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Flexibility from bioenergy - The role of bioenergy in balancing the electricity grid and providing storage options

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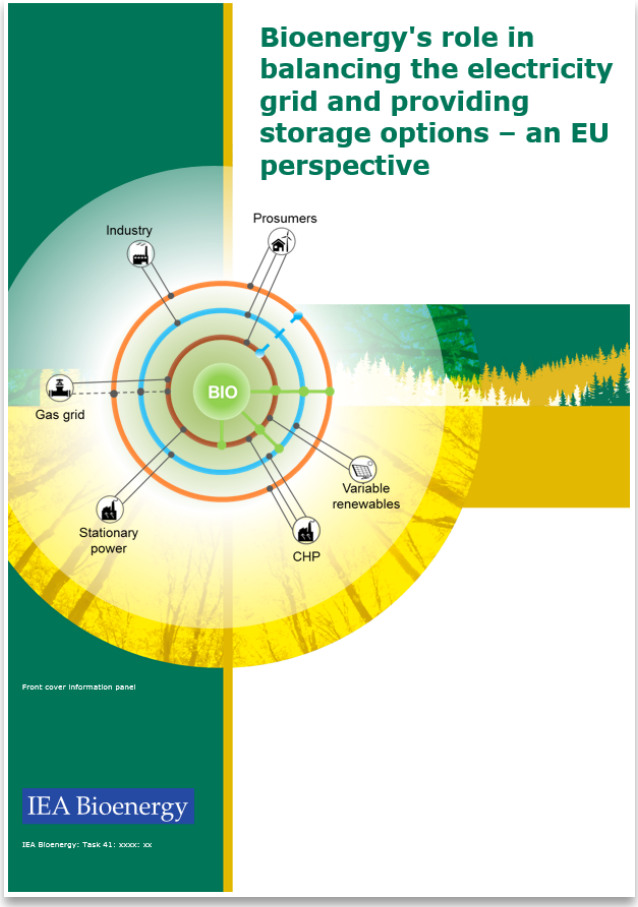

http://www.ieabioenergy.com/wp-content/uploads/2017/02/IEA-Bioenergy-bio-in-balancing-grid_master-FINAL.pdf

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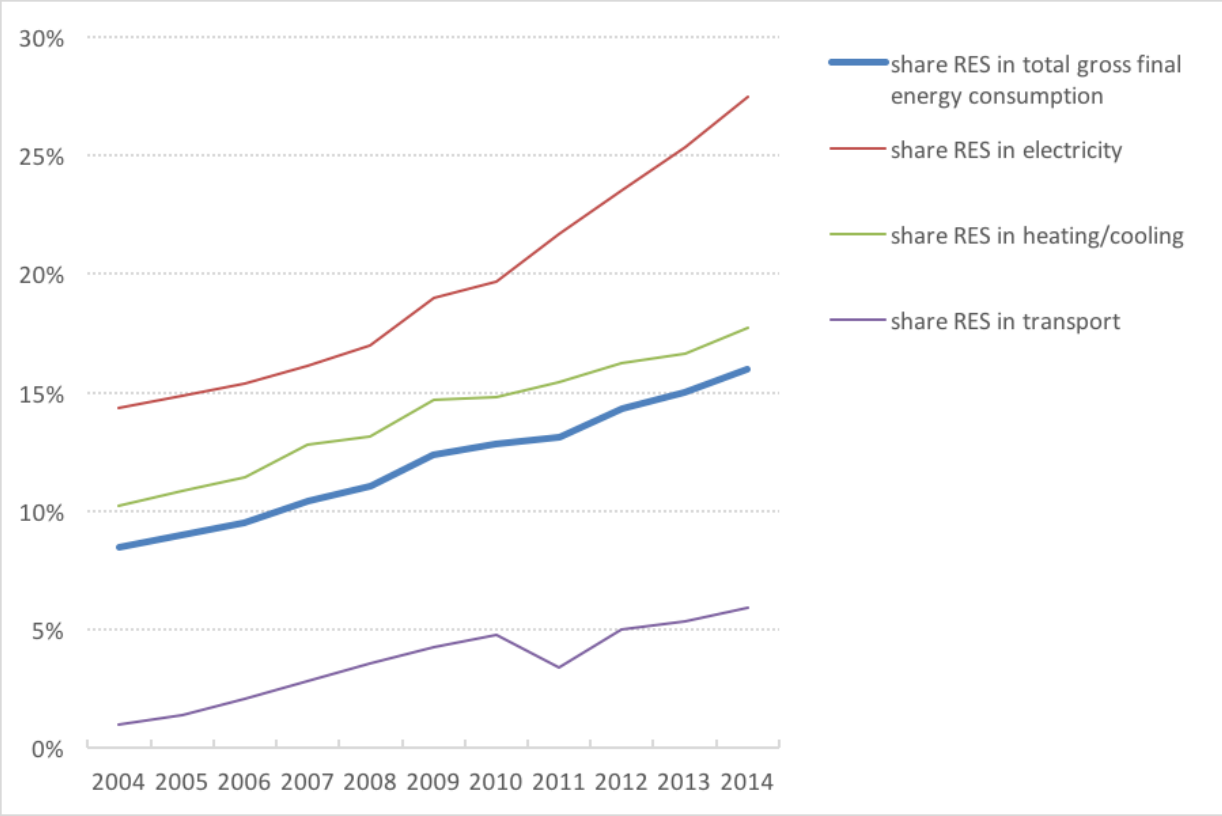
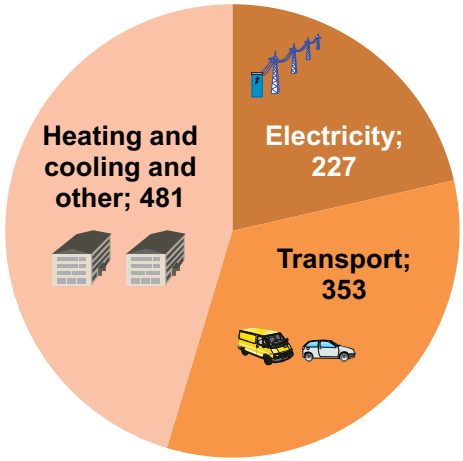
Role of renewables, bioenergy and bioelectricity today



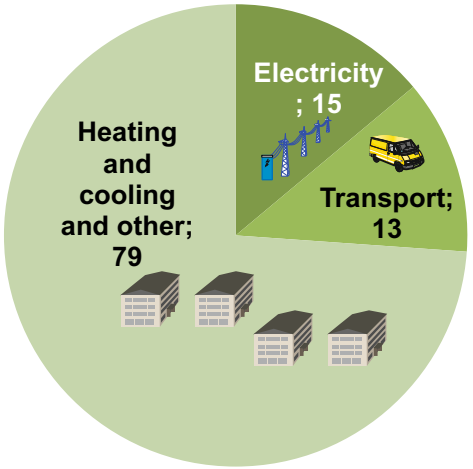
Development of the share of renewable energy in gross final energy consumption and in the three energy sectors: electricity, heating and transport EU 28 (Eurostat 2016)

Heating and cooling – a not so well hidden secret

EU-28 Final energy consumption in 2014, 1 061 Mtoe



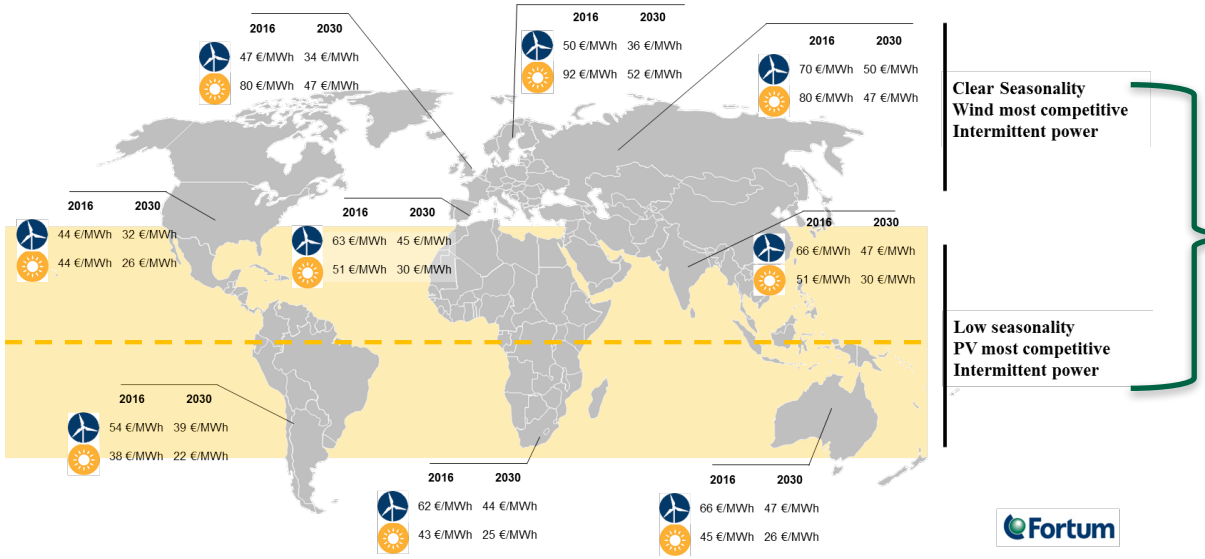
EU-28 Bioenergy in final energy consumption in 2014, 107 Mtoe



Proportion of heating and cooling in total final energy consumption and final energy consumption of bioenergy in EU 28 (2014, Mtoe)

Changing roles, market drivers and business models

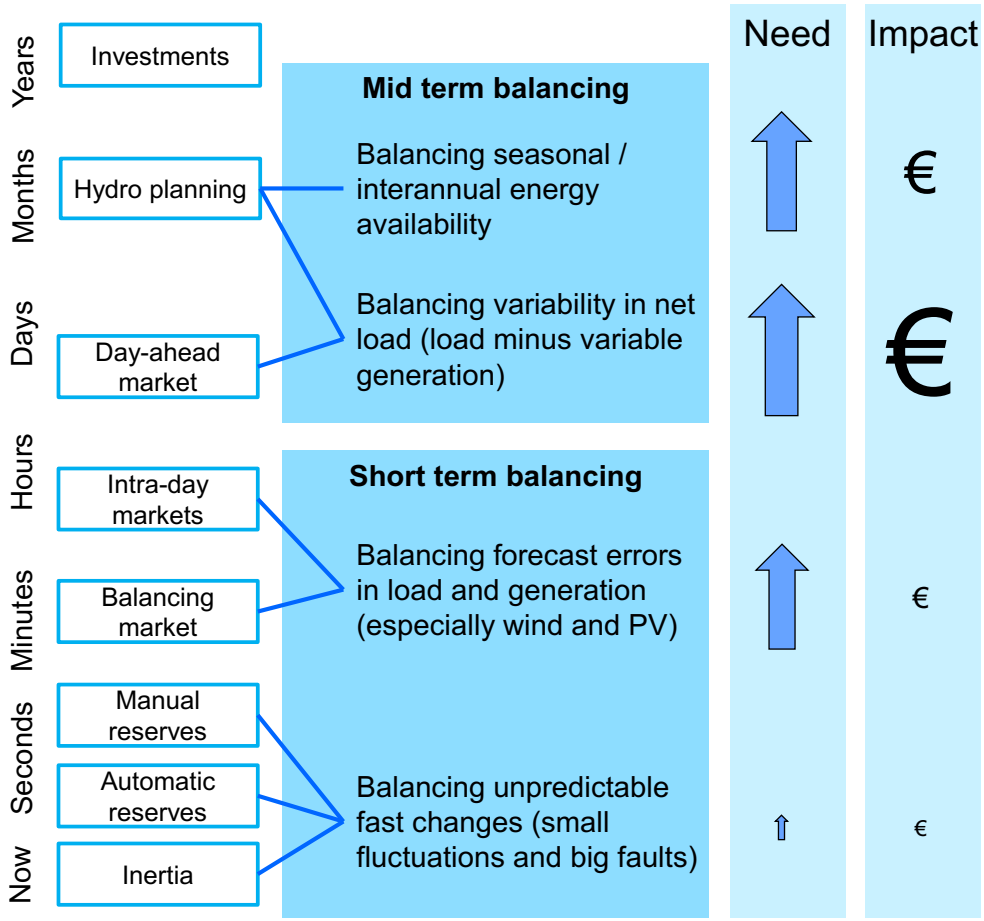
In Europe, 2030 targets and renewable, solar and wind electricity penetration drives market change



Electrification and price formation change the role of consumables and grids and earning logics will drive change and create new business models

Solar and wind energy resources and associated levelised cost of electricity [Langer, Energy market transformation from energy optimized to capacity optimized system, 16.8.2016, Helsinki]

Value of balancing



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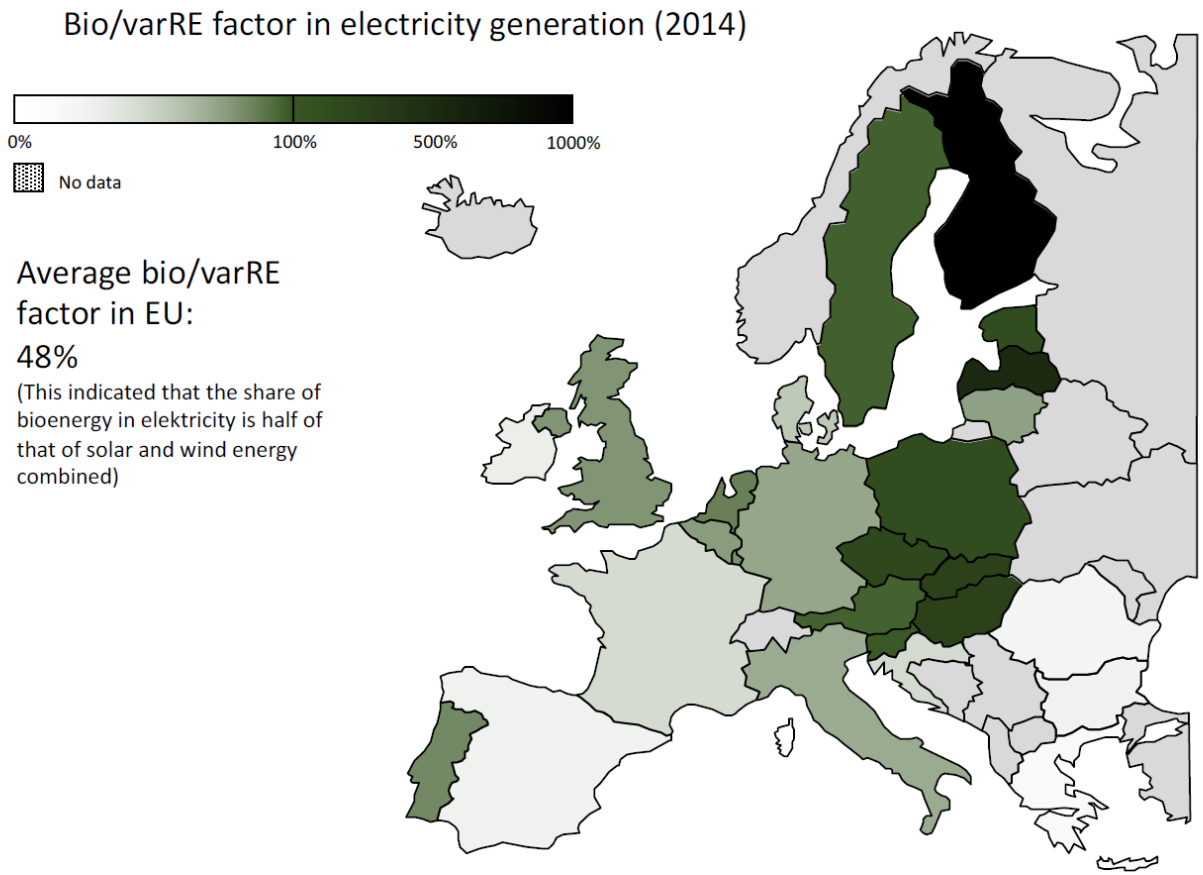
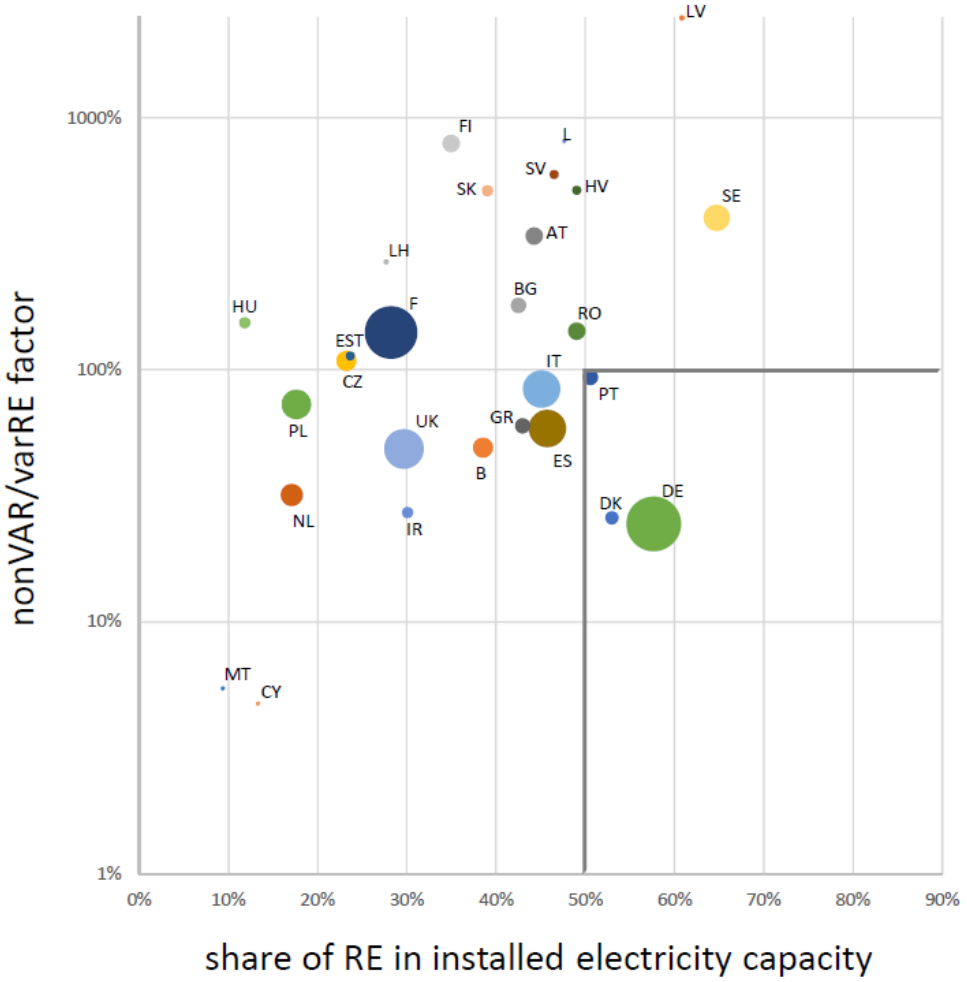
Share of bioelectricity and variable renewable electricity



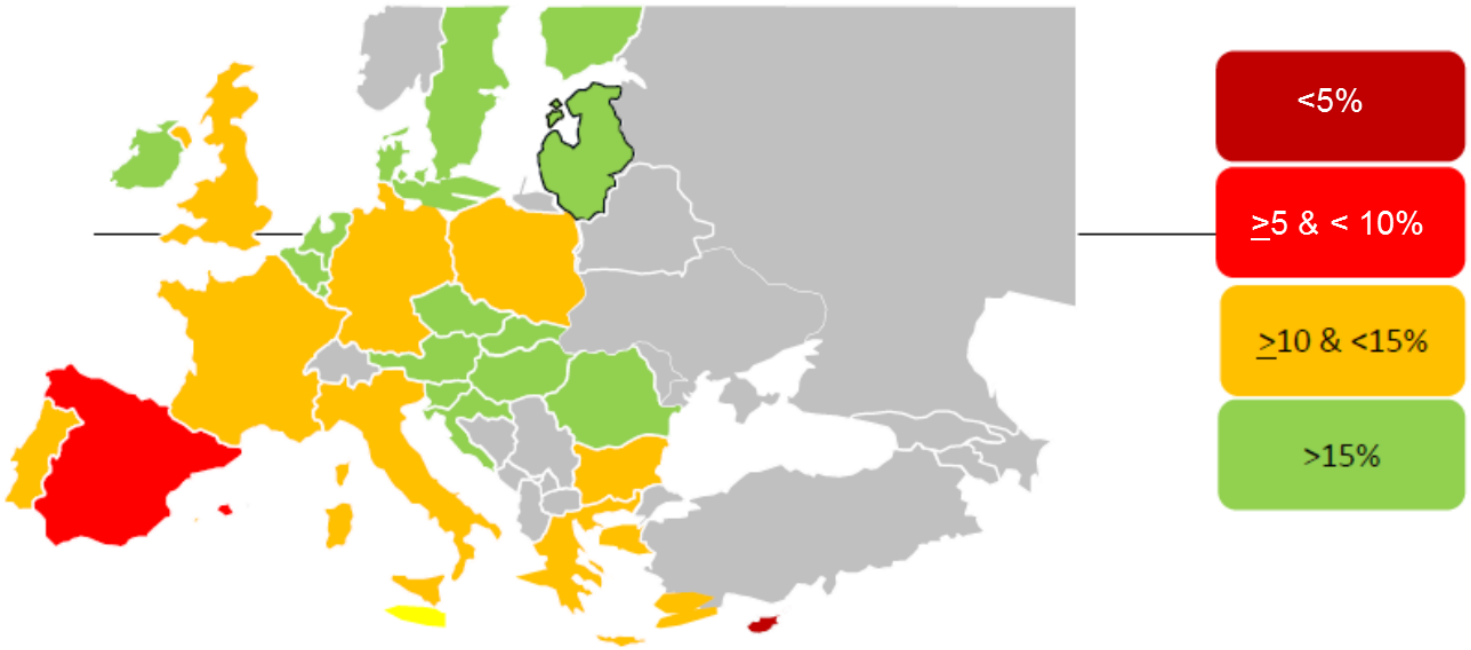
Based on: Eurostat, Eurobserver, 2015

Bio and variable RE in installed electricity capacity



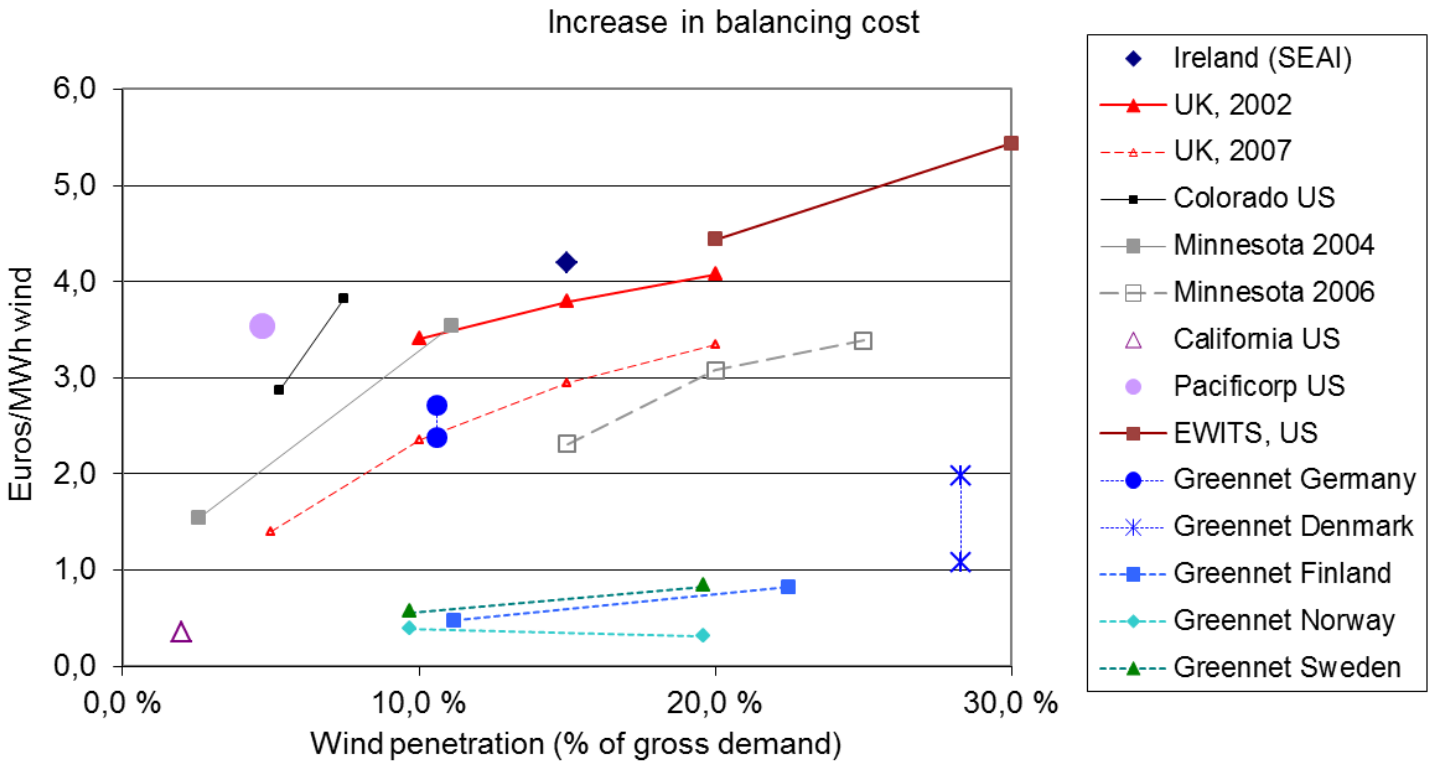
Ratio between bio and variable RE in installed electricity capacity in 2014 (the size of the dots reflects the total TWh generated electricity).

Grid connections – where is the need for balancing?



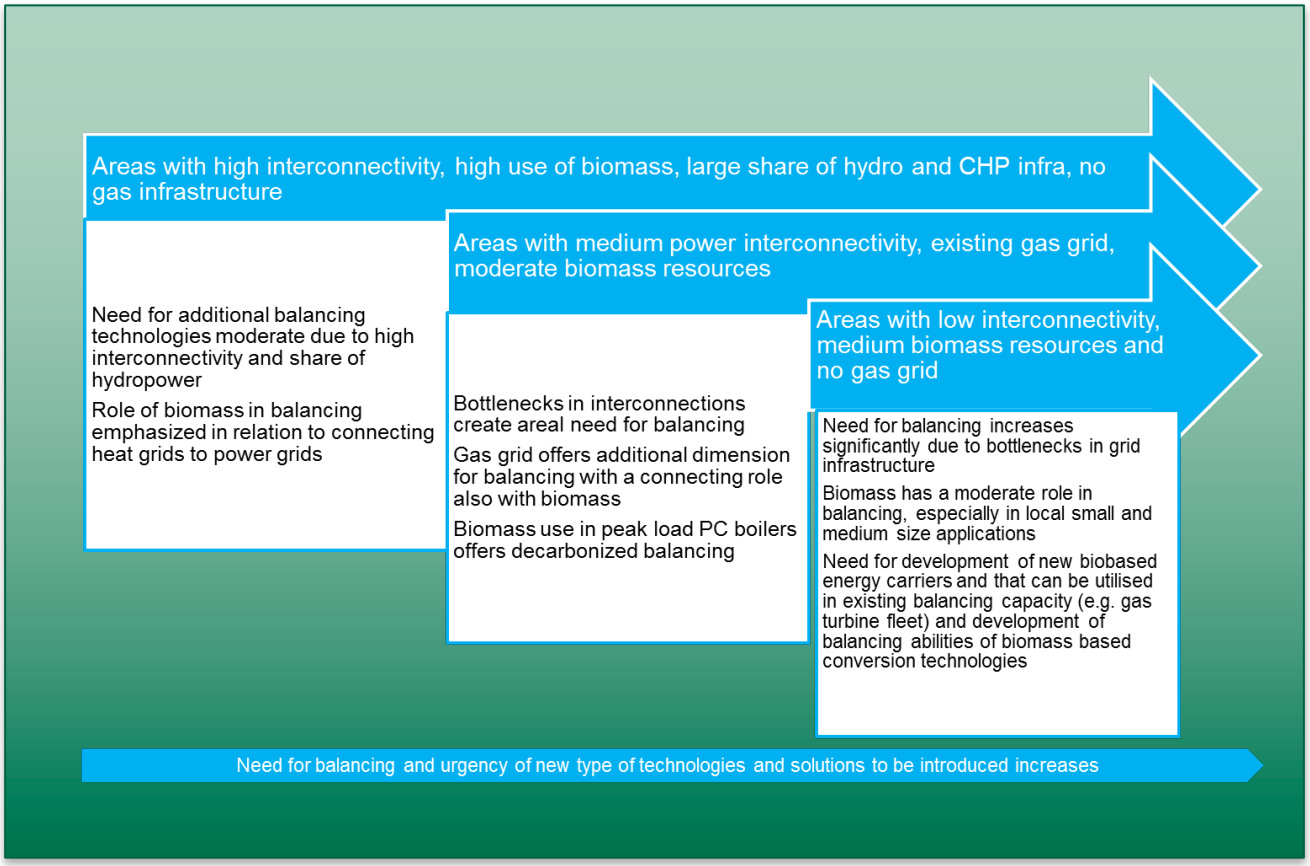
Expected status of grid interconnection capacity level 2020 after implementation of PCI

”True” need of balancing capacity



Holttinen et al. Design and operation of power systems with large amounts of wind power, Final summary report, IEA WIND Task 25, Phase two 2009–2011. VTT Technology 75, Espoo 2013

Regional differences are significant



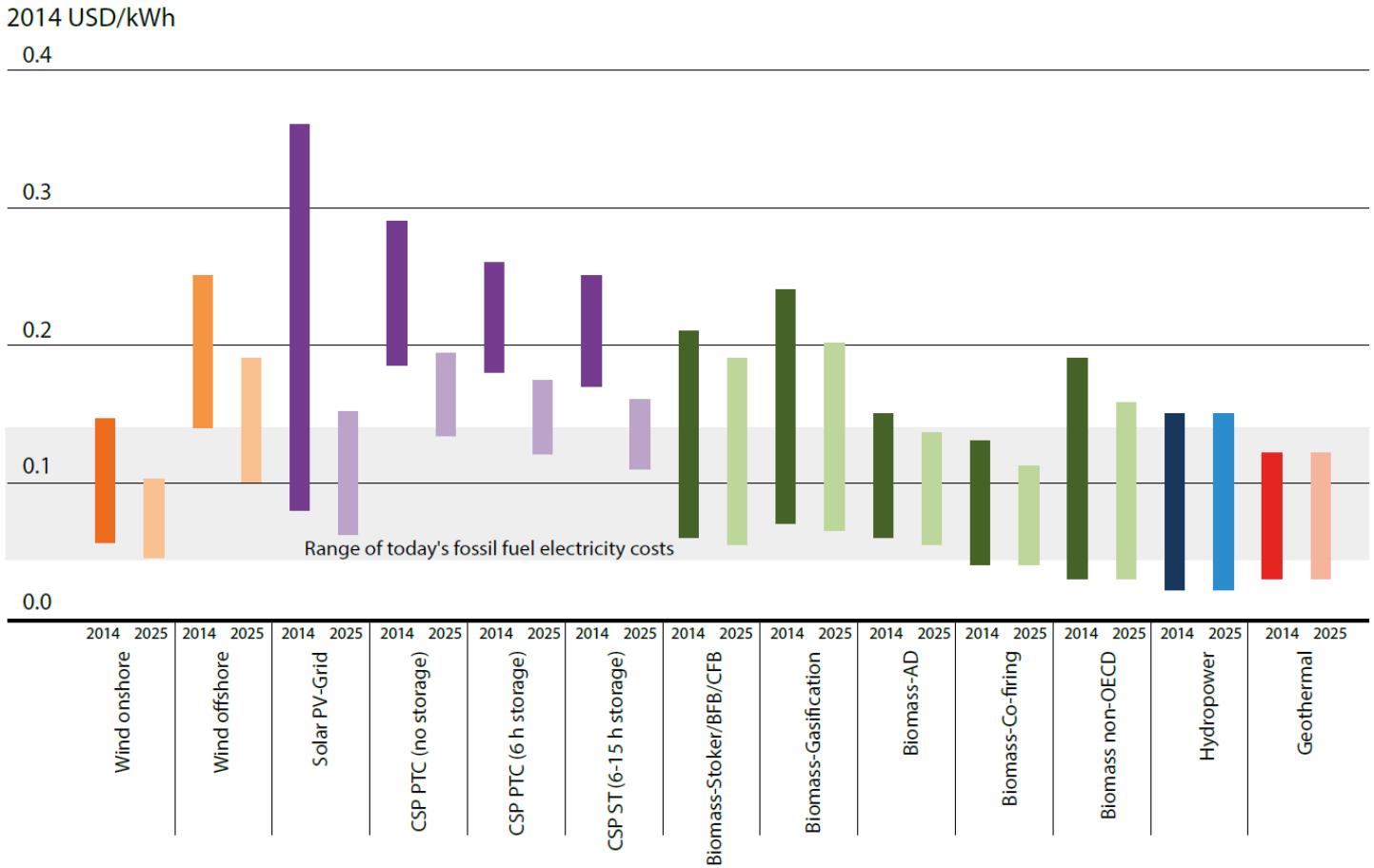
Opportunities for bioenergy in balancing the grid

- **Biogas**
  - Gas engines and gas turbines which have a quick response time, even from a cold start, as well as high ramping capabilities
  - Storage, potential?
- **Bioliquids**
  - Engines and gas turbines as well as in boilers for heating applications
- **Solid biomass**
  - Dedicated power plants, as a co-firing fuel in fossil (coal) plants
  - Slower response times -> seasonal balancing
- **Biomass in district heating and industrial CHP systems**
  - Slower response times -> seasonal balancing
  - Connection to heat grid brings significant additional balancing component

EXAMPLES OF FUTURE ASSETS FOR GRID BALANCING

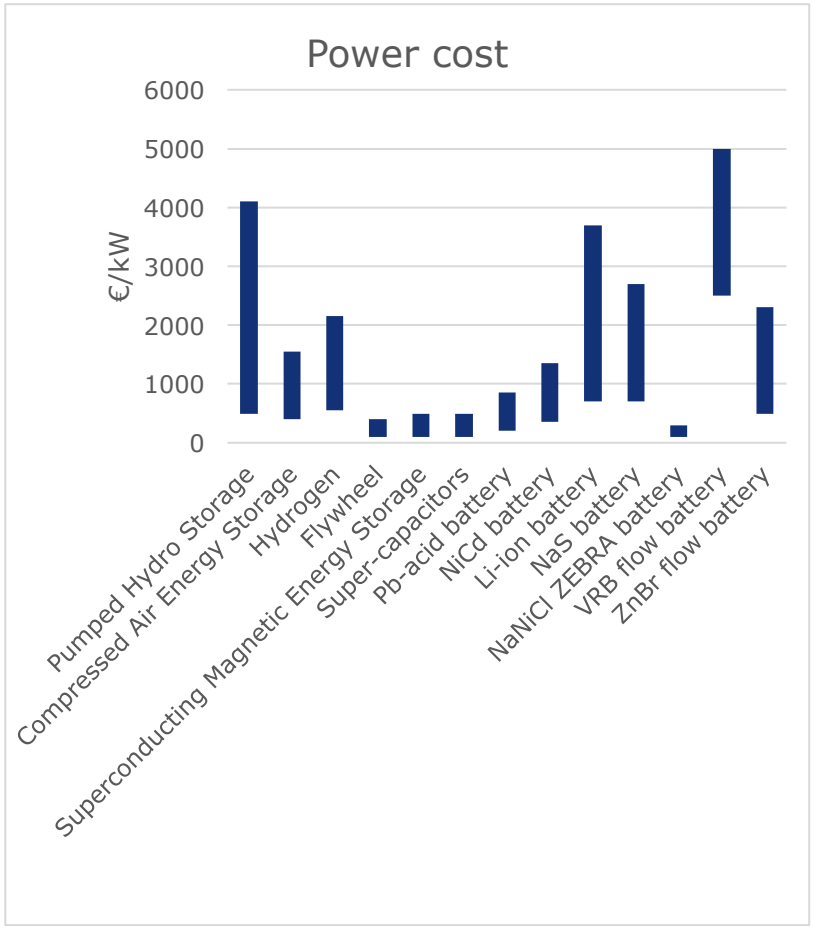
- Wide availability of biofuels also for peak electricity production
- H2 boosting as a means to store the "excess electricity"
  - Hydro treating of HVO, PO and HTL liquids (primarily for transport sector)
  - Upgrading of biogas
  - Gasification-based biofuels
- BIO-CCS and BIO-CCU providing rolling capacity as they enable negative GHG emissions creating a revenue stream decoupled from electricity market prices

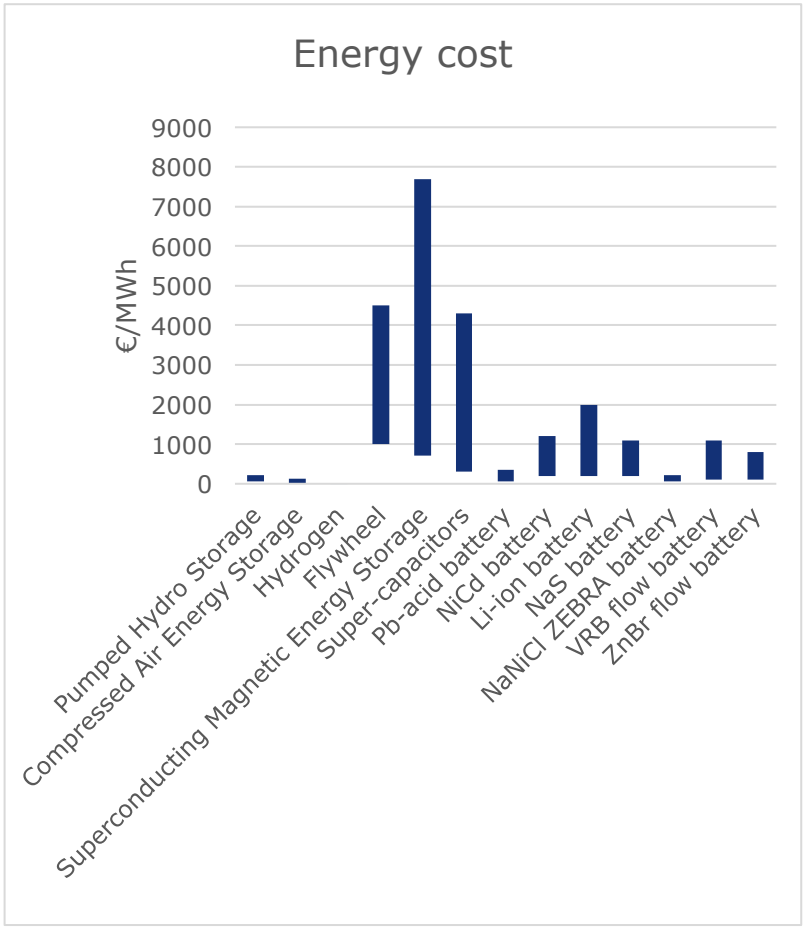
Cost of different technologies



Levelised cost of electricity (LCOE, US$/kWh) ranges by renewable power generation technology, 2014 and 2025 [IRENA, 2015]

Cost of storage technologies

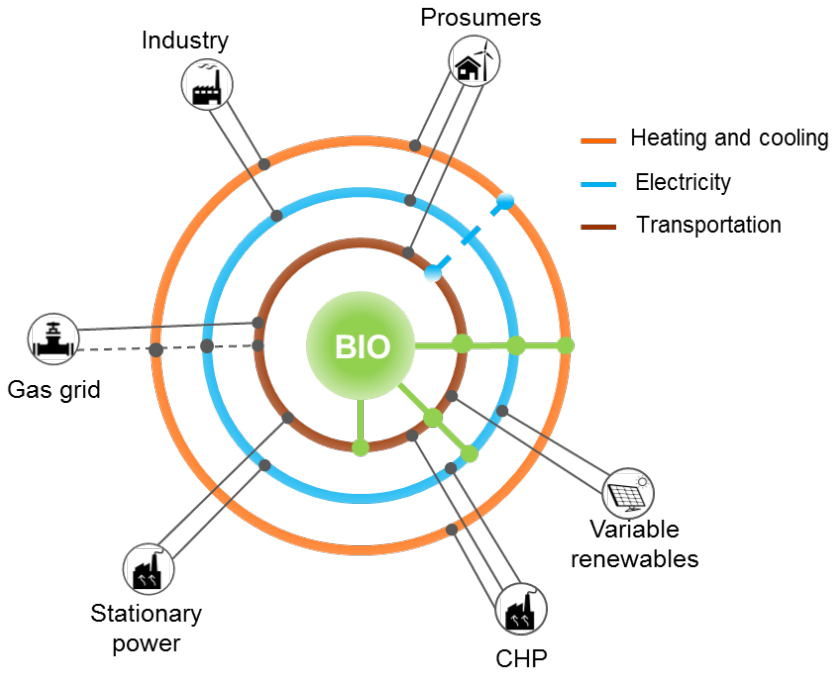




Bioenergy enables smooth transition

- Smart integration in system, area and production concept level offer most cost effective solutions
- There are state of the art biomass conversion technologies now entering the market that can provide storable fuels that could be used also for balancing (i.e. cellulosic ethanol and 2nd generation biodiesel).
- In the future new technologies and/or value chains are expected to come to the market, some with more dedicated approach to balancing. For example, periods with low electricity prices could be used to turn electricity into hydrogen which could be used in biofuel production.

Energy system that is significantly more distributed, interconnected and flexible than today's !



Conclusions

- In general **biomass can play a role in balancing** the grid as bioenergy dispatchable nature
  - A wide range of possible technical options exist to implement balancing actions
  - Most current biomass power plants have not been designed with grid balancing in mind, yet they can be optimised to incorporate more balancing aspects.
- **Biomass is largely used** in residential and industrial heat production and CHP (combined heat and power). Whereas the **conversion itself is not highly flexible, connecting it to a heat system brings significant additional flexibility opportunities**.
- Potential, role and technologies for balancing the power grid **varies significantly between regions** mainly due to differences in the current use and availability of biomass, existing infrastructure (such as gas grid) and the degree of grid interconnectivity and thus need for balancing capacity.
- Currently, the **role of bioenergy in balancing is increasing as time interval of balancing increases**, being most significant in **seasonal balancing especially in connection with heat grids**. The role in the future is seen to develop more towards short term balancing as the balancing needs also increase due to the increasing share of variable power generation.

Strengthening future role of bioenergy

- Three potential **technology development** paths can be identified in order to strengthen the role biomass can have in low carbon energy system
  - increasing the flexibility of existing assets by increasing flexibility of individual biomass installations and promoting smart integration of energy carrier distribution grids
  - developing more advanced biomass based energy carriers more suitable for electricity generation fleet capable for balancing operation
  - developing next generation concepts including wise biogenic CO_2 utilization and smart integration of renewable hydrogen.

Role must be based on **understanding of market need**, market change and formation of new business models

Thank you!

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