

Modeling the low-carbon energy transition of territories:

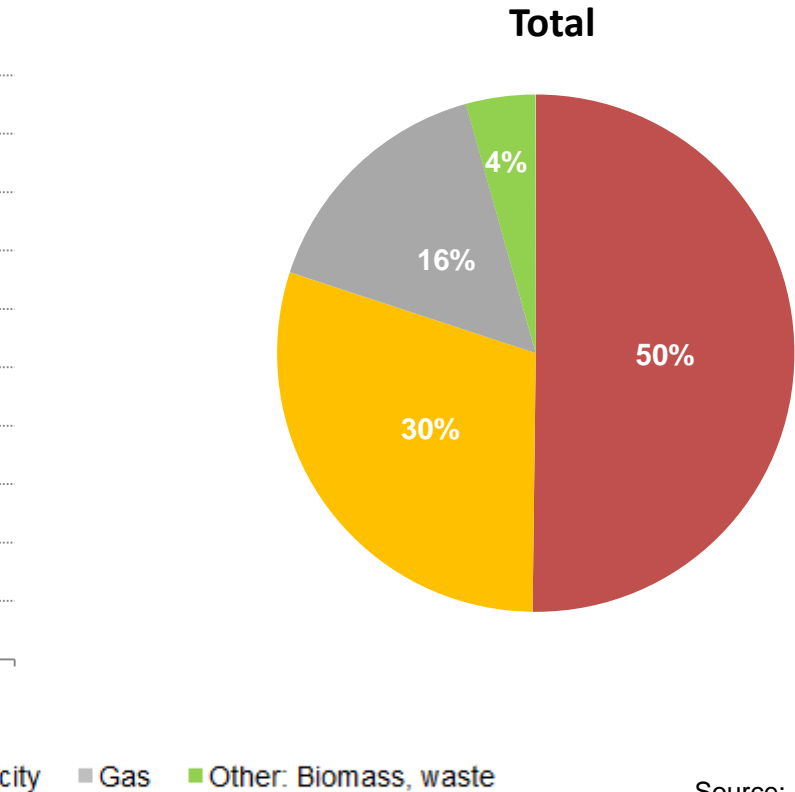
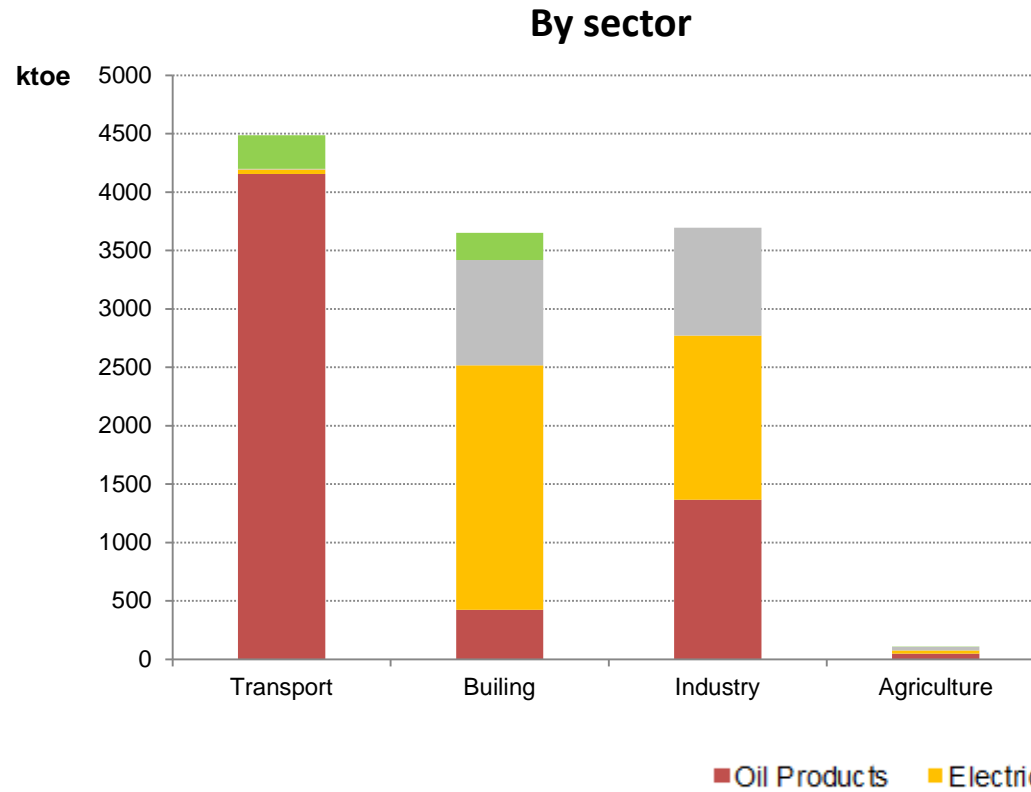
A TIMES-SUD_{PACA} model to assess the long-term
decarbonization strategy of the south-east region of France

Carlos ANDRADE, Sandrine SELOSSE , Nadia MAÏZI

The RÉGION SUD PROVENCE-ALPES-CÔTE D'AZUR



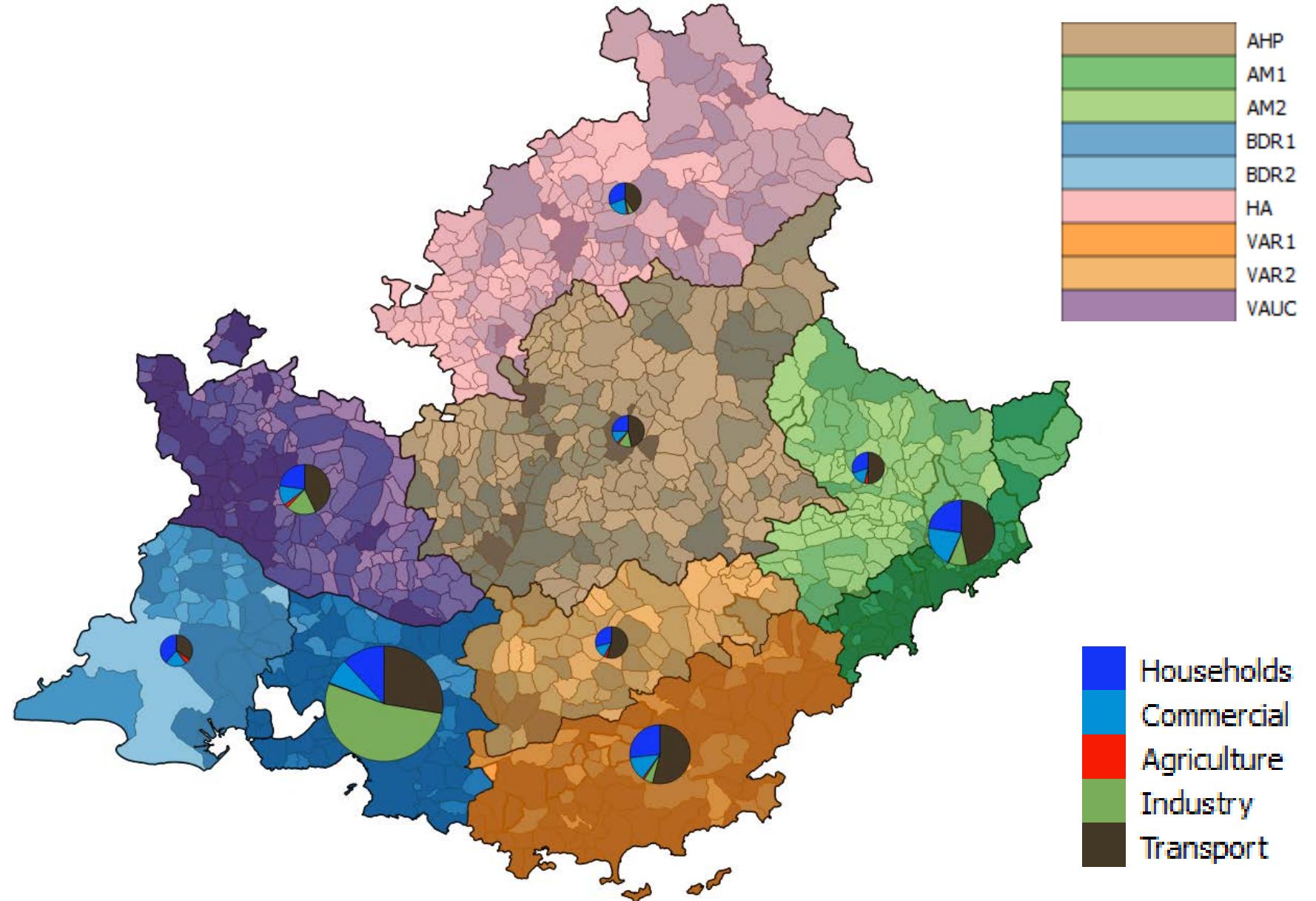
SUD PACA region's final energy consumption in 2016



Source: ADMOSUD

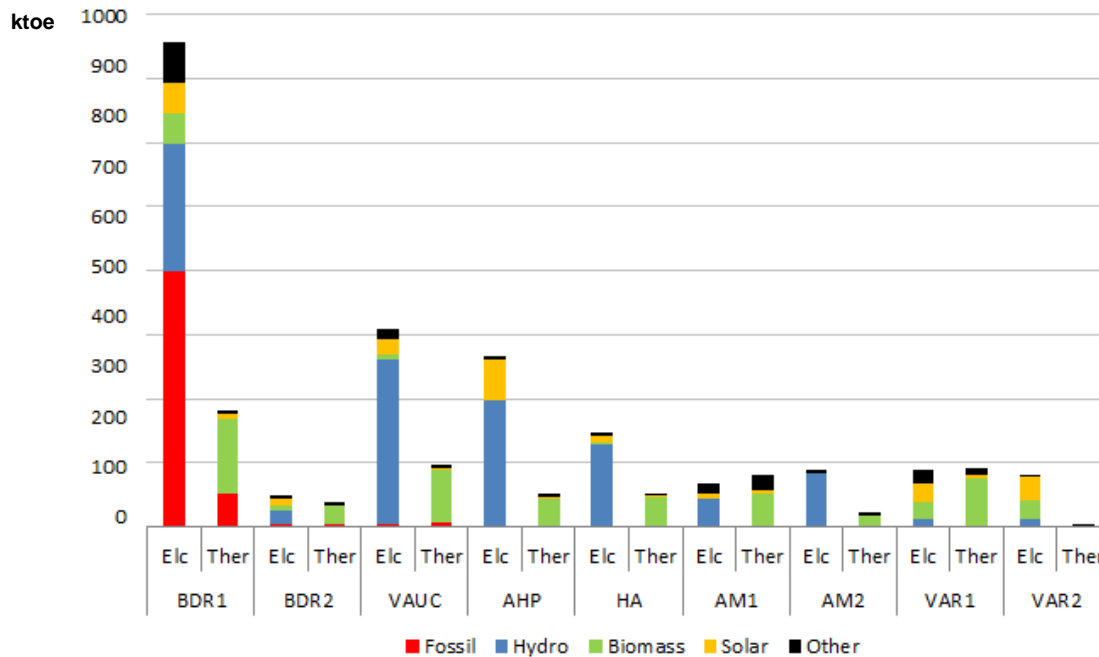
- With **11 940 ktOE** in 2016 the consumption of the SUD PACA region represents **8%** of the French energy consumption
- Fossil fuels cover **66%** of regional energy consumption
- **50%** of households in the region own at least one car
- Heat production accounts for **50%** of the energy consumed by the building sector

Final energy consumption in the SUD PACA Region in 2016 by department

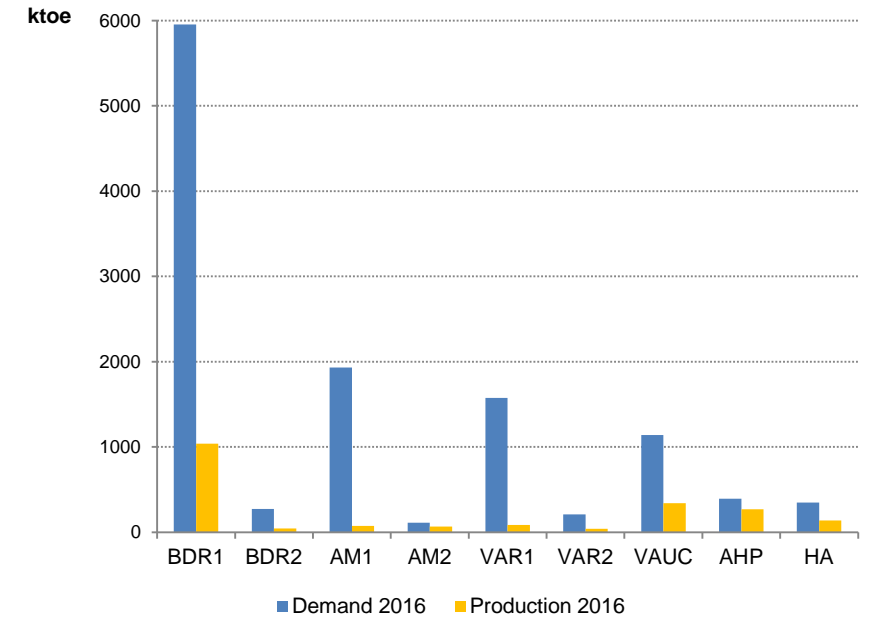


Final energy production by department of the SUD PACA Region in 2016

Final energy production

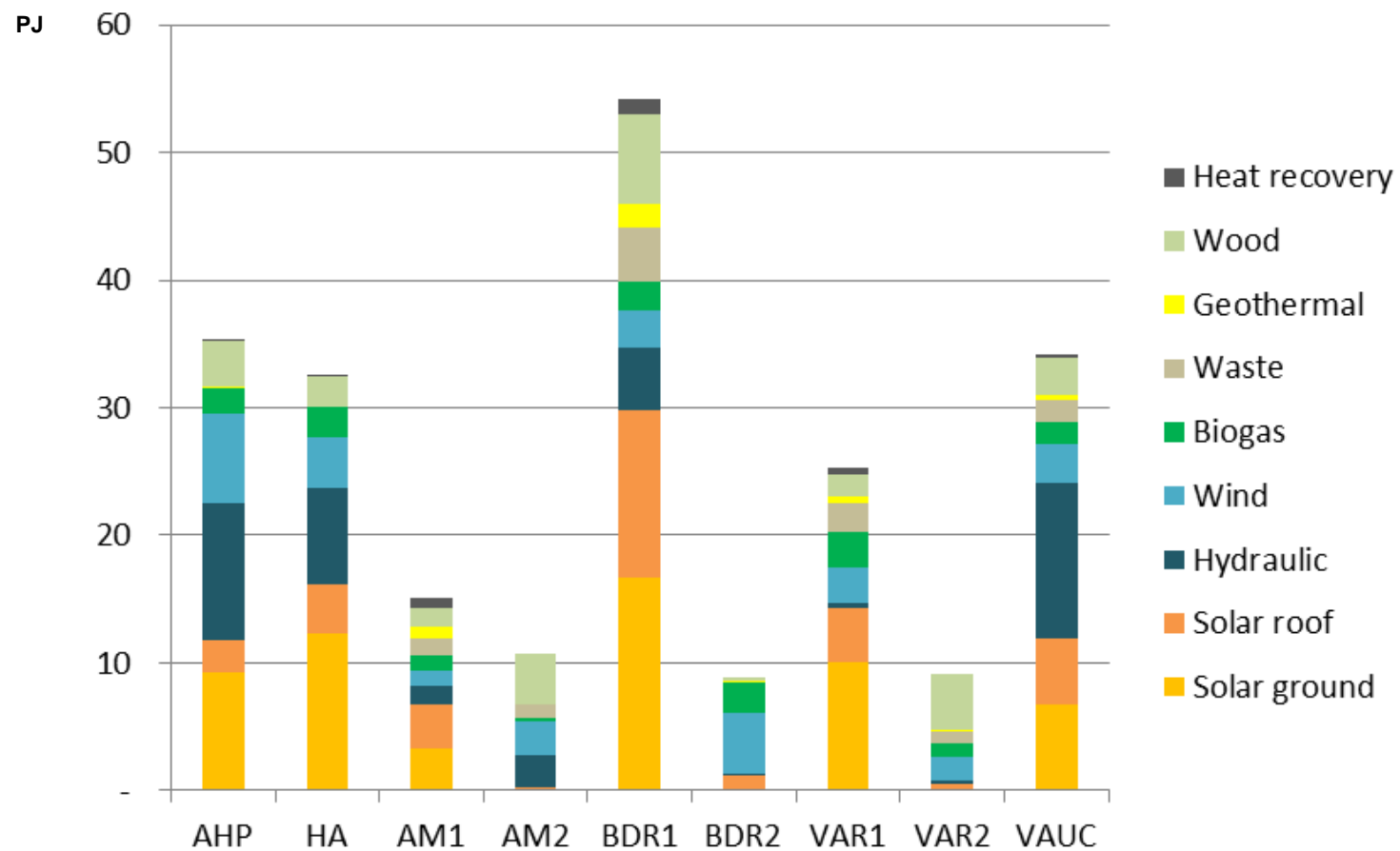


Departments' production vs demand



- The SUD PACA region produces around **15%** of the energy it consumes
- Renewable resources account for **70%** of the final energy production
- Zone 1 of Bouches-du-Rhône produces **50%** of the regional production
- Biomass is a significant energy source especially for heat production

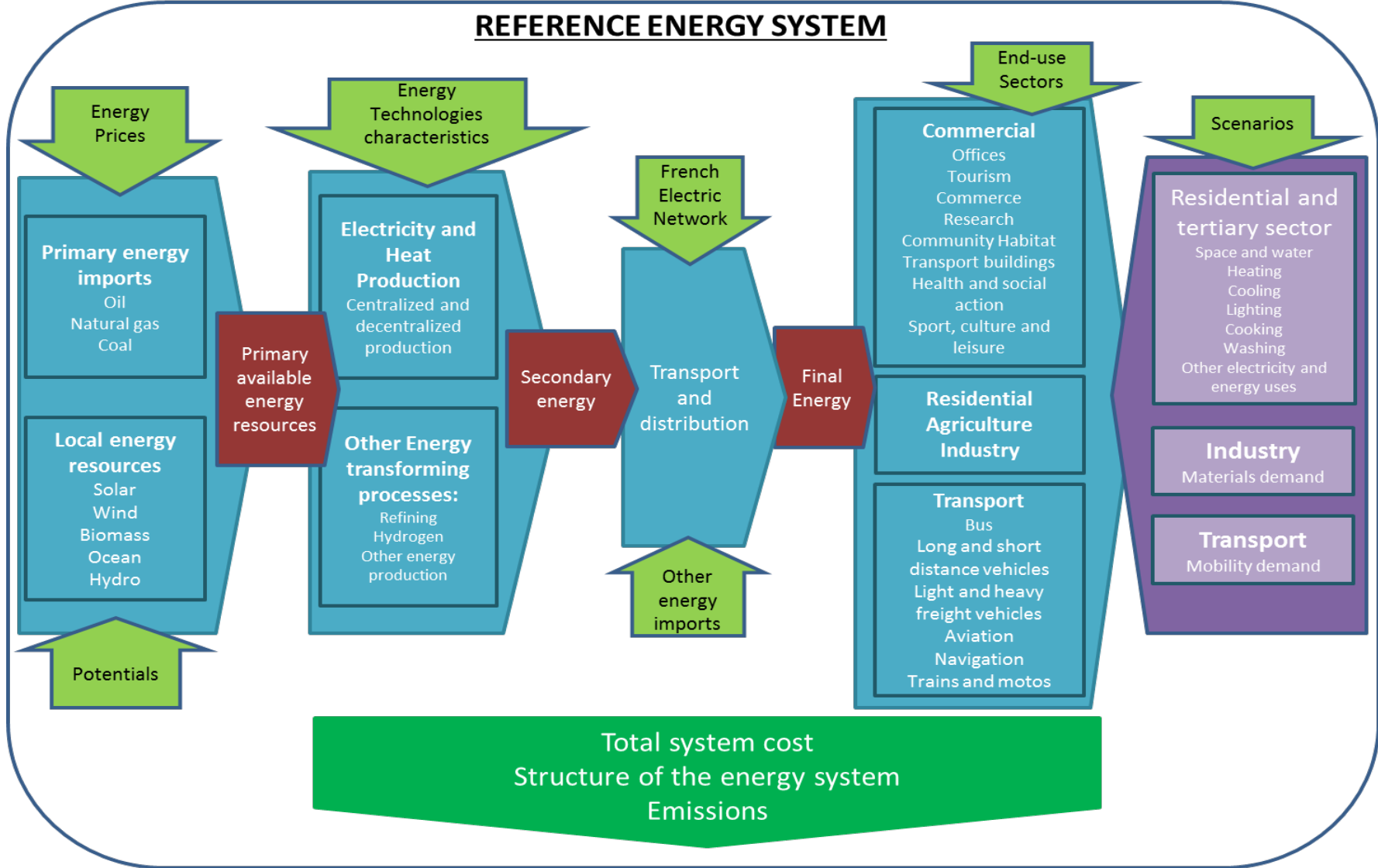
2050 renewable energies technical potential



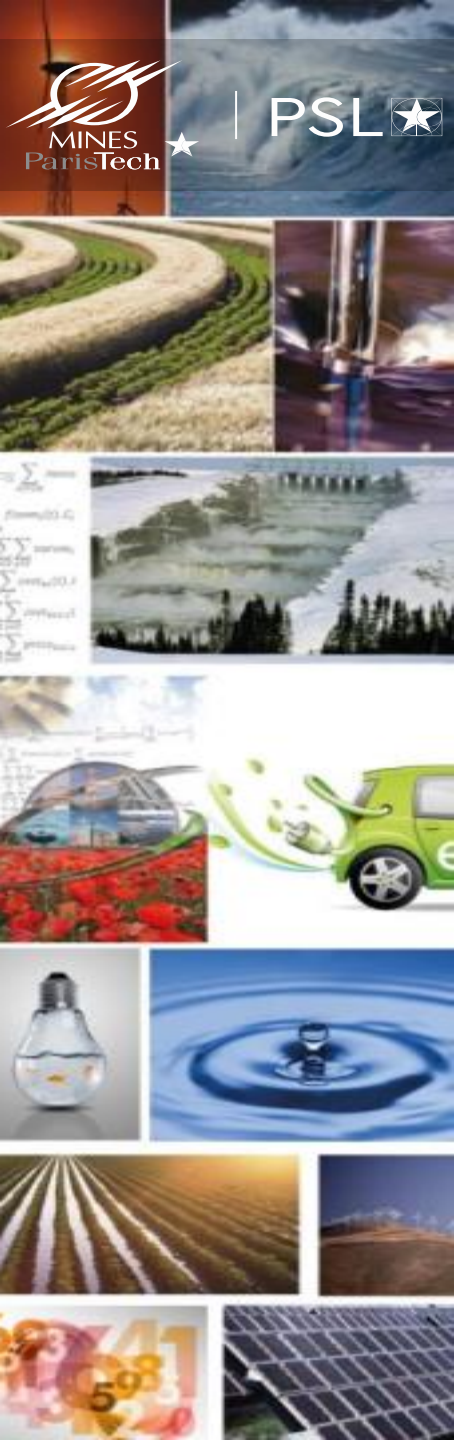
- Solar is the most important source of renewable energy in the SUD PACA region representing around 40% of the total potential
- Renewable energy potentials can cover up to 55% of current energy demand



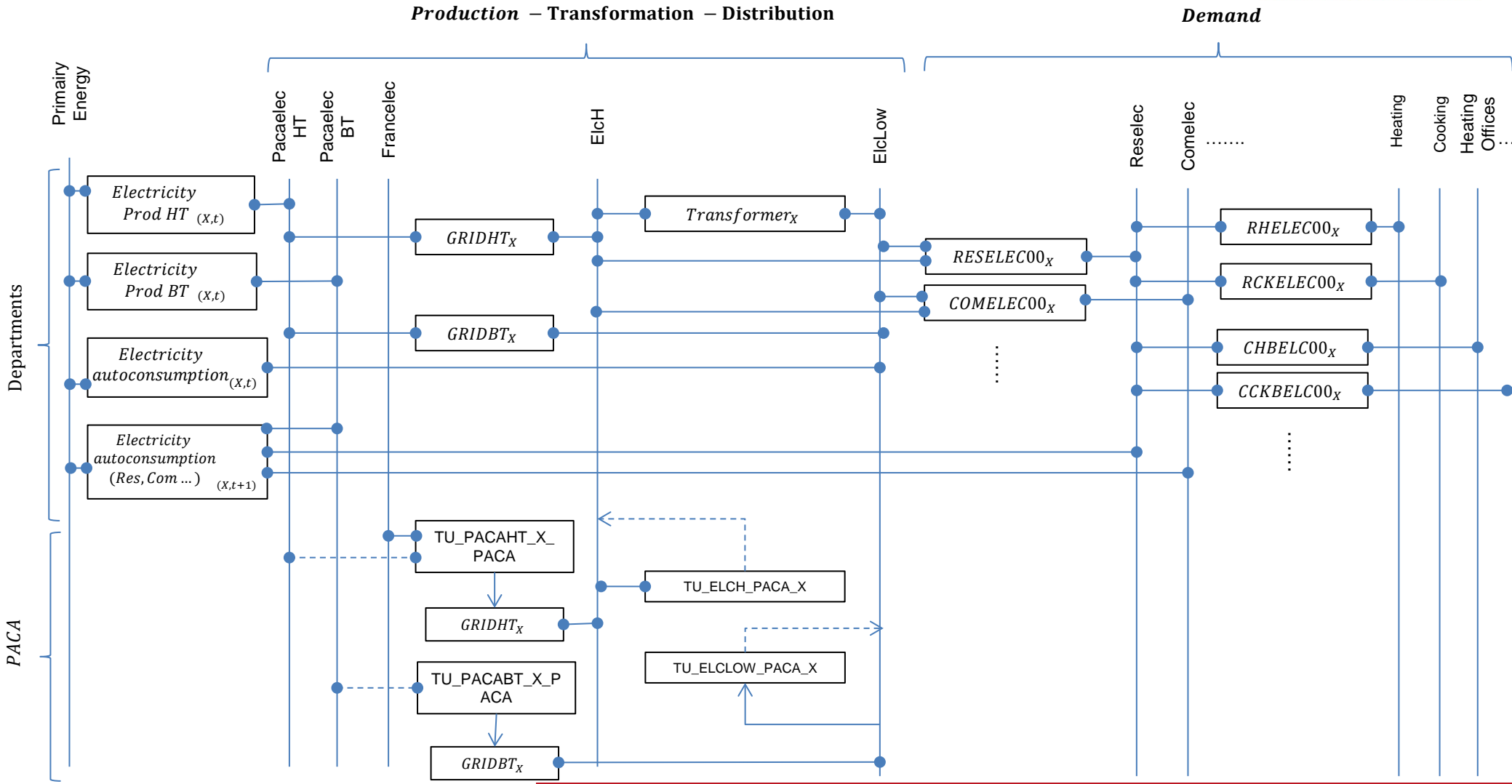
Prospective – Modeling - TIMES



$$NPV = \sum_{r=1}^R \sum_{y \in YEARS} (1 + d_{r,y})^{REFYR-y} \cdot ANNCOST(r,y)$$



TIMES SUD PACA : Electric system representation



$x \in A ; A = (Zone_1 \dots Zone_{10}),$
 $t = 2016$

Scenarios

1. **Reference** : What is the most optimal solution according to potentials



Demand follows past trends



2. **Carbon Neutral (CN) – SRADDET** :
Production objectifs proposed by the region
SUD PACA

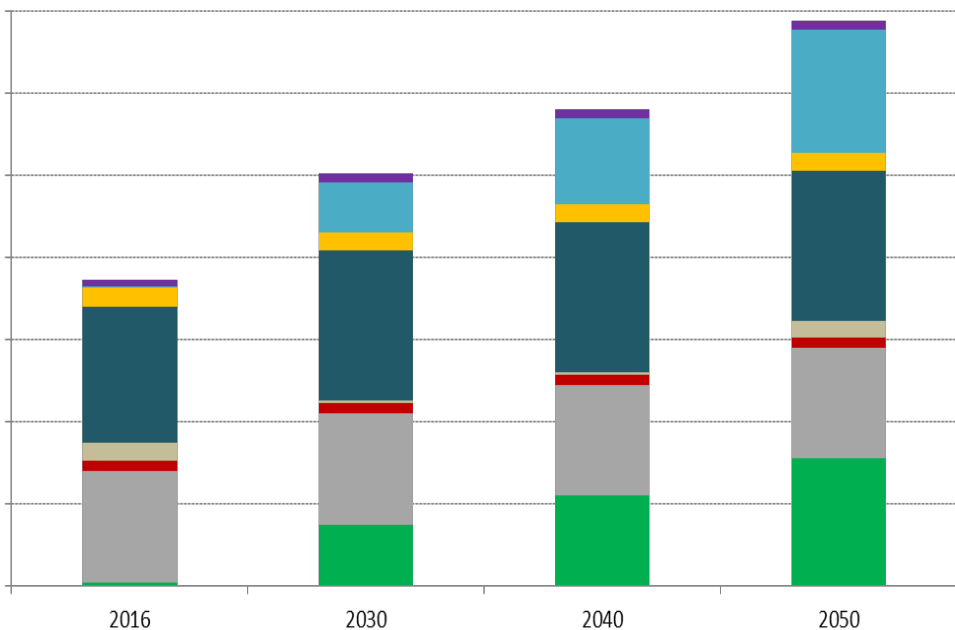


Production (MW)		2012	2020	2025	2030	2050
Electricity	Hydroelectricity0	3 073	3 756	3 929	3 956	4 100
	Wind	45	557	1068	1597	3305
	Photovoltaïque	596	6912	9779	11730	46852
	Biomasse	0	141	172	172	172
Thermal	Heat recovery	1199	2 749	3 611	4 300	6546
	Solar Thermal	20	509	781	998	2065
	Biomass	80	352	514	650	1283
	Biogas	14	71	162	267	570
	Gasification	0	55	153	267	586
TOTAL		5 027	12 353	16 558	19 637	65 479

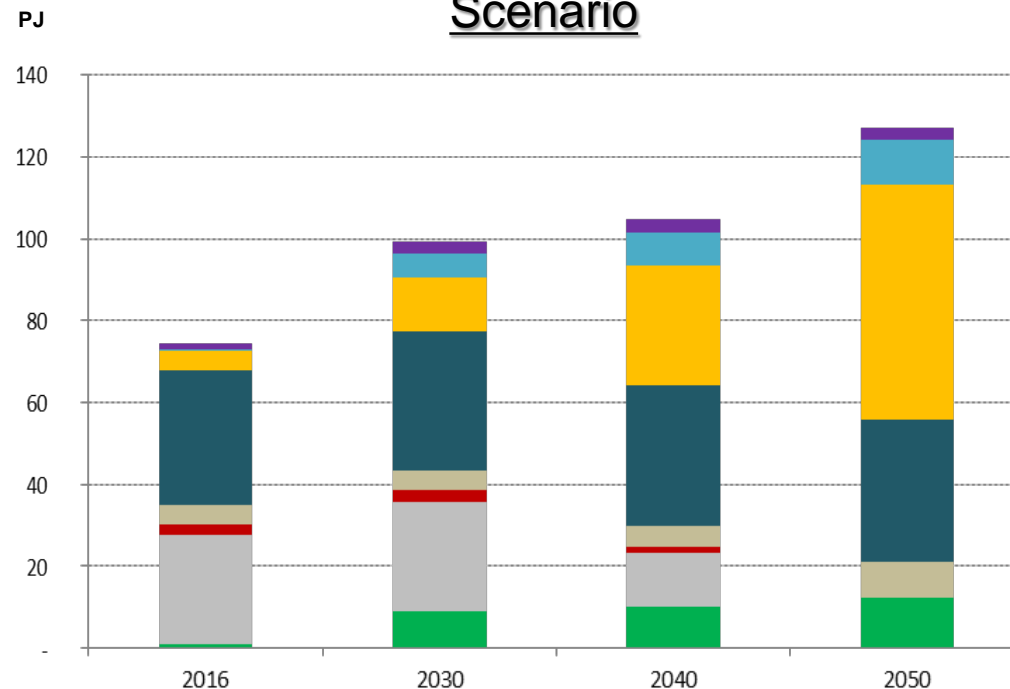


Possible trajectories : production in the reference vs carbon neutral scenario

Reference Scenario



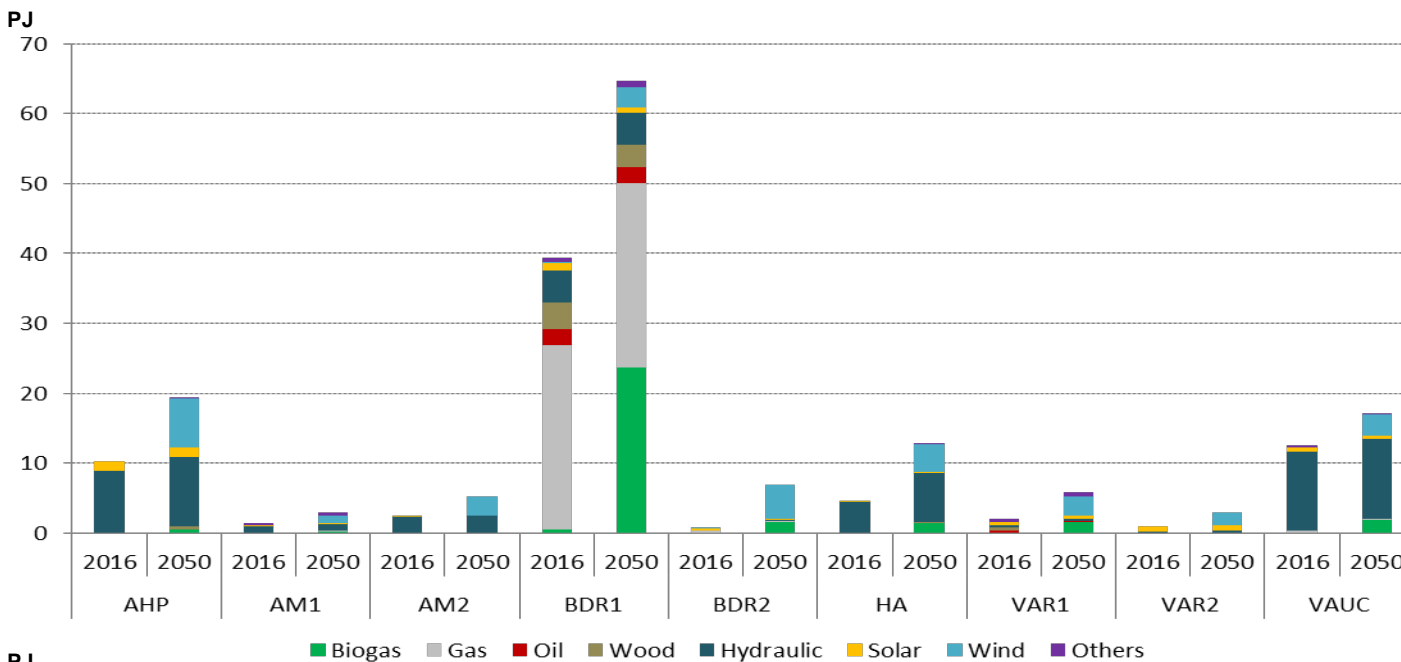
Carbon Neutral Scenario



■ Biogas ■ Gas ■ Oil ■ Wood ■ Hydraulic ■ Solar ■ Wind ■ Others

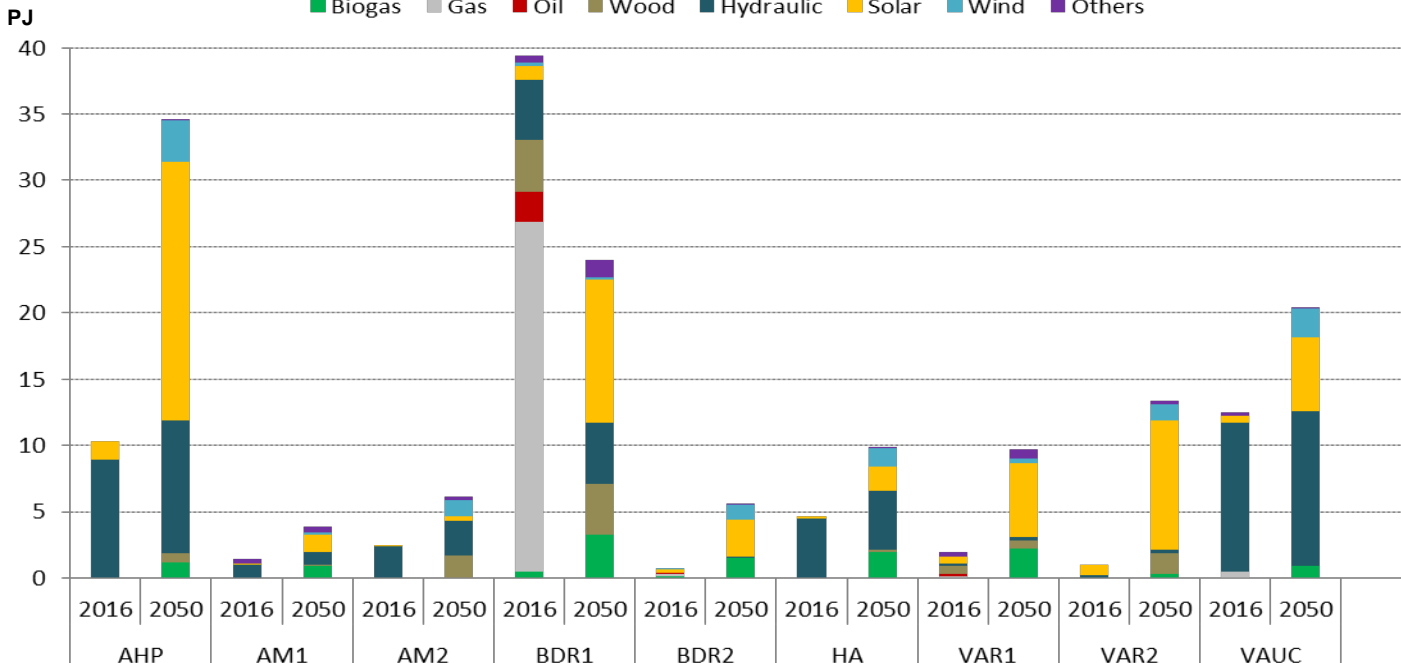
- Fossil fuels represent **21%** of the total electricity produced in the reference scenario while in the carbon neutral scenario there is no use of fossil fuels to produce electricity
- Biogas and wind energy represent each one **22%** of the total energy produced in the reference scenario while solar energy represents **45%** of the total production in the carbon neutral scenario

Evolution of the final energy production by department



Reference Scenario

- Wind energy is developed at its maximum potential
- Bouches-du-Rhône represents still almost **50%** of the total production

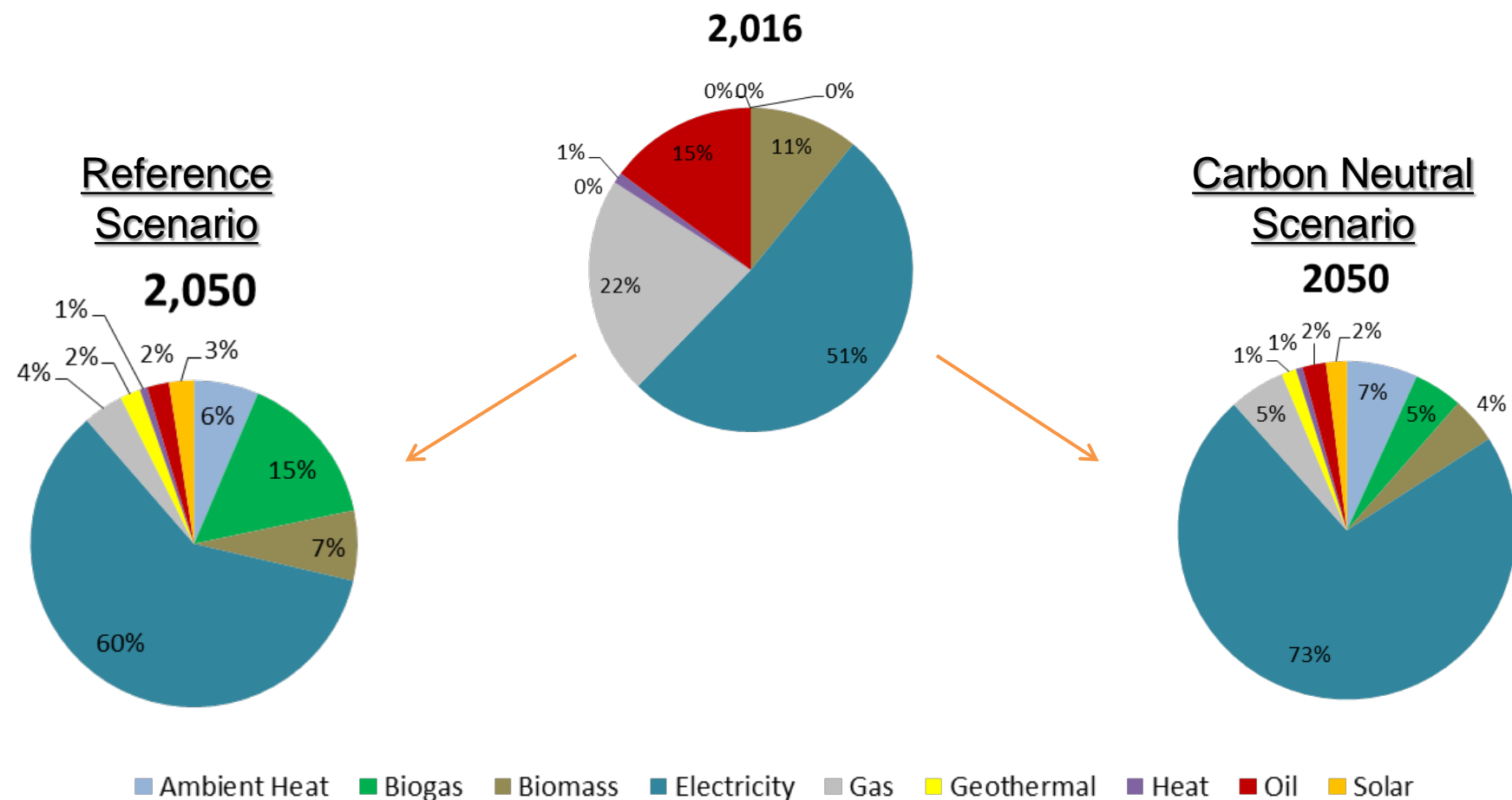


Carbon Neutral Scenario

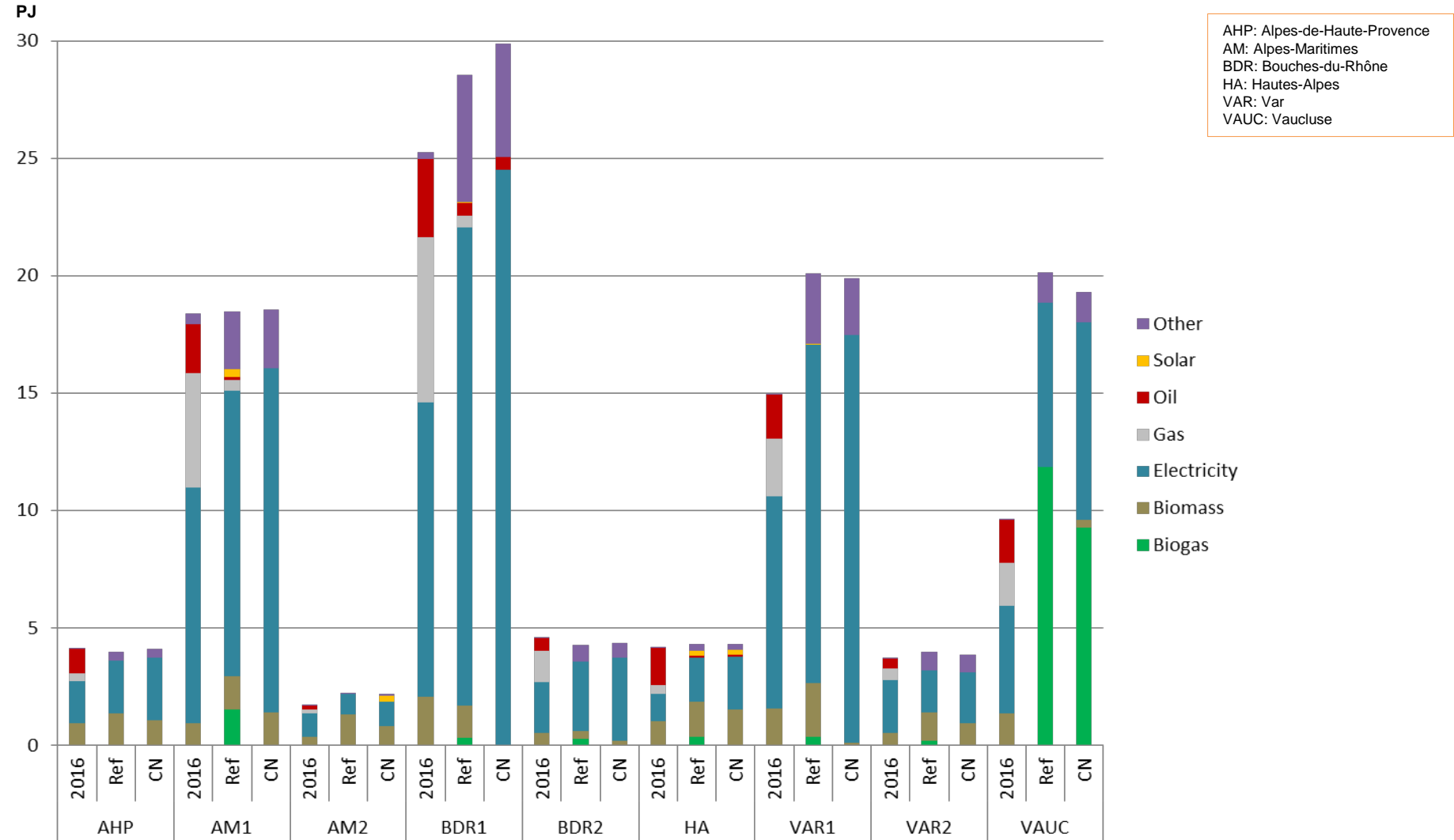
- Alpes-de-Haute-Provence represents almost **30%** of the total production and is now the greatest producer in 2050
- Most of the new production comes from low consumption zones

AHP: Alpes-de-Haute-Provence
 AM: Alpes-Maritimes
 BDR: Bouches-du-Rhône
 HA: Hautes-Alpes
 VAR: Var
 VAUC: Vaucluse

Final energy demand in the building sector

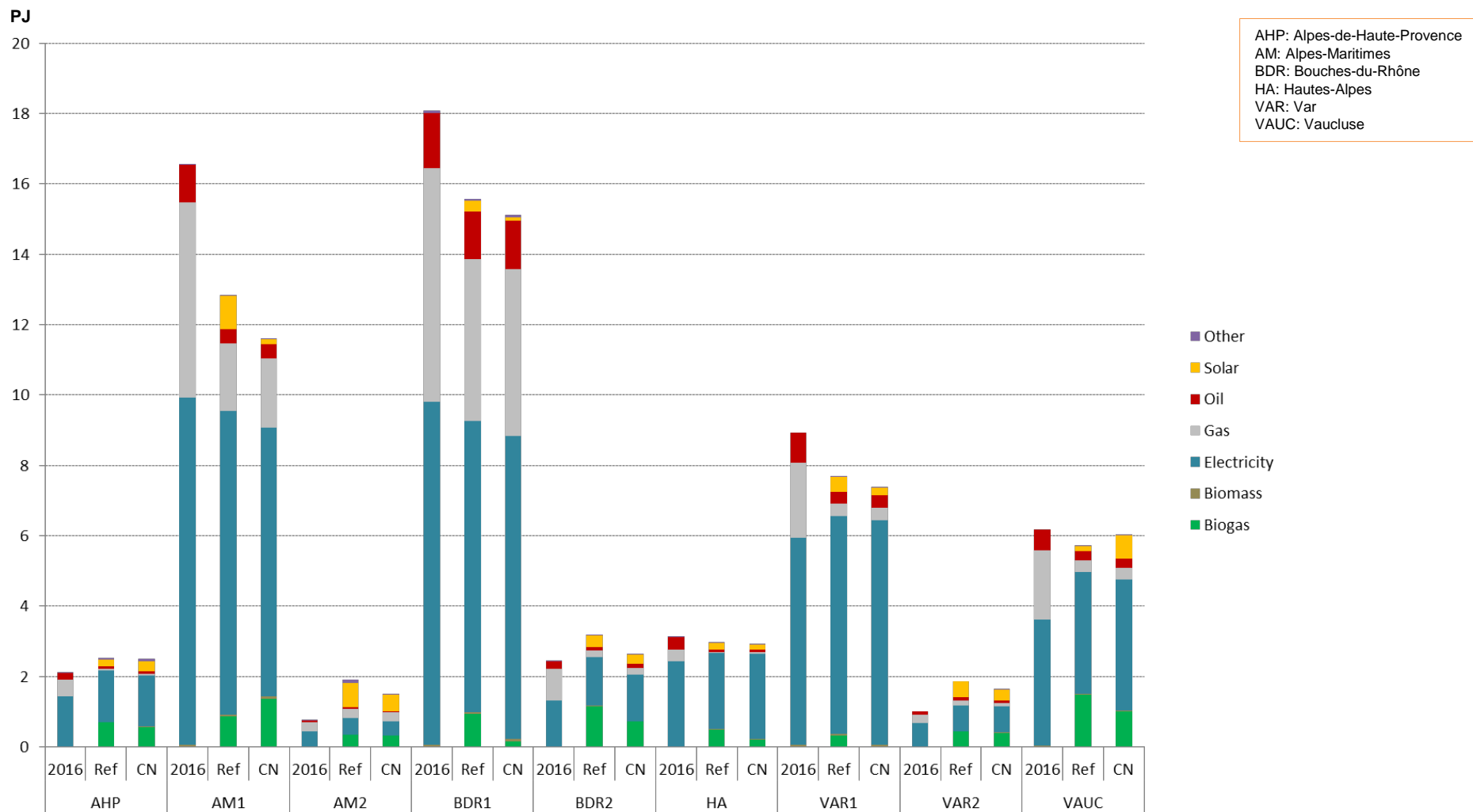


Final energy demand in the residential sector : Reference vs Carbon Neutral scenario



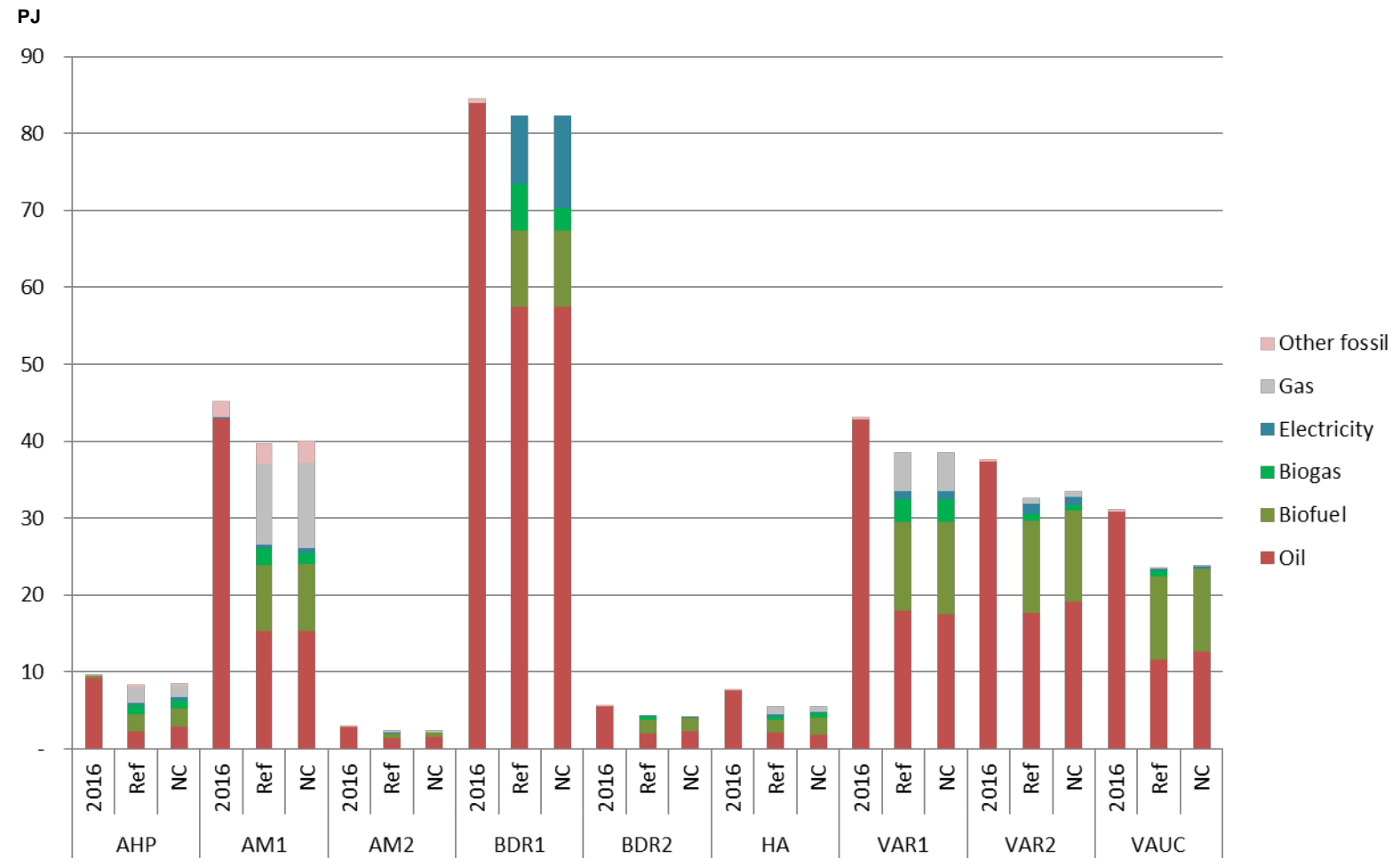
- Energy demand in the residential sector in 2050 is **15 %** higher than that of 2016
- Fossil fuel has been almost replaced principally by the use of electricity

Final energy demand in the commercial sector : Reference vs Carbon Neutral scenario



- Energy demand in the commercial sector in 2050 has decreased in around **9%** with respect to 2016
- Fossil fuels use in 2050 are still an important source of energy representing **14%** of the total energy demand

Final energy demand in the transport sector : Reference vs Carbon Neutral scenario



- Oil products represent **53%** of the final energy demand of the transport sector
- Emissions are reduced in around **40%**
- The service demand that is the most decarbonised is the transport of individual passengers



Conclusion

- Past trends show that demand from some energy services is already on its way to decrease energy consumption, for example in the commercial sector, but the rate at which it is decreasing will not fulfill the objectives established by the region.
- Electricity is an important energy vector that can help the decarbonisation of the building sector, but for the transport sector it remains limited.
- With the current structure of the energy system of the regions SUD PACA, it is hard to capture the total potential of solar energy.



eurac
research

3rd International Conference on
Smart and Sustainable Planning
for Cities and Regions 2019

THANK YOU FOR YOU ATTENTION

Carlos ANDRADE

carlos.andrade@mines-paristech.fr

PhD student

MINES ParisTech PSL Research University Centre for Applied Mathematics Sophia Antipolis

PhD research co-founded by ADEME and the Region SUD Provence-Alpes-Côte d'Azur with the partnership of SCHNEIDER ELECTRIC

**MINES ParisTech PSL Research University
Centre for Applied Mathematics Sophia Antipolis**