The new water module of the JRC-EU-TIMES model

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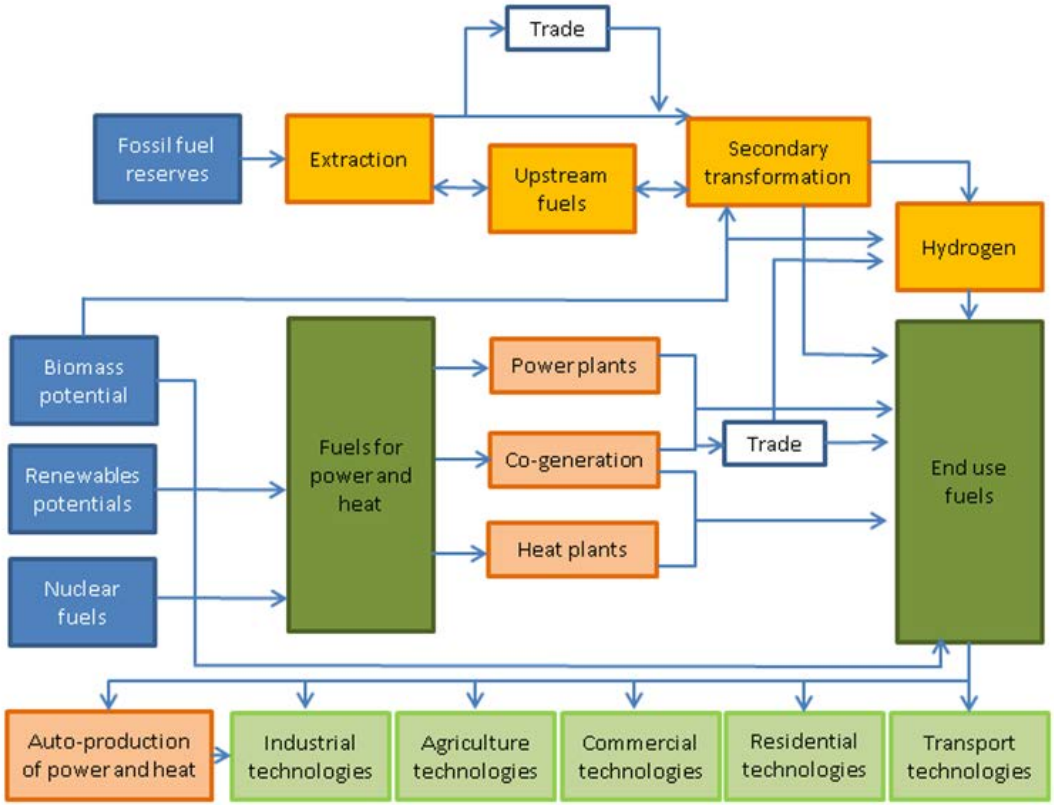
The JRC-EU-TIMES model



Reference Energy System

It is a bottom-up, technology rich model of the European energy systems, representing 28 EU Member States (EU28) plus Switzerland, Iceland and Norway and the 6 Balkan countries from 2010 to 2050 (and beyond), with each country constituting one region of the model.

The main drivers and exogenous inputs are:

(1) the "theoretical" end-use energy services and materials demand;
(2) techno-economic characteristics of the existing and future energy related technologies;
(3) present and future sources of primary energy supply and their potentials;
(4) policy constraints and dynamic assumptions.

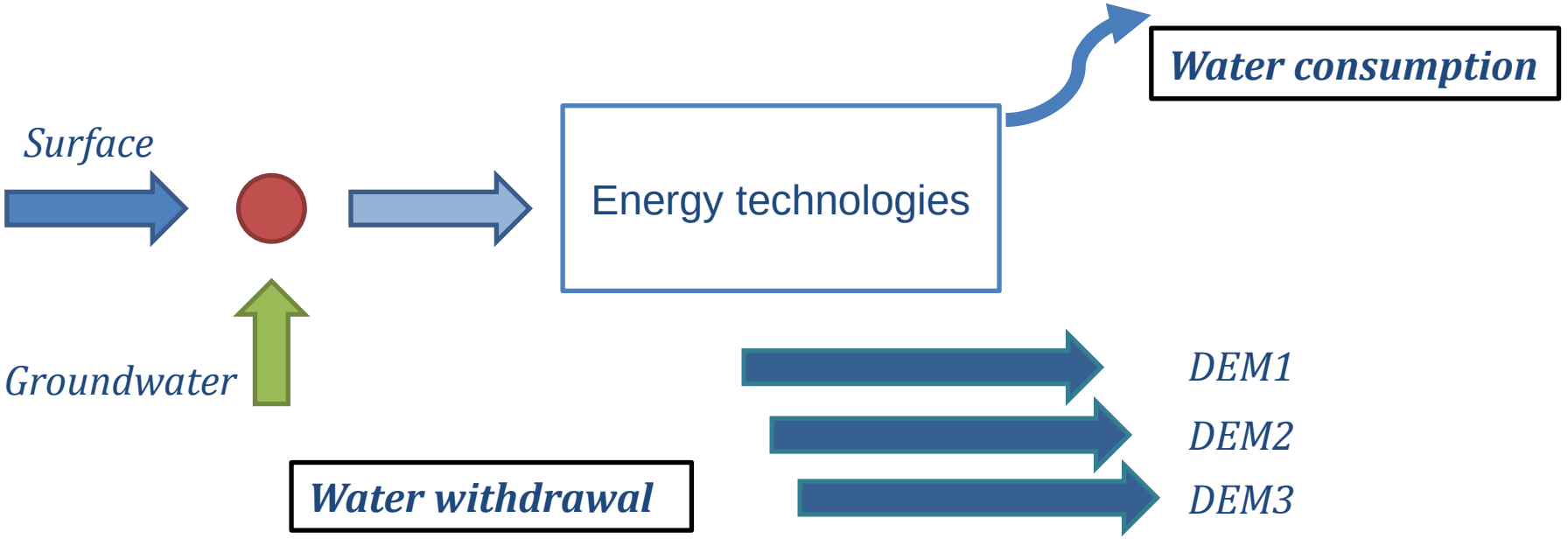
Key goal: designing a “flexible module” to represent a wide variety of energy-water feedback, while keeping the current structure of the JRC-EU-TIMES model and minimising the changes in the existing structures/templates.

Water consumption (WC) is the portion of water use that is **not** returned to the original water source after being withdrawn. Consumption occurs when water is lost into the atmosphere through evaporation or incorporated into a product or plant (such as a corn stalk) and is no longer available for reuse.

In contrast, **water withdrawals (WW)** may be returned to the water source (albeit at a potentially lower quality) to be used again by other consumers or by the natural environment, and hence represent a *more equivocal metric* for assessing regional water impact.

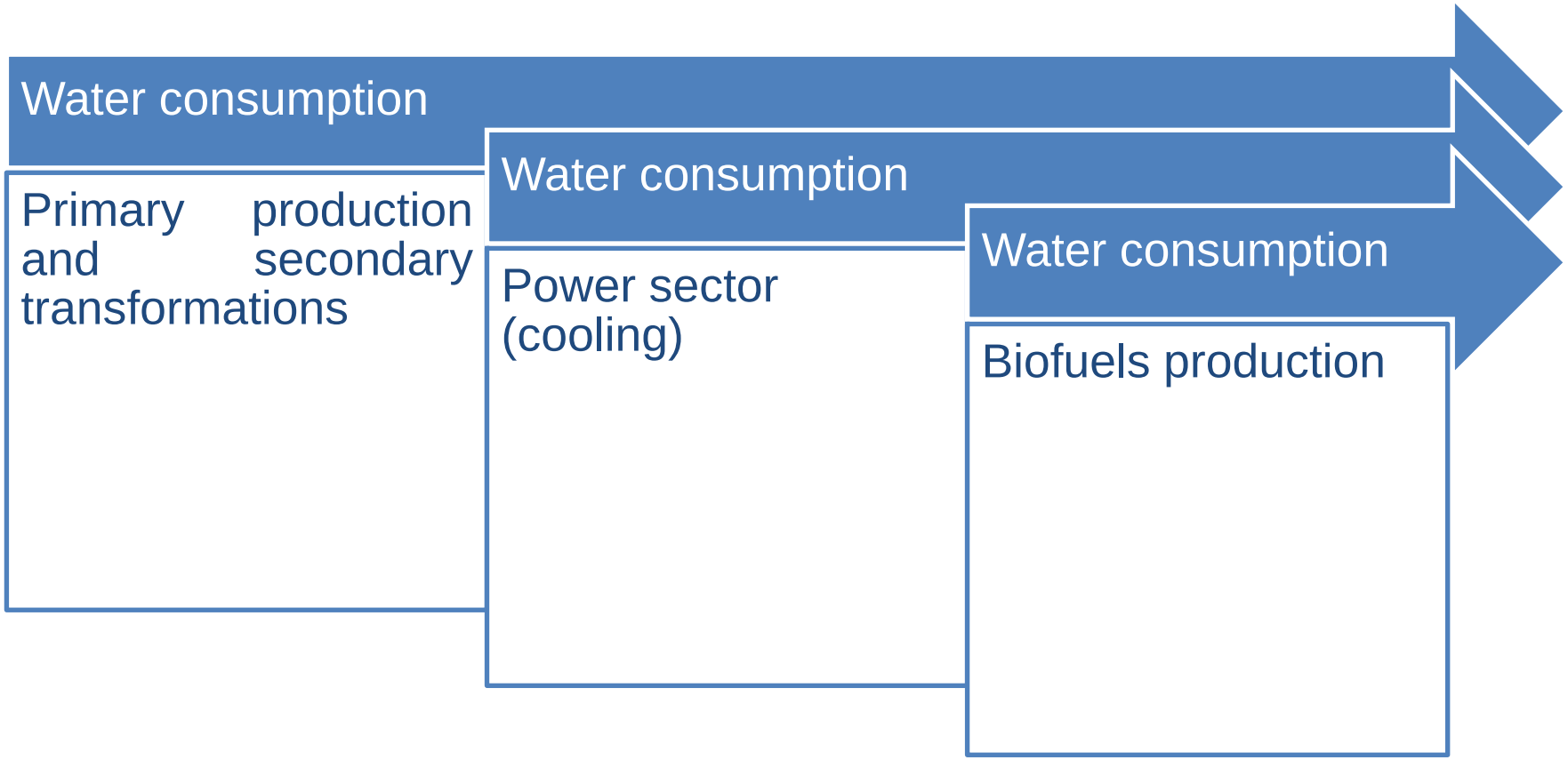
Water management

The logic scheme of the water module



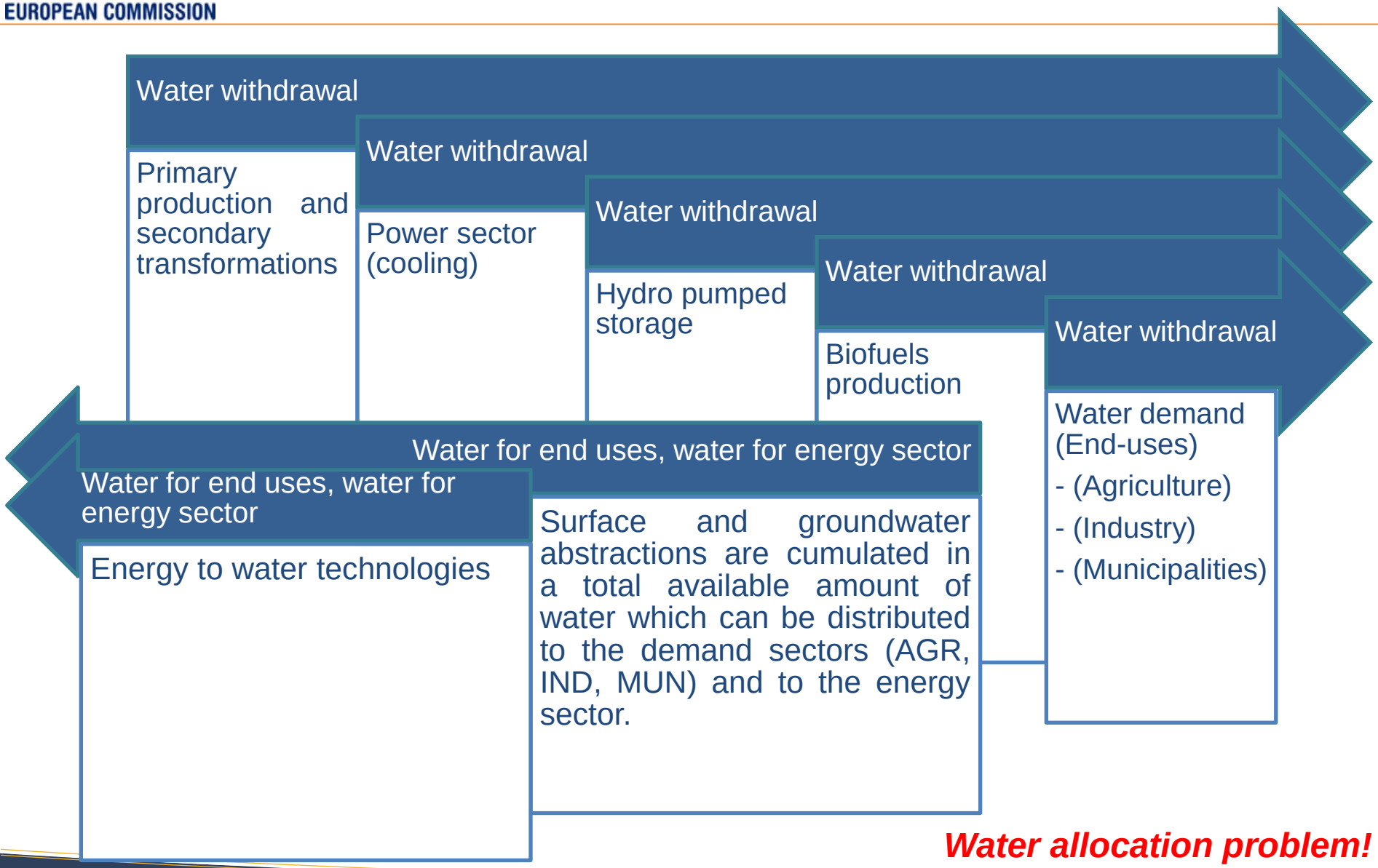
The current design makes use of national (aggregated) values, with no distinction by water body (and location of supply/demand).

Design of the module can be duplicated (or repeated "n" times) to simulate different water bodies of the MS, supplying water to a certain type of processes/activities only.



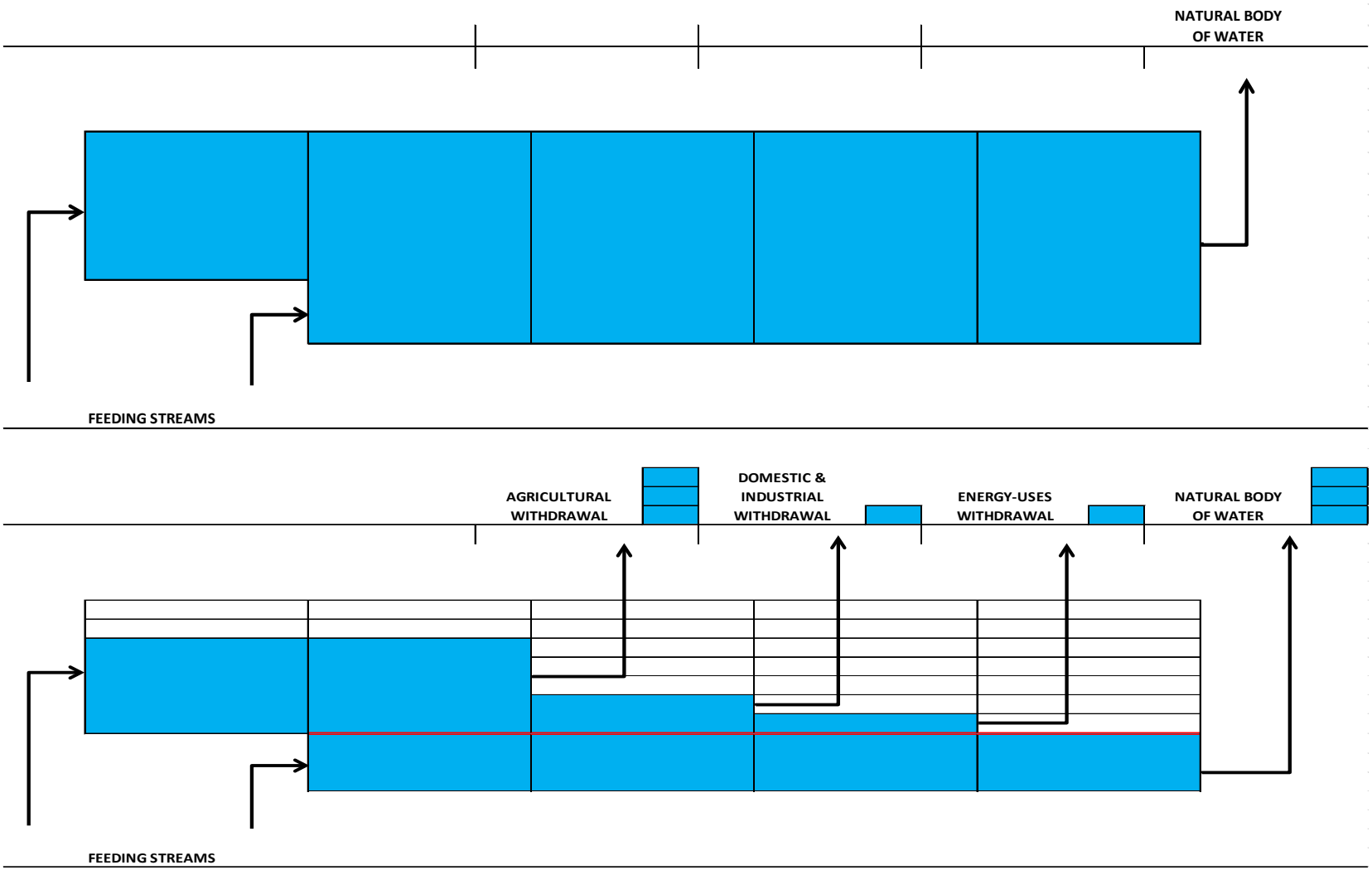
No balance!
Water-energy trade-off!

Water withdrawals



Water allocation problem!

Water withdrawals (design)



Possibility to control/constrain the WW

The Water Module is created on the basis of a data repository file which collects, elaborates and organises the water-related information.

Sources:

- *AQUASTAT* (is FAO's global water information system, developed by the Land and Water Division. It is the most quoted source on global water statistics)
- *World Energy Outlook 2016* (chapter on the water-energy nexus)
- Database of power plants cooling systems
- …

The Water Module is built on a combination of few "new" VEDA_FE files (in spreadsheet form)

- **SubRes files**: to represent the water chain (WW) and the new technological options (dry cooling system, energy-to-water technologies, etc.)
- **Scenario files**: to control the water module, represent natural, technical and policy constraints.

Flexibility of the water module: how it can be used

- *Standard* (no water module)

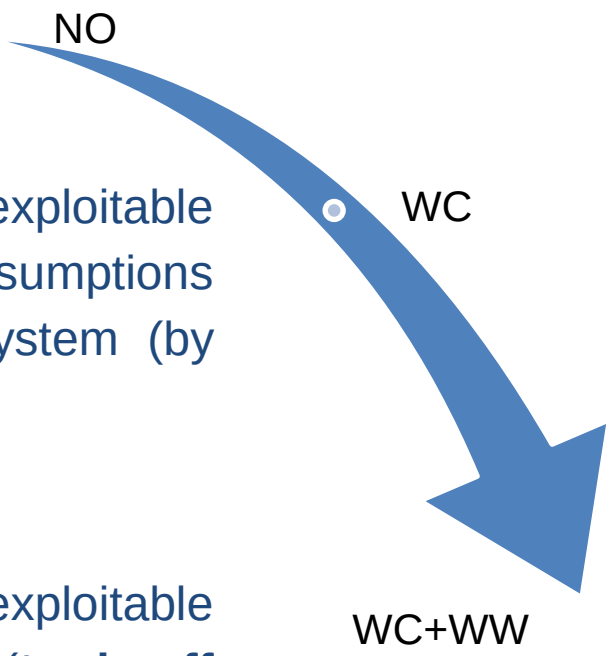
→ users disable the water module of the model thus making a standard energy-specific constrained optimisation.

- *Simplified water module*

→ representation of non-energy (water) demands and exploitable water limits, as well as the calculation of water consumptions (**trade-off water-energy**) of the European energy system (by MS).

- *Full functioning water module*

→ representation of non-energy (water) demands and exploitable water limits, the calculation of water consumptions (**trade-off water-energy**) of the European energy system (by MS), as well as the analysis of the **water allocation problem** (withdrawals) across the competing uses/sectors (per TS and MS).



Scenario 1

→ for 2030 GHG path is consistent with runs from Winter Package 2016 (-40%). For 2050, it has the REF2016 value (~ -50%). No water consumption constraints.

AT	BE	BG	CH	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	Values in bcm/y
0.14	0.20	0.28	0.06	0.01	0.47	1.58	0.09	0.01	0.13	0.42	0.14	1.12	0.02	0.25	0.04	2010
0.04	0.09	0.05	0.03	0.01	0.17	0.46	0.08	0.01	0.07	0.30	0.12	1.19	0.00	0.07	0.03	2030
0.03	0.07	0.04	0.00	0.01	0.16	0.39	0.06	0.01	0.04	0.31	0.11	1.24	0.00	0.08	0.02	2050

IS	IT	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK	UK	EU-28	Values in bcm/y
0.00	0.40	0.03	0.00	0.00	0.00	0.23	0.38	1.04	0.07	0.25	0.15	0.02	0.13	2.40	**9.61**	2010
0.00	0.29	0.02	0.01	0.00	0.00	0.16	0.37	0.21	0.04	0.06	0.22	0.01	0.07	0.79	**4.55**	2030
0.00	0.18	0.03	0.00	0.00	0.00	0.13	0.36	0.22	0.02	0.06	0.21	0.01	0.05	0.65	**4. 15**	2050

- Water consumption for primary and secondary transformations: from **1.57** bcm/y to **0.94** bcm/y (due to the decline in domestic fossil fuel production).
- Water consumption for electricity generation (including auto-producers): from **4.06** bcm/y to **3.16** bcm/y.

- Water withdrawal for the energy sector drops from 71.56 bcm/y to 50.12 bcm/y.

Scenario 2

→ Water consumption reduction policy in the energy sector. Long-term limits on the water consumptions (reduction of 30% based on the value of 2010) are included for each MS.

→ energy efficiency / renewables / reduced domestic production / dry cooling options…… "Trade-offs".

Scenario 3

→ Five MS are supposed to be subject to a regulation which prohibits (for Cyprus and Malta) or limits (for Italy, Spain, and Greece) the *water withdrawal in the energy sector* during the summer season (for all the three summer slices) from 2030.

→ E2W technologies (seawater) can be used to cool the power plants and produce desalinated water for the end-uses.

Challenges and open issues

- Data issues / cooling systems per PP / WW and WC factors
- PP efficiency losses (dry cooling systems vs water-based)
- Identification of dry options (what plants)
- Energy-to-Water (the other side of the nexus)
  - make explicit consumptions for pumping and water treatment
  - energy efficiency improvements (water demands drive energy consumption)
- Self-consistency of the storylines

……

Thank you!

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