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Flexibility, distributed resources and multi-energy systems

International Institute for Energy System Integration
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Presentation Outline

Context: EU Energy policies

- ✓ Overall policy aims 2020 – 2030 - 2050
- ✓ Highlights

Flexibility needs

Flexibility answers

Integrating energy systems

2020 Policy, 2030 proposals

Energy – Climate objectives

- ✓ 2020: 20% renewable energy, up to 35% renewable electricity:
- ✓ 2030: 27% renewable energy, up to 45% renewable electricity (proposed)

Security of supply

- ✓ Diversified sources, emphasis on endogenous sources, combining concentrated and distributed generation
- ✓ Infrastructure to exploit evolving energy mix, efficient use of existing infrastructure, e.g. electricity & gas, increase of energy system robustness

Competitiveness

- ✓ Completion of a European market for electricity
- ✓ Enabling new services, new market opportunities

2050 EU Energy Roadmap: Main lessons

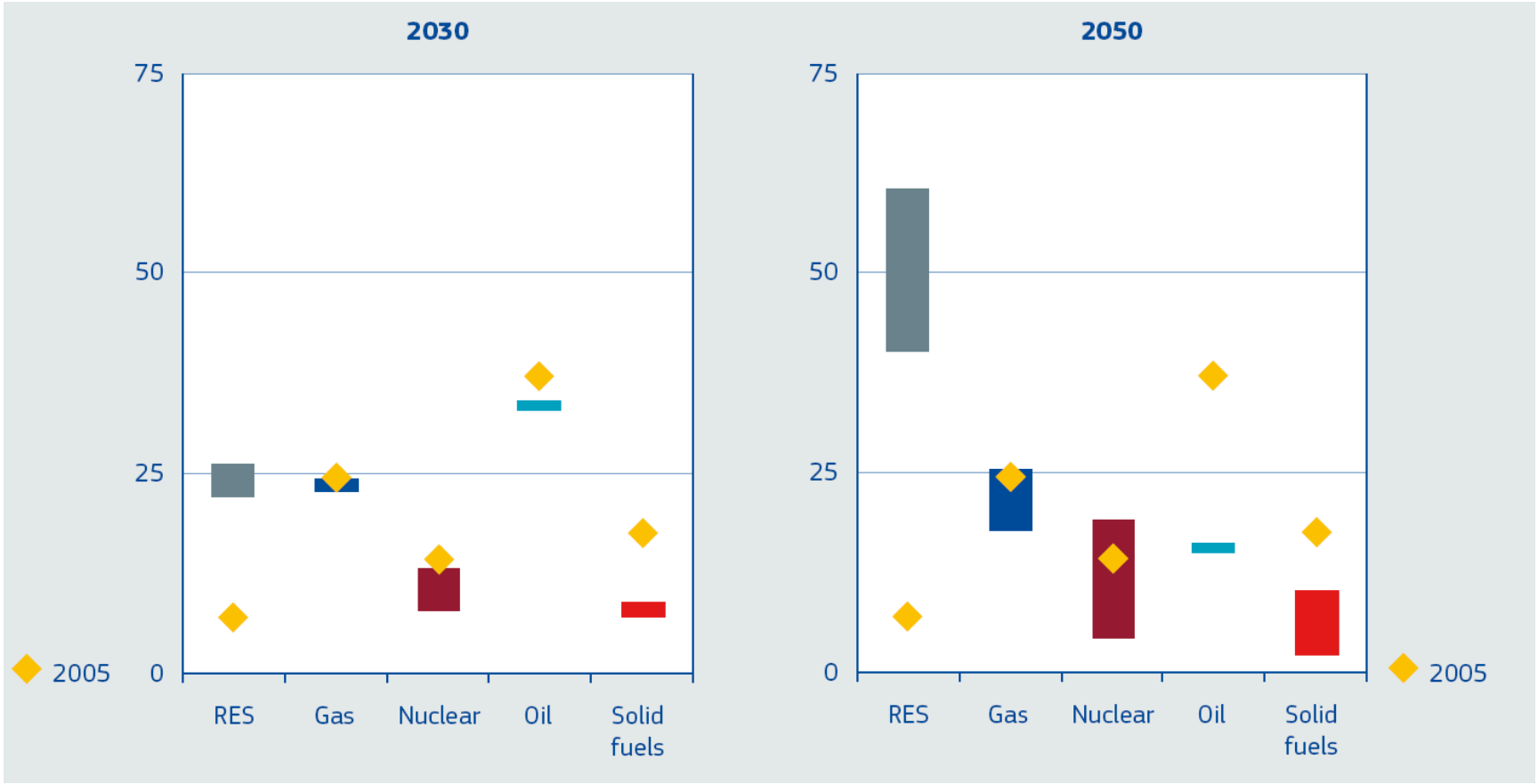
Decarbonisation of the energy system is possible

- ✓ No significant cost penalty with respect to "current policies" scenario

Transition from today's energy system needs to be prepared

- ✓ Need for very significant increase in energy efficiency
- ✓ Very significant increase of renewable energy in the mix
- ✓ From high variable costs to higher capital costs
- ✓ Lower dependence on fossil fuels
- ✓ Large increase of the use of electricity as an energy vector
- ✓ Important investments needed in electricity grids
- ✓ Very significant decarbonisation of electricity production: ±60% (2030), >95% (2050)

2050 Roadmap Energy Mix (primary)



Need for flexibility in the power system

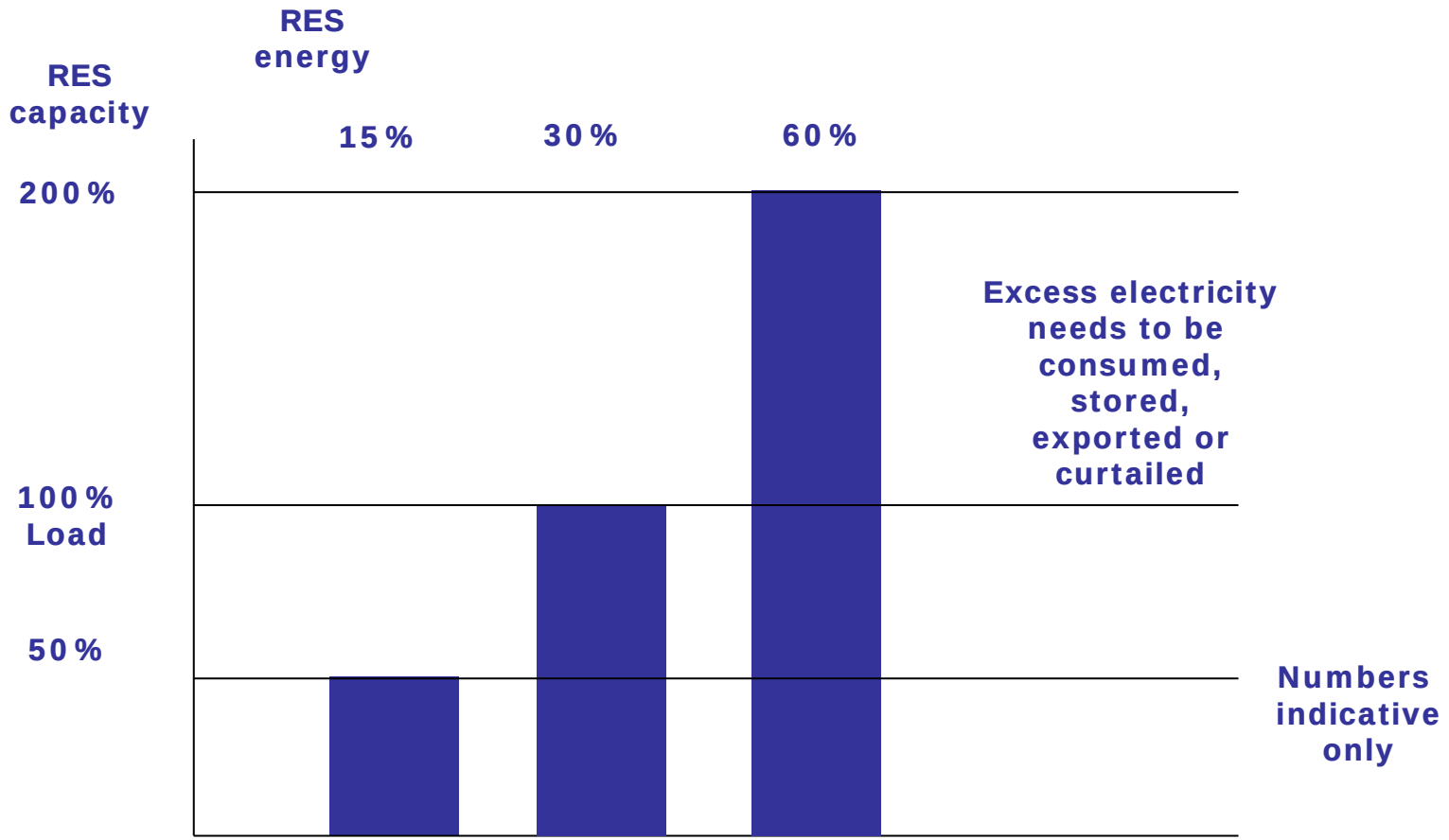
Variable renewable generation in Europe (end 2013)

- ✓ Wind: 121 GW (source: GWEC)
- ✓ Photovoltaic: 80 GW (source: EPIA)
- ✓ Peak/average Load: 530/380 GW (source: ENTSO-E)
- ✓ Not uniform: much higher concentration in DE, DK, ES, IT, IE, ...

Challenges

- ✓ Events with renewable generation > load at national level
- ✓ Inaccuracies in prediction of wind / solar power
  example: unforeseen fog leading to 8800 MW PV day-ahead error in DE
- ✓ Very high ramp rates
- ✓ High frequency volatility
- ✓ "Trading errors" due to trading on 1hr basis

RES Electricity: Energy – Capacity



Inspired by Mainova

Where can excess electricity be sent?

Current RES deployment concentrated in areas with better potential

- ✓ Wind parks in more windy areas
- ✓ PV in more sunny areas
- ✓ Some rural areas become net exporters – grid stress from generation
- ✓ Urban areas are net importers

More dispersed RES in the future?

- ✓ Many rural areas expected to become net exporters – planning?
- ✓ Urban areas remain net importers
- ✓ Important amount of "local" balancing (within +- 100 km)?

Important change at local distribution level

Also important need for regional/pan-European exchange

- ✓ Offshore wind, hydropower, concentrated solar, etc.

Storing or consuming excess energy?

40 MJ (+- 11kWh) corresponds approximately to :

Fossil fuels

- ✓ Gasoline: 0.9 kg (1.1 litre)
- ✓ Natural gas: 0.8 kg (1m^3)

Storage

- ✓ Electrochemical: Lithium-Ion battery: 50-100 kg
  (Current compact EV's: +- 6-24kWh, mid-term to 40kWh?)
- ✓ Mechanical (Pumped Hydro): 1m^3 of water at 4,000 meters
  Very large reservoirs available, mostly exploited in Europe
- ✓ Heat: 1m^3 of water heated by 10 °C
  Important unexploited potential

"Storage in the output product"

- ✓ Example: (Energy to produce) Aluminum: 0.7 – 0.85 kg

Importance of chemical and heat vectors for delivery & storage

Enlarging the scope of balancing

To include:

- ✓ Multiple vectors: electricity, gas, heating, cooling, H2, etc.
- ✓ Multiple inputs: electricity, fuels, RES heating & cooling, geothermal, etc.
- ✓ Conversion, delivery, storage, consumption
- ✓ Multiple outputs: including fuels, heating, processes, water, H2, etc.

Scale of balancing:

- ✓ Optimisation of different vectors at local level:
  building? district? City/ community?
- ✓ Some imbalances remain in an optimised system
- ✓ Regional & continental approaches, e.g. electricity and gas transmission

Power-to-x?

Power-to-heat

- ✓ Important intrinsic inertia, can be multiplied at limited cost
- ✓ Heating/cooling networks in some cities

Power-to-gas (H2 or synthetic gas)

- ✓ Exploiting the important gas storage and delivery infrastructure
- ✓ Efficiencies to be improved

Power-to-transport

- ✓ Exploiting the storage needed for the transport application
- ✓ Technical issues for EV/PHEV mostly resolved, starting rollout
- ✓ Many competing market models

Power-to-fuel, to chemicals, etc.

Detailed low-GHG energy scenarios 2050

Many detailed studies at national level covering e.g.

Substantial energy efficiency gains

Consumption: heating

- ✓ Solar heating, ground heat pumps, air heat pumps
- ✓ Biomass CHP;
- ✓ District heating/cooling grids, heat storage

Consumption: transport

- ✓ Battery electric vehicles, fuel-cell electric vehicles
- ✓ ICE-based vehicles: from power-to-gas, power-to-fuel, biofuel

Consumption: other electricity

- ✓ From wind – onshore & offshore, solar, hydro, biomass

Important to detail the logistics in time and space

Source: inspired by Mainova

SET Plan Integrated Roadmap

I. Energy Efficiency

II. Competitive, Efficient, Secure, Sustainable & Flexible Energy System

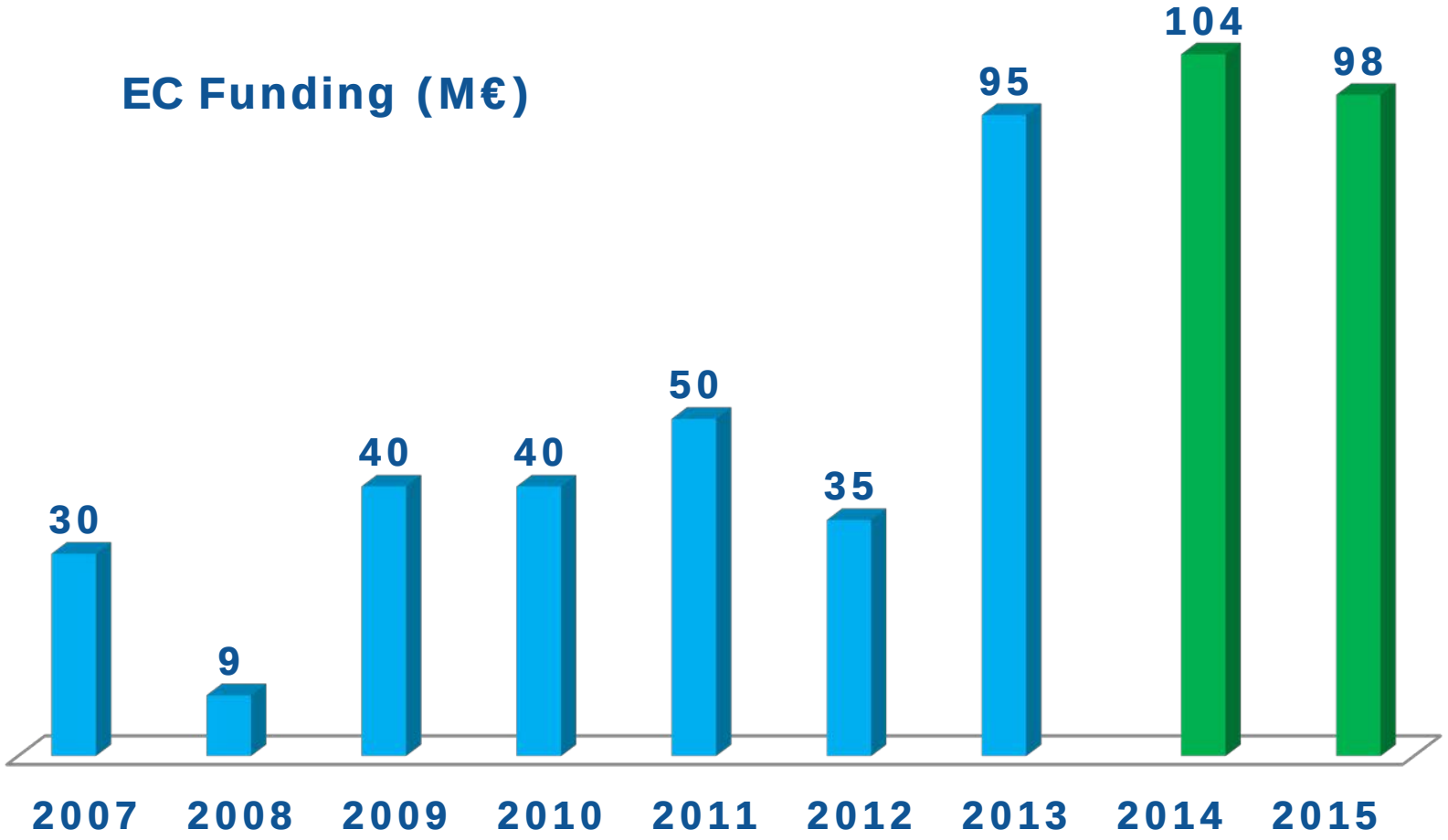
III. Smart Cities & Communities; Market Uptake Measures

IV. Synergies, Roles & Tasks of Actors

V. Monitoring & Review

European Commission

Grids & Storage FP7 – Horizon2020



Research and Innovation

FP7 electricity grids projects started 2013, opportunities for collaboration

New roles and tools for DSO's:

- ✓ INCREASE – 1 September 2013
- ✓ evolvDSO – 1 September 2013
- ✓ IDE4L – 1 September 2013
- ✓ DREAM – 1 September 2013

Integration of Electric Vehicles:

- ✓ Impact on DSO network planning: PlanGridEV – 1 September 2013
- ✓ Interface conformance testing: COTEVOS – 1 September 2013

Transmission projects:

- ✓ Reliability & Risk assessment : GARPUR – 1 September 2013
- ✓ Stakeholder support: INSPIRE-GRID – 1 October 2013
- ✓ Large-scale demonstration of wind integration technology (in negotiation)

Integrated Research Programme

- ✓ EERA Joint Programme Smart Grids: ELECTRA - 1 December 2013

Thank you

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http://www.smartgrids.eu/

http://www.gridplus.eu/

http://ec.europa.eu/research/energy/index_en.cfm

http://ses.jrc.ec.europa.eu/smart-grids-observatory

http://ec.europa.eu/energy/index_en.htm