University day 2015

# FLEXIBILITY@HOME

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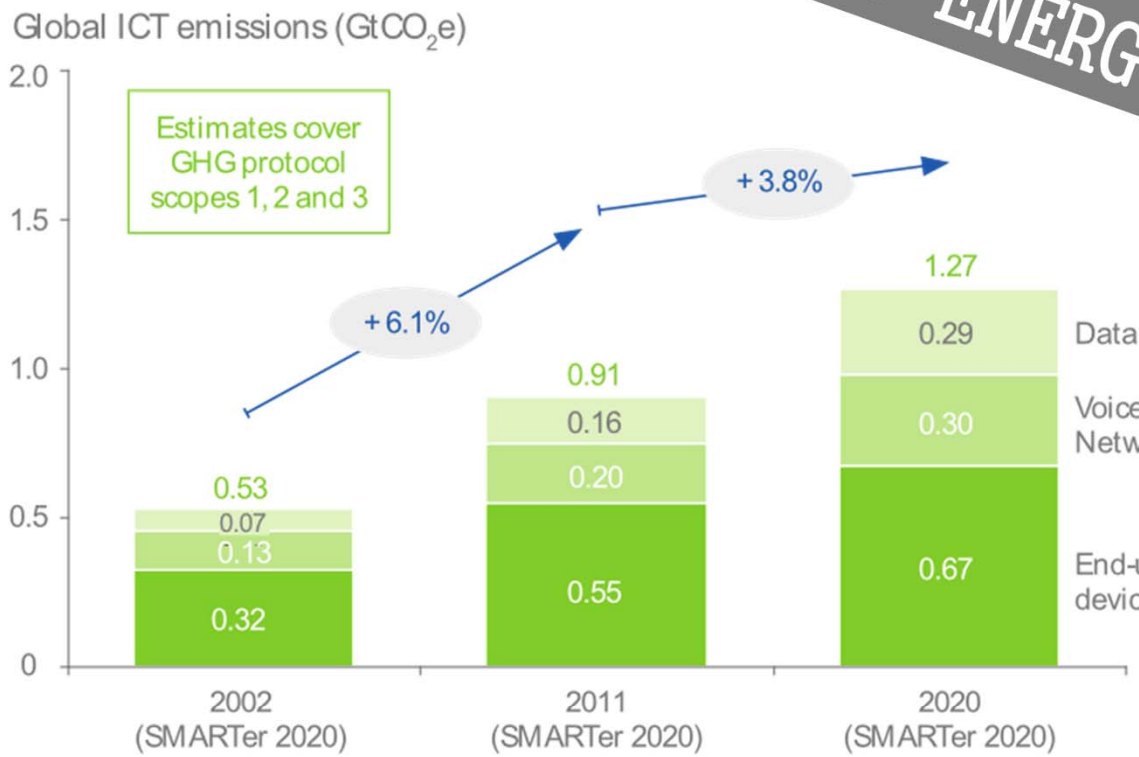
@neutralaccess

http://informatica.uniurb.it/ http://virtualsense.it/

# ICT NEEDS ENERGY




| | CAGR % 2002-2011 | CAGR % 2011-2020 |
|---|---|---|
| Data centers | 8.6 | 7.1 |
| Voice & Data Networks | 4.7 | 4.6 |
| End-user devices | 6.1 | 2.3 |

| | 2002 (SMARTer 2020) | 2011 (SMARTer 2020) | 2020 (SMARTer 2020) |
|---|---|---|---|
| ICT as percentage of global emissions | 1.3 | 1.9 | 2.3 |
| Global GHG emissions ($GtCO_2e$) | 40 | 48 | 55 |

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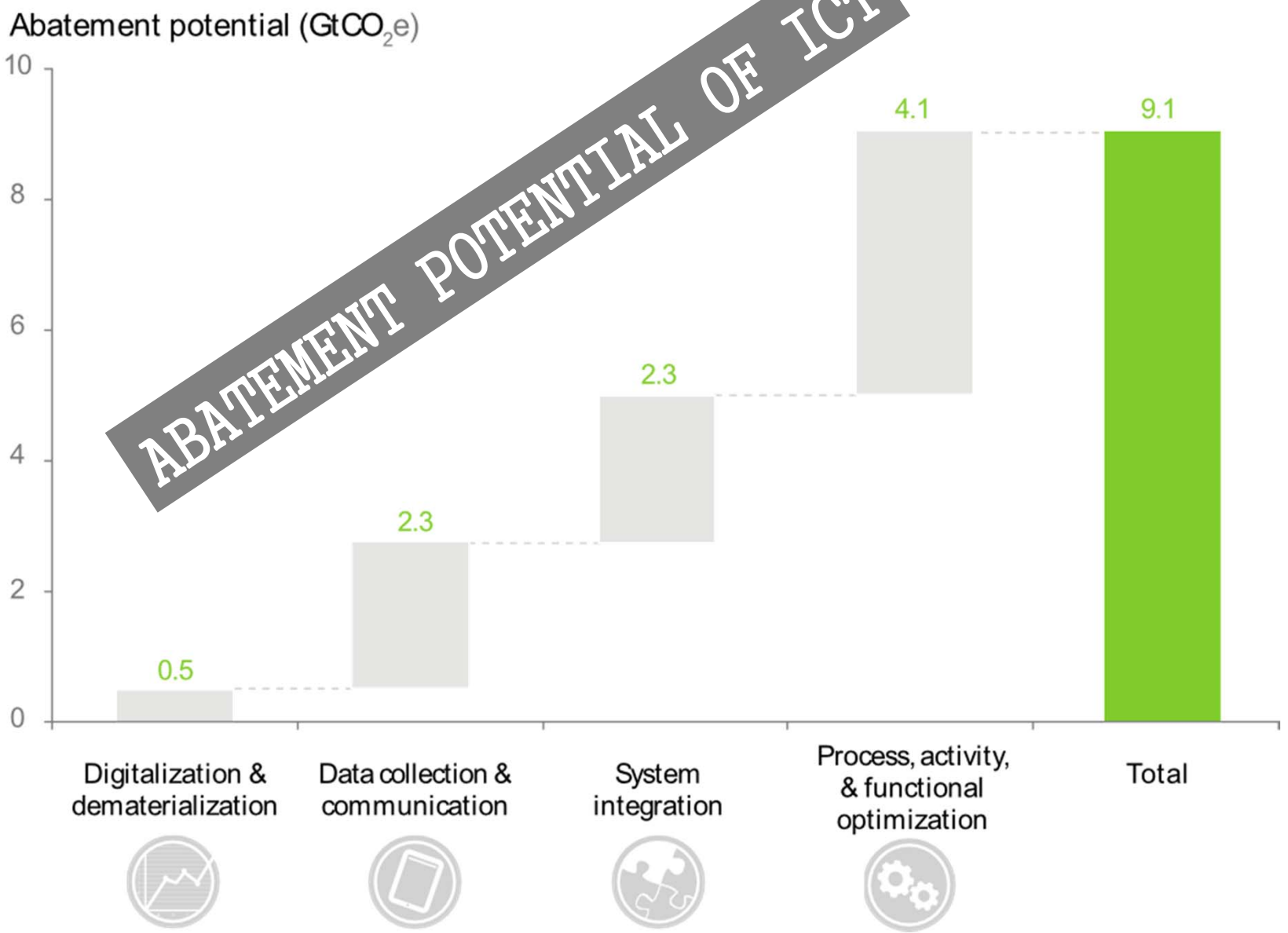
# ABATEMENT POTENTIAL OF ICT

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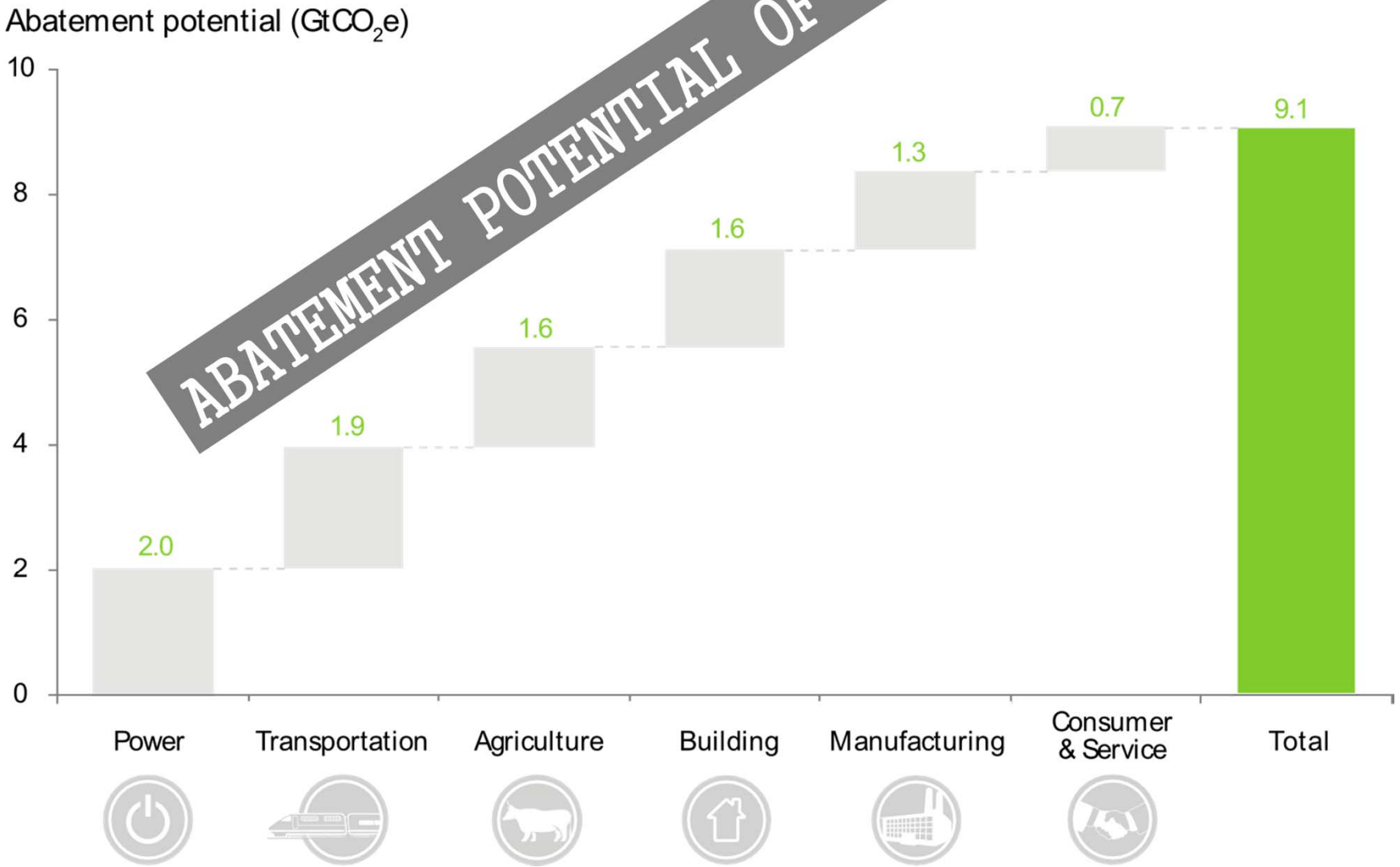


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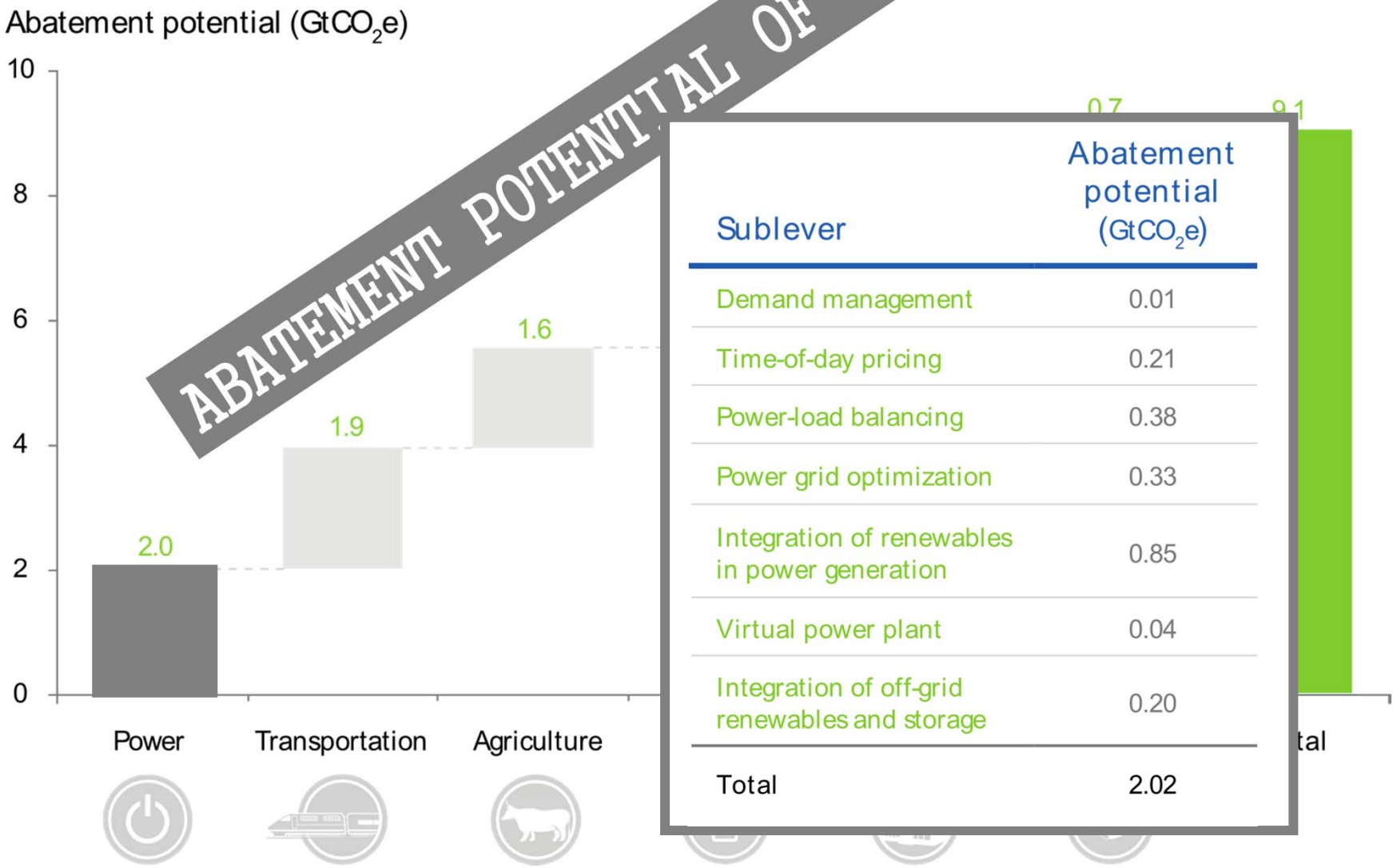
# ABATEMENT POTENTIAL OF ICT




| Sublever | Abatement potential ($GtCO_2e$) |
|---|---|
| Demand management | 0.01 |
| Time-of-day pricing | 0.21 |
| Power-load balancing | 0.38 |
| Power grid optimization | 0.33 |
| Integration of renewables in power generation | 0.85 |
| Virtual power plant | 0.04 |
| Integration of off-grid renewables and storage | 0.20 |
| Total | 2.02 |

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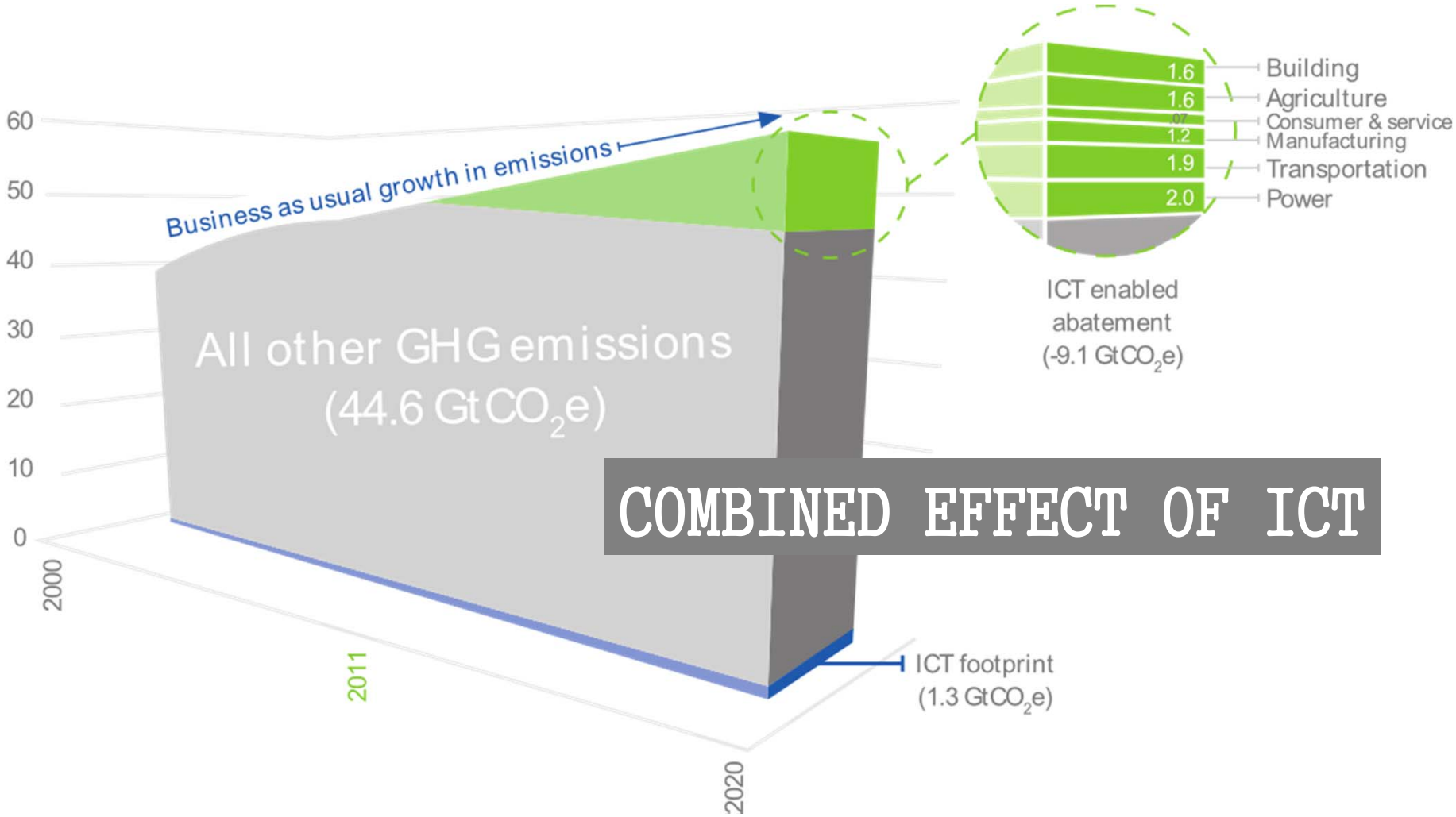


# COMBINED EFFECT OF ICT

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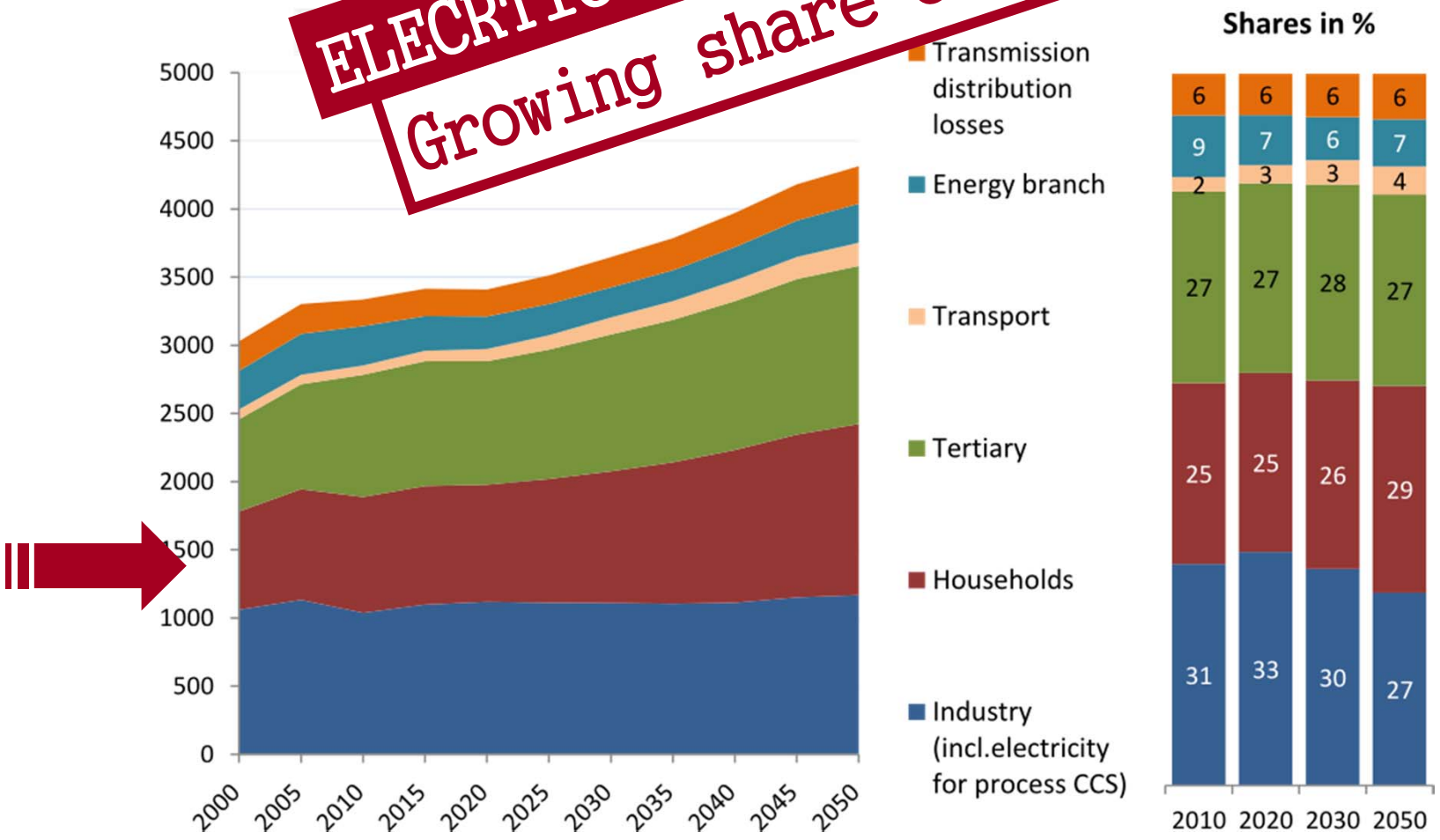
# ELECRTICITY DEMAND
## Growing share of households

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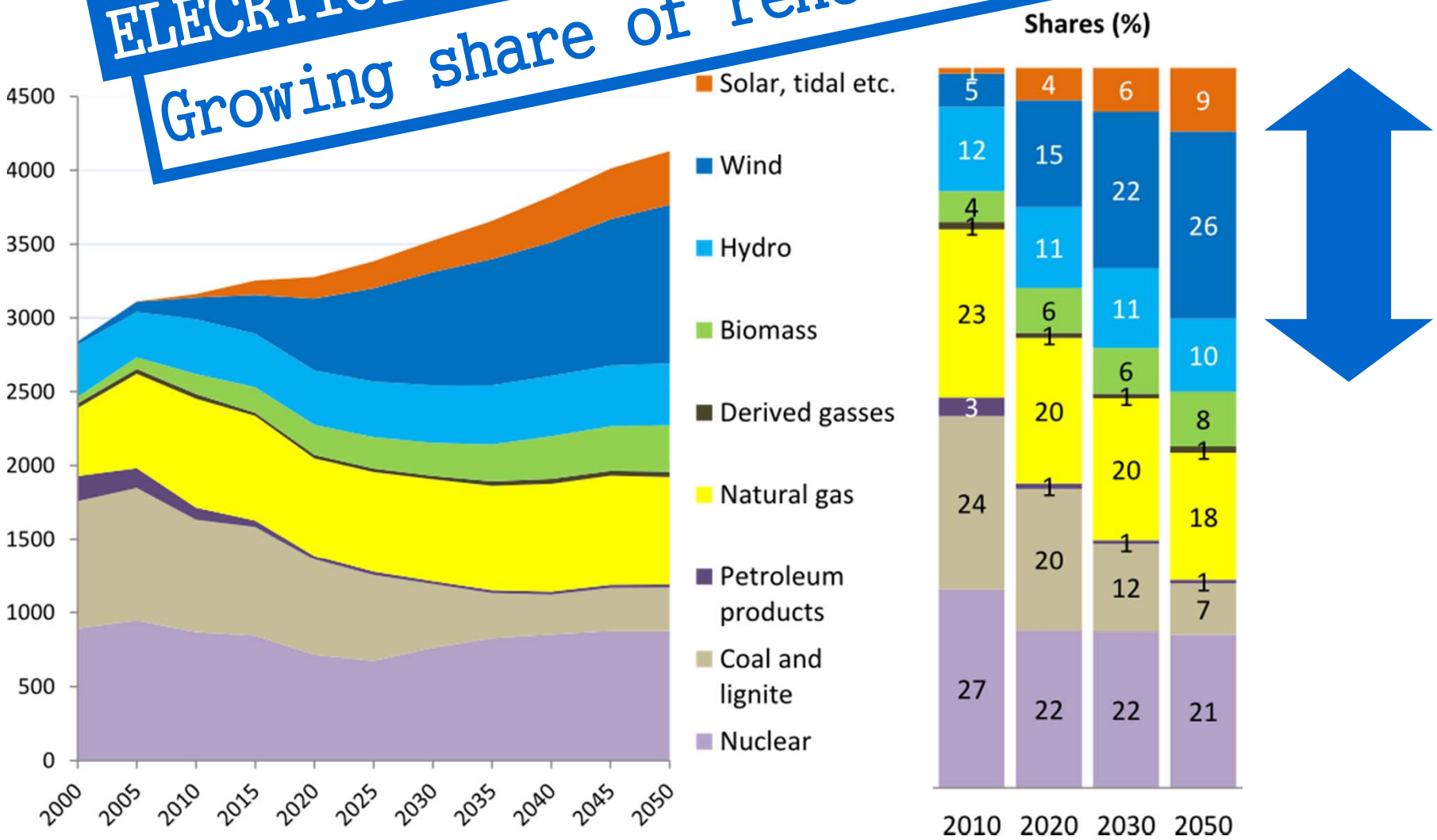
# ELECRTICITY GENERATION
## Growing share of renewables

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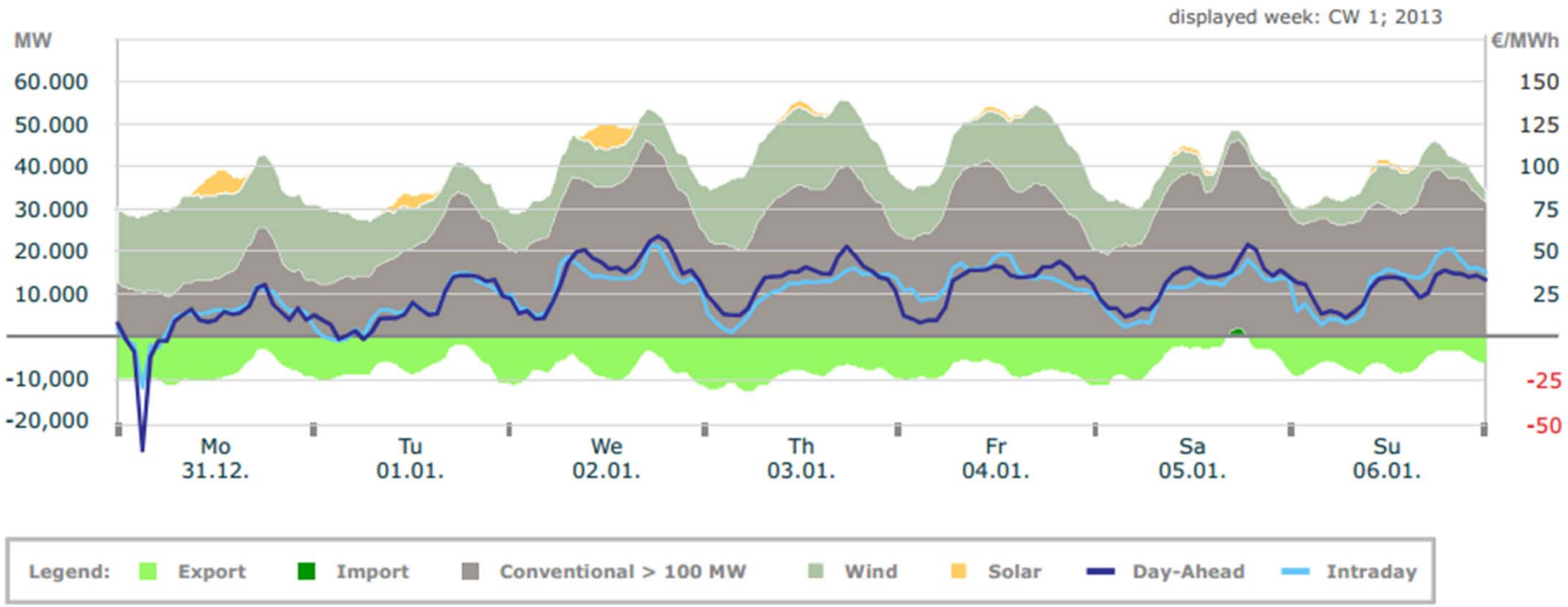
# RENEWABLES

## Vary over time

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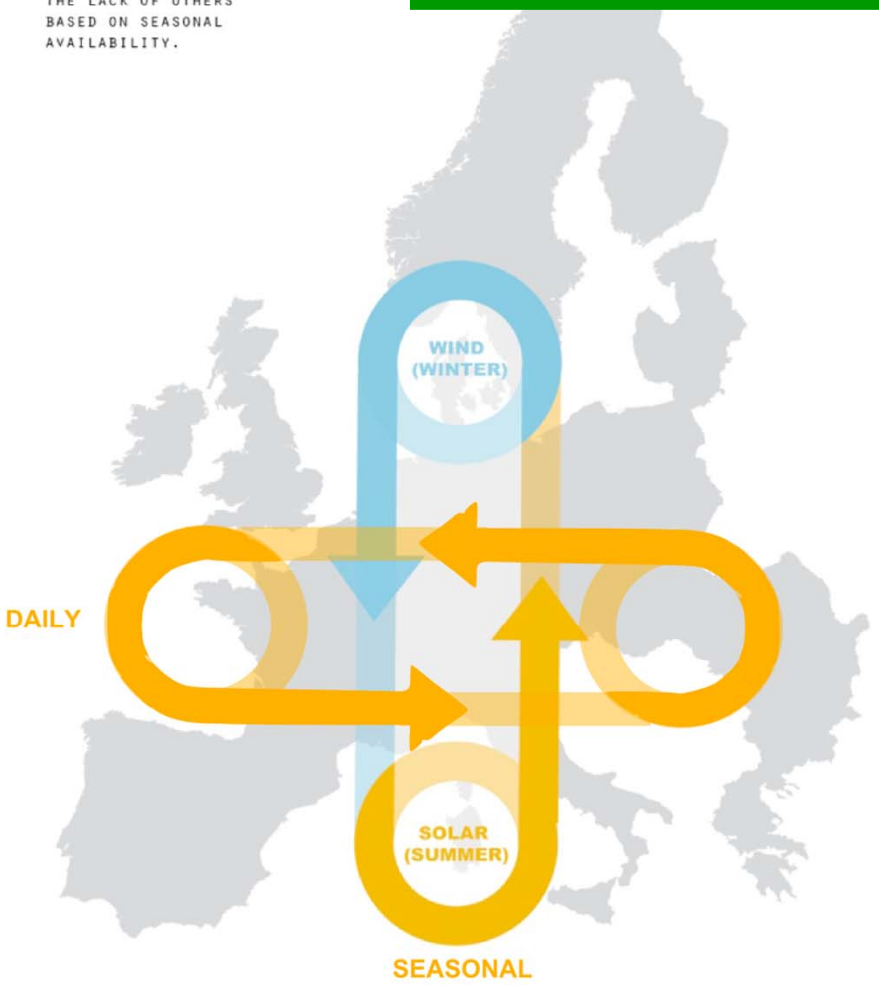
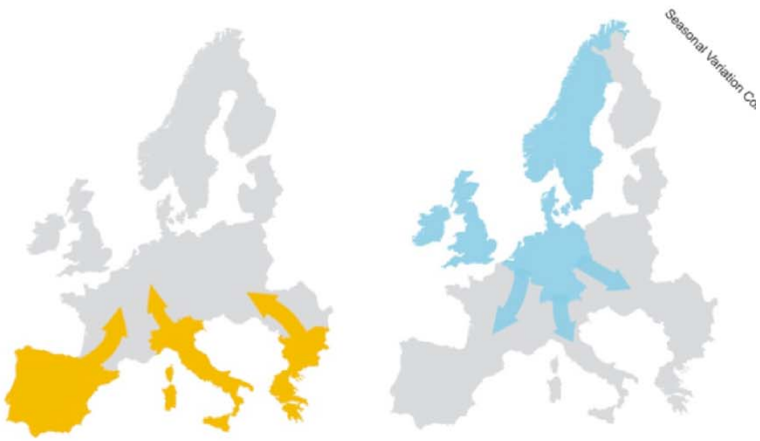
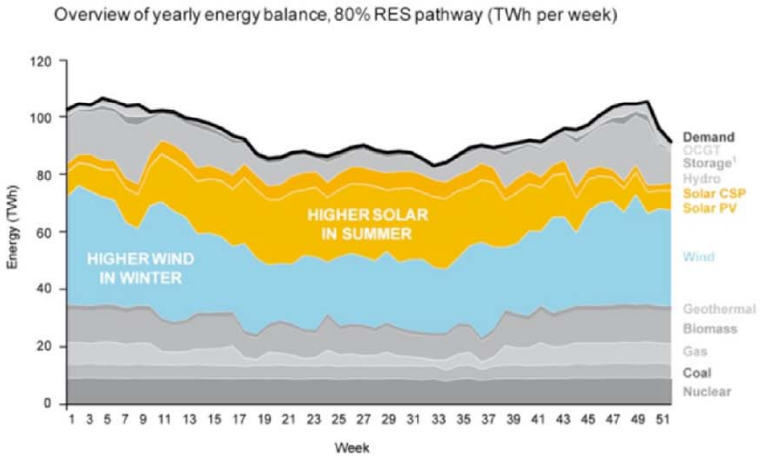
# RENEWABLES
## Vary in space

OVER THE
OF THE Y
INTEGRAT
EUROPE ALLOWS FOR
SOME ENERGY SOURCES
TO COMPENSATE FOR
THE LACK OF OTHERS
BASED ON SEASONAL
AVAILABILITY.

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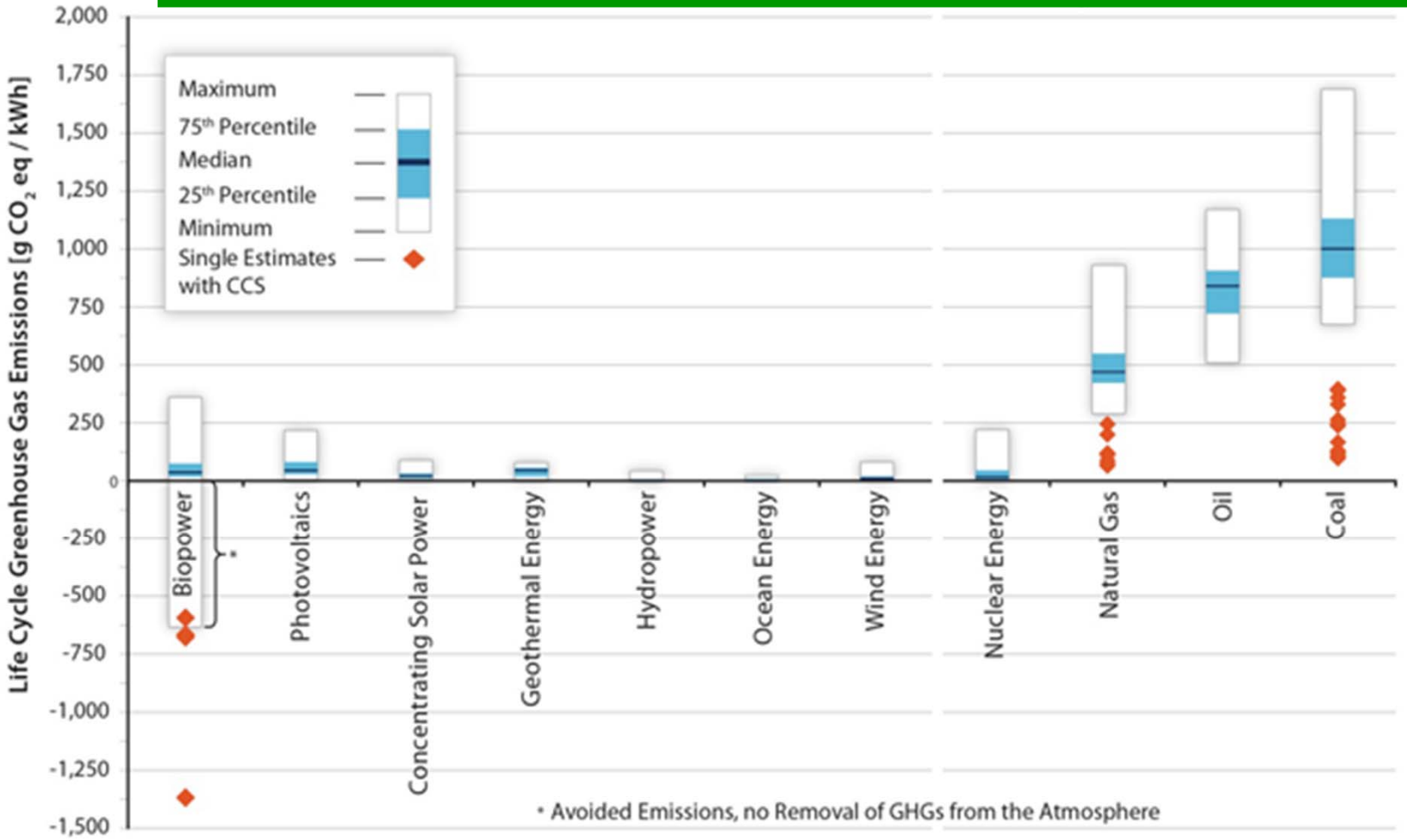
RENEWABLES

# Decouple emission from consumption

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## ENERGY

Should be used when and where it is available

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# FLEXIBILITY

Needed at both sides of the grid to keep the network at 50Hz in spite of uncertainty

## Network codes

## Primary reserve

1.5%

Unused capacity that can be activated in seconds

## Demand/Response

Changes in electric usage implemented directly or indirectly by end-use customers/prosumers from their current/normal consumption/injection patterns in response to certain signals

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# DEMAND-SIDE FLEXIBILITY

| Instrument | Nature | Reaction | Timescale | Scale |
|---|---|---|---|---|
| Contractual conditions | Static | Subject to decision | Months | Aggregator |
| Day-ahead market | Dynamic | Subject to decision | Days | Country |
| Intra-day market | Dynamic | Subject to decision | Hours | Country |
| Real-time price signal | Dynamic | Subject to decision | Minutes | Local-area |
| Control signals | Dynamic | Automatic | Seconds/minutes | From single site |

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# VALUE OF FLEXIBILITY

Every MW of primary reserve enables the connection of 66MW of renewables

Flattening consumption peaks and valleys reduce the need for overprovisioning

Demand-side flexibility reduces the need for underproduction

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# CO2 ABATEMENT POTENTIAL OF ICT

## Should take flexibility into account

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# ENERGY@HOME

Energy operators

Telco

Vendors

End-users

Global optimization

End-user engagement

Energy@home

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# ENERGY@HOME

Bridges the gap between smart energy grid and smart devices

Smart grid

Smart home

Smart device

Smart plugs

Not so smart devices

Energy@home

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# FLEXIBILITY@HOME

From 25% to 29% of electricity demand

Opportunism

Time shift

Space shift

Coordination

Load interruption

Motivation/Awareness

Price signals

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# FLEXIBILITY@HOME

Ideally

Smart grid

Home gateway

Smart appliances

Highly motivated end-users

Real-time price signals

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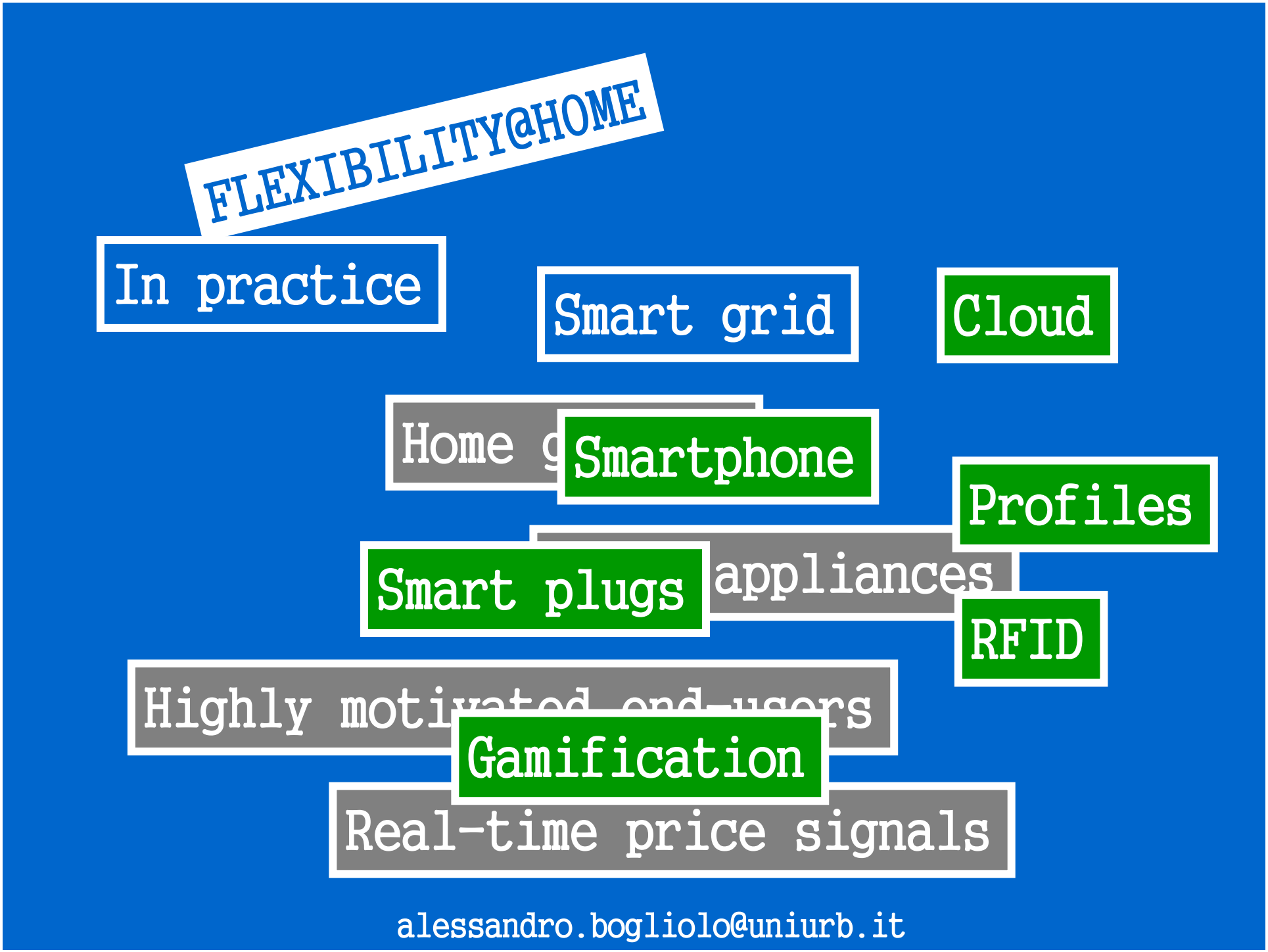
FLEXIBILITY@HOME
In practice
Smart grid
Cloud
Home g
Smartphone
Profiles
Smart plugs
appliances
RFID
Highly motivated end-users
Gamification
Real-time price signals
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# FLEXIBILITY@HOME Components

- Grid
- Building
- Home
- Appliance

Cloud

Profile repository

Flexibility meter

Advanced Smart Plug

RFID

Real-world mobile game

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# FLEXIBILITY@HOME Profiles

Power profiles with
interruptibility annotation

## ID

Vendor - appliance - cycle

## Characterization

Advanced smart plug + mobile app
Power disaggregation
Vendors' contribution

## Storage

Cloud-based open data repository

## Matching

Advanced smart plug / power disaggregation

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FLEXIBILITY@HOME

# Flexibility meter

Couter of the flexibility
Made available by a
building/home/customer

## Slack of scheduled tasks

Completion deadline

## Margins of working conditions

Temperature

## Interruptibility of ongoing cycles

As annotated in the profiles

## Overall electricity demand

Of scheduled/active tasks

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# FLEXIBILITY@HOME

## Gamification

Real-world mobile game
Providing additional incetives
Simulating real-time price signals

### Real world

Interaction with real-world appliances

### Game

Cooperation / Competition

### Price signals

According to a scoring function

### Emulation/Monetiztion

Costless test of new pricing models

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# FLEXIBILITY@HOME

Can be built soon on top of E@H

Relax access constraints

Engage endusers in unleashing houshold flexibility potential

Allow stakeholders to play with the flaxibility market

Pave the way to flexibility-aware policymaking and regulations

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