Evaluation of scenarios for an energy, economic and social transition of the Fessenheim region (ESTEES project)*

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* **Evaluation de scénarios pour une transition énergétique, économique et sociale de la région de Fessenheim (projet ESTEES)**

"Energy transition" Session

Summary

- Context
- Project objectives
- Research methodology
- Energy analysis & planning tool EnergyPLAN
- Reference scenario and validation
- Energy transition scenarios 2030
- Towards Renewable Smart Energy Systems by 2050

Context

- Fessenheim NPP decommissionning
  → sustainable energy conversion of the territory 2020 - 2050
- global warming accelerating
- energy and geopolitical crises

Main guidelines

(1) drastically reduce energy and material consumption = **sufficiency**

(2) change the energy system : **renewable, resilient, efficient, sectorial-storage coupling**

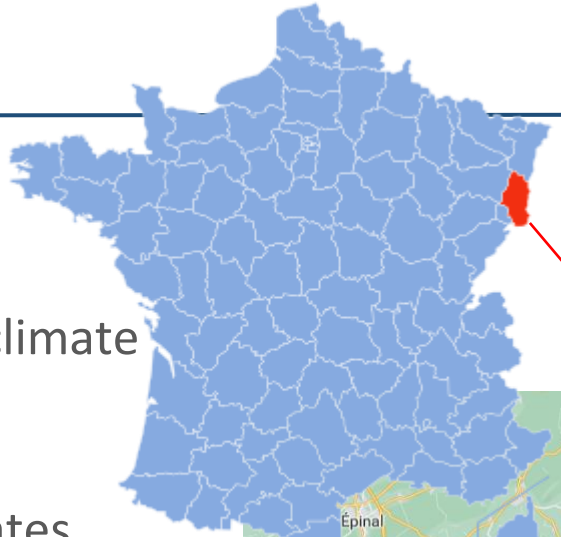
Energy-climate pathways 2030-2050 of the Fessenheim territory

(1) structural energy system changes → climate neutrality

(2) energy investment and costs pathways (holistic vision)

(3) socio-economic, environmental and health benefits

Project Objectives

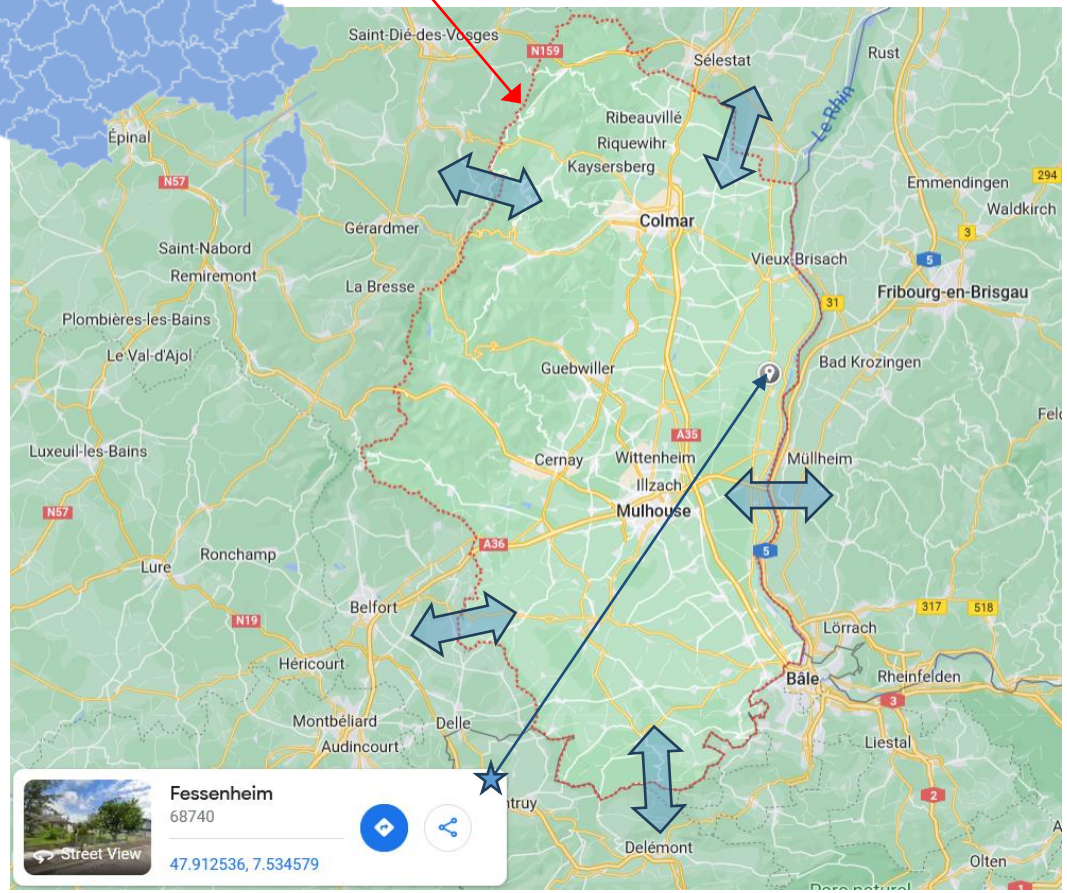


- **developing** a permanent and accurate energy-climate **data-base** of the Haut-Rhin department
  - structure
  - construction methodology for further updates and simulations
- **simulating** possible transformations of the **energy system**
  - Reference scenario 2018 – simulation – validation
  - Transition scenarios 2030 & 2050 – assumptions and parametric design – simulations
- **comparing** with official **regional schemes**

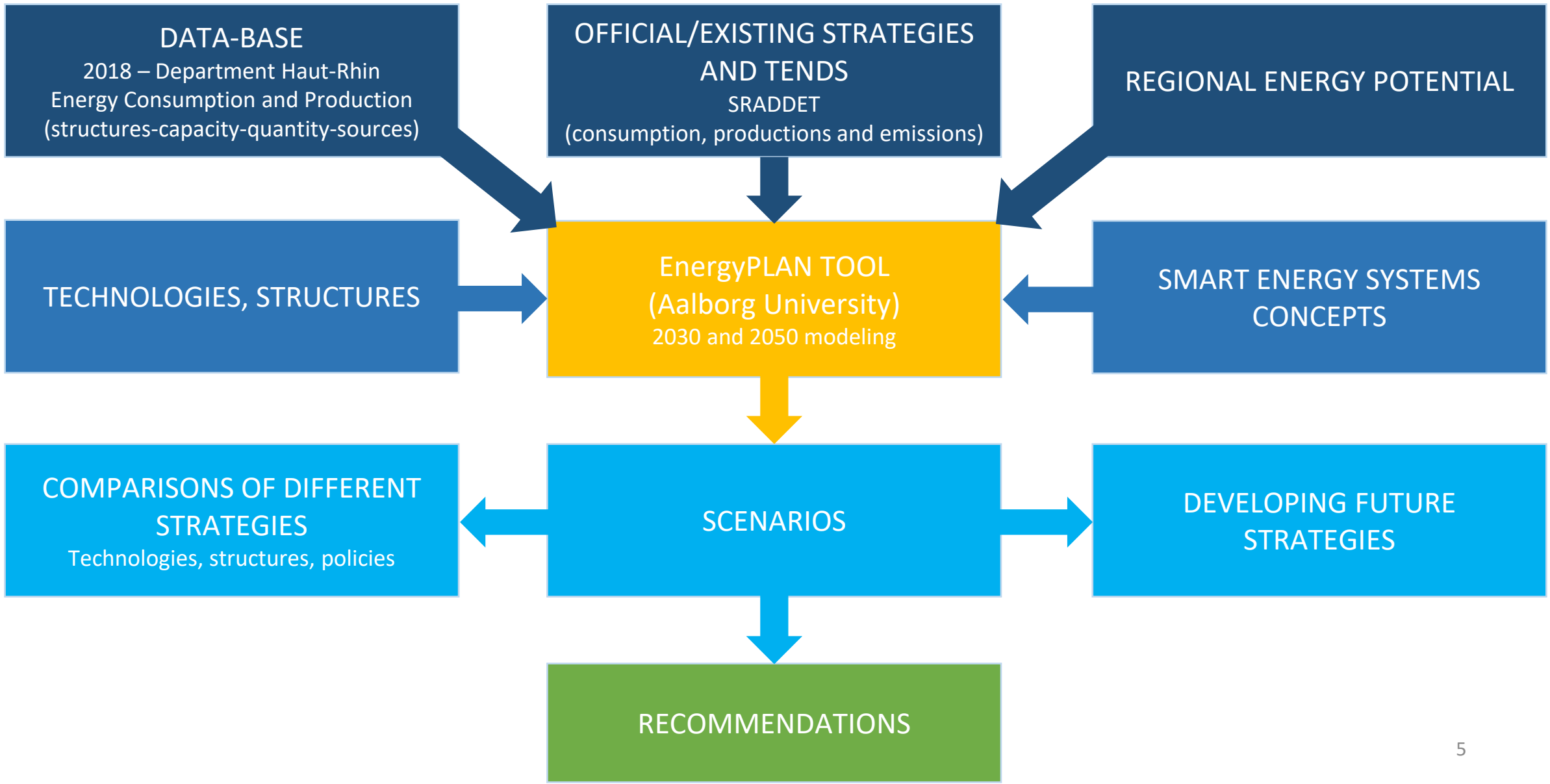
→ cost analysis

→ planning recommendations

→ publications



Research methodology



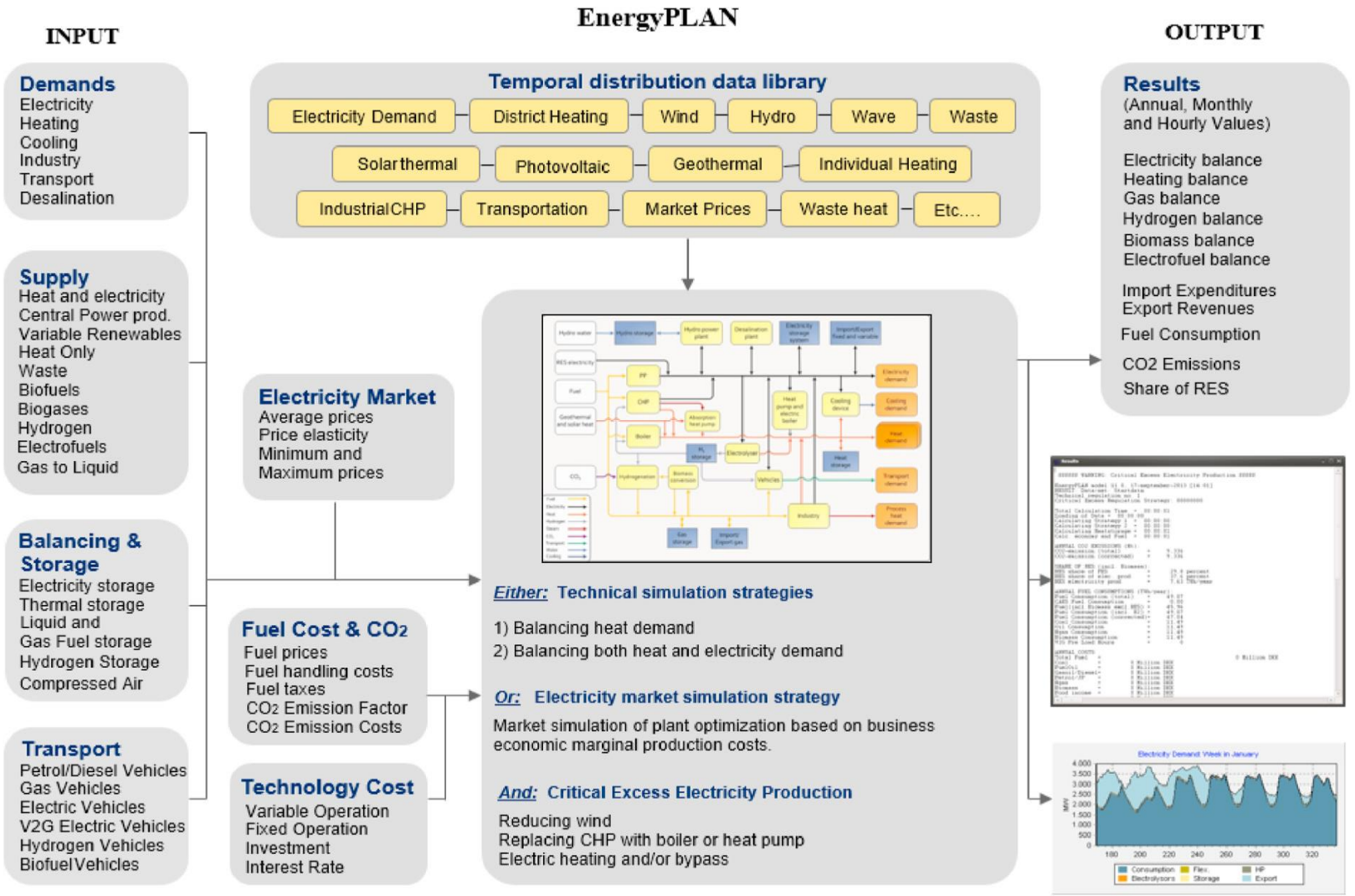
Energy analysis & planning tool EnergyPLAN

Scientific litterature

- > 400 references (mentioned, reviewed or considered)
- > 300 applications
- used worldwide (all continents)
- different scales (local, national, international)

Characteristics

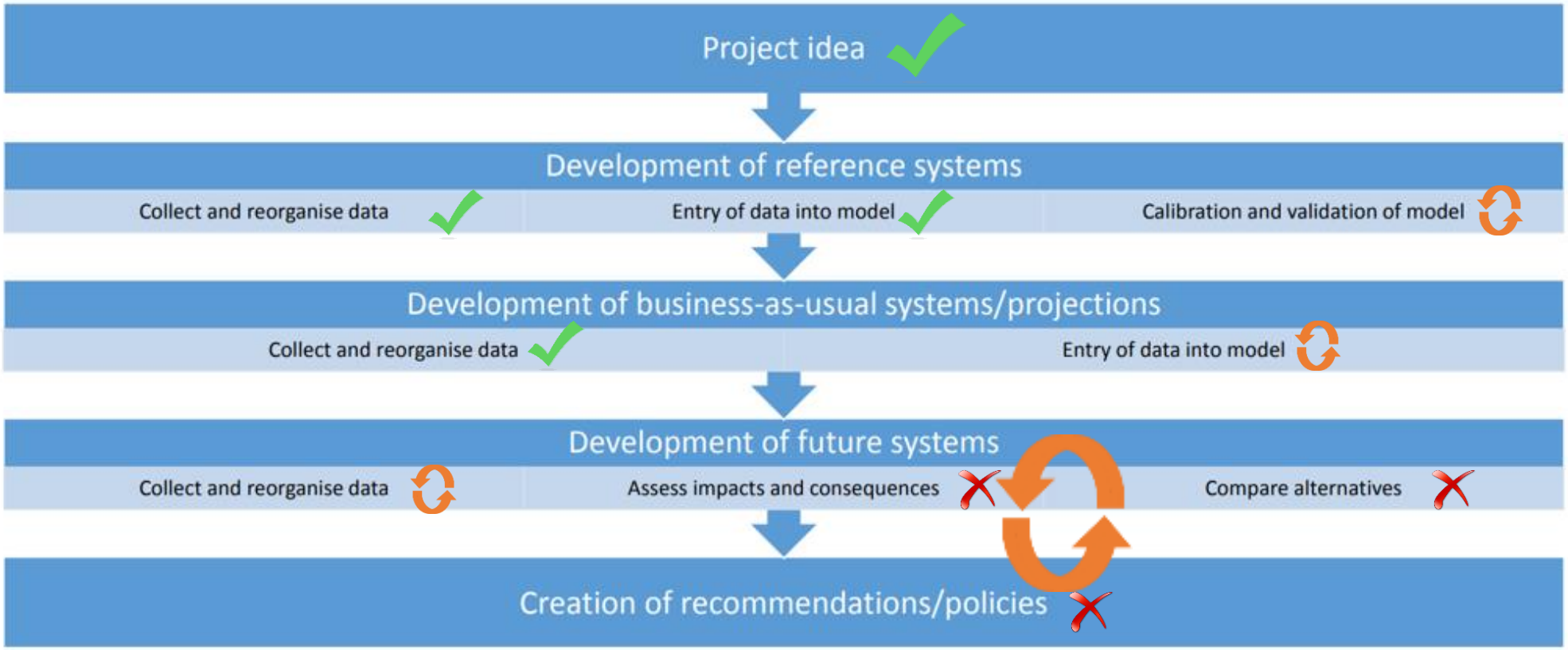
- holistic (electricity, heating, industry, transport, GES)
- hourly simulation over a year
- classical/Smart Energy System
- storage & sector coupling
- optimization strategies
- fast
- variability demand/production
- balancing heat & electricity
- technical/economic optimization
- present and future technologies



→ Energy Planning Dpt, University Aalborg (since 1999)

Energy analysis & planning tool EnergyPLAN

work progress



Steps from Jakob Zinck Thellufsen, Aalborg University

Reference scenario and validation

various sources of data

Observatoire climat · air · énergie Grand Est

ODRÉ OPENDATA RÉSEAUX-ÉNERGIES

RTE

R-GDS Réseaux Gaz naturel Strasbourg

...

Detailed energy-GHG data-base

Current situation

Reference year: 2018

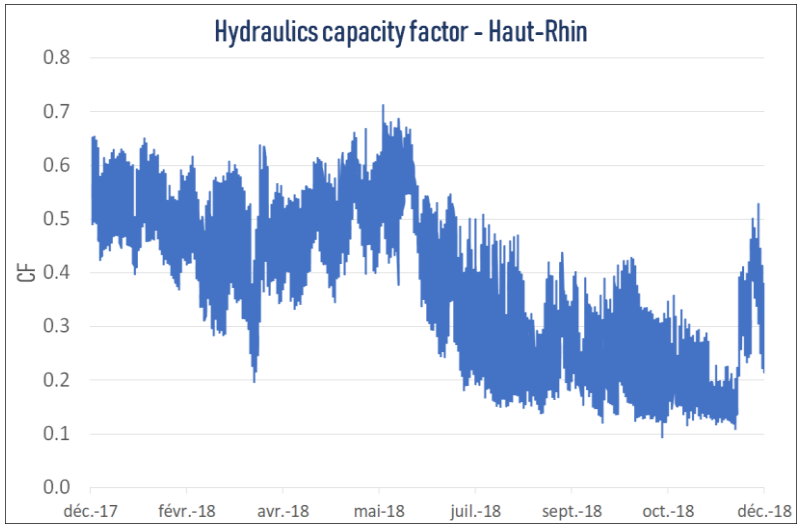
- fuel/electricity/transport/ heating demand
- demand/production hourly distribution
- infrastructure (CHP, DH, storages, capacities)

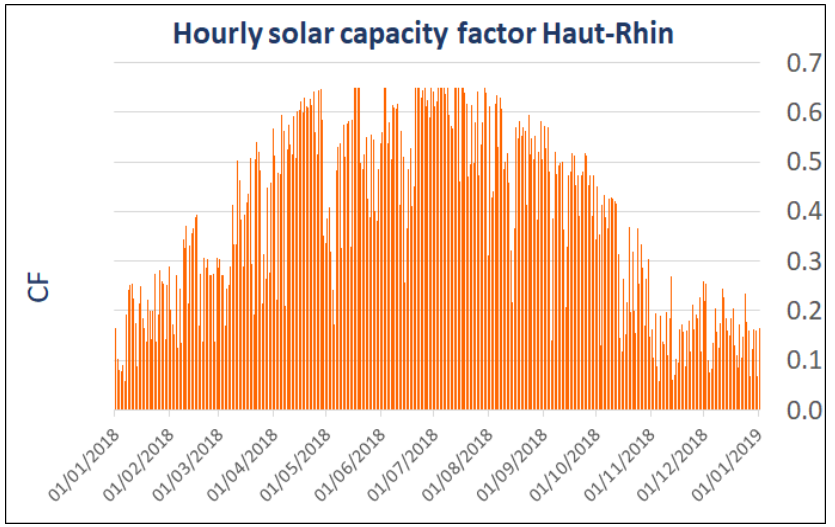
Validation

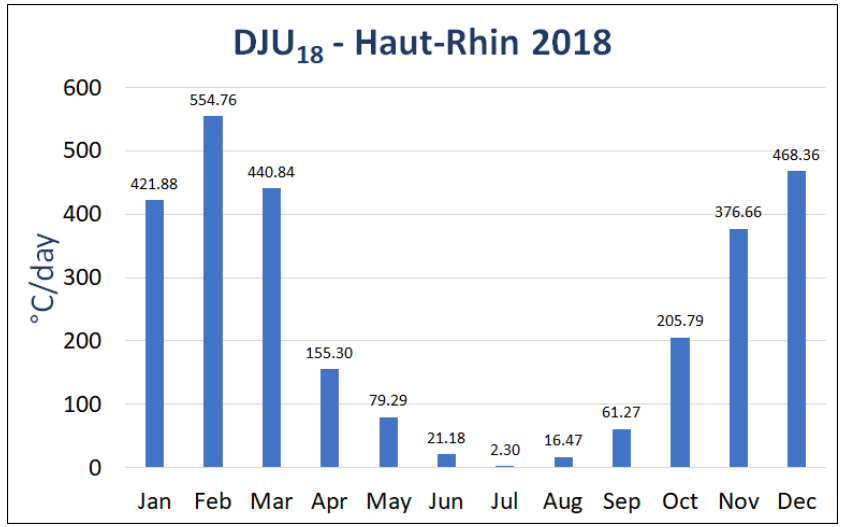
Control of coherence (demand-production ; GHG)

Difficulty accessing to

- accurate, detailed data
- coherent information's structure
- aggregated for the department
- hourly-distributions



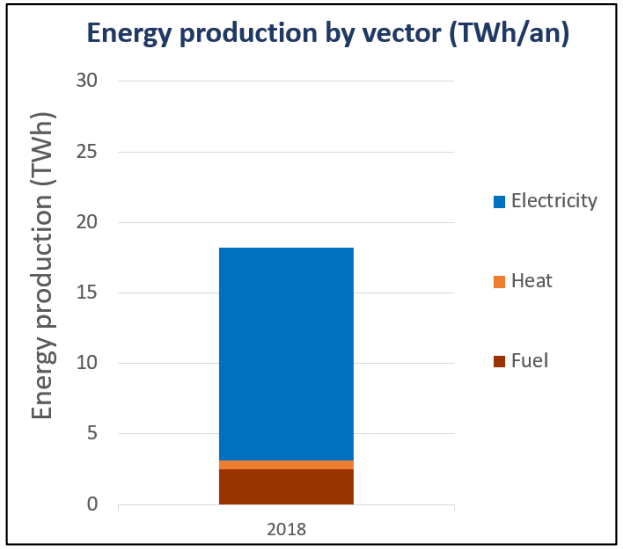


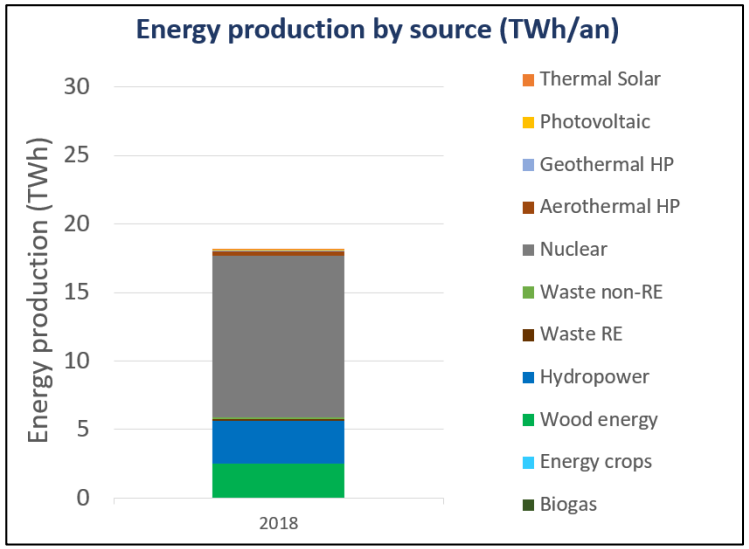


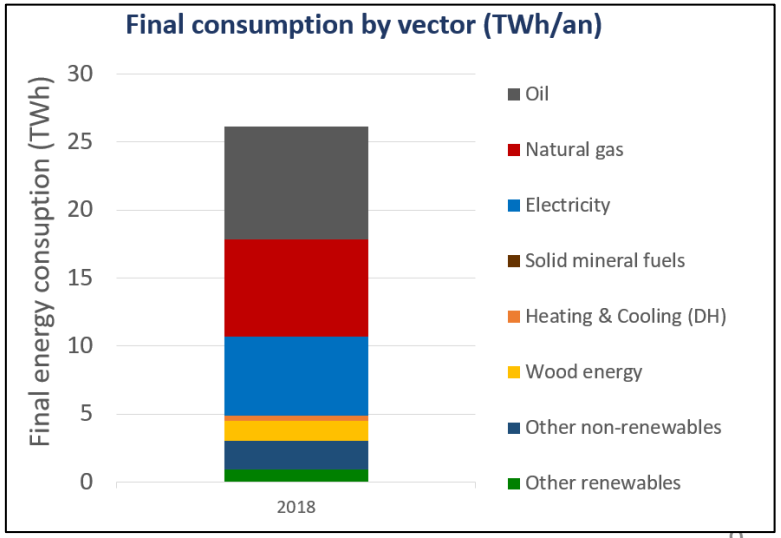
Reference scenario and validation

Haut-Rhin department

reference scenario - validation EnergyPLAN			
Fuel consumption (GWh/year)	**ATMO GE**	**EnergyPLAN**	**Relative difference**
Oil	8069	8070	0.0%
Natural gas	7167	7542	5.2%
Total	**15236**	**15612**	**2.5%**
CO2 emissions (ktCO2)	**ATMO GE**	**EnergyPLAN**	**Relative difference**
Oil	2114	2150	1.7%
Natural gas	1913	1993	4.2%
Total	**4027**	**4143**	**2.9%**
Electricity import/export (GWh/year)	**ATMO GE**	**EnergyPLAN**	**Relative difference**
	9 235	9526	3.1%
Renewable electricity production (GWh/year)	**ATMO GE**	**EnergyPLAN**	**Relative difference**
River Hydro	3080	3068	0.4%
PhotoVoltaic	63	62.7	0.5%





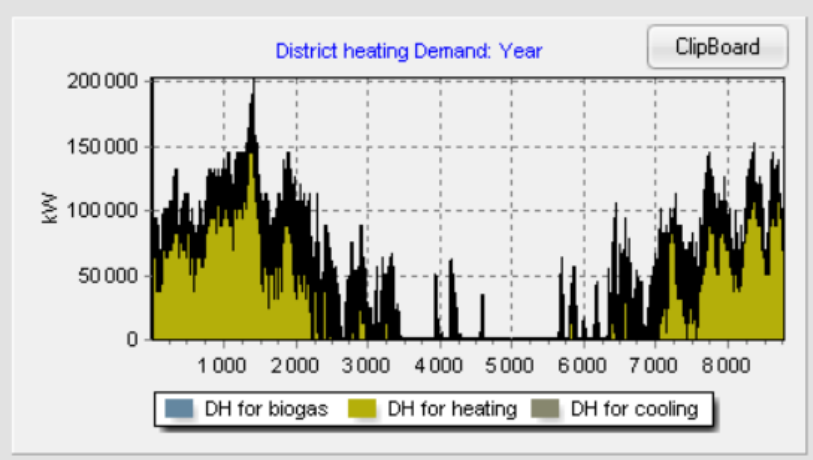


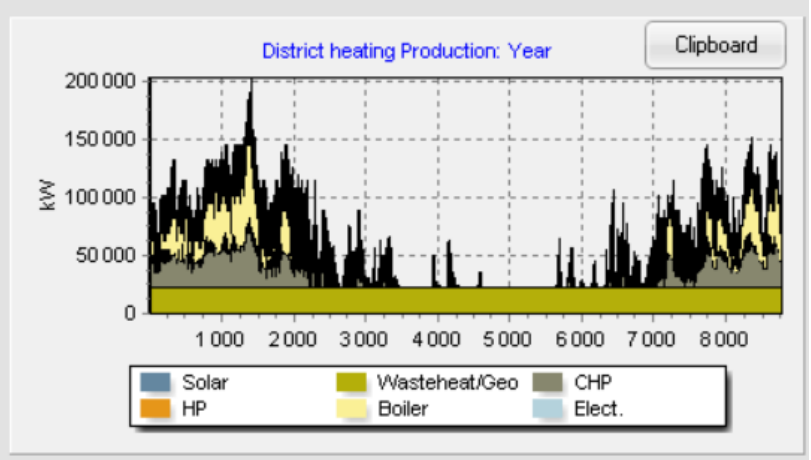
Source : Invent'air 2022 ATMO Grand Est

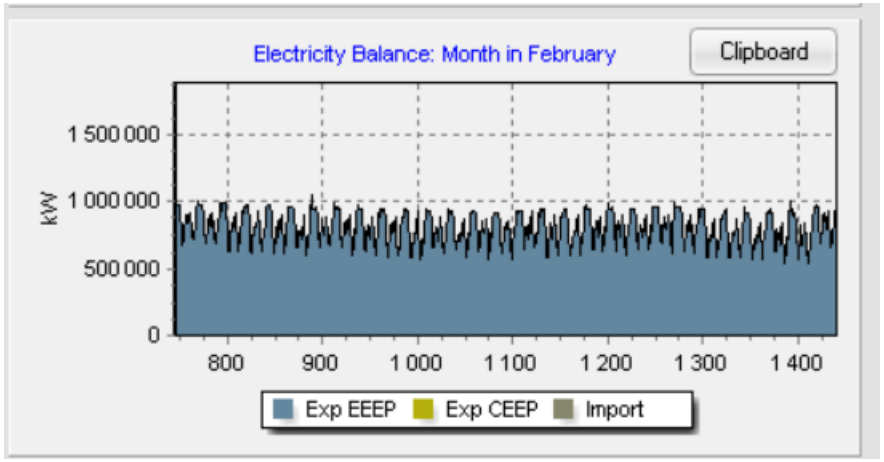
Reference scenario and validation

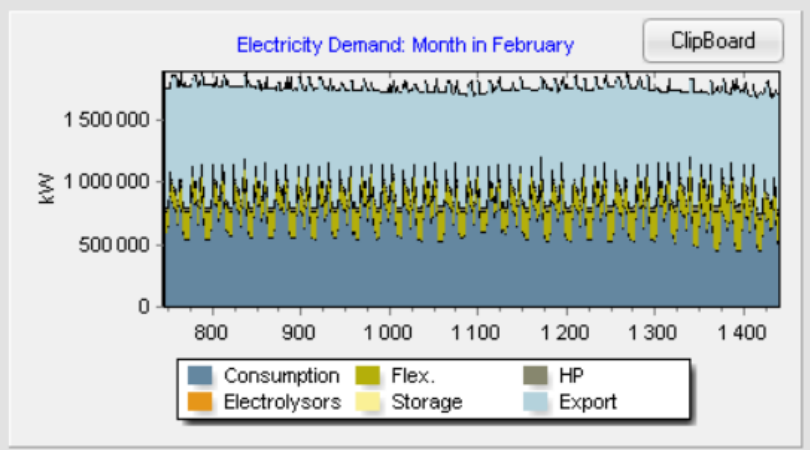
Hourly simulations

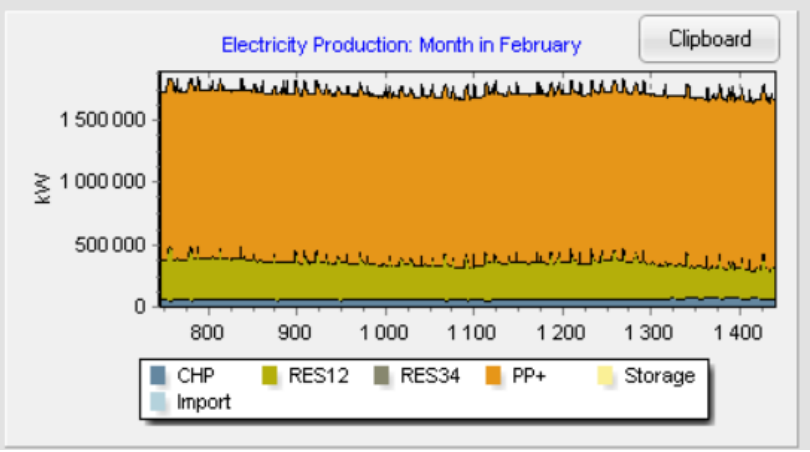
- district heating
  demand/production/storage
- electricity
  demand/production/balance
- gas
  demand/balance











Energy transition scenarios 2030

SRADDET
Regional plans for spatial planning, sustainable development, territorial equality

- energy and climate goals
- more ambitious or equal to national strategies
- regional strategy
- general but not prescriptive guidelines
- do not detail pathways

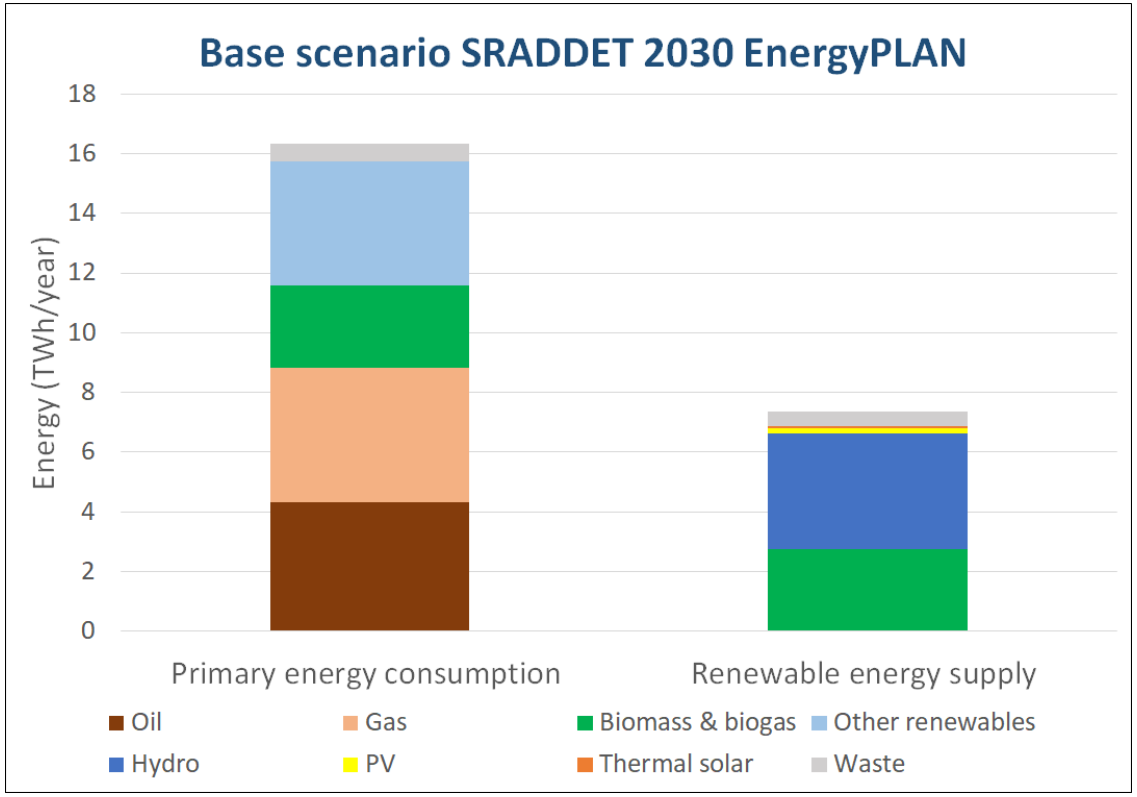
Challenges

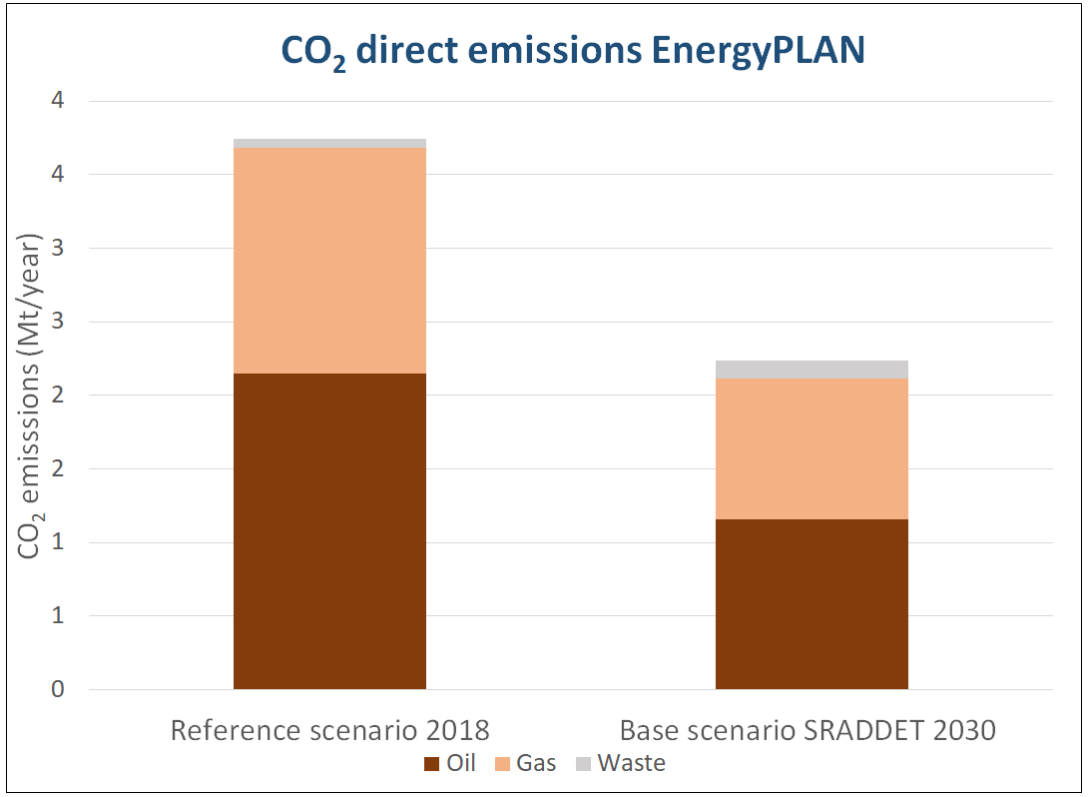
- local territory adaptation (Haut-Rhin)
- energy structure changes (production, regulation, storages, etc.)
- cross sectorial integration
- transport decarbonation
- Regulation
- RE production choice

Assumptions for reference scenario 2030

- following the main guidelines of the SRADDET
- no structural change
- sectorial consumption reduction considered
- final consumptions unchanged base scenario SRADDET/EnergyPLAN

Energy transition scenarios 2030

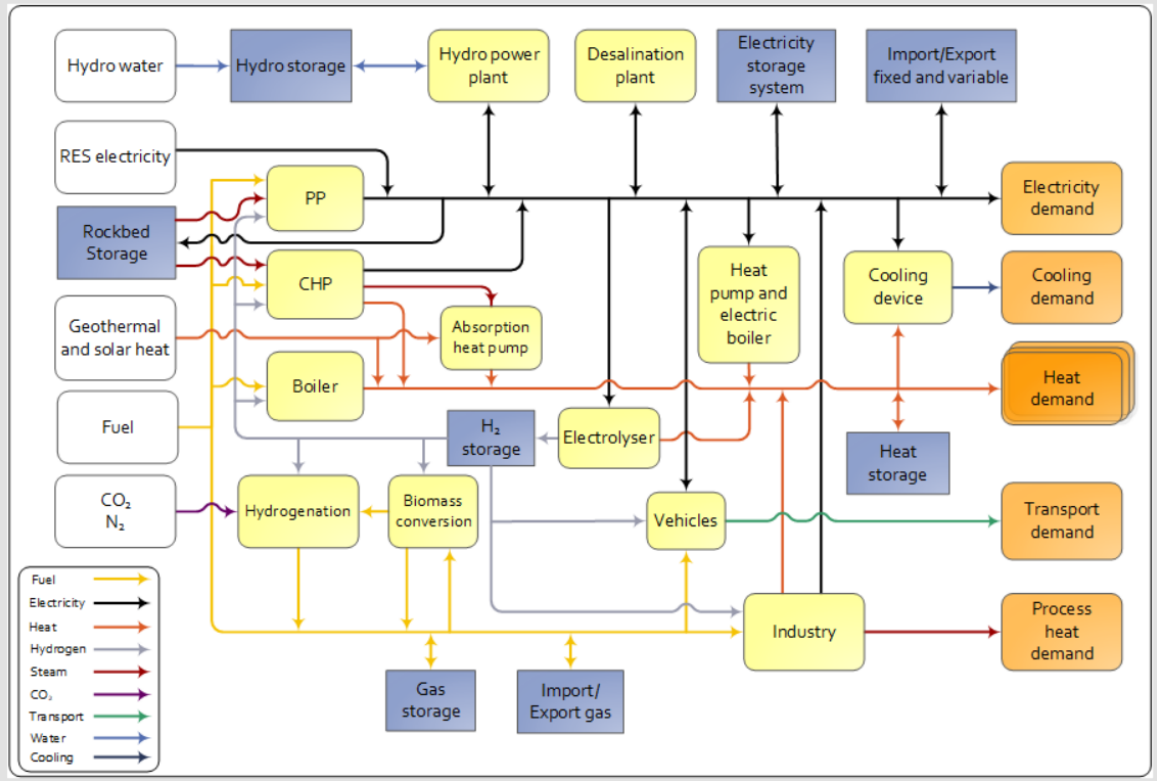


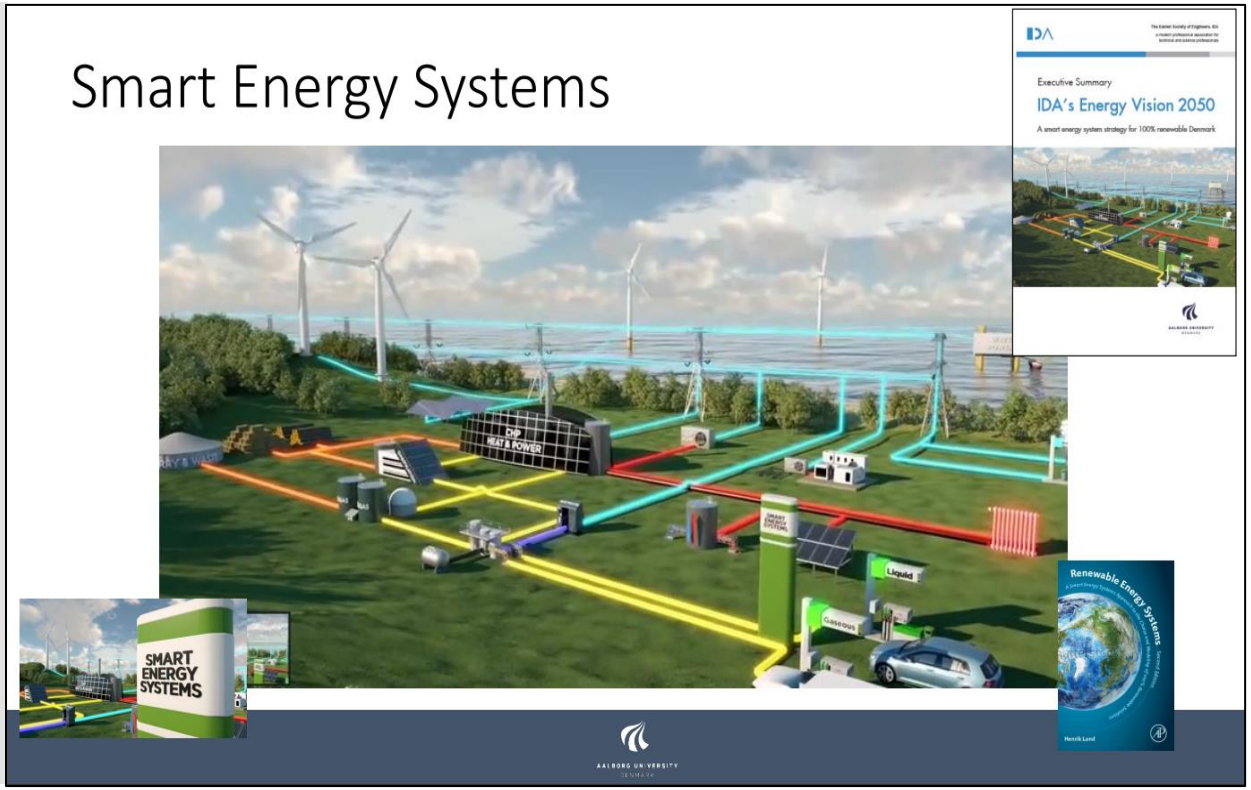


Haut-Rhin department

base scenario SRADDET 2030 EnergyPLAN			
	Balancing Heat = reference	Balancing Heat & Electricity	Difference
Electricity import (GWh/an)	1691	1691	0.00%
Electricity export (GWh/an)	528	499	-5.49%
Gas and biomass consumption (GWh/an)	8115	8082	-0.41%
CO_2 emissions (kt/an)	2236	2235	-0.04%

Towards Renewable Smart Energy Systems by 2050





Smart Energy Systems concept

sector couplings (electricity, heating, cooling, gas, transport)

+

multi-energy, multi-scale storage coupling + DHC-CHP

+

intelligence (flexibility, metering, regulation, optimization)

Smart Energy Systems objectives

→ maximize energy efficiency
→ maximize RE penetration (up to 100%)
→ minimize electricity excess and costs
→ resilient system (hourly balanced electricity, heating, cooling, gas)

Towards Renewable Smart Energy Systems by 2050

Detailed energy-GHG strategy

- effective carbon neutrality (elimination of GHG emissions)
- energy sufficiency + efficiency objectives -55% / 2012
- > 100% RE supply with local productions + RE exchanges with surroundings + interconnections
- overall Smart Energy System implementation (CHP, DHC, couplings, storages)
- maximizing thermal renewable productions (solar thermal, geothermies)
- minimizing biomass production (sustainable use)
- optimizing seasonal solar thermal storage for District Heating & Cooling
- maximizing ecological transport (pedestrial, cyclist, tram, train)
- electrifying public and individual transports (trams, trains, busses, vehicles, trucks, ferries, barges)
- maximizing V2G storage, battery storage → minimizing transmission lines, backup units → maximizing grid stability
- hourly heating, cooling, electricity, gas balance

work in progress

Evolutive energy-GHG data-base

- new renewable supply capacities
- new thermal, electricity, methane, hydrogen storage capacities (daily, weekly, seasonal scales)
- new distribution-conversion units (DHC, CHP, HP, electrolysers)

work in progress

Scenario 2050 simulations

→ costs comparison of numerous RSES structures → investment & decision planning tool

work in progress

Thank you for attention

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