



Impacts of regulatory and market design trends on RES(-E) pathways



Topical workshop:

Electricity markets and RES integration

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Workflow

Key challenges of electricity market design



Potential design elements to cope with these challenges



Current trends in electricity market design and regulation



Implications of design elements on RES pathways

Input

- WHAT design trends to consider?
- HOW are they composed?

Method

- WHAT are suitable methods?
- HOW are they applied and combined?

Output

- WHAT characteristics should be assessed?
- HOW can the impact be interpreted?

Input

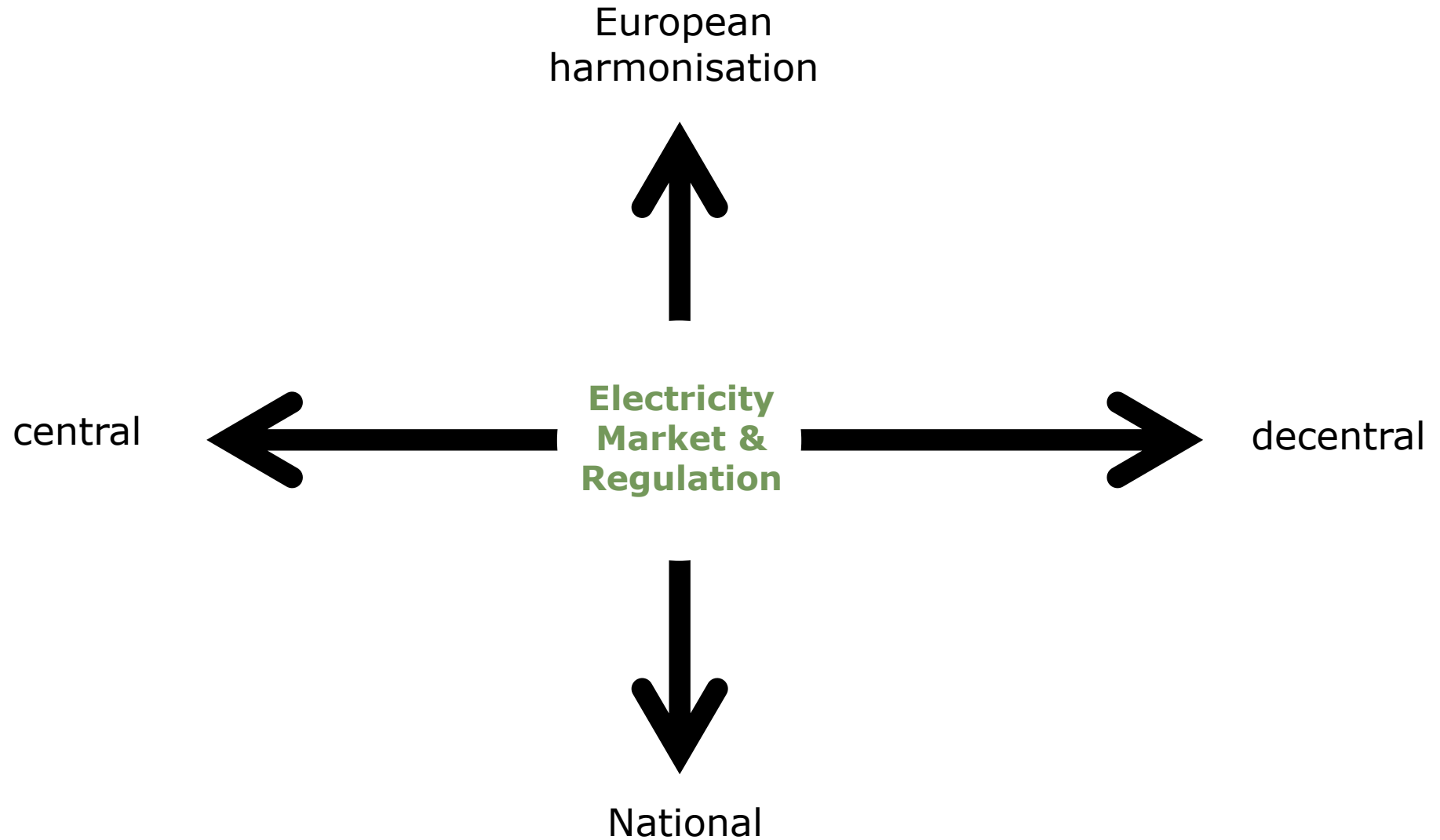
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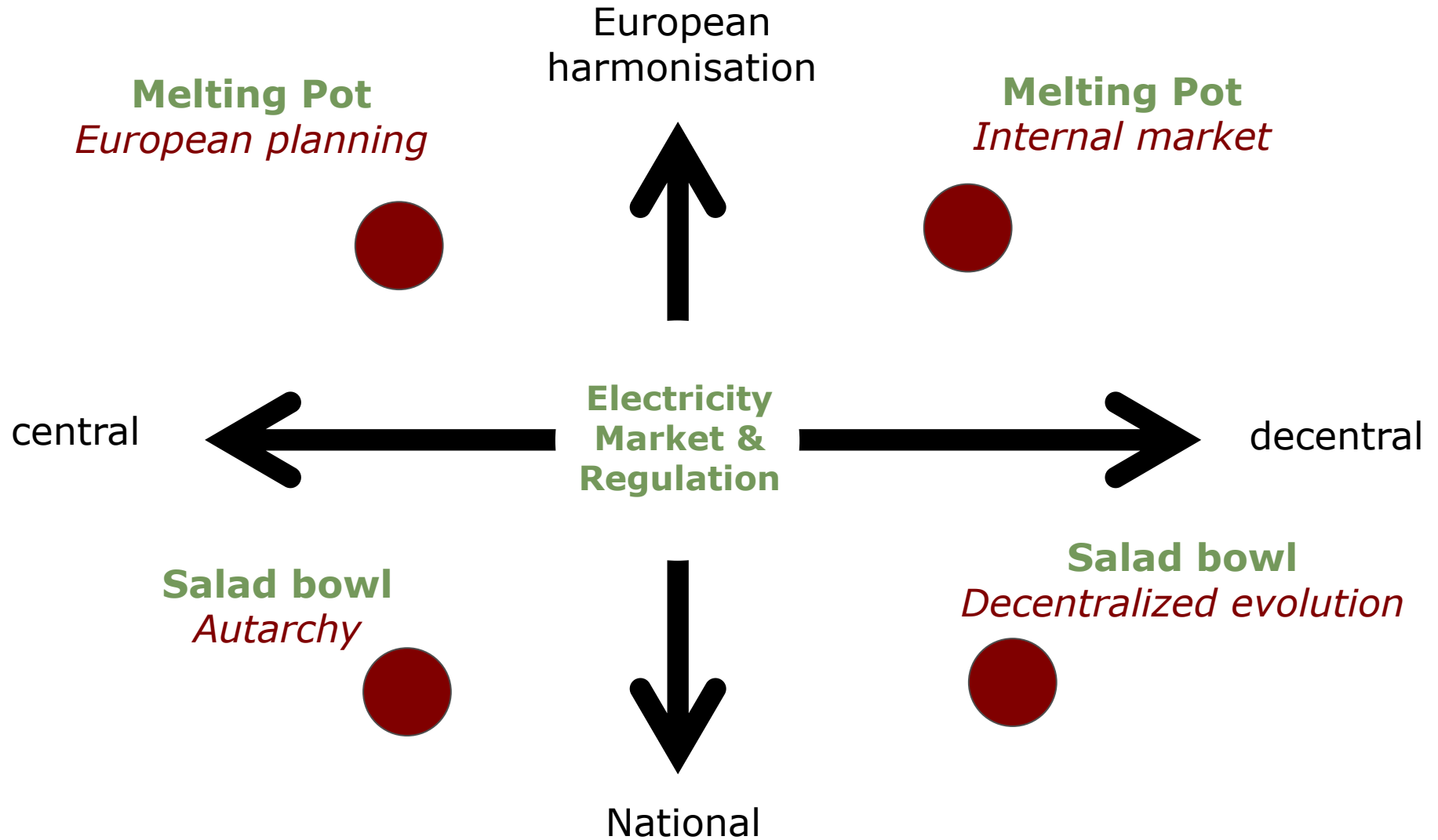
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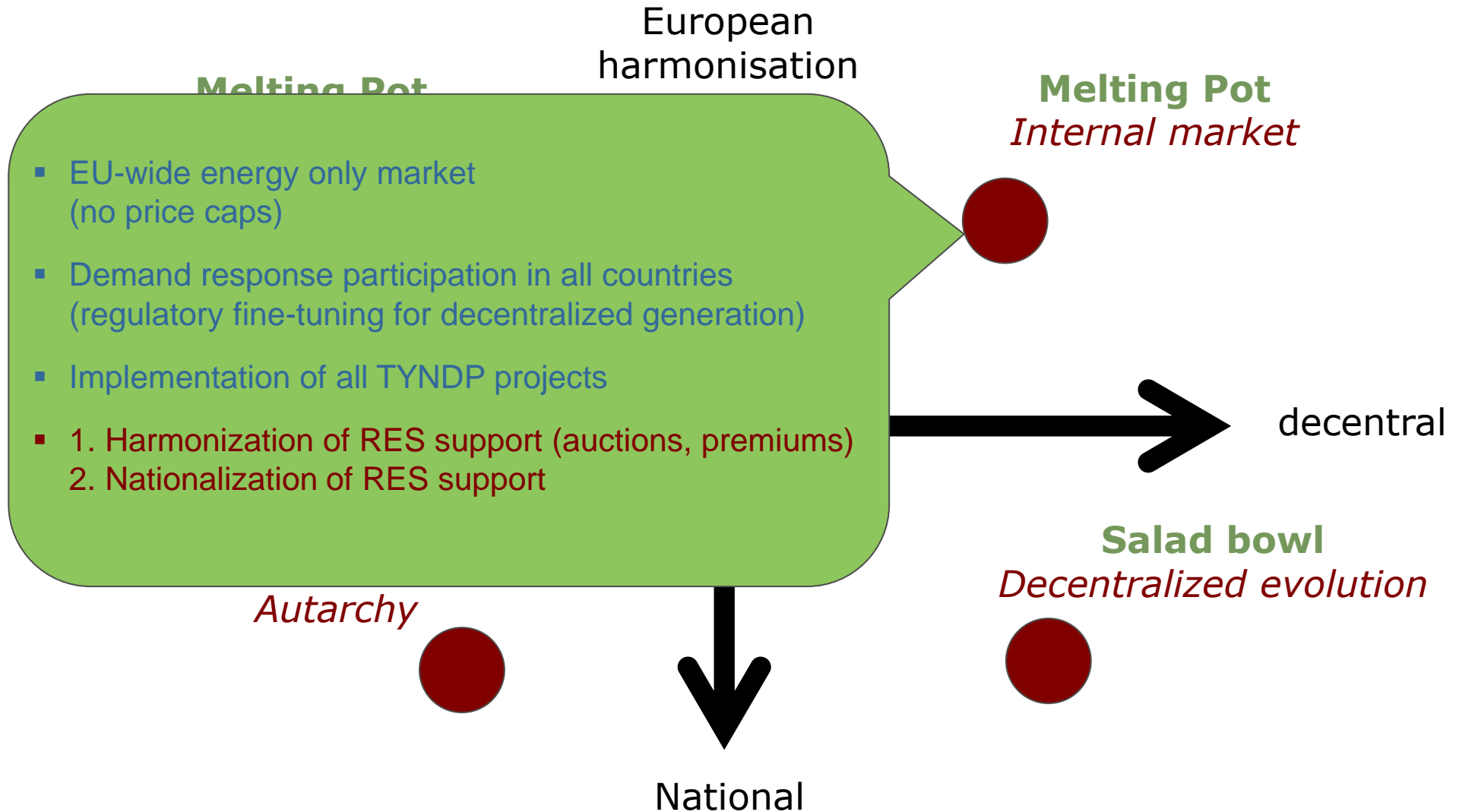
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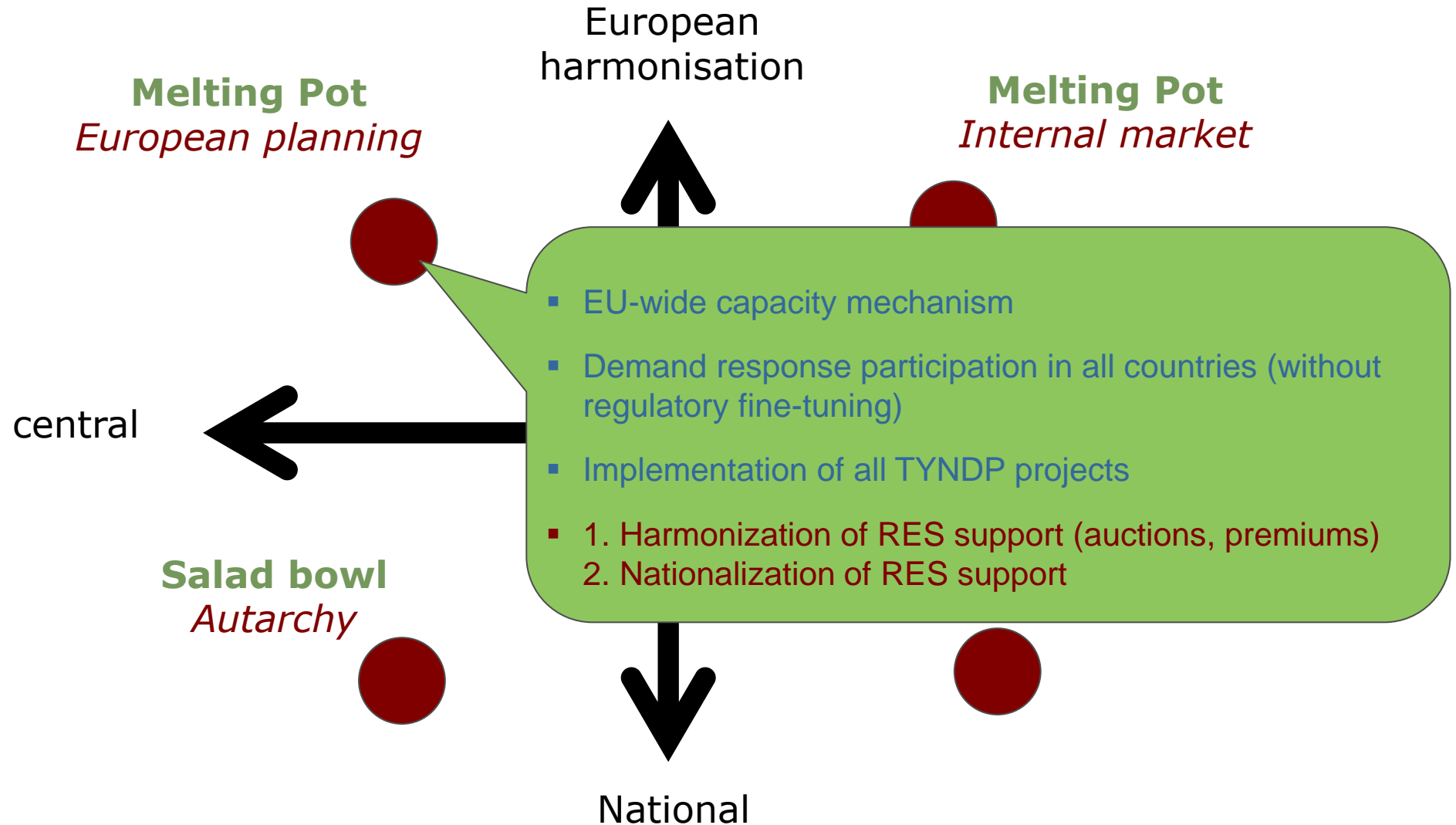
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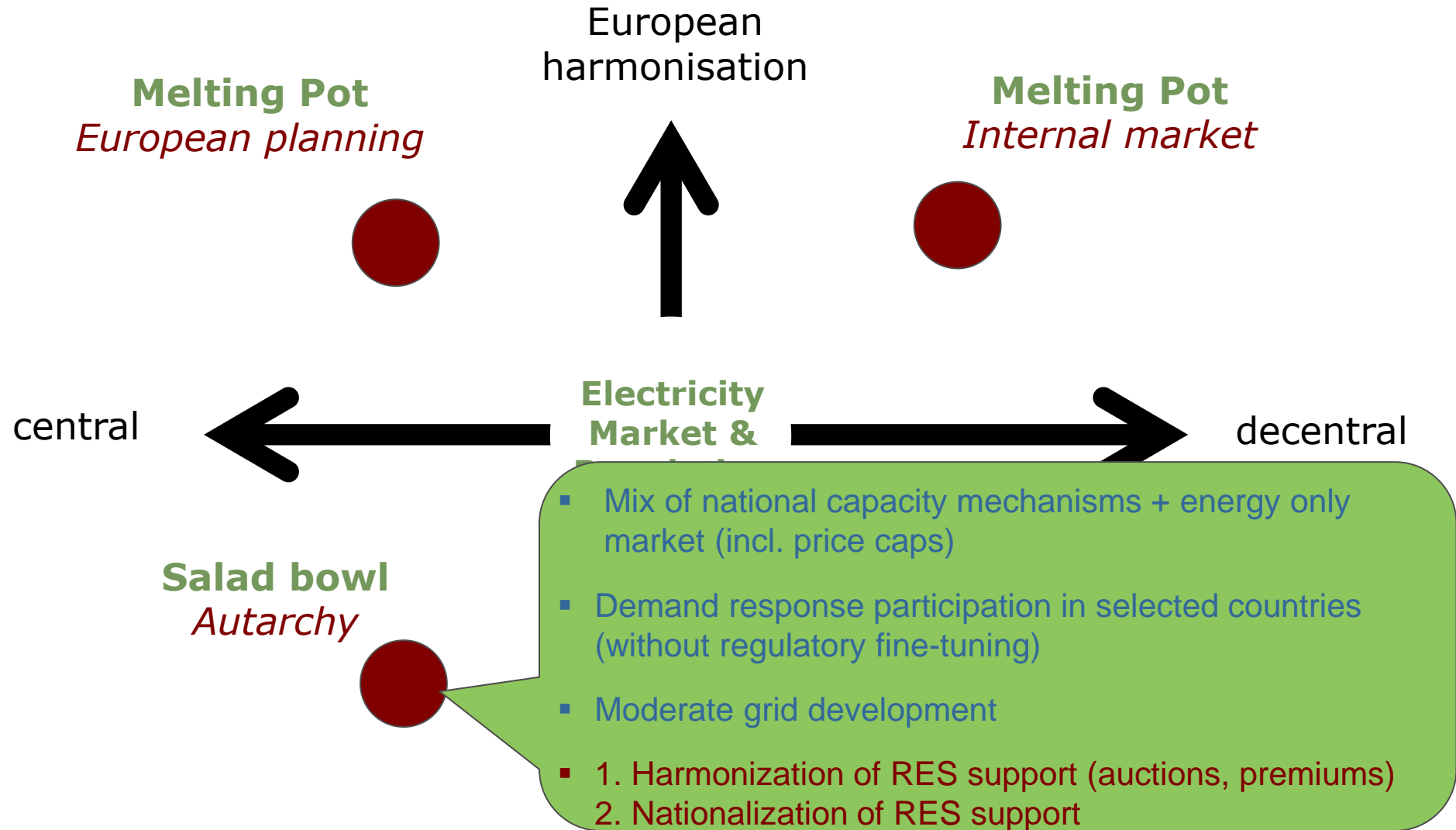
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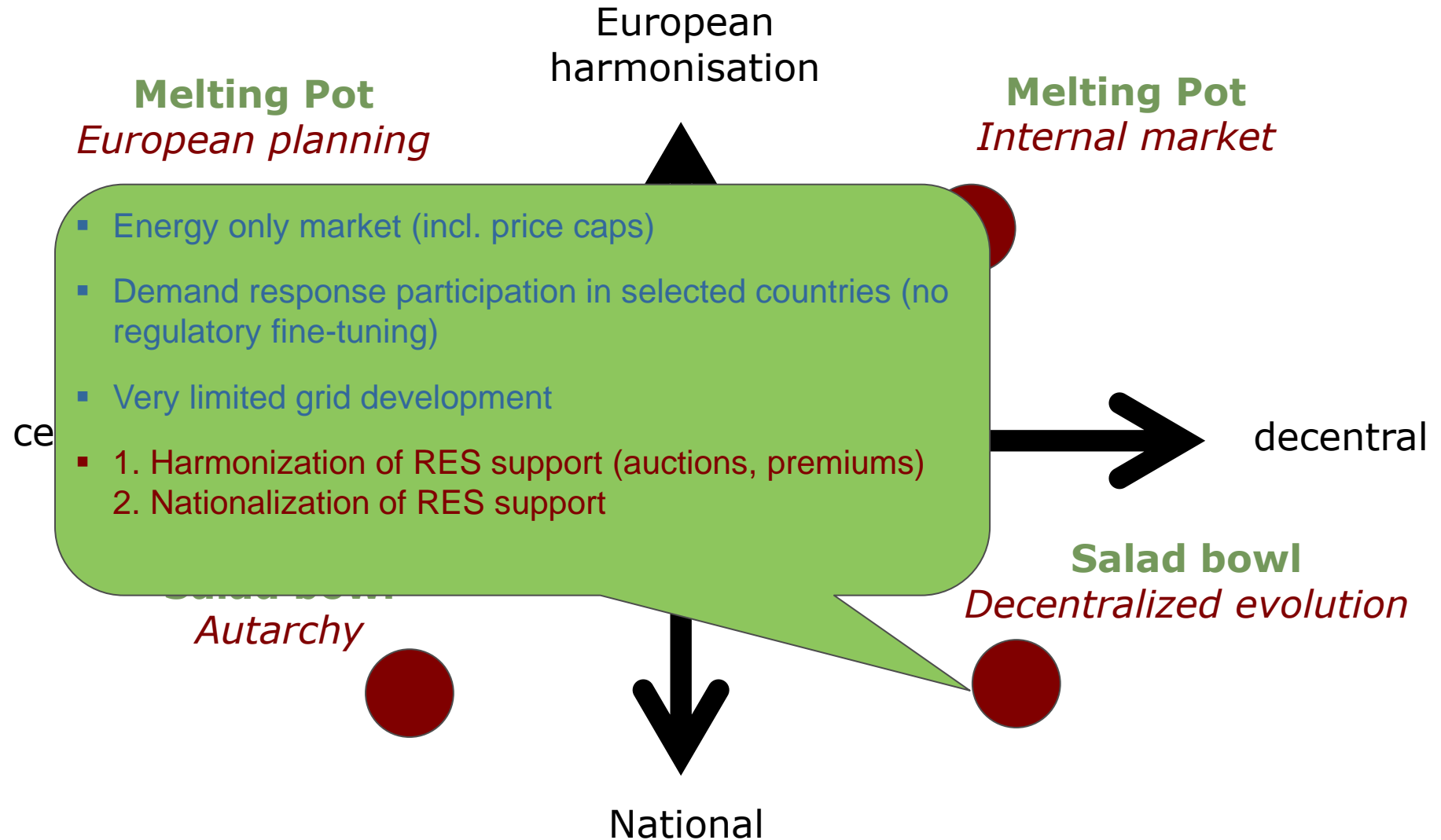












Characterization of RES pathways

Support costs

How much to pay on top of market value of generation?

- Generation costs – market value of generation
- Ambition level (EU28 -> 27% (all RES) of energy consumption in 2030)
- Cooperation activities
- Technology innovation

Target achievement

Can the specific targets be achieved with regard to amount and time?

- Cap on support costs
- Non-economic barriers (e.g. regulatory)
- Technology specific targets

Centralized/ decentralized

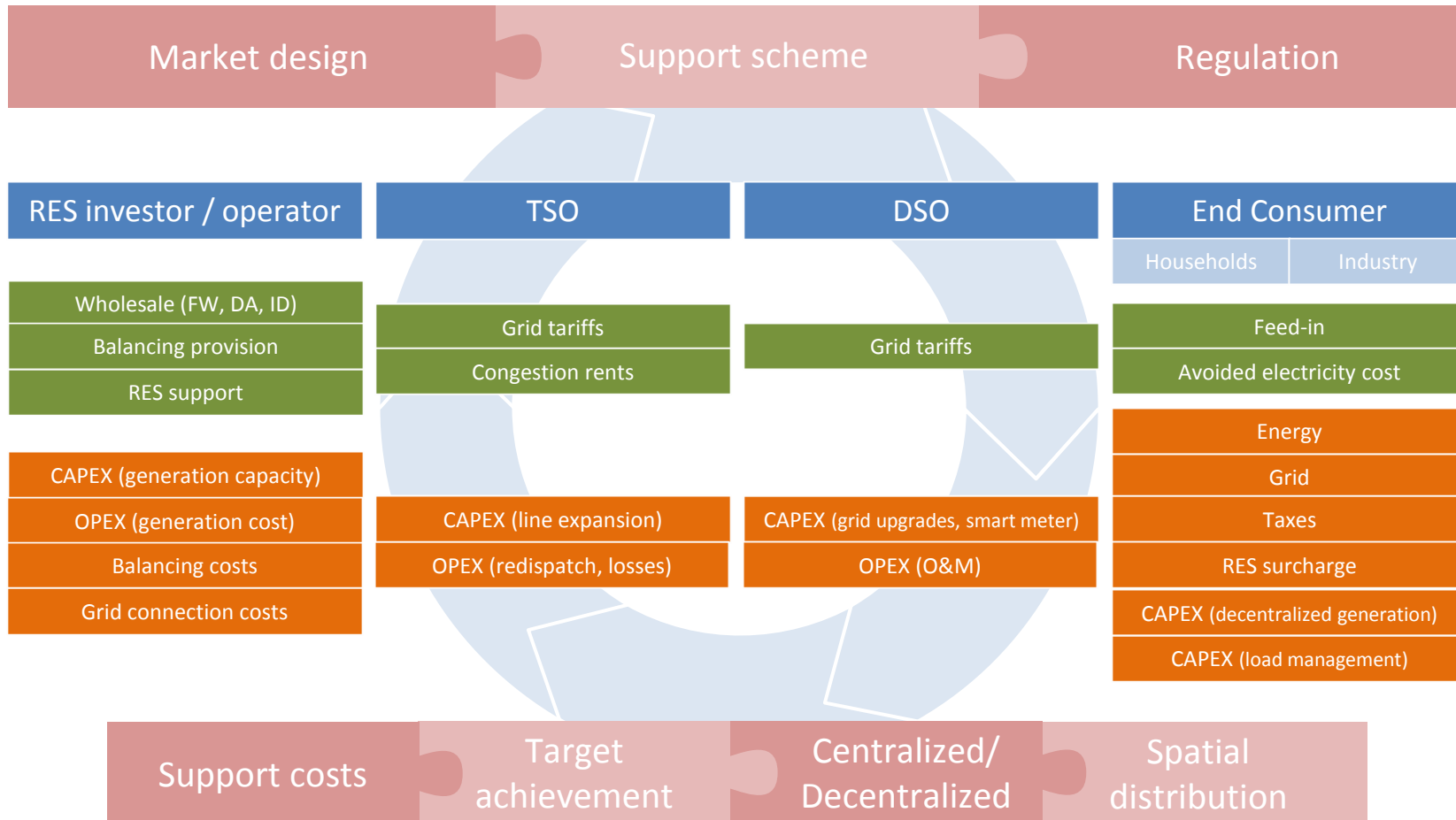
To what extent is it beneficial to get self-sufficient?

- (Opportunity) Costs of decentralized generation
- Design of grid tariffs, taxes and potential exceptions
- Value added through synergies (EV (Storages), heat, ...)

Spatial distribution

At what locations will RES be installed?

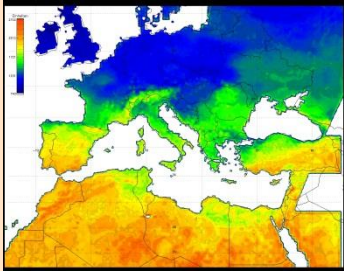
- Ability of market design to express and support scheme to consider locational value of RES generation
- Grid expansion and pricing (connection costs)
- Burden sharing



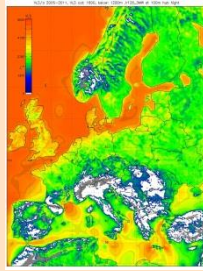
■ Actors
■ Revenues
■ Costs

Applied energy models (Green-X, HiREPS, ...)

Solar PV



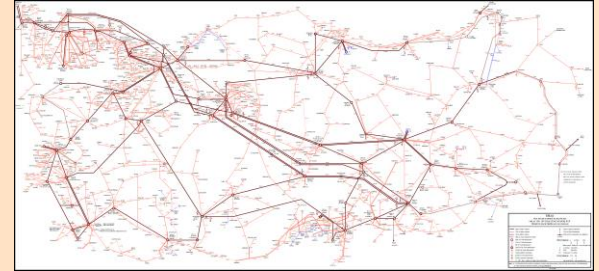
Wind



Locational power plant database

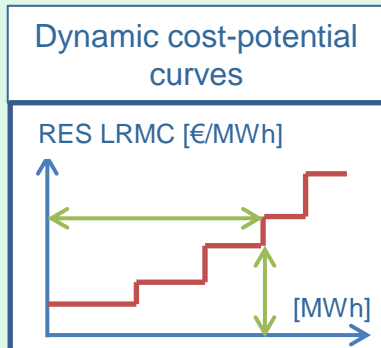


Transmission Grid



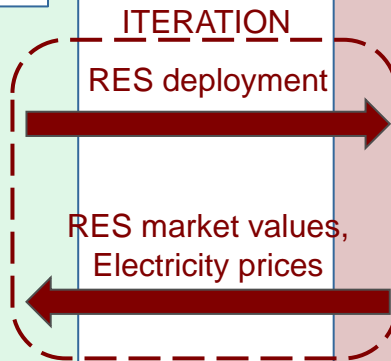
Yearly time resolution (2006 – 2050)

RES policy Non-economic barriers



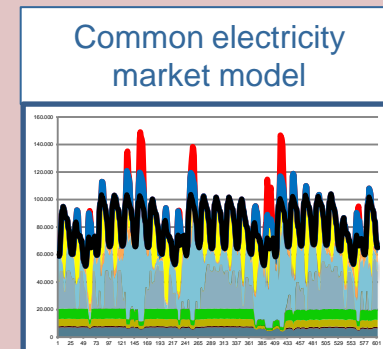
RES support expenditures RES investments

Energy/CO2-prices
Technology costs



Hourly time resolution (8760h)

Supply Storage Demand

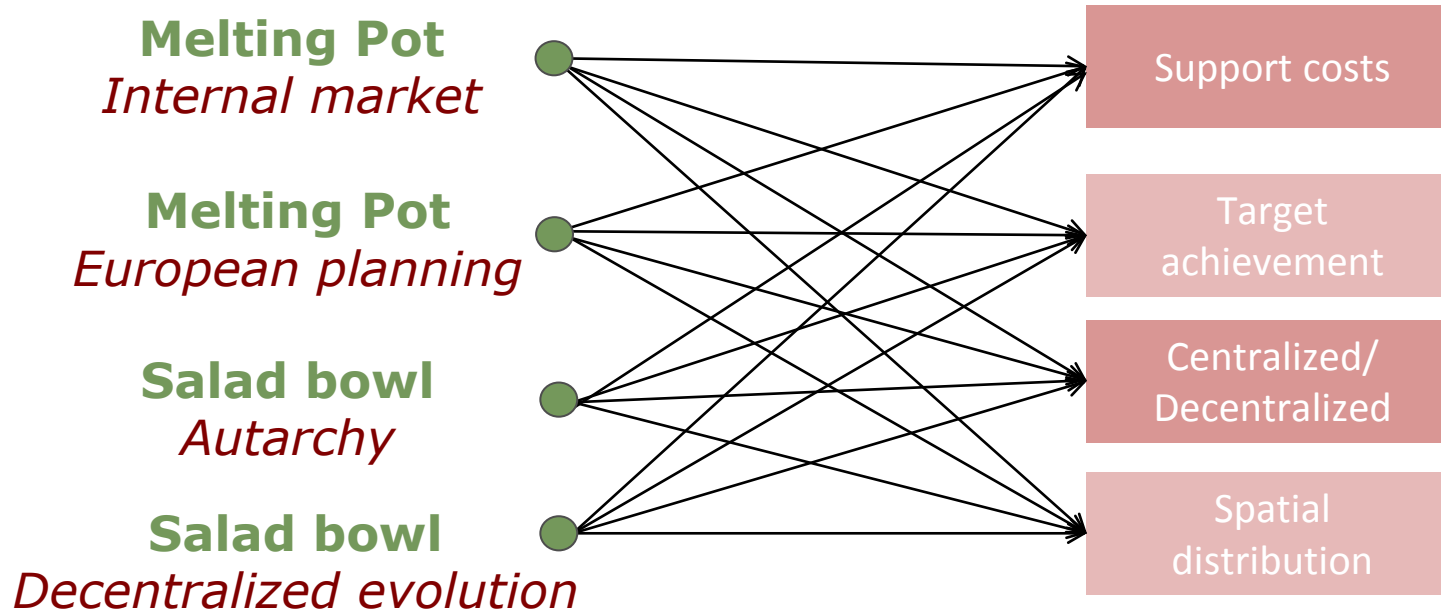


Electricity prices
Total system costs

Power plant dispatch/ -commitment

Transmission grid utilization

Comparative assessment of impacts of trend scenarios on RES pathways per country



Feedback to RES policy assessment work package

Your input is highly welcome!

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Motivation

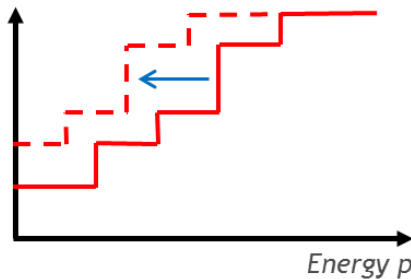
- ❑ Increasing impacts of rising RES-E shares until 2030
- ❑ Numerous adjustments of market design and regulation are necessary
- ❑ Most of adjustments are taken for granted and modeling work do not reflect current regulatory trends

- Identification of regulatory barriers and constraints
- Mismatches between the actual regulatory frame and requirements
- Impact of regulatory and market design trends on RES policy pathways

RES generation costs

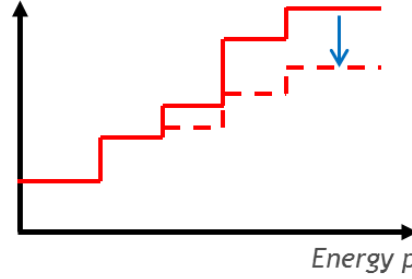
Dynamic cost-resource curves

Costs per Unit



Shift due to utilization of existing resources

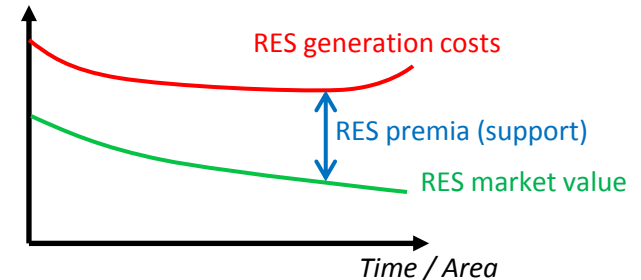
Costs per Unit



Shift through technology learning

RES support costs

Costs/Value per unit



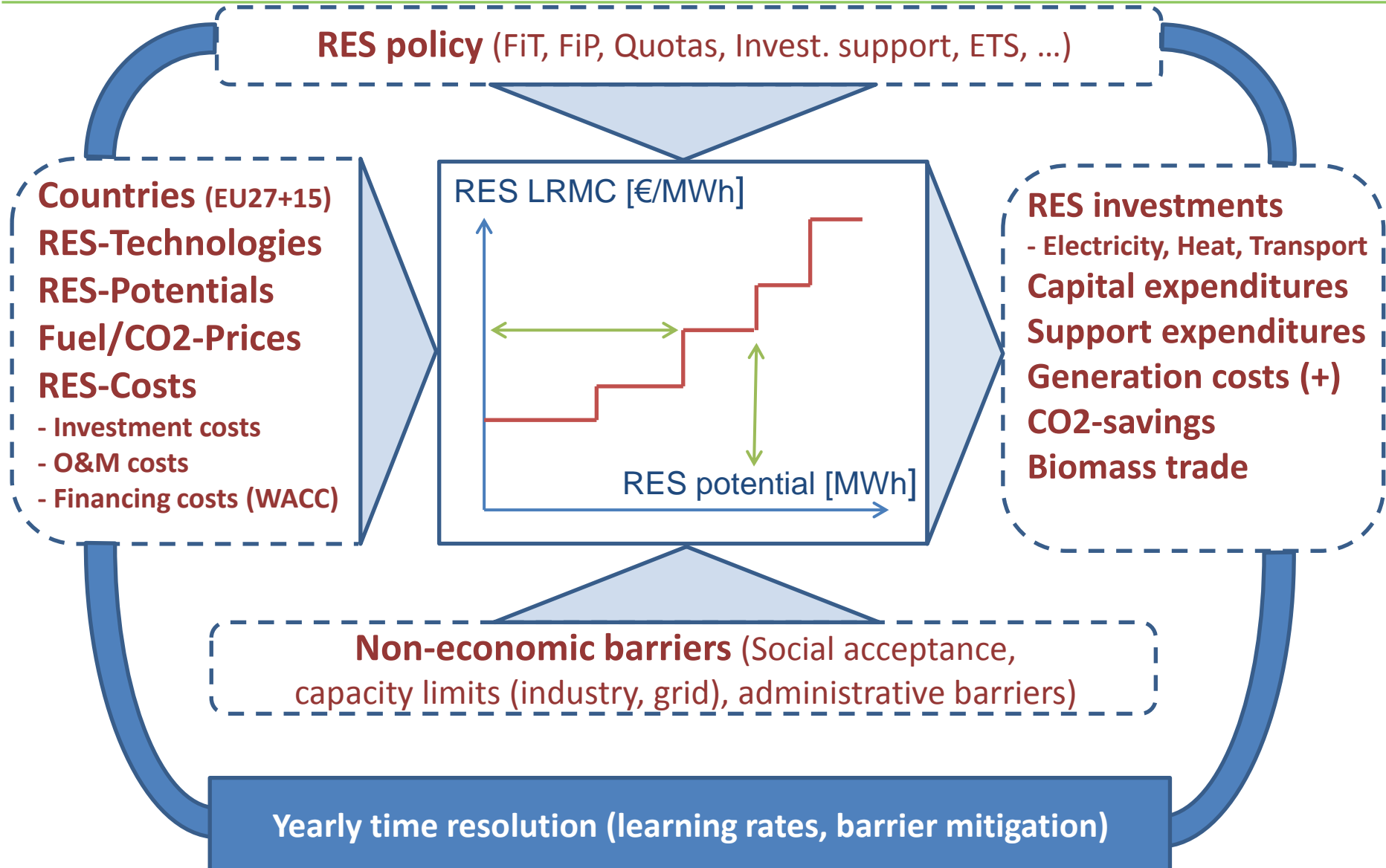
Assumptions

- What areas are eligible for deployment of RES (exclusion of nature reserve/parks, minimal distance to streets/buildings, ...)
- What concrete technology is used for conversion and how is it installed? (hub height and capacity of wind turbines, installation angle of PV, ...)
- What are the endogenous/exogenous learning rates per technology? (RES deployment in the rest of the world, technology innovation, ...)
- What risks are associated with deploying a certain type of RES (support instrument, country risk, technology risk, type of investor ...)

Assumptions

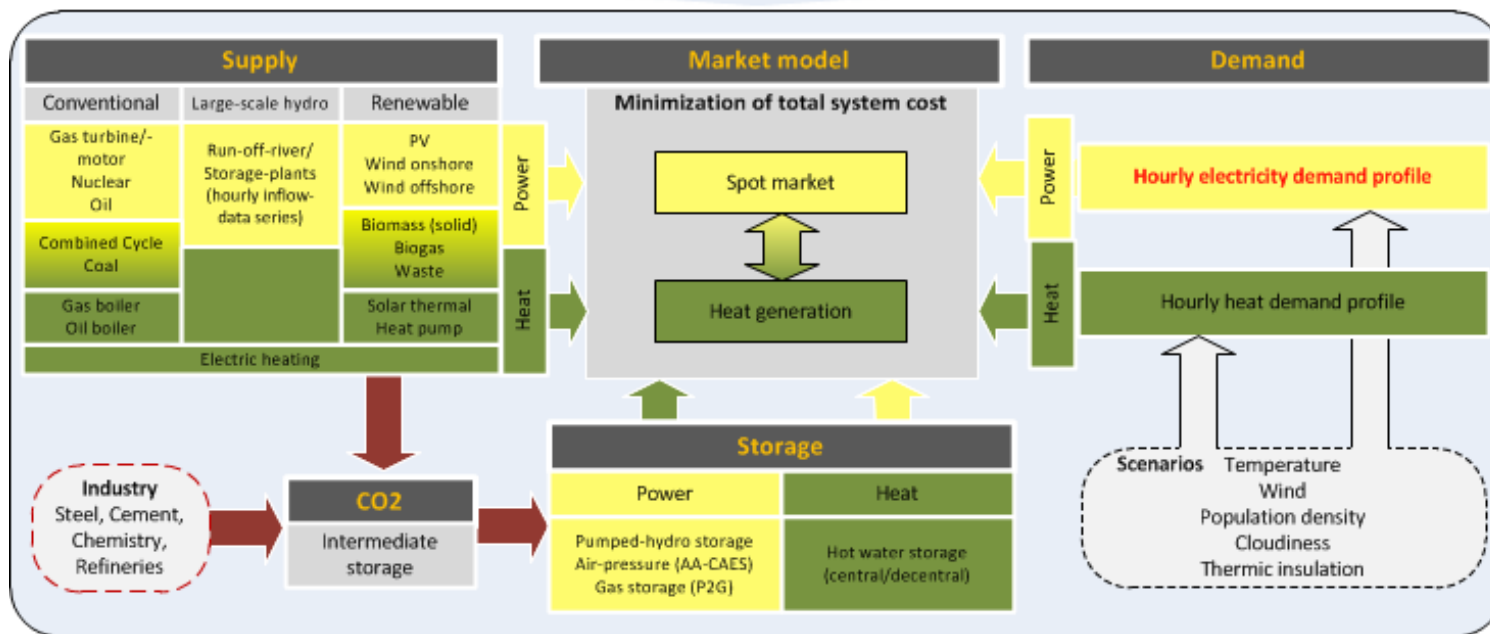
- What are the wholesale electricity prices in different regions?
- What type of support is applied (FiT, RES premia, RES quota, auctions, ...)
- Are RES allowed to participate in all electricity markets (day-ahead, intra-day, balancing markets)

Green-X model overview



HiREPS model overview

Framework parameter					
Prices	Fuel prices CO2 – price Taxes	Potentials	Technical potentials of RES Additional feasible hydro power Energy efficiency potential	Policy	Security of supply level Nuclear power policy Support measures and national action plans



Model results					
Costs / Prices	Total system cost (fix, variable) Average generation cost (electricity, heat) Marginal generation cost / electricity price Economics of power plants	Operation	Investments/decommissioning of capacities Unit-dispatch/-commitment (plant-specific) Yearly generation structure (hourly) Load-flows in the transmission grid Electricity im-/export	Ecology	Fuel consumption CO2 - emissions