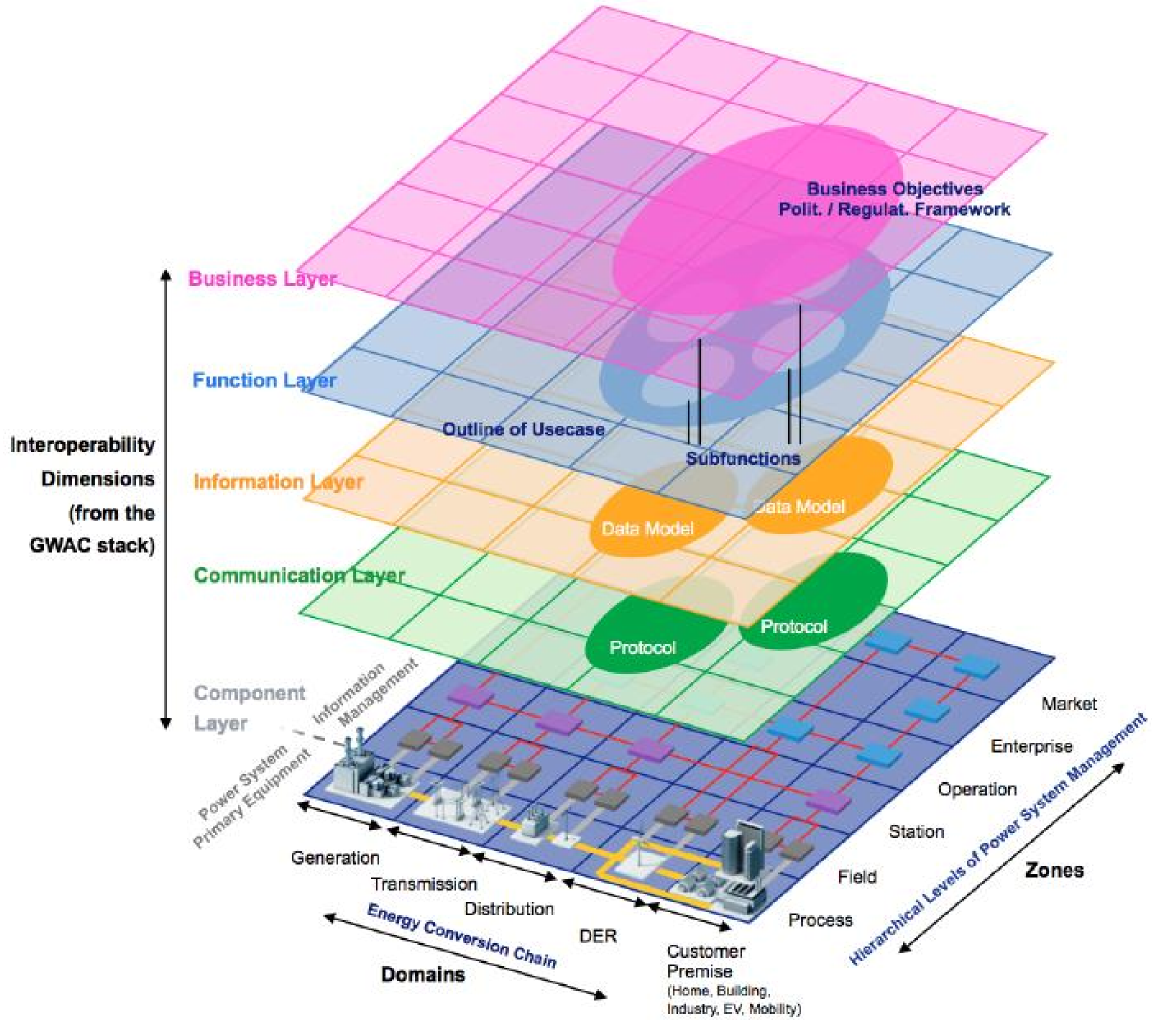
Important design considerations in a smart grid architecture:

- Division of roles and responsibilities over grid operators, market parties and consumers and resulting exchange of information
- Required/Desired measurements and control-actions
- Initiation (time-based or event-based) and refresh-rate
- Bandwidth and total information load
- Type(s) of communication network(s) required
  - Internet (VPN)
  - Power Line Carrier
  - Wireless
  - Dedicated telecommunication network (fiber, CDMA)
- Integration of (smart) home and (smart) grid

Smart Grid Architecture Model



Smart Grid Architecture Model



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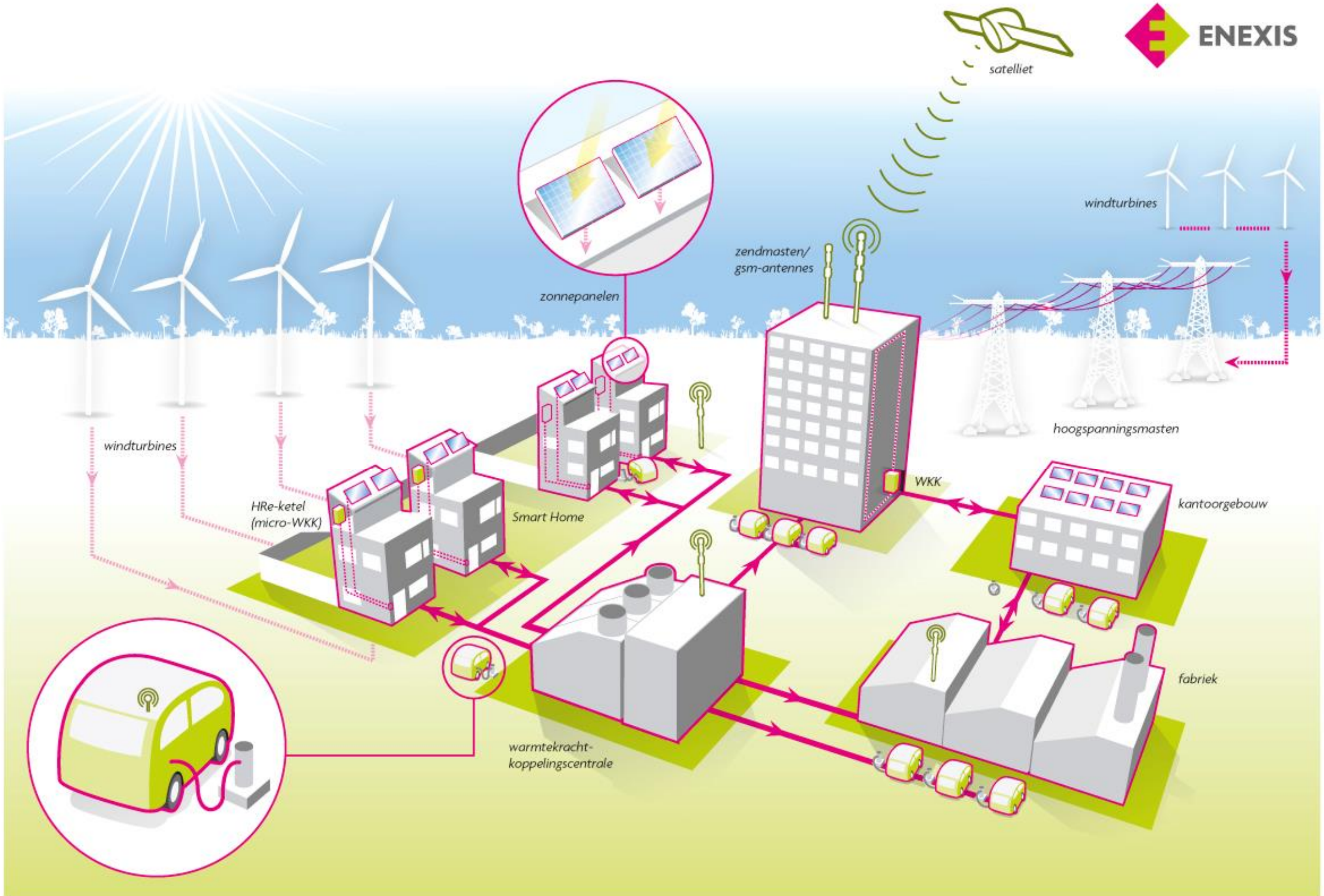
Challenges and next steps

- Transition to a sustainable energy supply is required but takes time
- This energy transition strongly affects electrical power systems:
  - Increasing role of electricity as an energy carrier
  - Downscaling electricity generation
  - Decreasing controllability of electricity generation
  - Increasing flexibility of consumption
- ñTraditionalò electrical power systems are not able to cope with these challenges
- Smart Grids deliver the intelligence required for a reliable, affordable and sustainable future electrical power system
- Architectural concepts for Smart Grids are still under debate and enabling technologies are under development

Smart Grids - Our common future*



Title of a report issued in 1987 by the World Commission on Environment and Development (WCED), generally considered to first ever put sustainablity on the global agenda

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The new energy

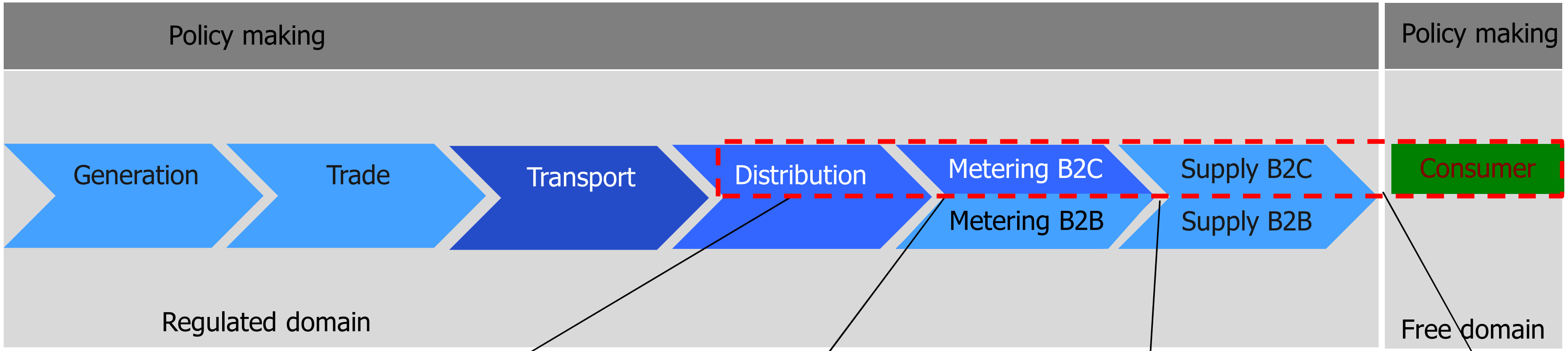
an increasingly entrepreneurial environment…. in the Dutch electricity retail sector

Paul Hermans
TPM ï Economics of Infrastructures

17 maart 2016

Delft University of Technology

Multiple drivers for entrepreneurship.... *(sector point of view)*



Grid Infrastructure:
↑ IT penetration (with OT)
↑ replacement investments
↑ de-central "e" feed-in

Role of information

Metering Infrastructure:
-Digital metering (Smart M)
-Remote management
-TOU registration / Feed-in
-Real time cons. Data

Role of information

Mode of Governance
-Unbundled market functions
-Public / Private domain

Mode of Organisation
-Grid Connectivity split from Energy-delivery services

Retail market
-Ca 40% of NL has switched
↑ Product differentiation
-New Entrants

- Play of the game changes

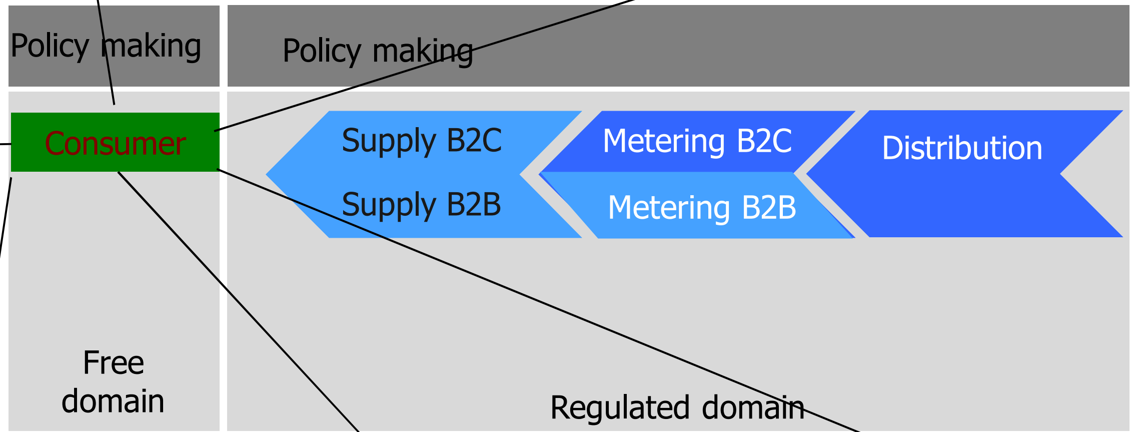
Publicly owned National operator
Publicly owned Regional operator
Privately owned International / Local

Multiple drivers for entrepreneurship.... *(consumer point of view)*

Local policy makers:
- Subsidize PV/mCHP
- 300 local cooperations

Housing corporations:
-Invest in energy saving
-Stimulate individual initiatives

... Role of information...



Local Generation
-PV penetration
-mCHP

E-Transport
-Sales of Hybrid vehicles

My energy profile
-Increasing share of wallet
-Increasing Switching
-Increasing awareness

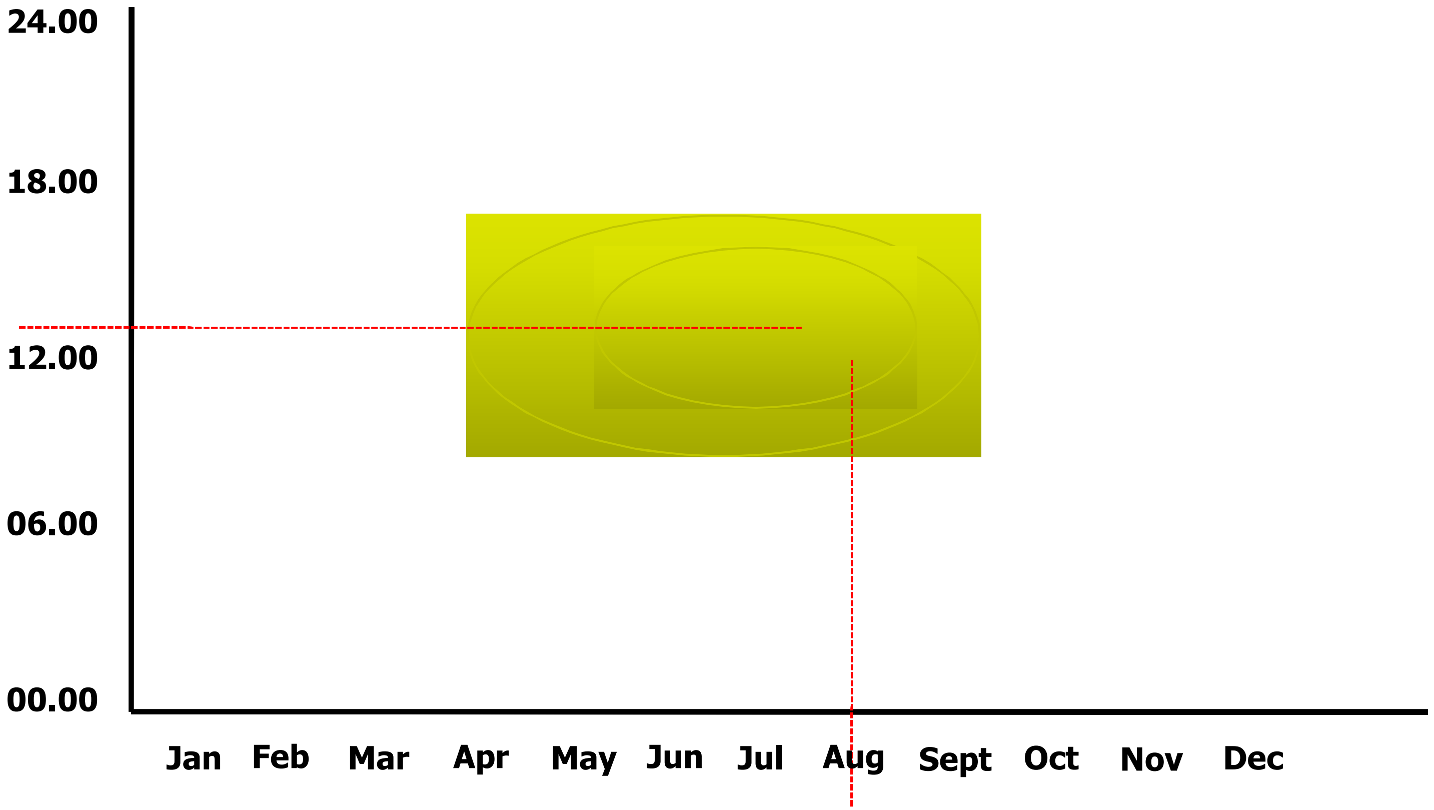
-Energy outsourcing services
-Energy mgt applications

Mobile Info Services
-Social media
-Penetration of touch screen
-Real time information need

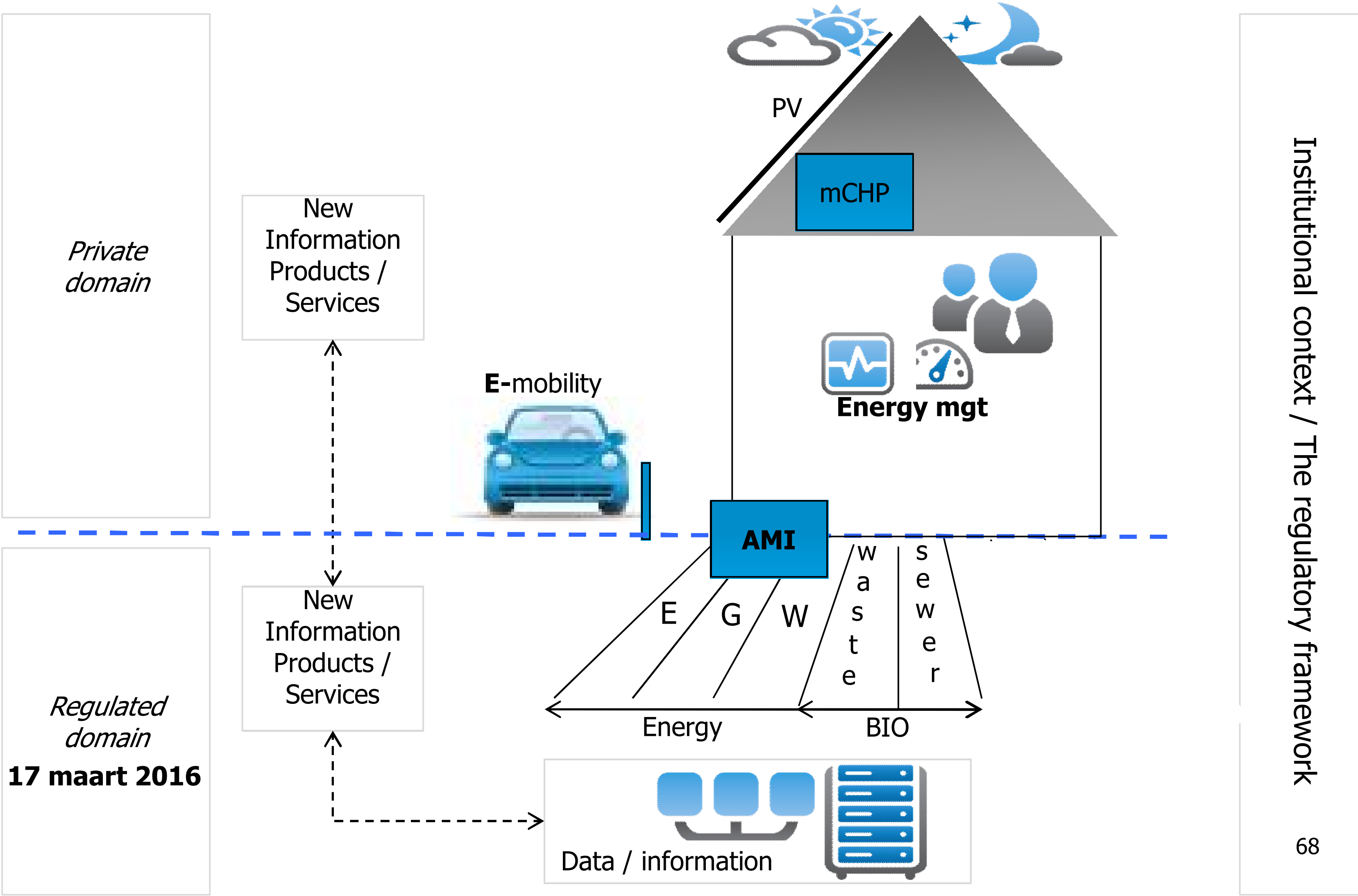
And lot's of other developments

Publicly owned National operator
Publicly owned Regional operator
Privately owned International / Local

Private domain – impacting entire system – Ger/NL



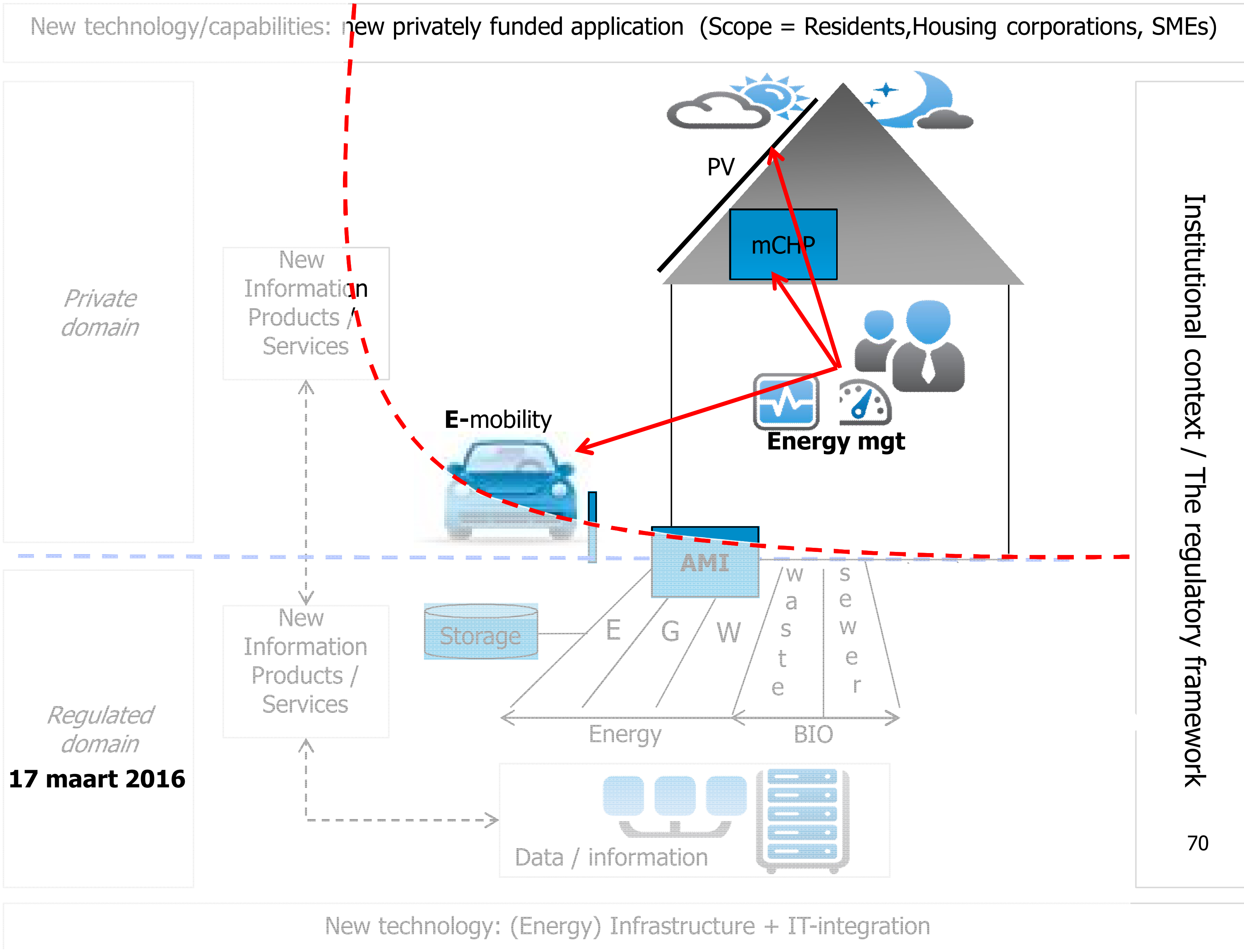
New technology/capabilities: new privately funded application (Scope = Residents,Housing corporations, SMEs)



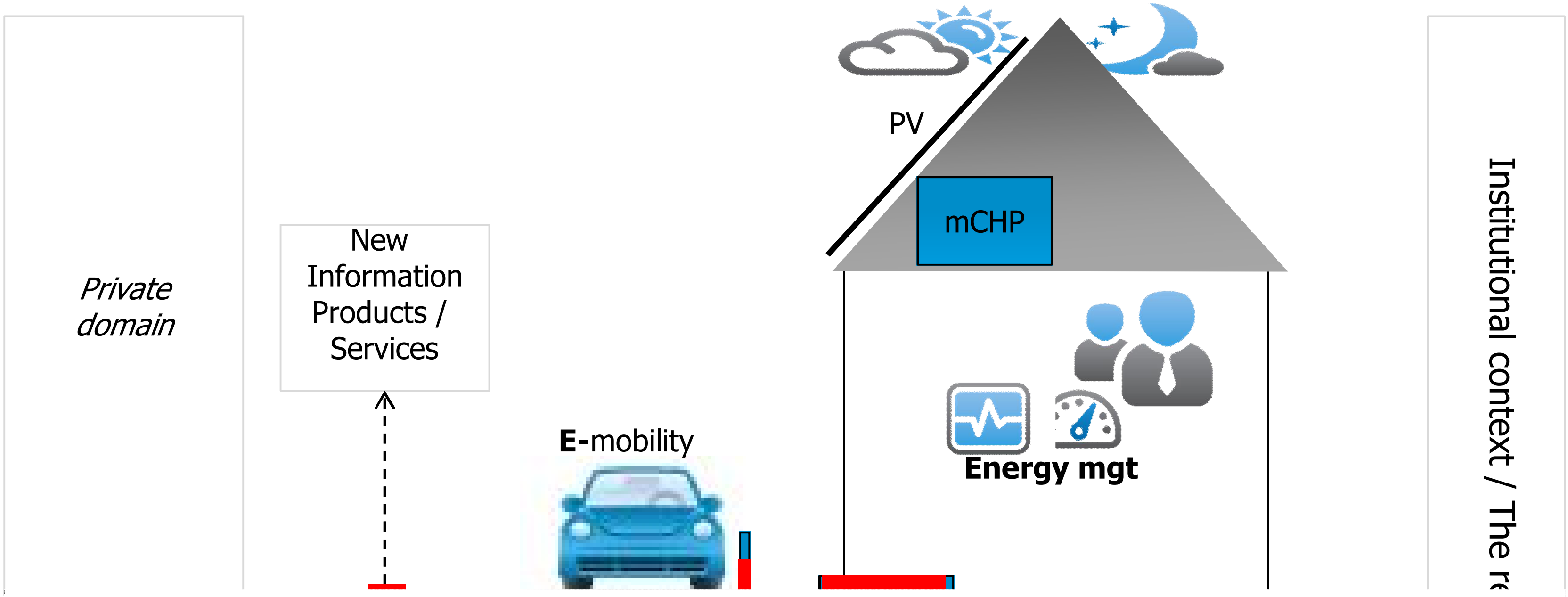
New technology: (Energy) Infrastructure + IT-integration

Human Beings – electricity – the role of meaningful info

Making choices - a long way to go


New technology/capabilities: new privately funded application (Scope = Residents,Housing corporations, SMEs)
Private domain
New Information Products / Services
PV
mCHP
E-mobility
Energy mgt
AMI
Storage
E
G
W
waste
sewer
Energy
BIO
Regulated domain
New Information Products / Services
Data / information
Institutional context / The regulatory framework
New technology: (Energy) Infrastructure + IT-integration

New technology/capabilities: new privately funded application (Scope = Residents,Housing corporations, SMEs)



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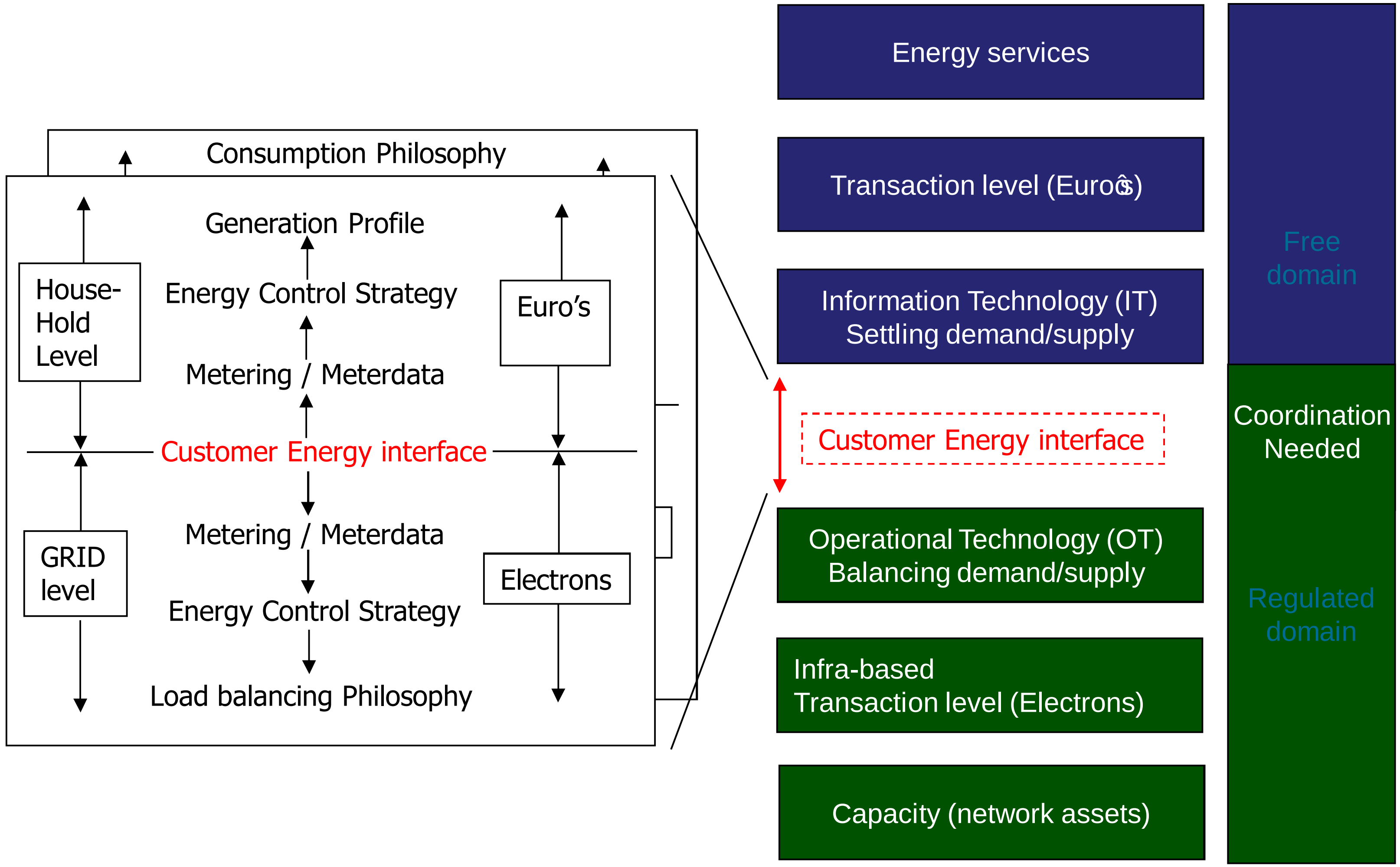
Analysis of the 'energy interface'



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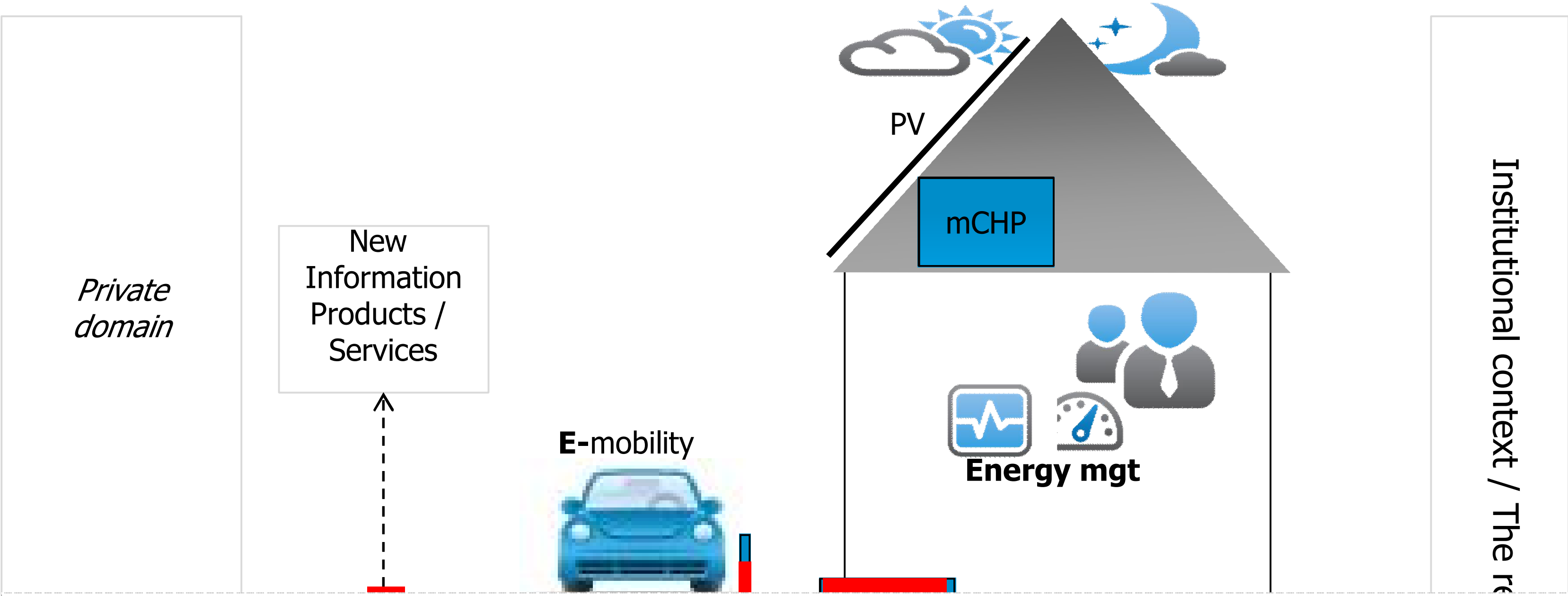

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Coordination model - supply and capacity

MODEL A
-'Load' seems leading
- managing demand?
- achievable penetration?
- IT costs for DNO/DSO

- conflict with supply function

MODEL B
- No coordination
- DNO/DSO = *Capacity provider*
- Potentially heavy grid
  investments

MODEL C
- Agent based transaction

- Agent:
  'acts' based on variables
  DNO influences variables
  DNO-focus on balancing cost

Agent

Outcome:
Buy / Sell ?
Generate y/n ?

Consumer follows

Seems impossible in NL
- Culture
- Institutional framework

Consumers do as they like

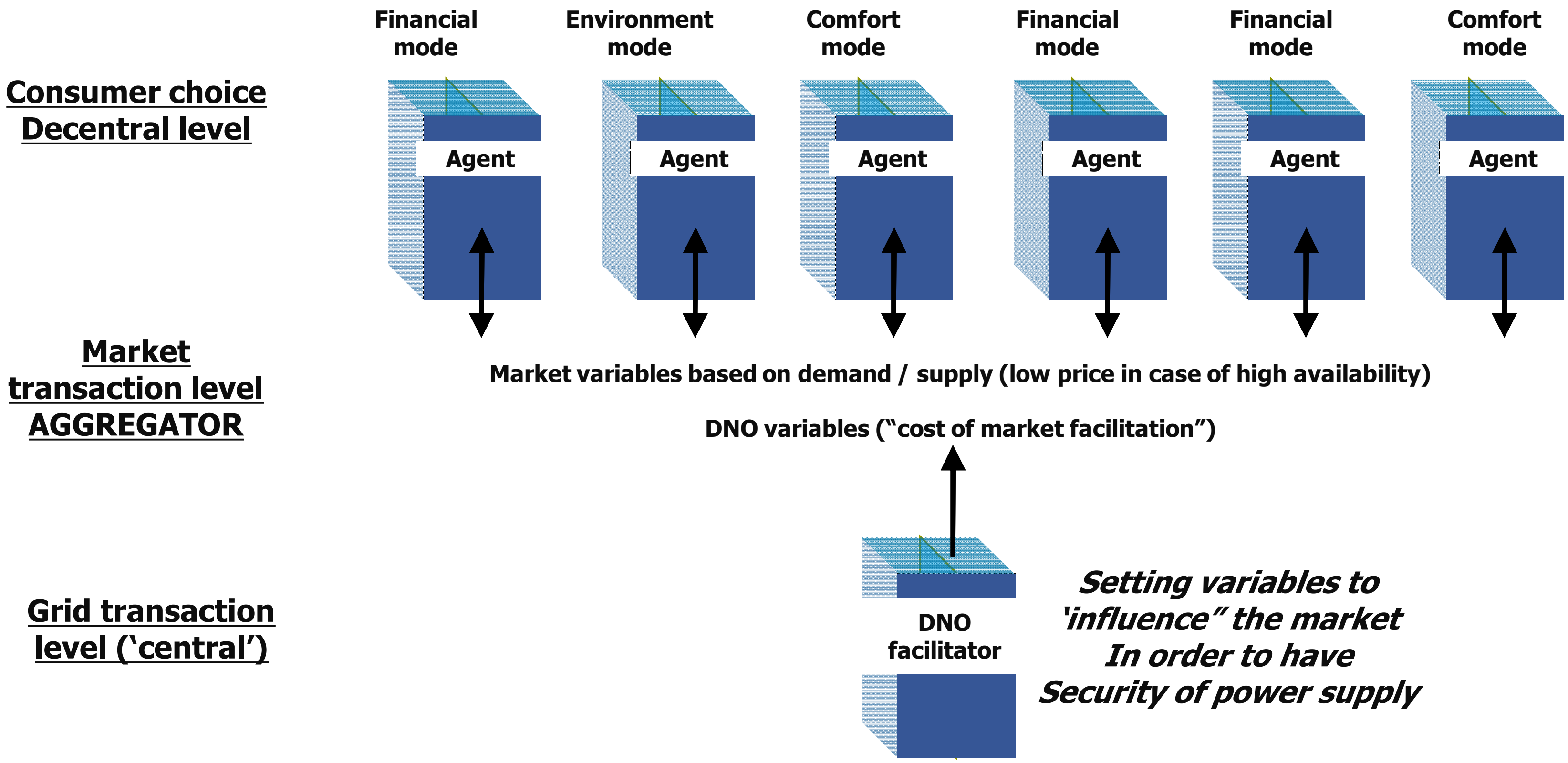
Not: "gebruiker betaalt"

Potentially high societal cost

Agent follows consumer preference…

- Financial optimal mode
- Environmental optimal mode
- Flexibility (comfort) mode

Example – Capacity market for flexibility – cash as incentive



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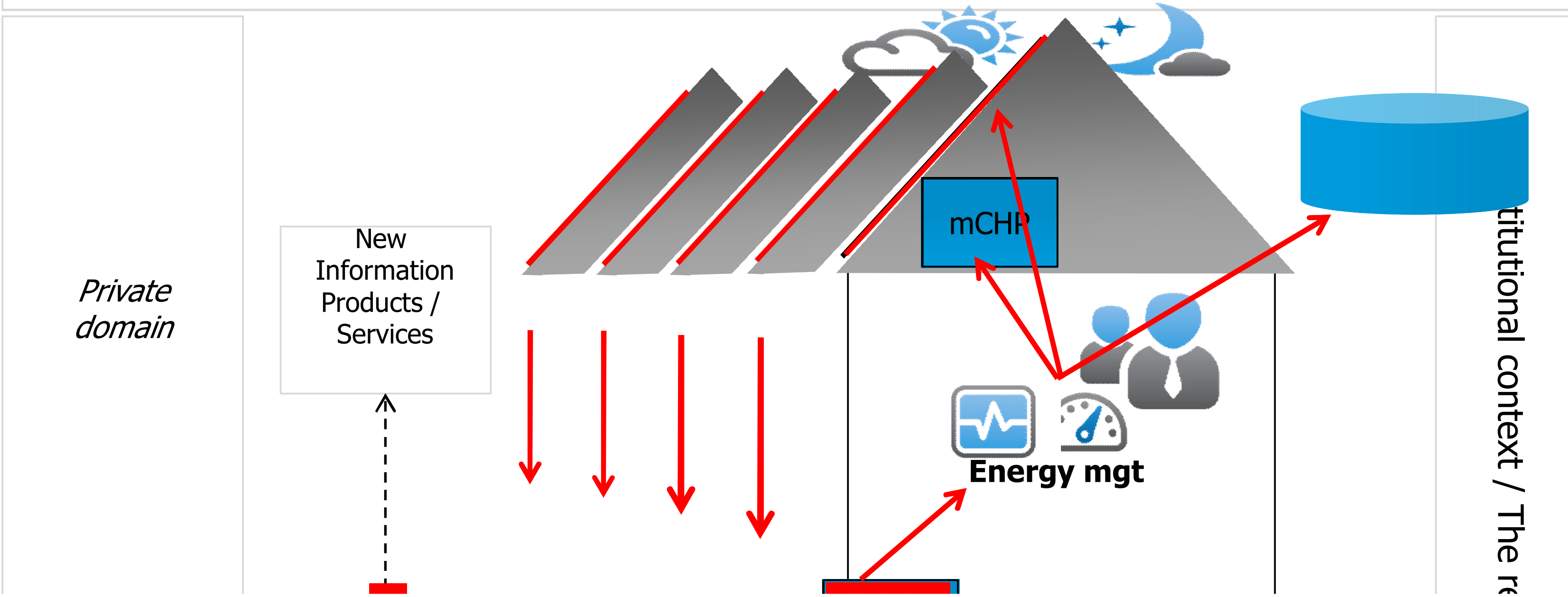

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Trend and take away

Connection types are becoming more pluriform / diverse

→ Portfolio of services
→ Indirect demand management / coordination types?

What will be the core "economic value" of the future?

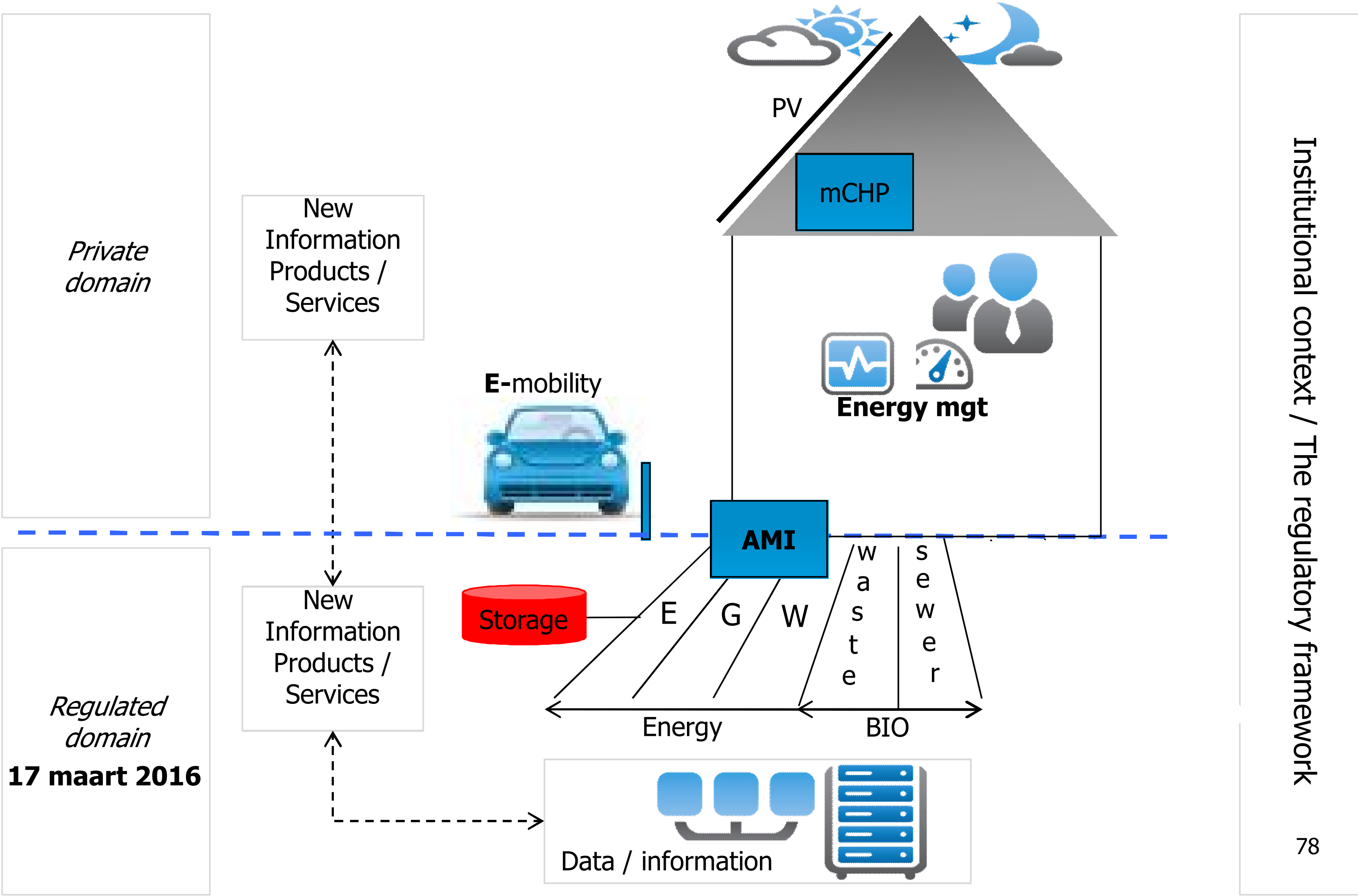
→ kWh
→ Capacity?

What will be the role of "price" ?

→ Outcome of the market
→ Input for the market

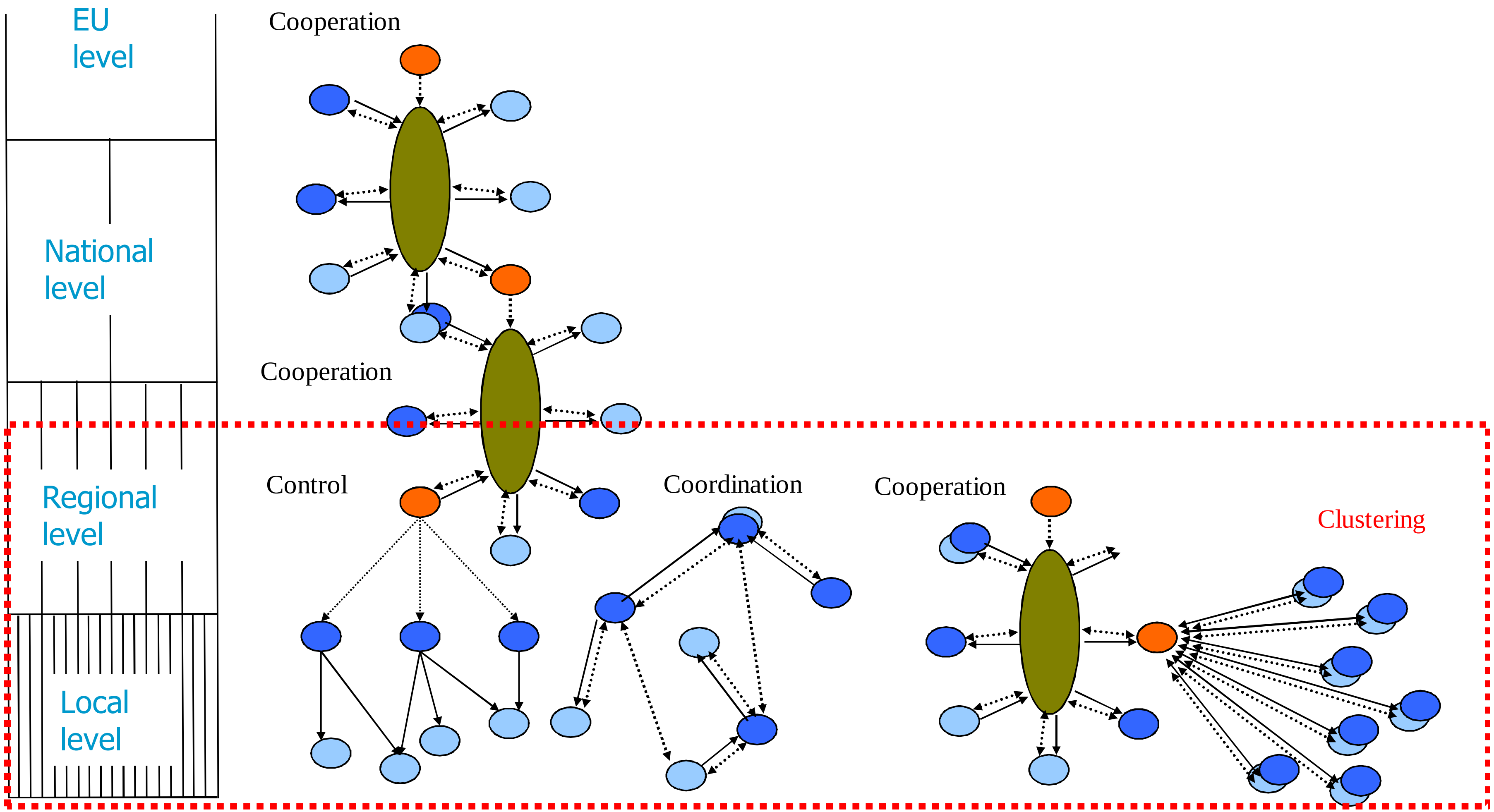
TU Delft

New technology/capabilities: new privately funded application (Scope = Residents,Housing corporations, SMEs)



New technology: (Energy) Infrastructure + IT-integration

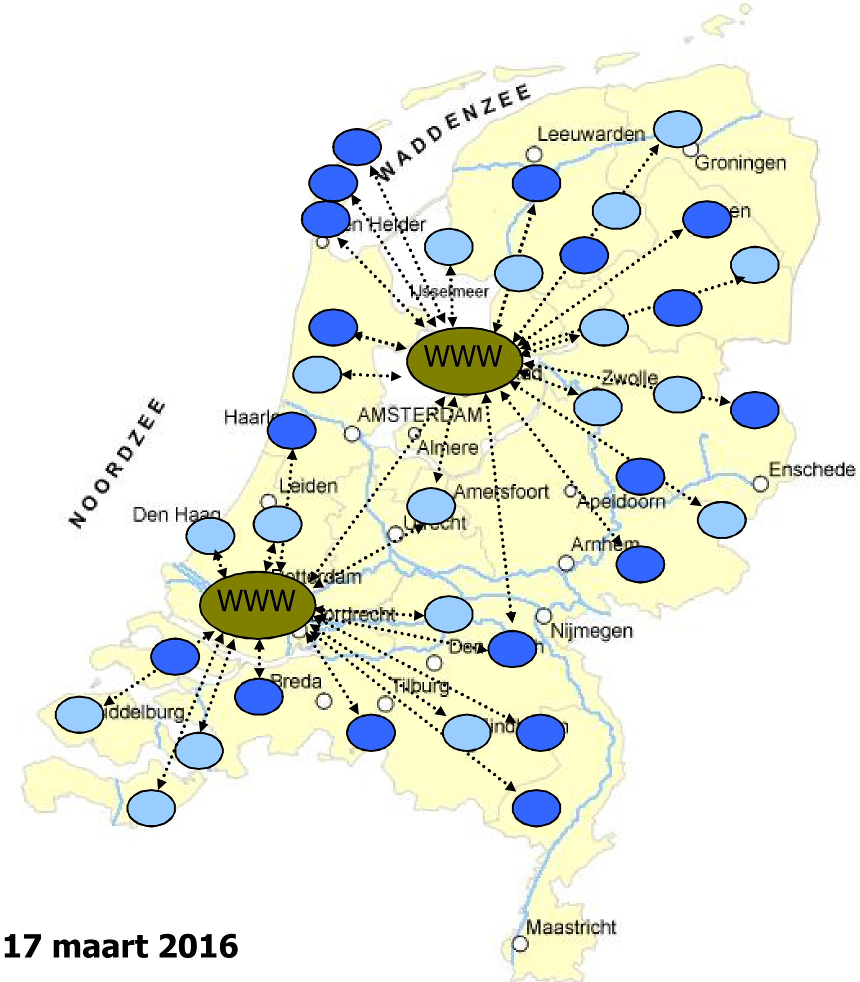
Energy transition - Who will be playing, what role....?



Example A: more "local regulation" | **Example B: "more self organisation"**

Production
Consumption
DSO / intermediary
Market
Energy flow
Information flow

Example – actual focus: demand / supply



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Production

Consumption

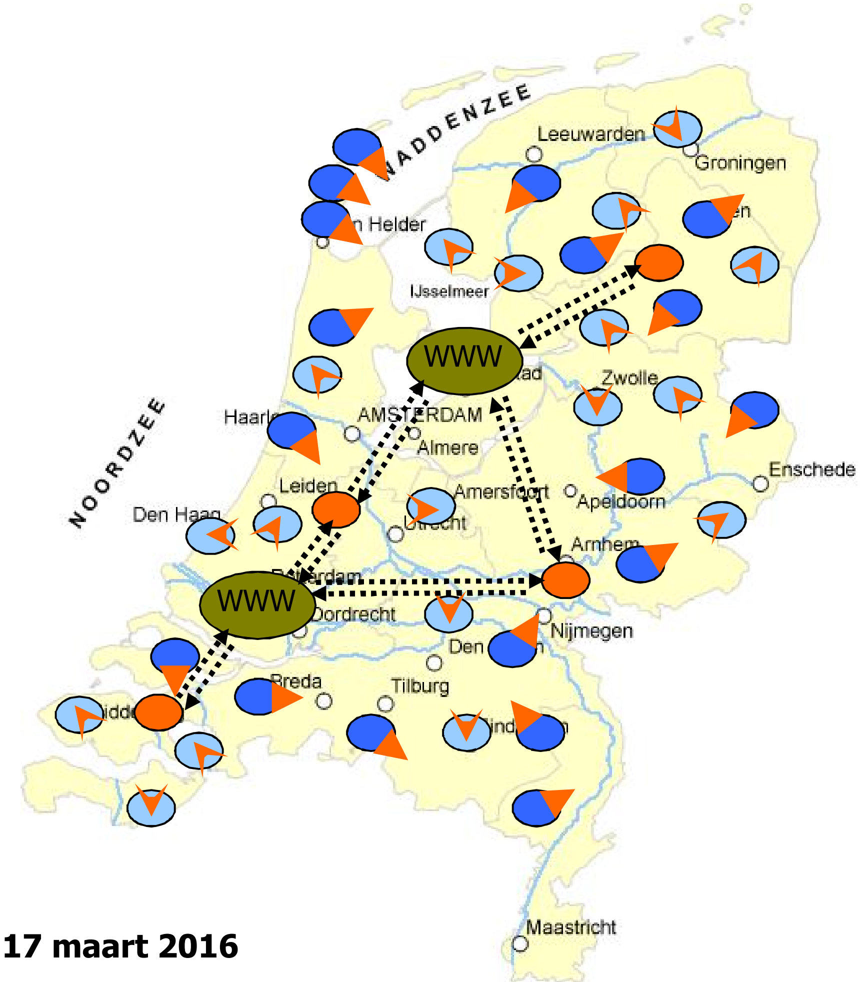
DSO (=infrastructure)

Market (=information)

Energy flow

Information flow

Example – independent market facilitation..



DNO facilitates the market by:

- Infrastructure - Electricity "settlement".

- Metering - Administrative settlement

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Production

Consumption

DSO (=infrastructure)

Market (=information)

Energy flow

Information flow

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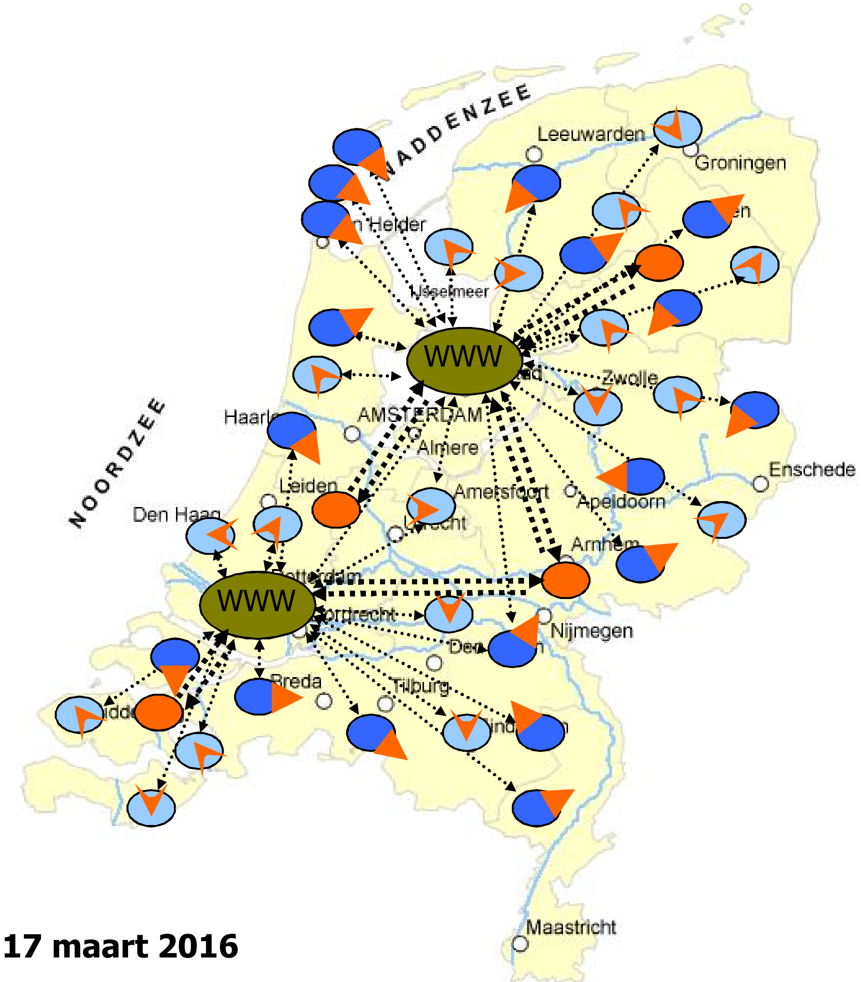
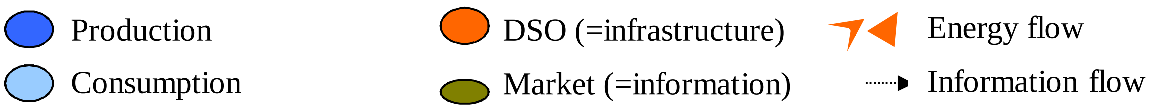
Example – Full picture



Q1: is "price" an outcome of the market ?
or…
is "price" an input for the market?



Agenda

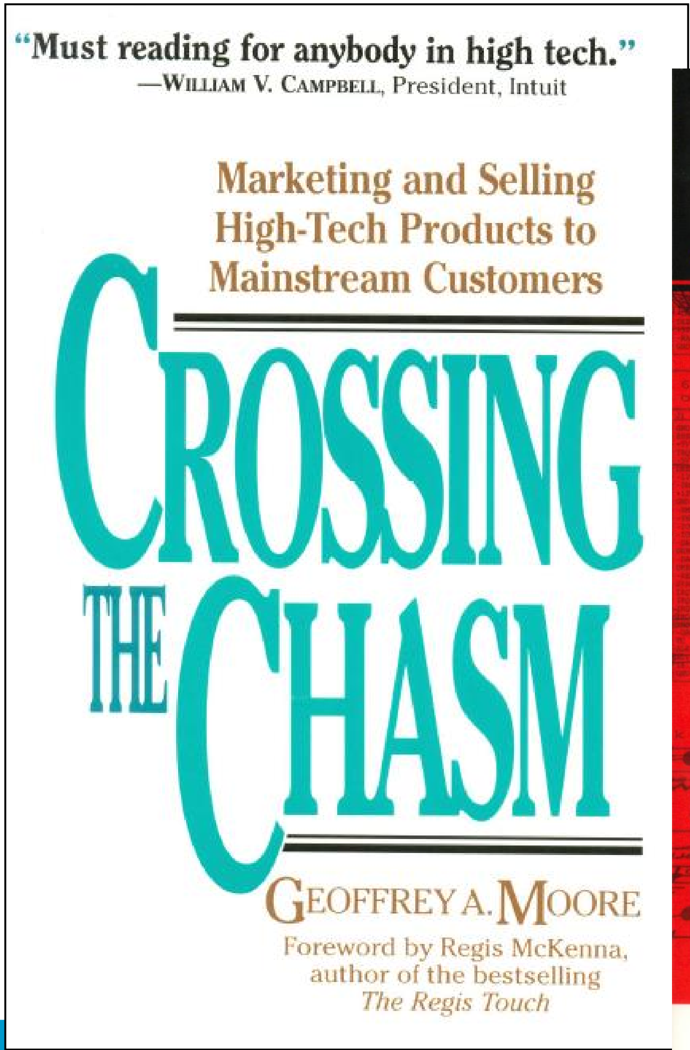
12:30-13:30 Registration
13:30-13:35 **Welcome** Evert-Jan Bouvy, KIVI-E & ETV
13:35-13:45 **Introduction** – Wolter Lemstra, TUDelft
13:45-14:15 **Key note** – Erik ten Elshof, Ministry Economic Affairs
14:15-14:45 **Smart Grids** – Han Slootweg, TU/e and Enexis
14:45-15:15 Coffee/Tea break
15:15-15:45 **Smart Homes** – Paul Hermans, TUDelft and AurumEurope

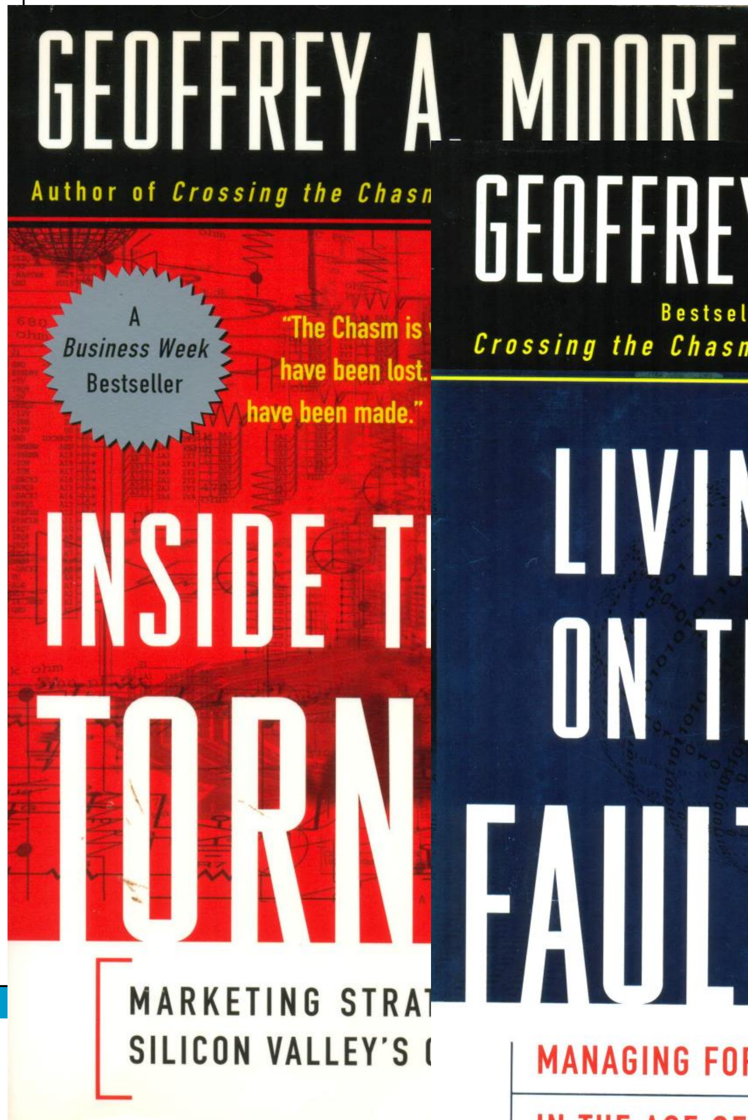
15:45-16:30 **Panel discussion** – Facilitated by Wolter Lemstra, TUDelft
Theo Fens, TUDelft TPM
Marten van der Laan, ICT Automatisering
Marco van Lochem, Alliander
Olivier Ongkiehong, RVO
Peter Palensky, TUDelft EE

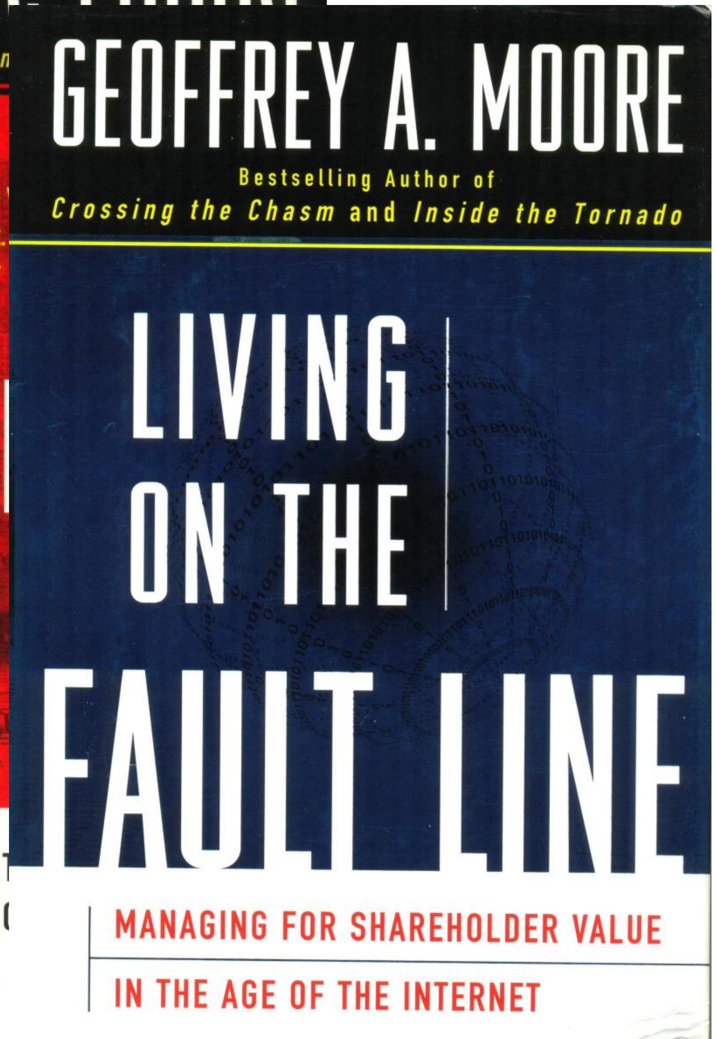
16:30-16:40 **Concluding remarks** and **next steps**

16:40-18:00 **Networking event** in the /PUB

Geoffrey A. Moore...







KIVI
Engineering Society

An analogy…

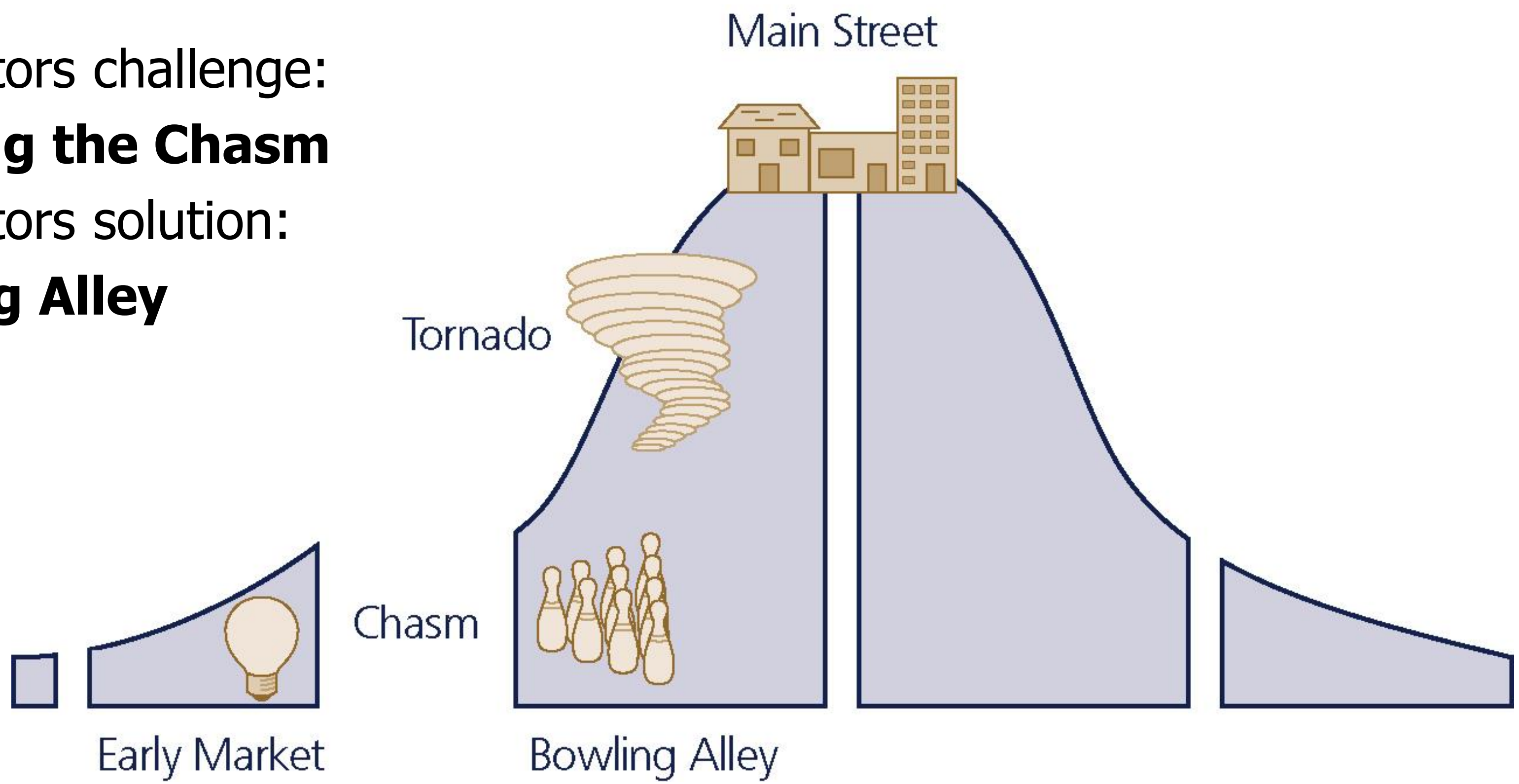
Geoffrey Moore (1991)**:**

The innovators challenge:

Å **Crossing the Chasm**

The innovators solution:

Å **Bowling Alley**



(Moore, 1991)

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Imagine the Future

It is Ours to Shape