

Modeling the energy transition of the south-east region of France: the role of hydrogen for the integration of variable renewables

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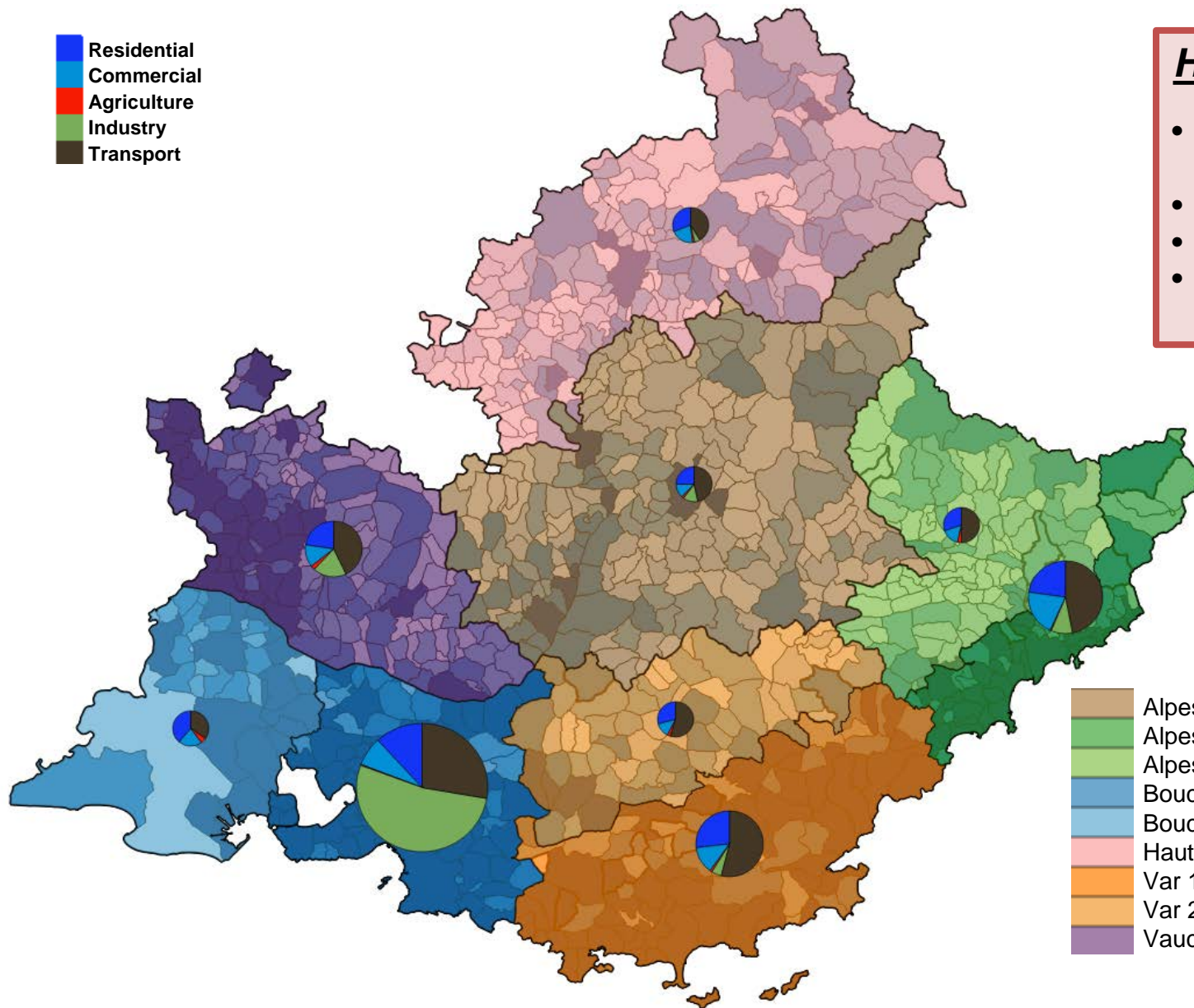
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Energy demand



- Residential
- Commercial
- Agriculture
- Industry
- Transport



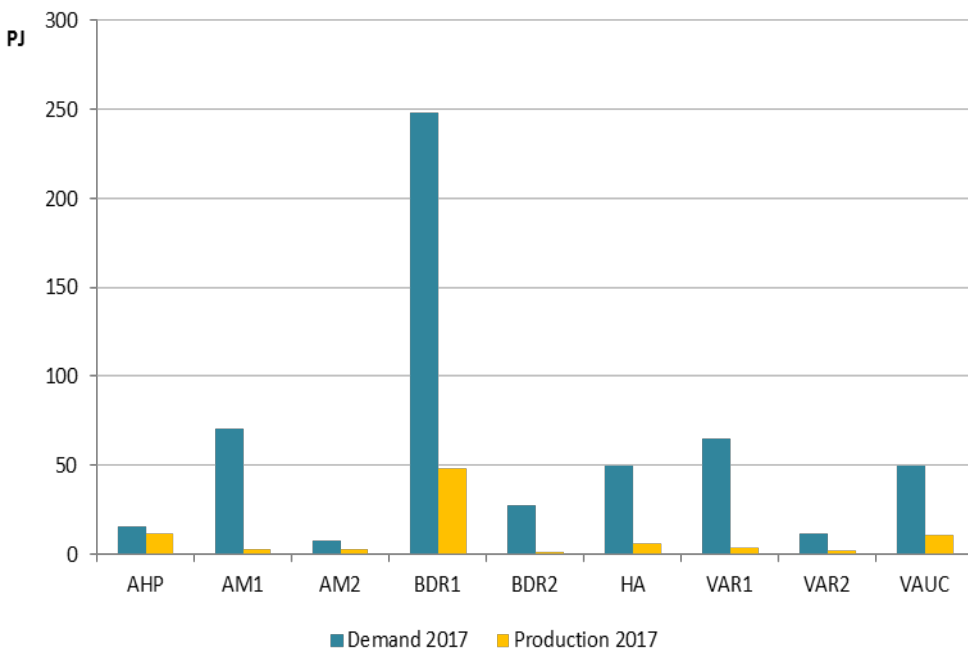
High energy consumption

- 12 Mtoe in 2017 (4th in France) (509 PJ)
- 65 % fossil fuels
- 30 % electricity
- 80 % of the energy consumption concentrated next to the littoral

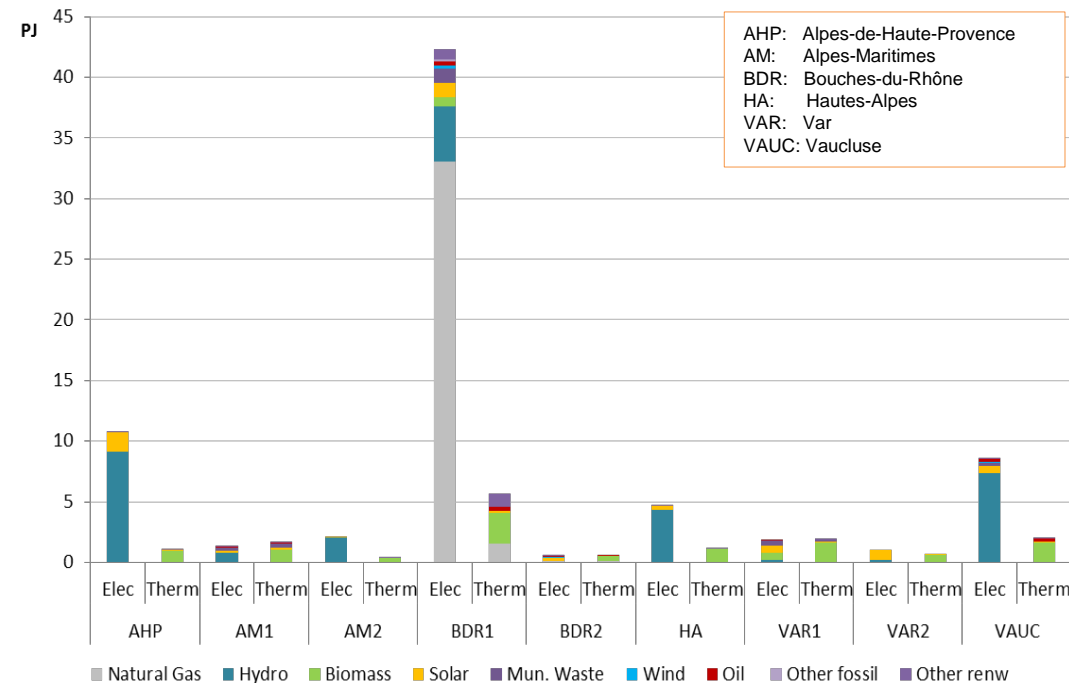
- Alpes-de-Haute-Provence
- Alpes-Maritimes 1
- Alpes-Maritimes 2
- Bouches-du-Rhône 1
- Bouches-du-Rhône 2
- Hautes-Alpes
- Var 1
- Var 2
- Vaucluse

Final energy production by department of the SUD PACA Region in 2017

Departments' production vs demand



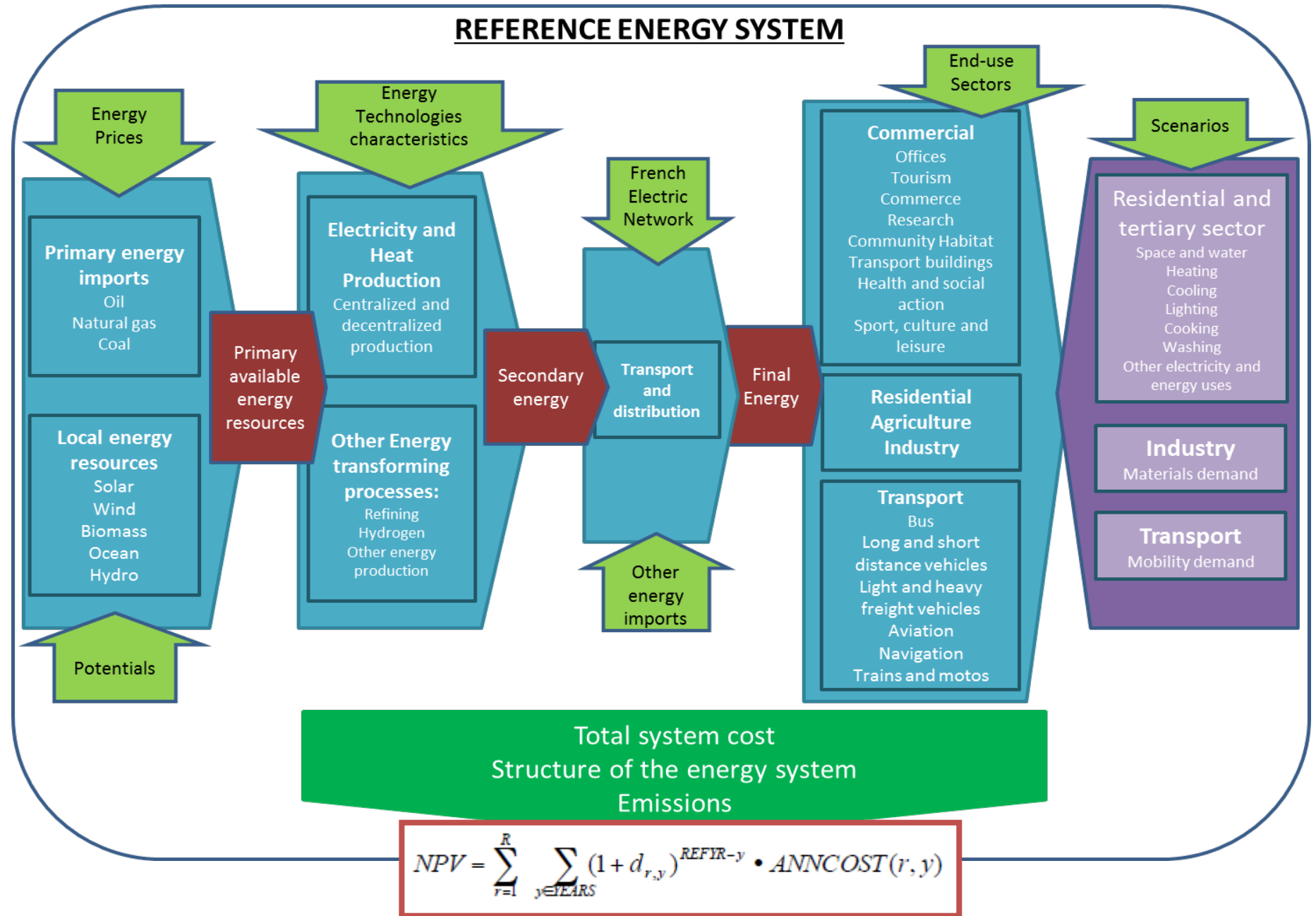
Final energy production



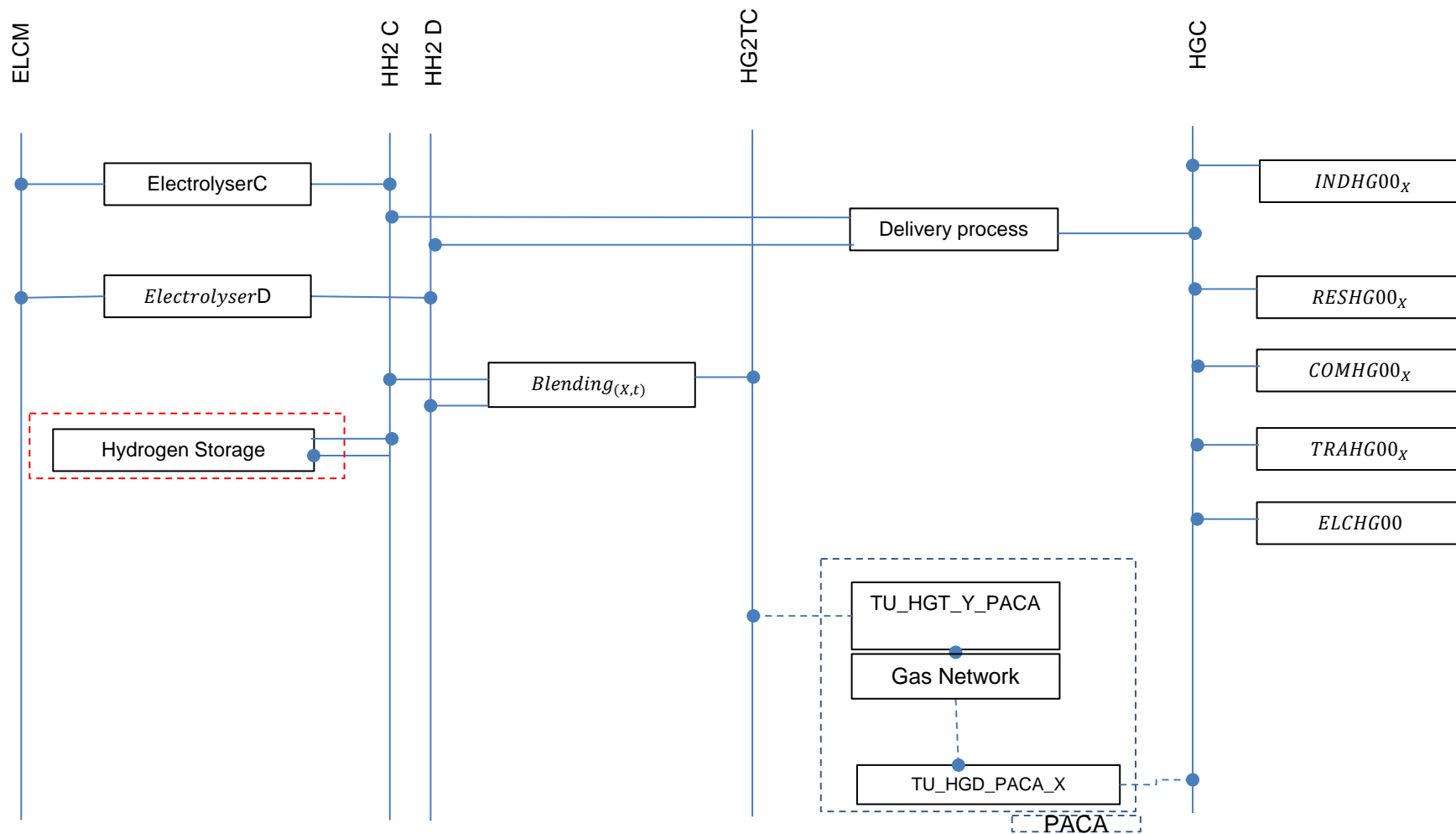
- Low energy production compared to consumption (17 % of the demand)
- Energy production mainly comes from fossil fuels (46 %)
- Production concentrated in the BDR1 (54 %)



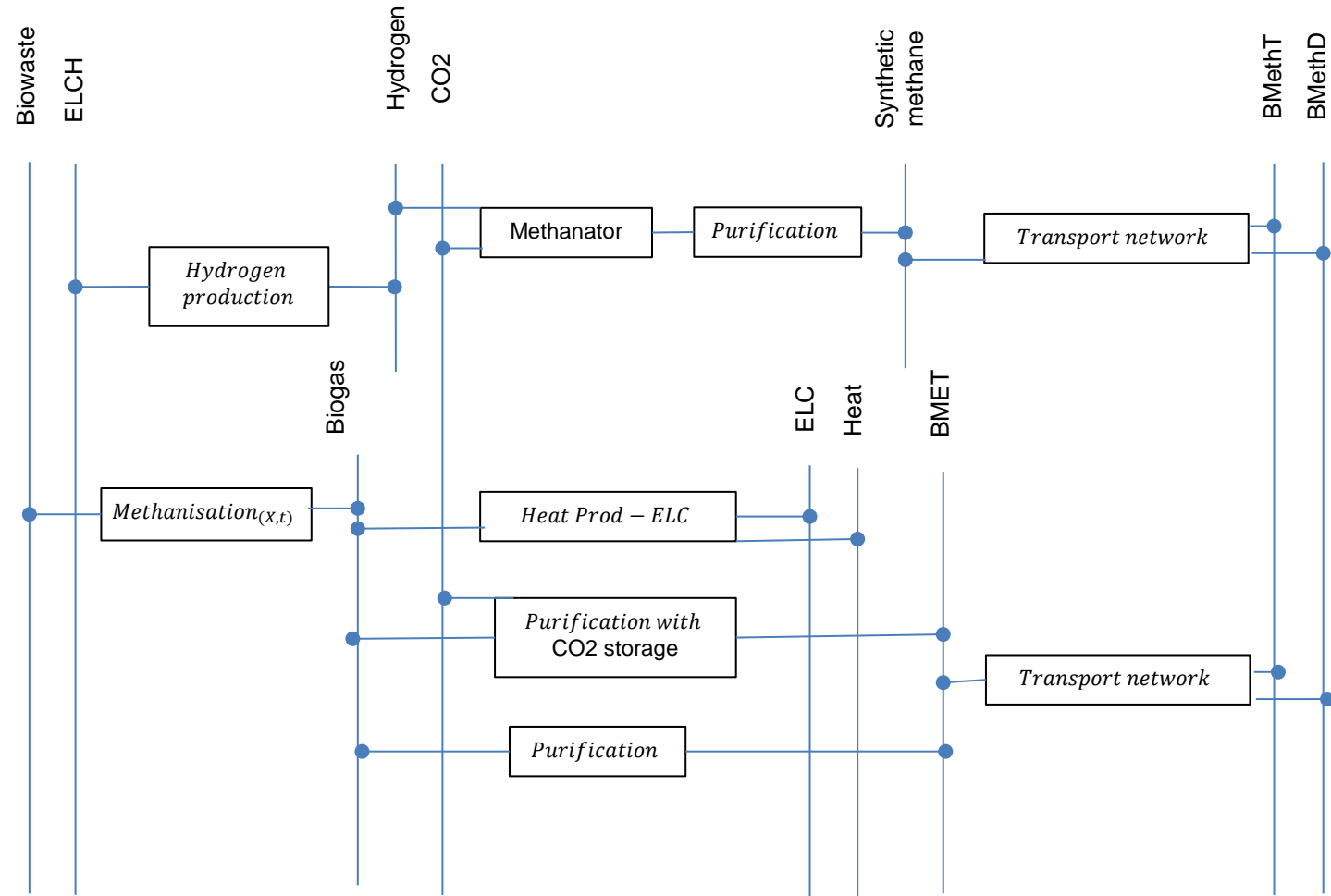
The TIMES-SUD_{PACA} model



TIMES-SUD_{PACA} model - Hydrogen production



TIMES-SUD_{PACA} – biogaz production



SER - biogas production

The scenarios

1. Reference (RF) : What is the optimal solution found by the model based on local energy potentials. No new technologies allowed



Demand follows past trends



2. SRADDET (SR): Integrates the main strategies proposed by the region in terms of energy production



The region targeted a 30 % demand reduction for 2050

3. New technologies (NT): How the use of hydrogen and other power-to-gas technologies can transform the energy system

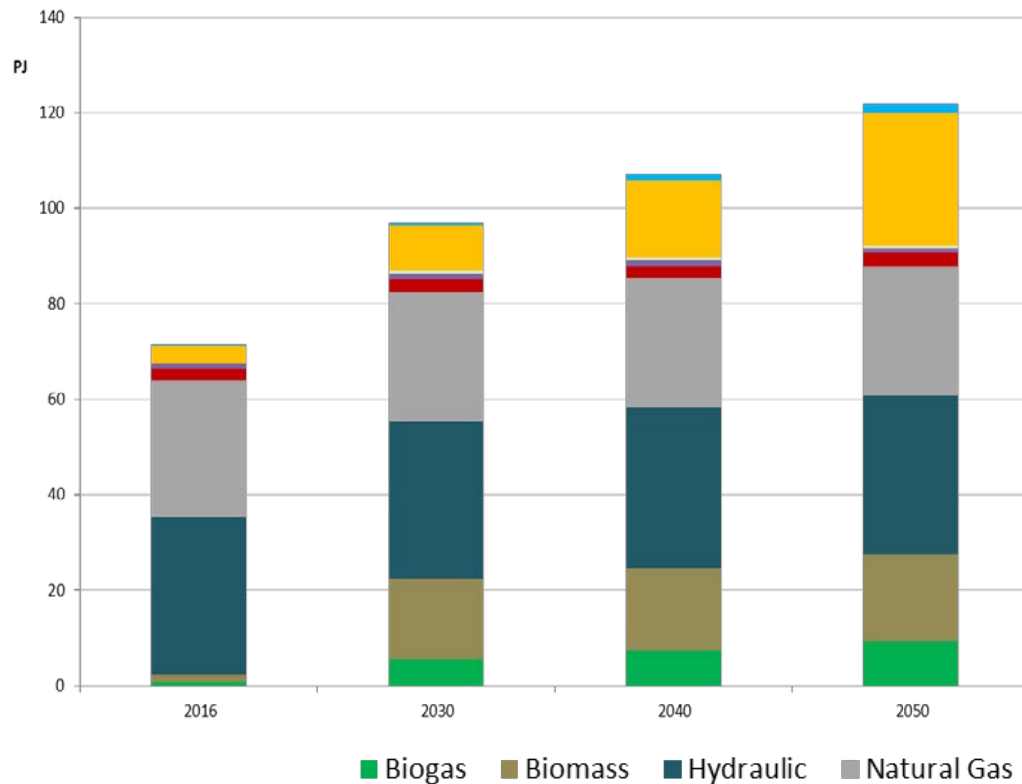
Production (MW)		2012	2020	2025	2030	2050
Electricity	Hydroelectricity	3 073	3 756	3 929	3 956	4 100
	Wind	45	557	1068	1597	3305
	Solar	596	6912	9779	11730	46852
	Biomass	0	141	172	172	172
Thermal	Heat recovery	1199	2 749	3 611	4 300	6546
	Solar thermal	20	509	781	998	2065
	Biomass	80	352	514	650	1283
	Methanisation	14	71	162	267	570
	Gasification	0	55	153	267	586
TOTAL		5 027	12 353	16 558	19 637	65 479



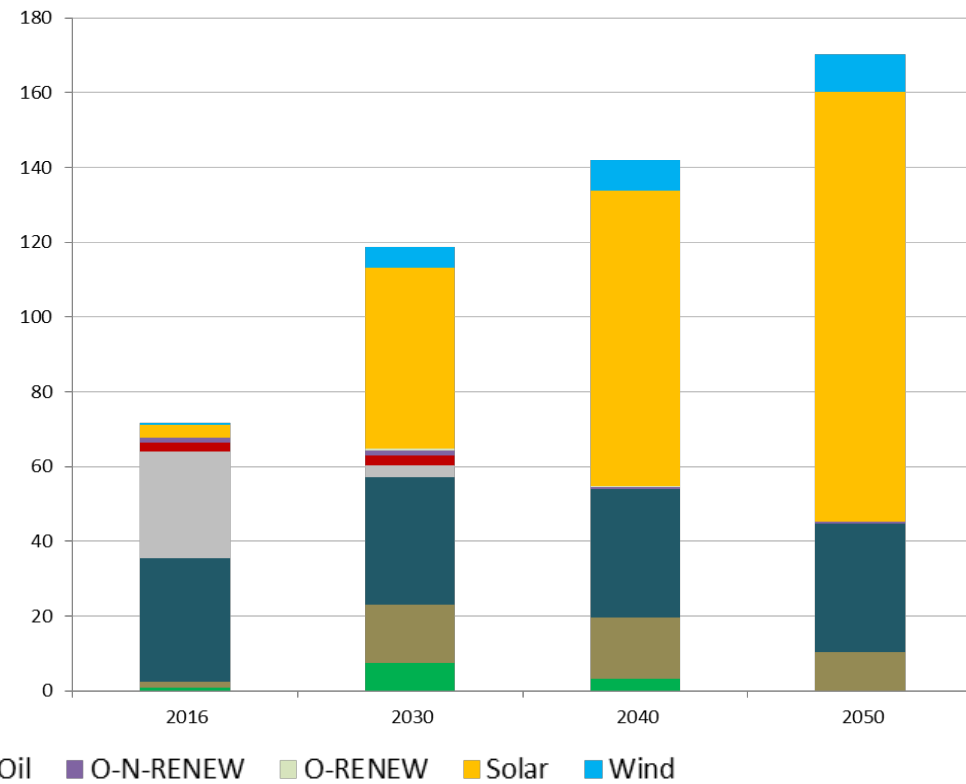
Intermittent renewables represent around 75 % of the established electricity capacity in 2050

Possible pathways – Power production

Reference scenario - RF



Scenario SRADDET - SR

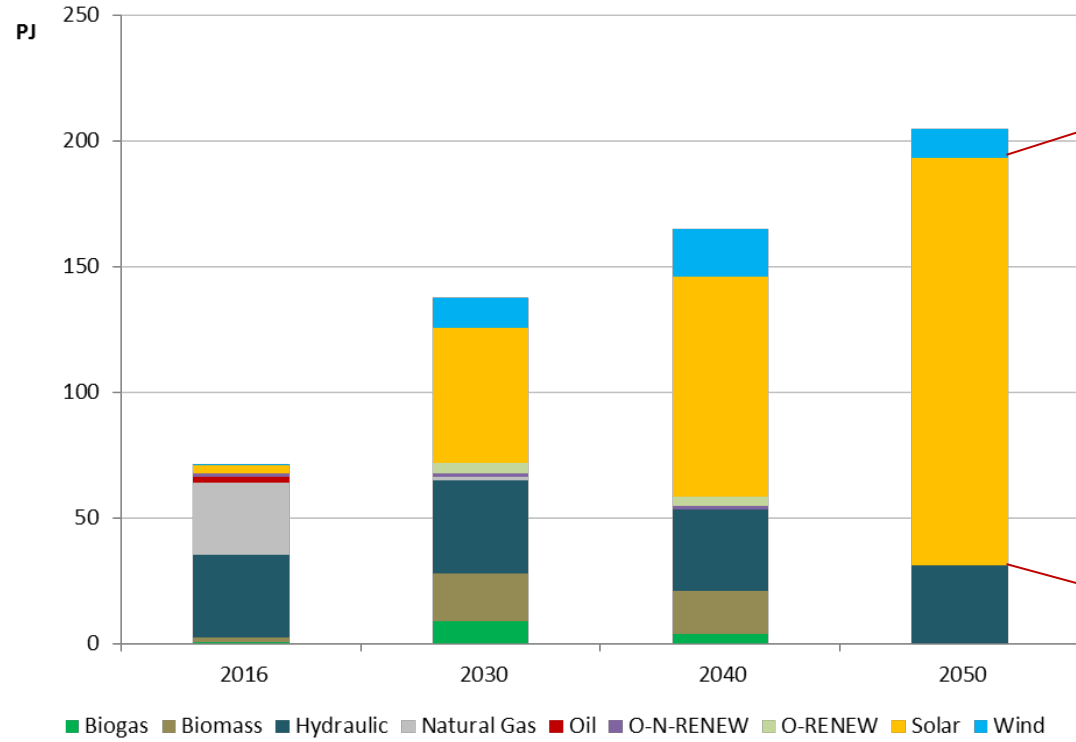


- In 2050, renewable energies represent **75 %** of the total power production in the RF, while in the SR there is no power production coming from fossil fuels.
- Bioenergies are used to produce **23 %** of the electricity in the RF, and just **6 %** in the SR.
- Solar energy represents **68 %** in the SR, and **23 %** in the RF.
- Production in the SR is **30 %** higher than in the RF

Possible pathways – Power production



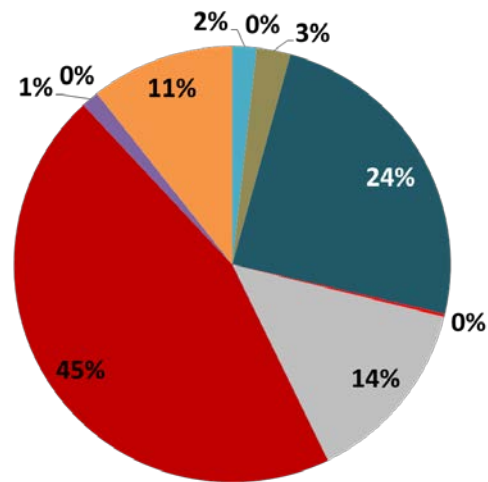
New technologies scenario



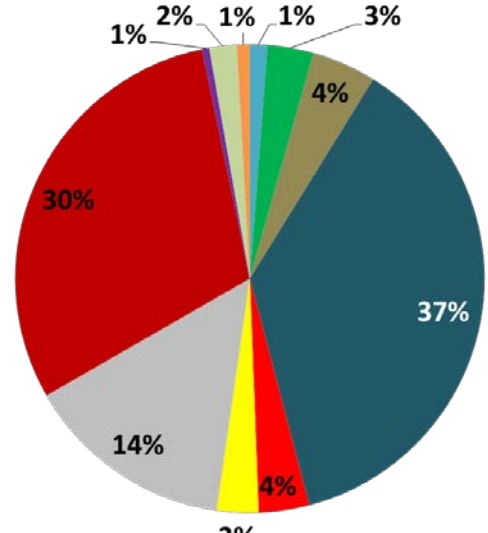
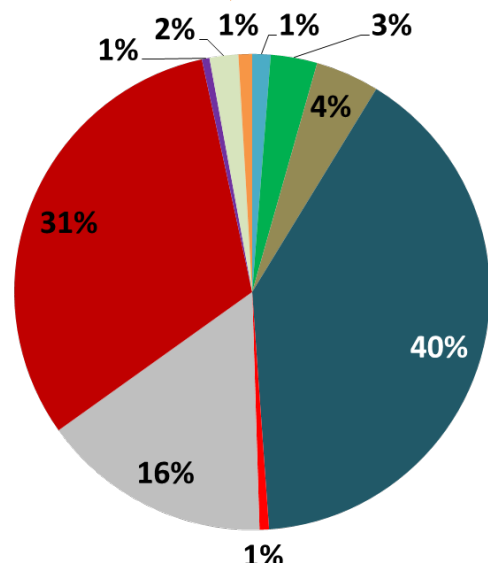
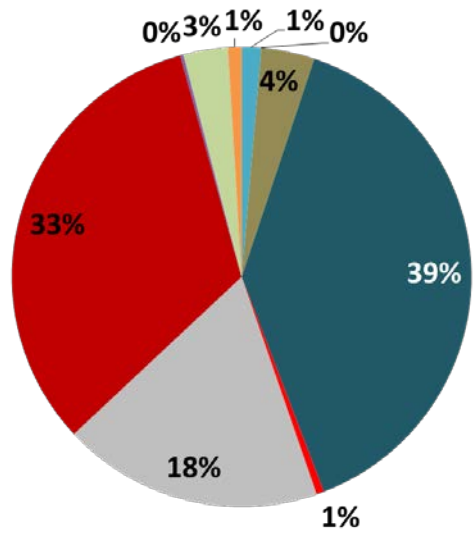
- Production is 20 % higher than the SR:
 - Higher electricity demand due to the hydrogen production
 - Decrease of electricity coming from the rest of France

Final energy consumption

2016



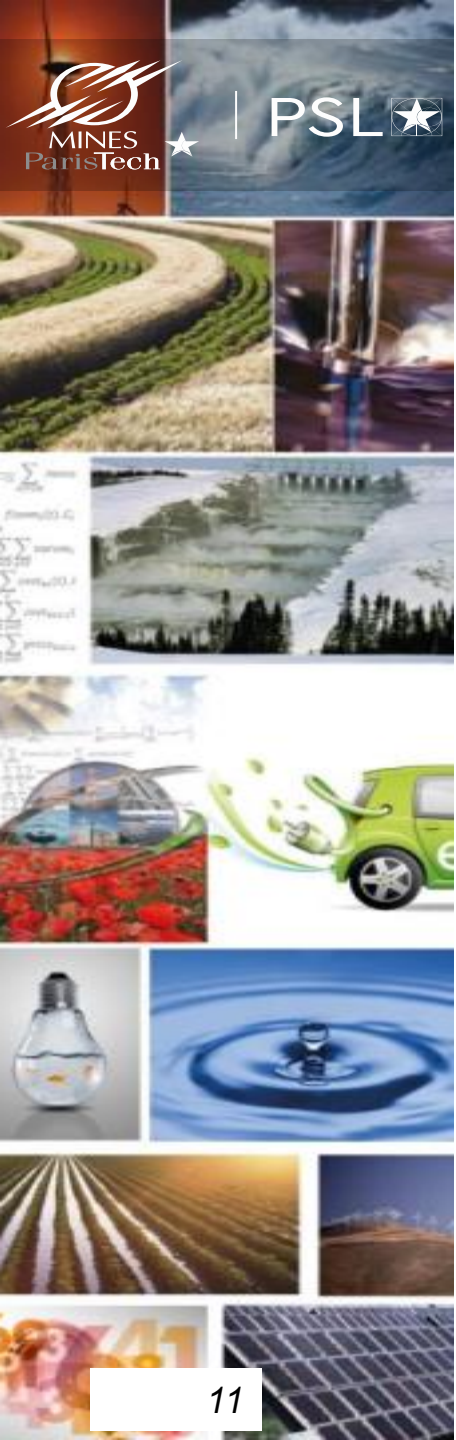
2050



Reference scenario

SRADDET

New technologies



Hydrogen consumption in 2050



Around 20 PJ consumed in 2050

- Habitat: Heating 68 %
- Industry – steam production 31 %
 - Chemical
 - Food & beverages
 - Other industries
- Transport 1 %
 - Buses
 - Private vehicles



Conclusion

- The region is in the path towards the decarbonization of its energy system, with the decrease of fossil fuels consumption and the development of clean technologies
- Further efforts are needed in order to increase the part of cleaner technologies in final consumption, and reach the objectives established by the region
- The integration of power-to-gas technologies seems to be a key factor in the path towards an energy transition of the energy system of the SUD PACA region



THANKS FOR YOUR ATTENTION

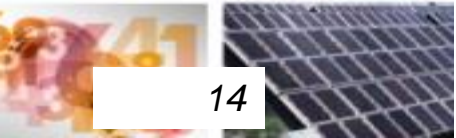
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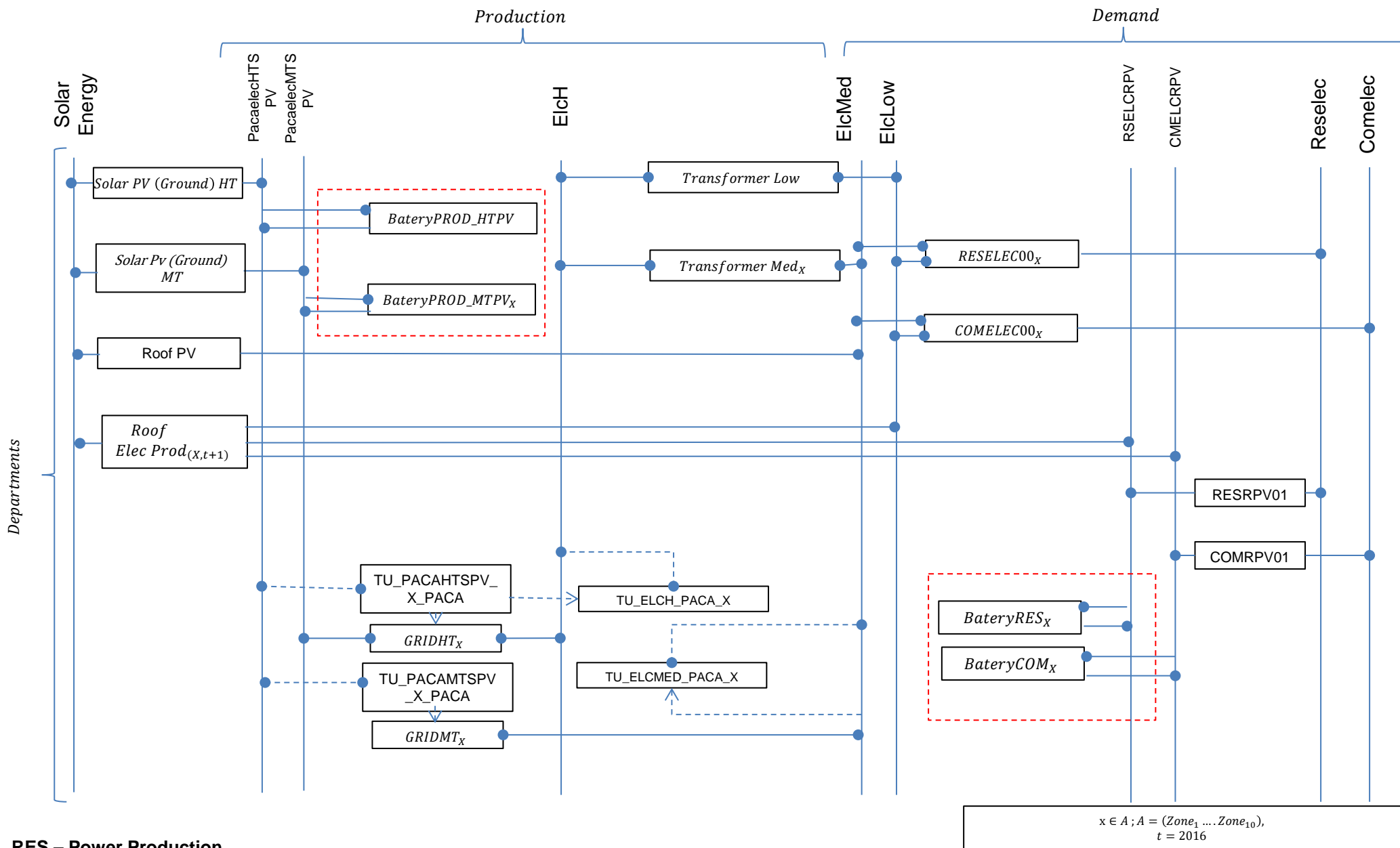
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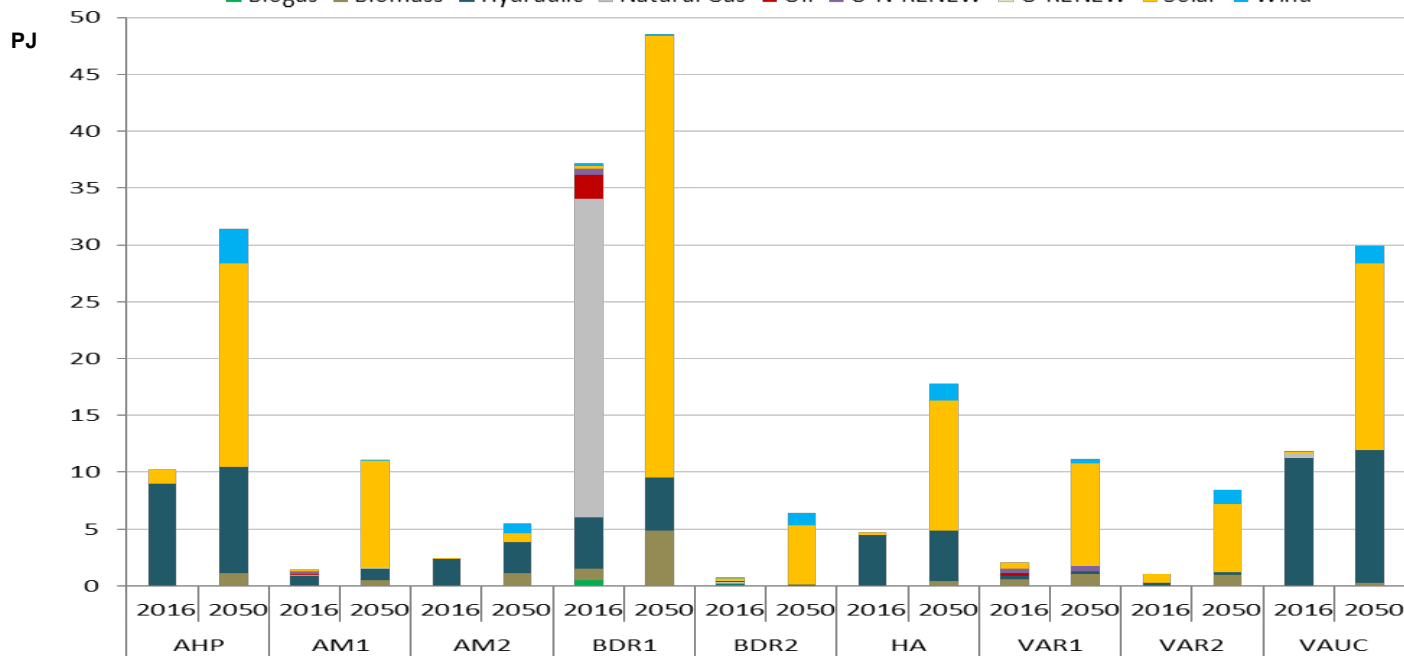
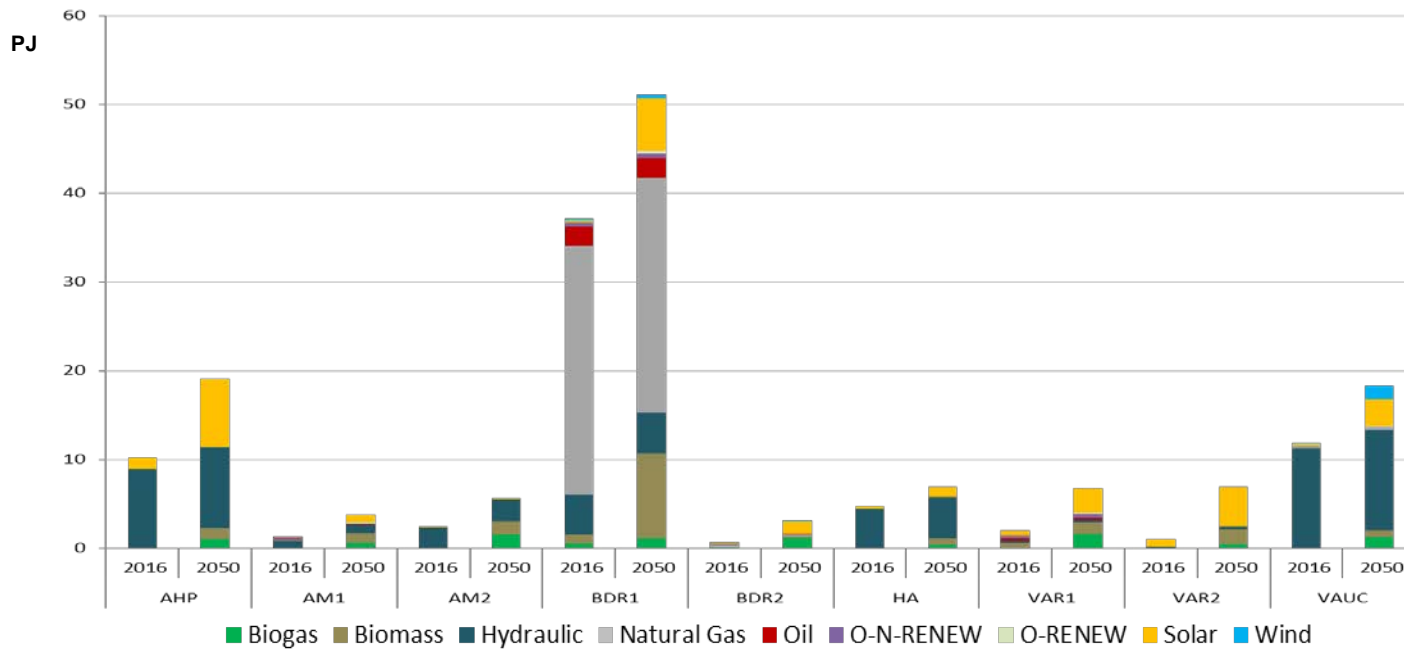


ANNEXES

TIMES-SUD_{PACA} model : Electric system



Possible pathways- Power production by zone



Reference scenario

- Production increases in all departments
- The BDR 1 is still the higher producer, representing 40% of the regional production

SRADDET scenario

- Production has mainly been developed in low consumption zones, which represents now around 50 % of the total production

AHP: Alpes-de-Haute-Provence
 AM: Alpes-Maritimes
 BDR: Bouches-du-Rhône

HA: Hautes-Alpes
 VAR: Var
 VAUC: Vaucluse

Possible pathways – Power production by zone

New technologies scenario

