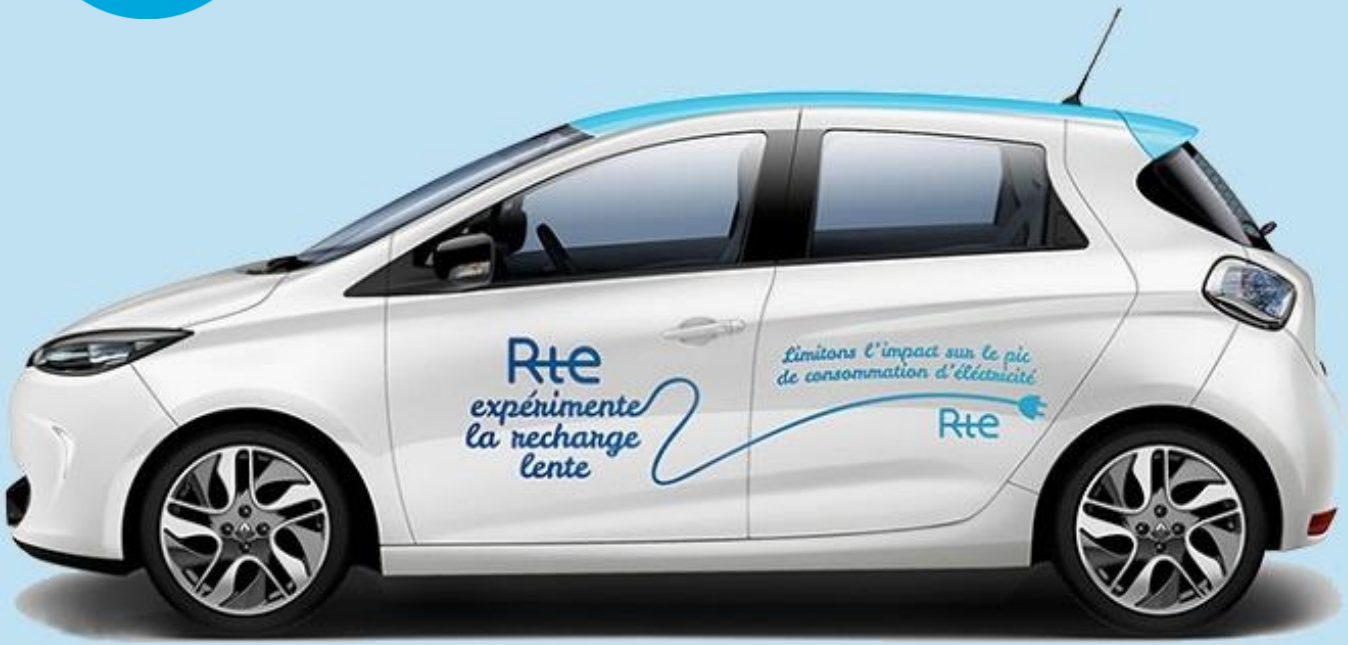
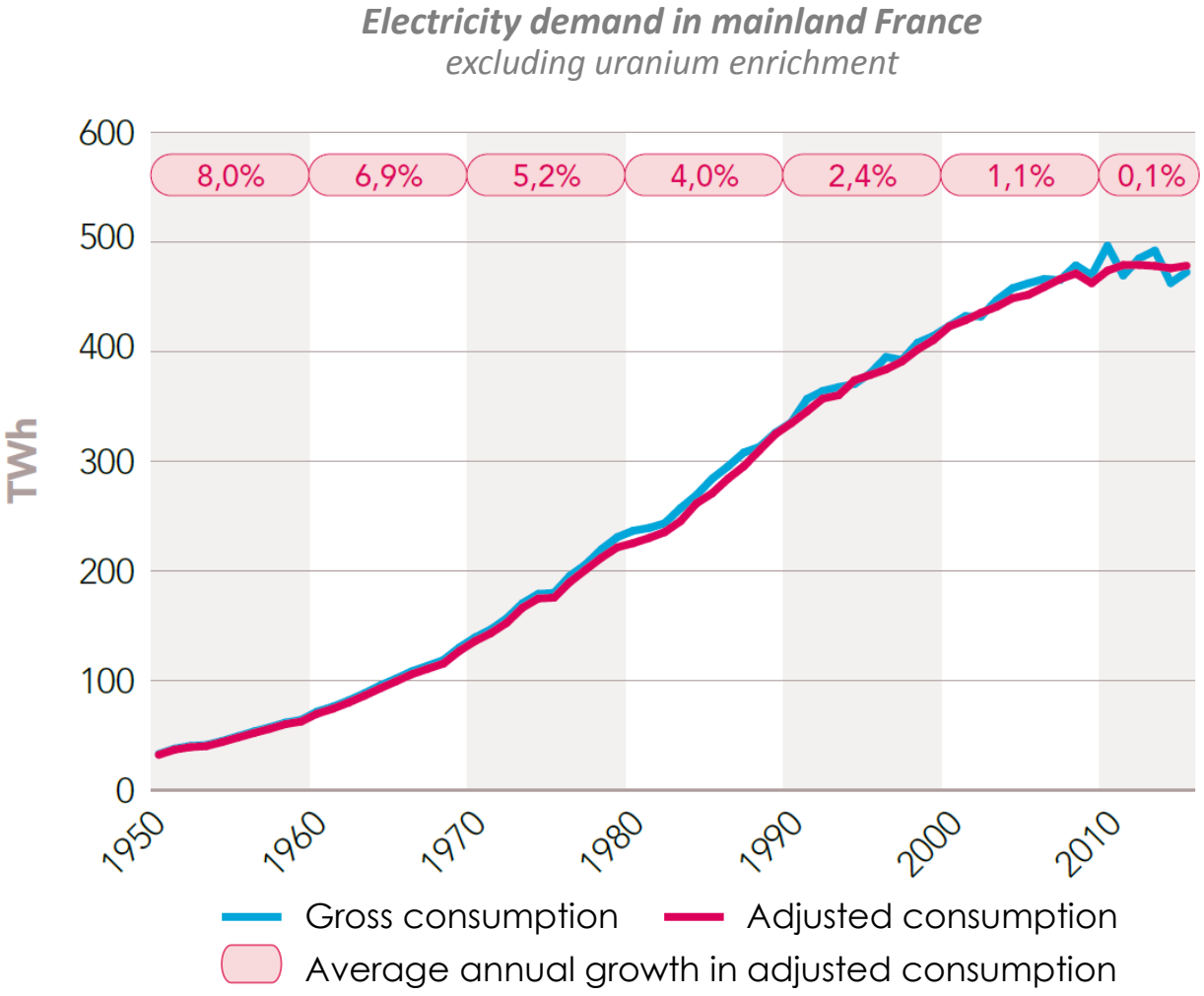


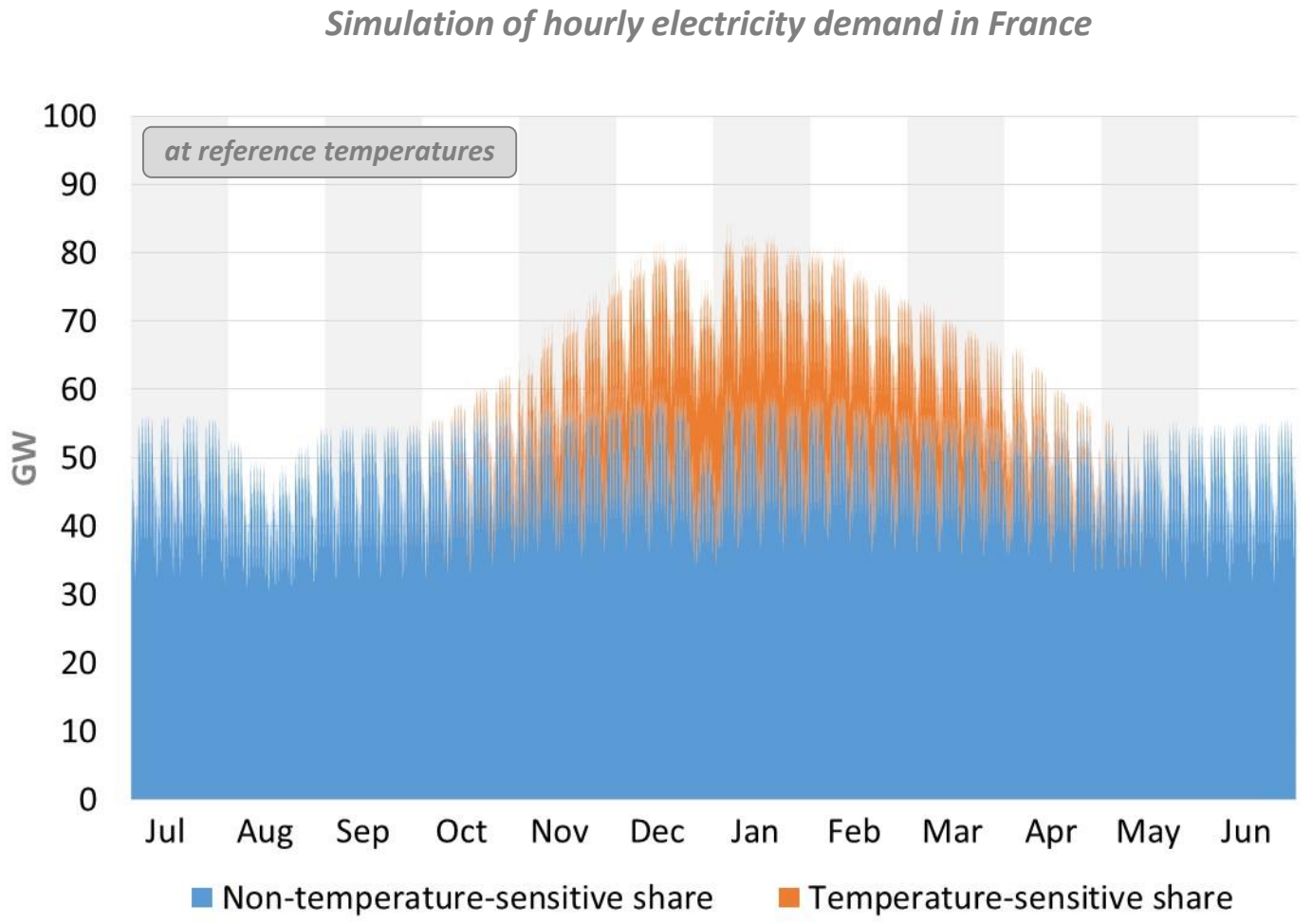
The impact of electric vehicle development on peak demand and the load curve under different scenarios of EV integration and recharging options

CEEM Conference Electric vehicles and the electricity system, Paris, 17 October 2016

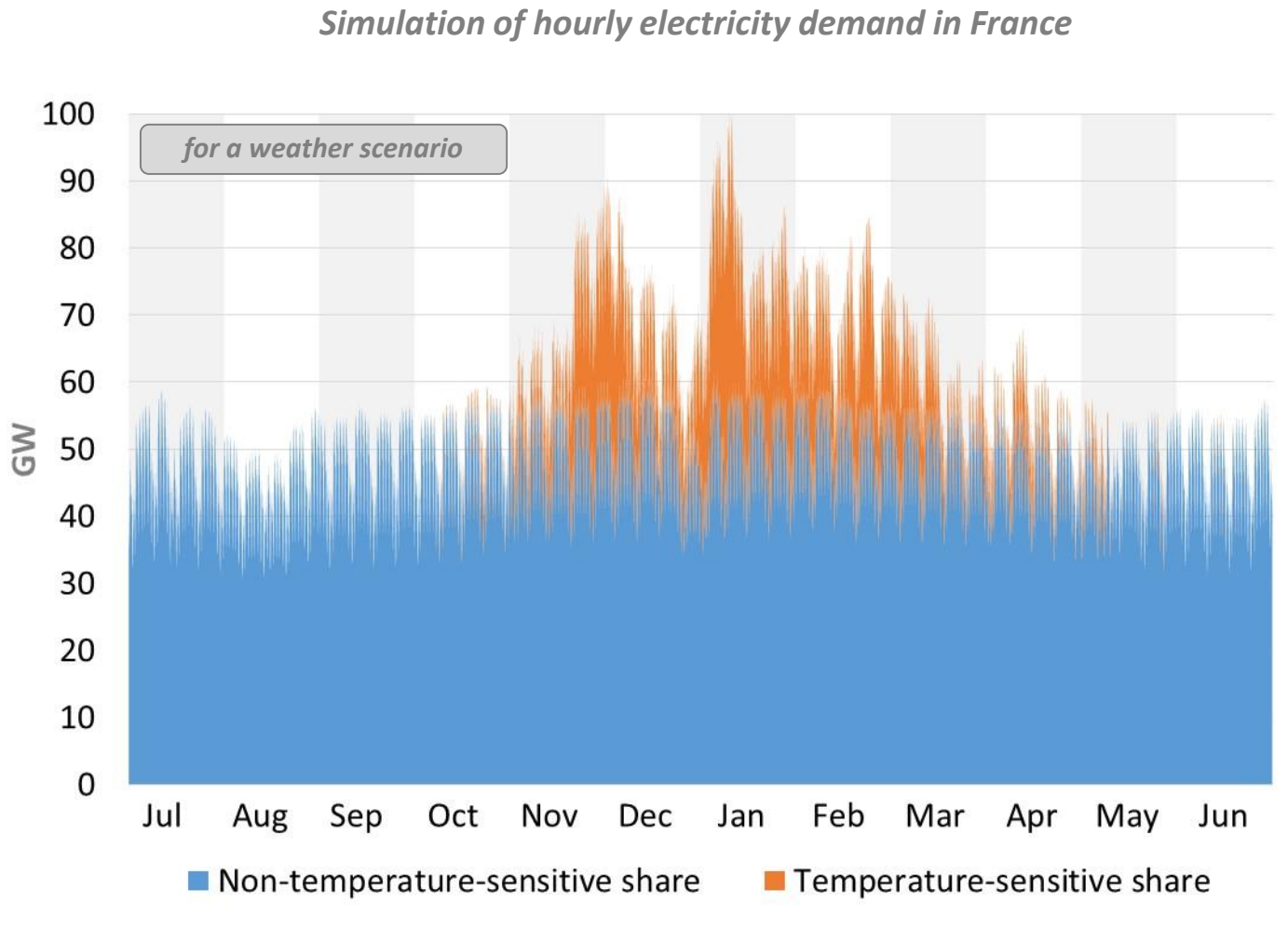
Electricity demand in France: a paradigm shift



An important seasonality of power demand…

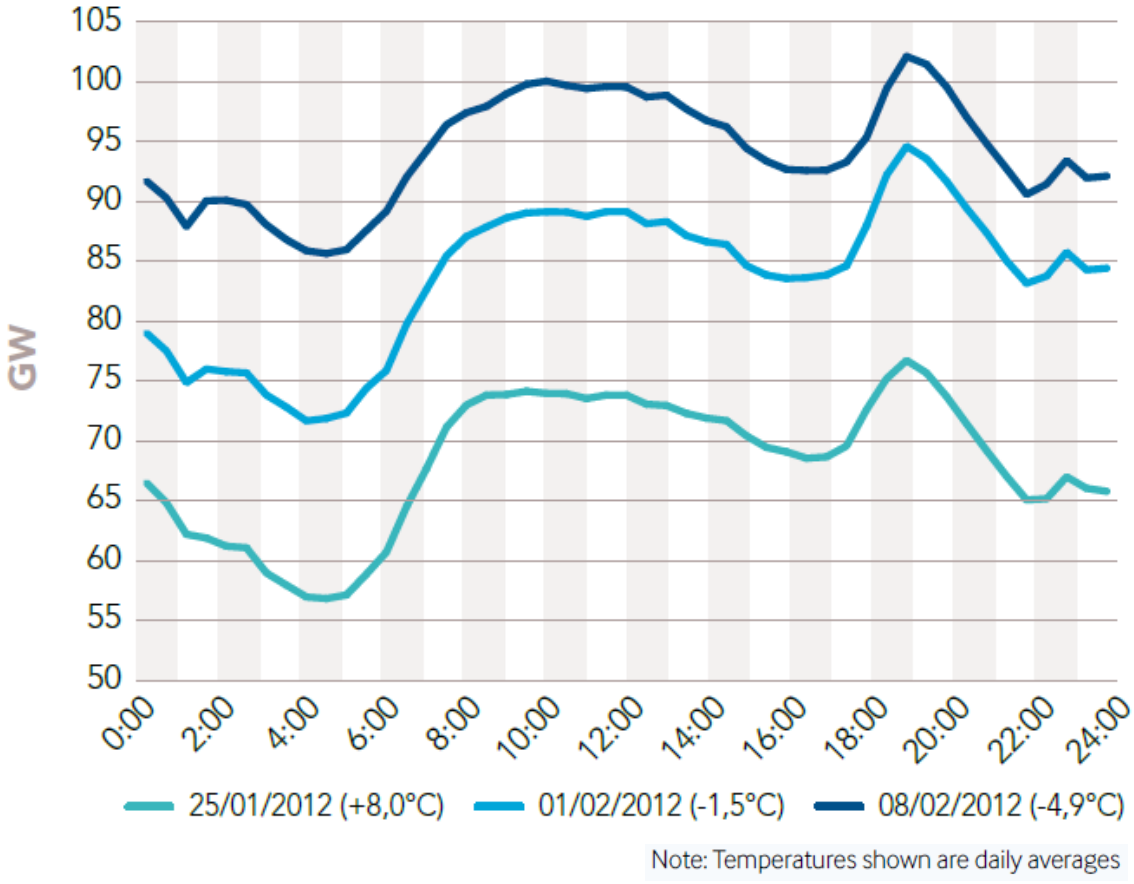


… with strong weather contingencies…



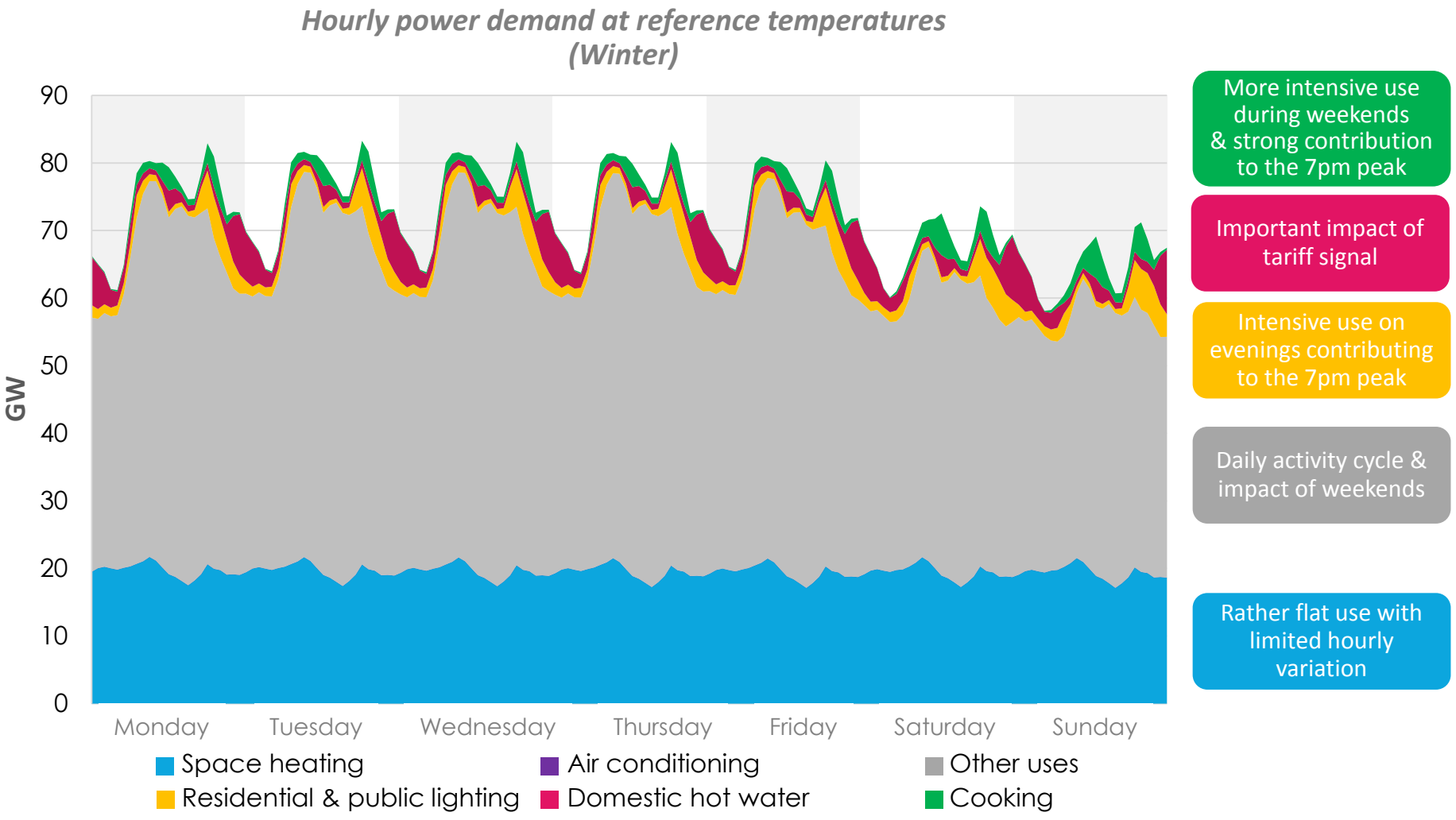
… which can induce significant level changes within a few days

Load curves on Wednesdays
before and during the cold spell of February 2012

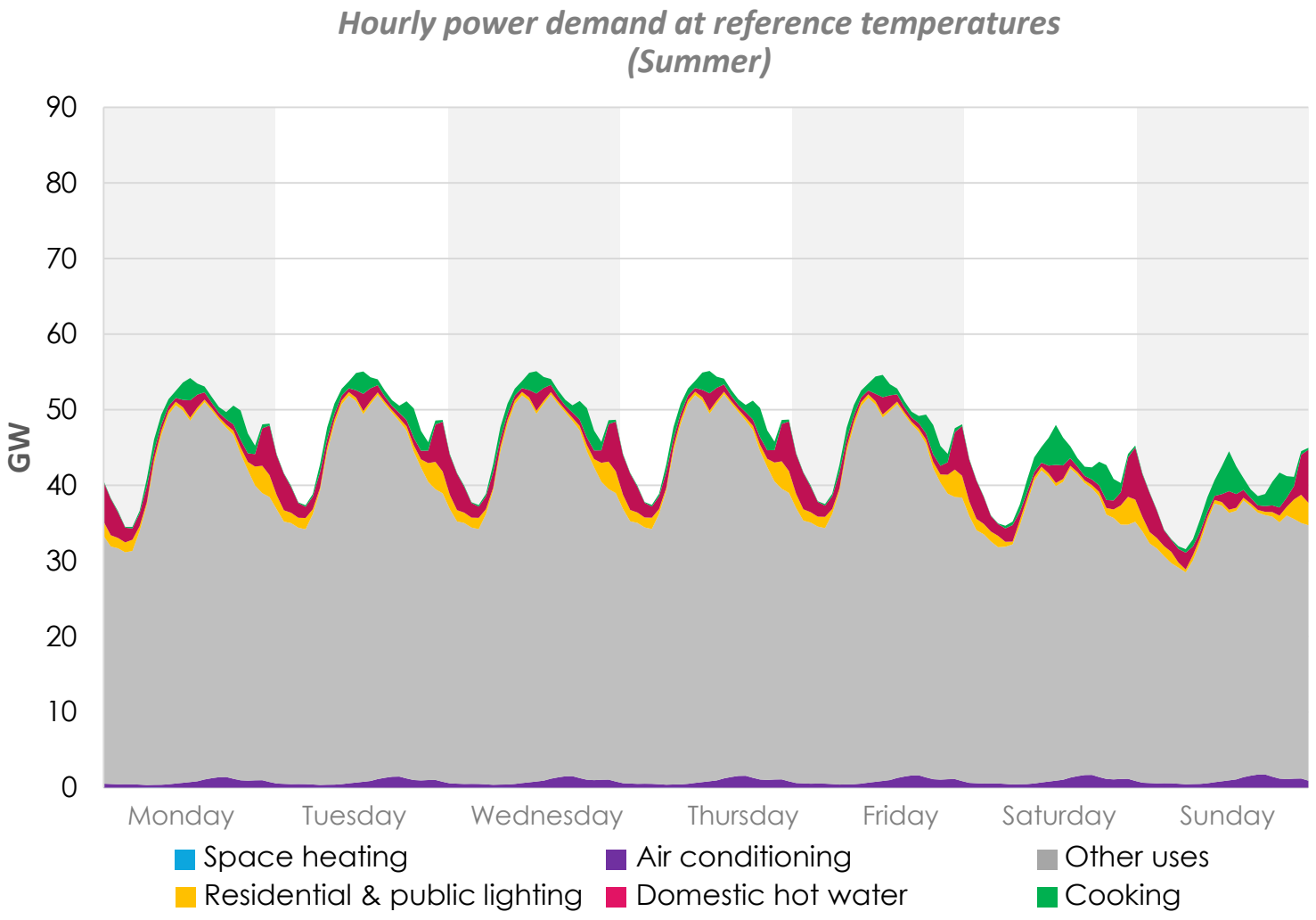


Note: Temperatures shown are daily averages

A regular weekly cycle
in Winter



A regular weekly cycle
in Summer



More intensive use during weekends & strong contribution to the 7pm peak

Important impact of tariff signal contributing to a weekend peak at 11pm

Use delayed in Summer, later in the evening than in Winter

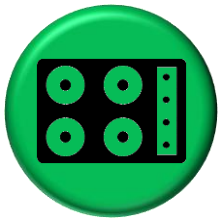
Daily activity cycle & impact of weekends

Air conditioning concentrated in the afternoon

Power loads will evolve in the coming years

- In a context of strong diffusion of energy efficiency and stagnation or even decline in electricity demand, the load curve should evolve in the coming years

General use of LEDs



Development of electric cooking

2012 Building Energy Regulation
Building renovation policy
Development of heat pumps

Switches between different technologies
Energy efficiency

Development of thermo-dynamic water heaters

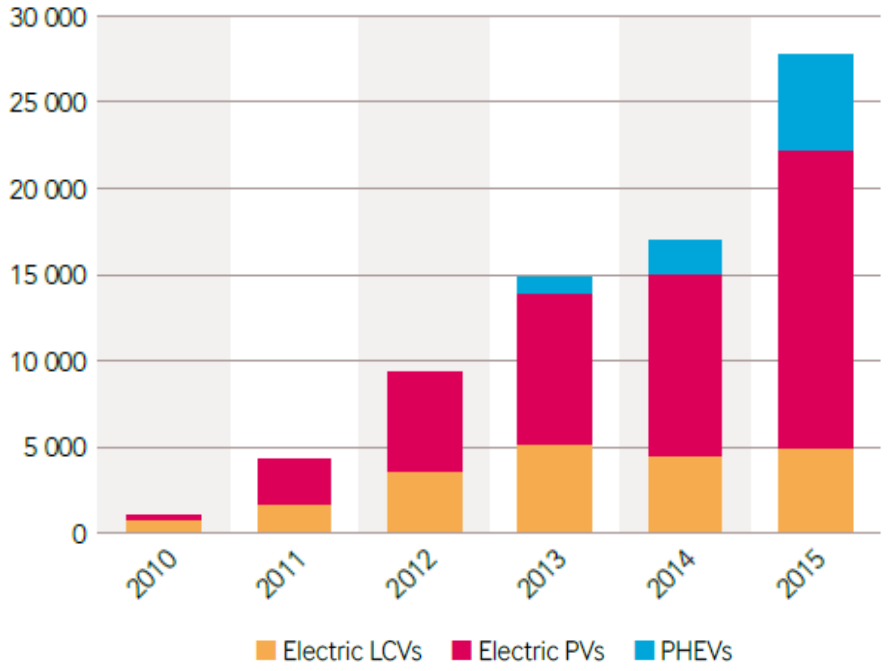
Strong development in the coming decades

A strong expected development of fully electric and plug-in hybrid vehicles…

- **A rapid increase in sales in France**
  - 1.2% in sales of passenger and light commercial vehicles in 2015
  - Sales up 38% over the first nine months of 2016 compared with the same period last year
- **Ambitious growth targets, with numerous support measures**

Current situation	*Multiannual Energy Plan 2030 target*
~ 100 000 EVs/PHEVs ~15 000 public charging points	4.5 million EVs/PHEVs 7 million charging points

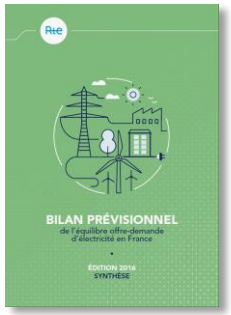
Registrations of new electric and plug-in hybrid electric vehicles in France



… incorporated within RTE's analyses

- **An assessment of global and local impacts is necessary**
  - to anticipate forecast variations in energy demand and grid development
  - but also new sources of flexibility for the electricity system supply-demand balance

- **Analyses carried out by RTE**



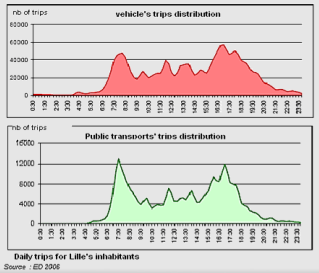
- to be used in risk assessment over a medium-term horizon and in prospective studies ("Generation Adequacy Report")

- to value (in economic, environmental and social terms) and support the emergence of flexibility coming from smart networks ("Réseaux Électriques Intelligents" report)

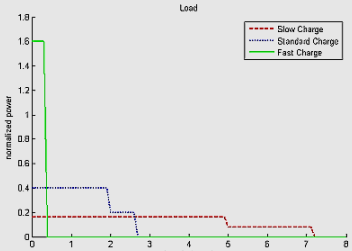
Modelling of charging of a fleet of EVs/PHEVs

- **From a vehicle…**
  - Main features (battery, range…)
  - For the different technologies (fully electric and plug-in hybrid vehicles)
- **… to a fleet of EVs/PHEVs and its charging load curve**
  - Use assumptions (vehicle's trips distribution…)
  - Scenario building for different fleets, uses and type of charging

Statistics about vehicles



Types of charges of batteries



Fleet description

Use assumptions

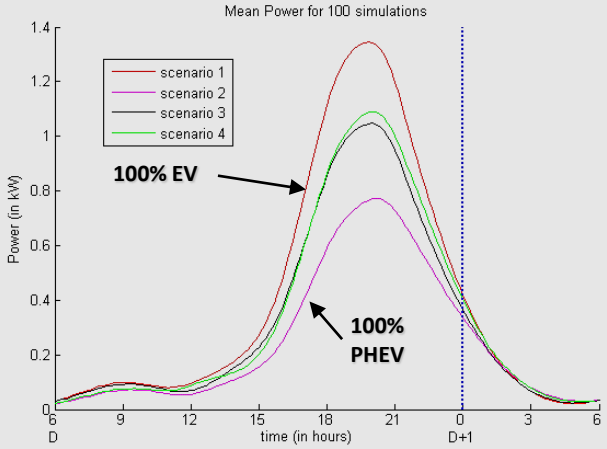
Types of charge management

Simulations

Source : Master Thesis for RTE - « Impact of the Electric Vehicle on the Electric System », Mélaine Rousselle (2009)

Load curves of the fleet

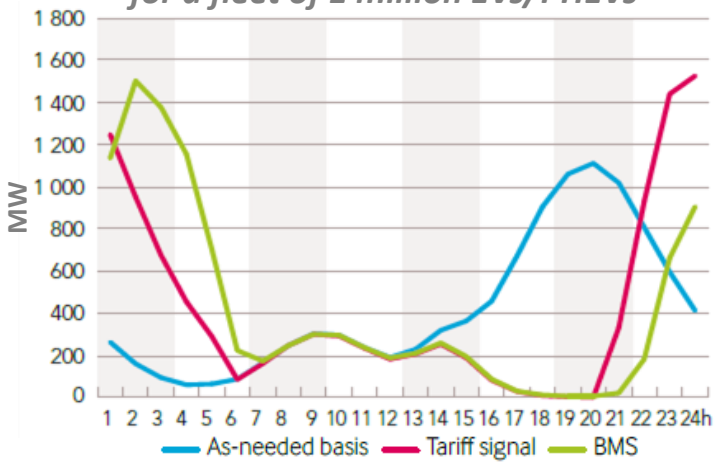
(example: "Natural charge profile")



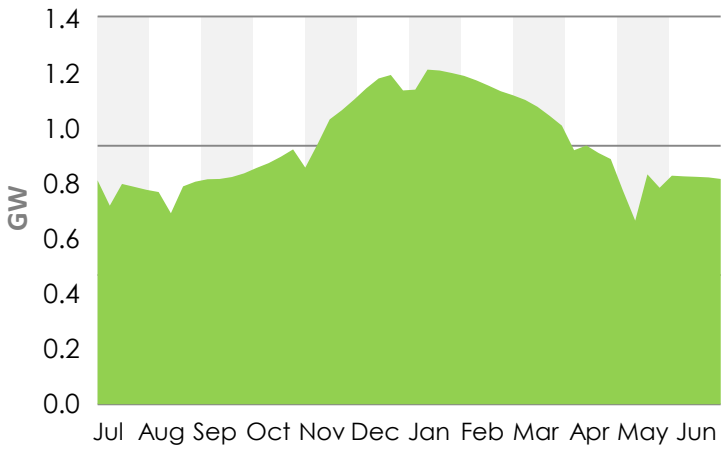
The profile of EVs/PHEVs charging will have a strong impact on daily loads

- Very different effects on the load curve according to the type of charging profile:
  - *"natural charge", based on needs* → should be avoided
  - *"tariff signal" management* → should be supported
  - *"battery management system"* → should be developed
- Three respective charging profiles have been elaborated with:
  - *intraday profiles reflecting the different charging options*
  - *a consumption up to 40% higher in Winter than in Summer*
- Illustration
  - *40% in response to tariff signals & 60% on an as-needed basis*
  - *Example of a fleet of 4 million EVs/PHEVs on a long-term horizon*

Load curve on a working day in January for a fleet of 1 million EVs/PHEVs

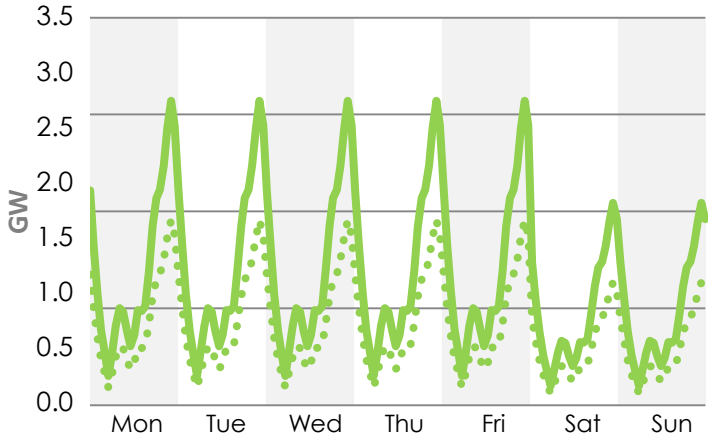


Weekly average load at reference temperatures

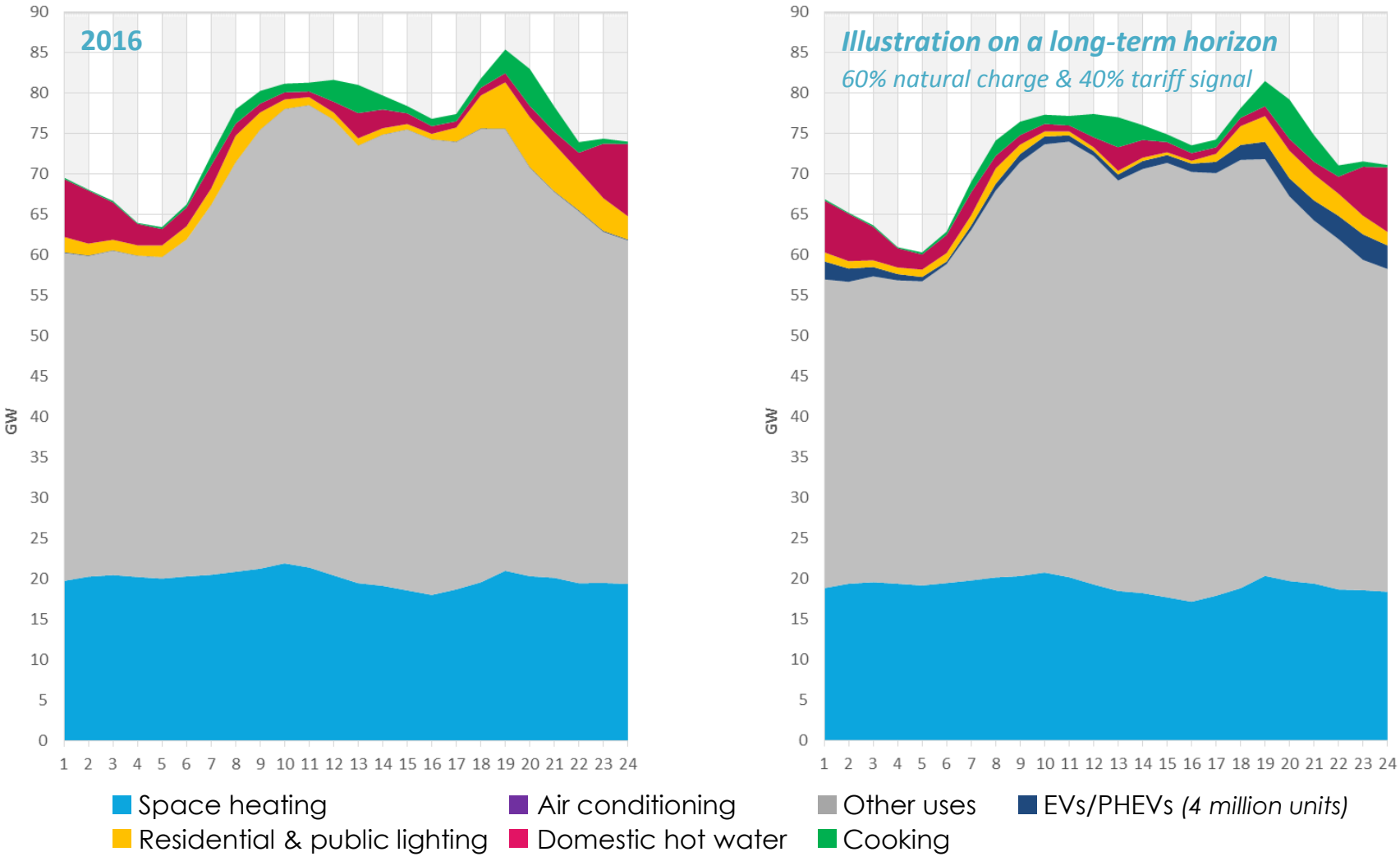


Hourly load at reference temperatures

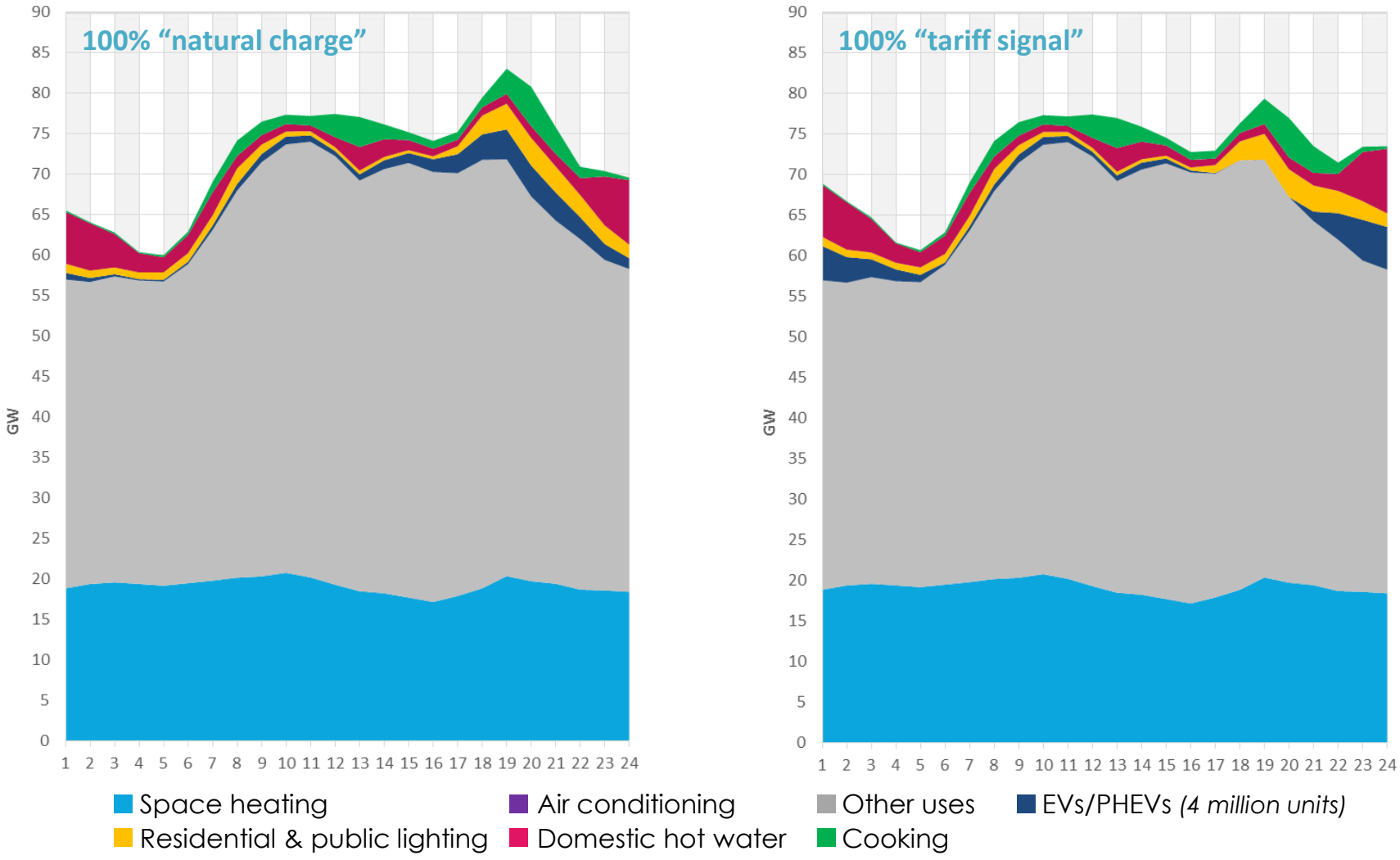
3rd week of January (bold line) and of June (dotted line)



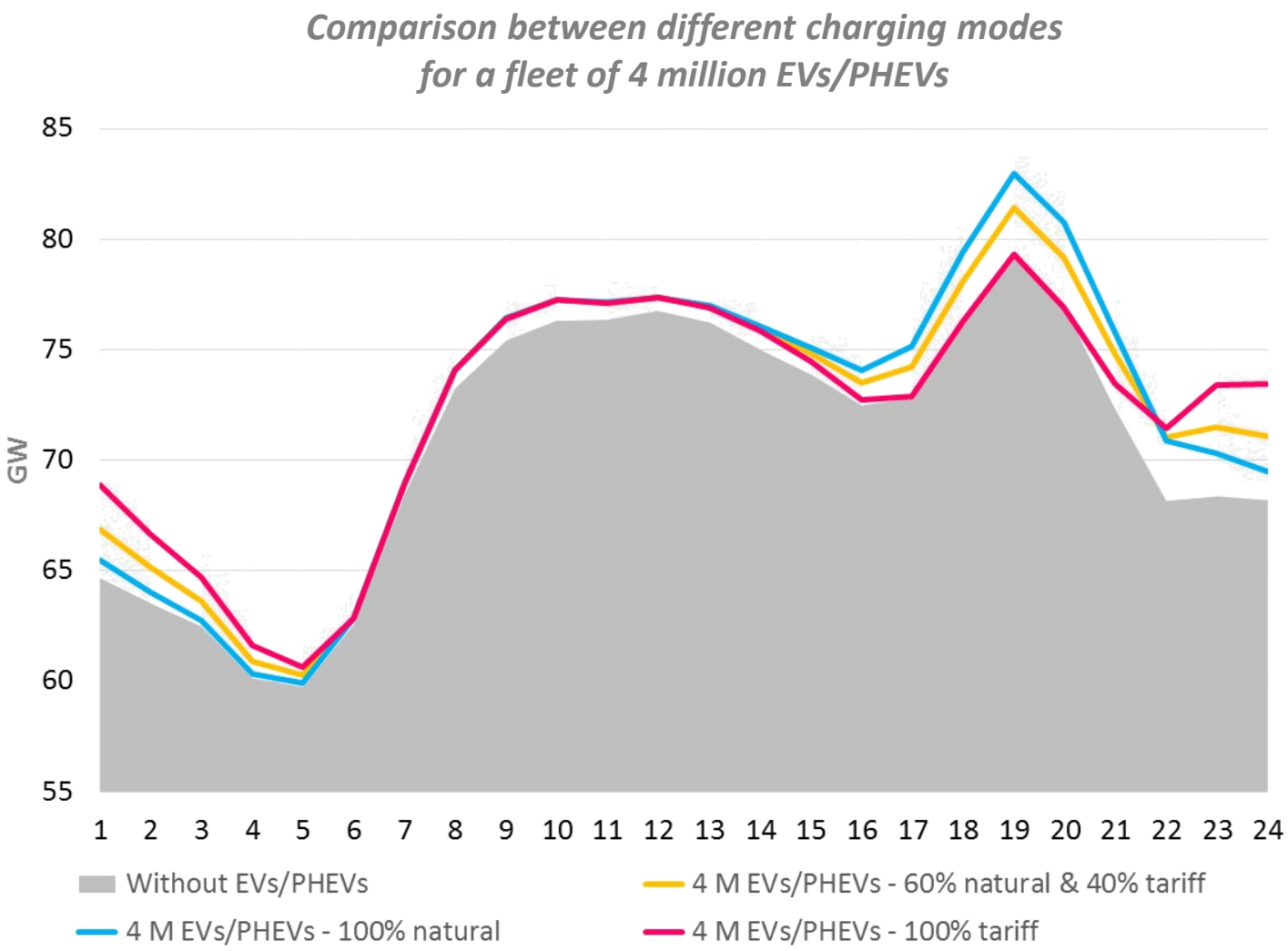
Hourly load of a Winter day
Illustrative evolution on a long-term horizon



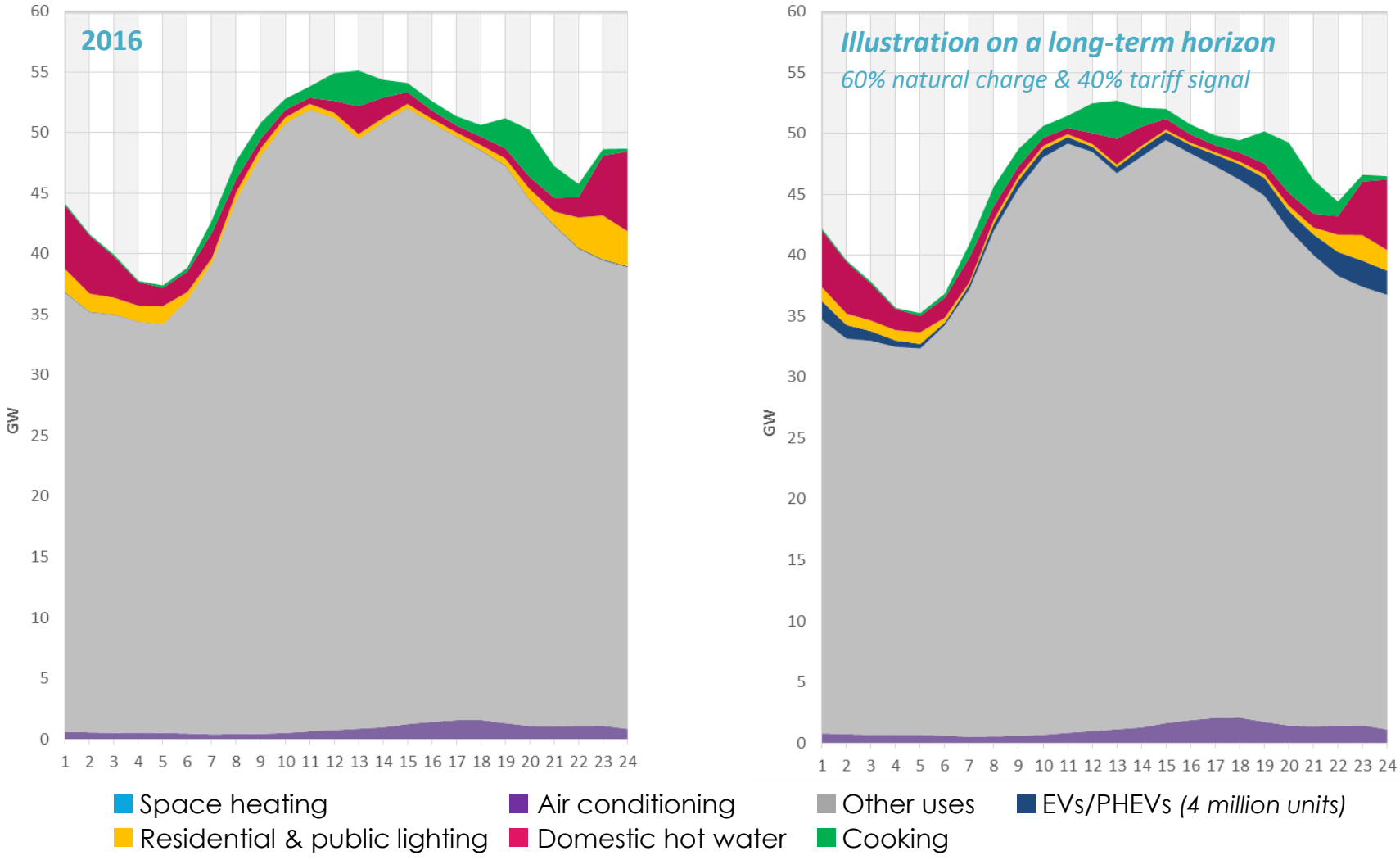
Hourly load of a Winter day with different charging modes



Hourly load of a Winter day with different charging modes



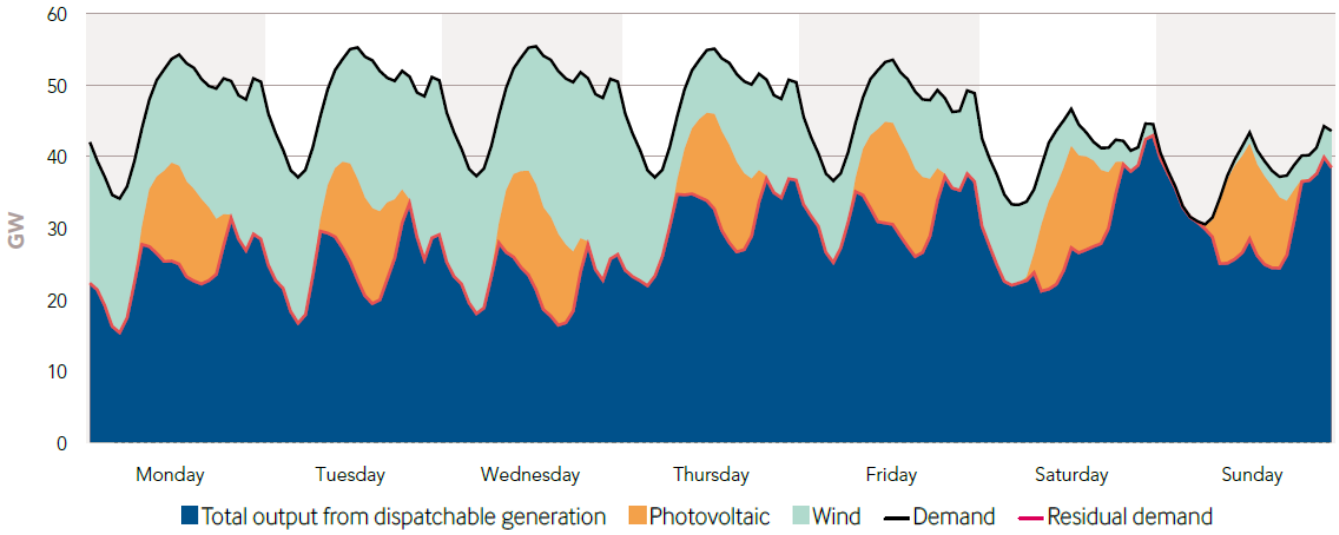
Hourly load of a Summer day
Illustrative evolution on a long-term horizon



Renewable energy development will have a great impact on the functioning of the power system

- In a context of steady growth of wind and photovoltaic power, **flexibility** will become a key issue

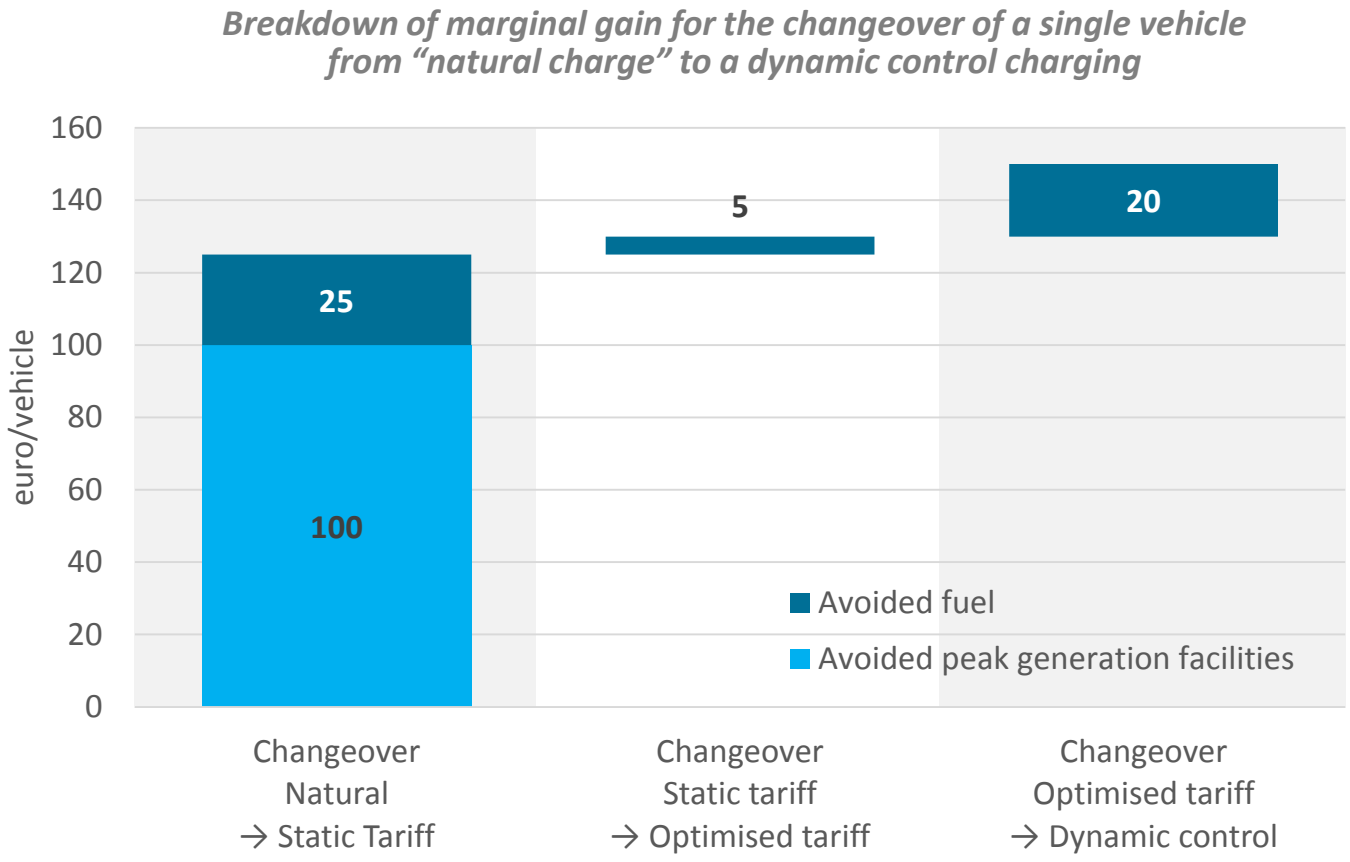
Residual demand – Example of a week from Monday 24th July to Sunday 30th July 2030, "New Mix" scenario in the 2014 Generation Adequacy Report for France



- The greater the variability of residual demand, the more flexibility sources are necessary, both on dispatchable generation and on electricity demand
- EV/PHEV charging management will have a key role to play
  → **toward a dynamic control of charging?**

Breakdown of gains from dynamic control of charging

- Initial situation for simulation: 30% of vehicle charging done on an as-needed basis and 70% in response to tariff signal



In conclusion

A potential source of flexibility for the electric system

- A growing volatility of residual demand
- Possible optimisation of EVs/PHEVs charging
- Benefits mainly driven by a shift of charging during off-peak hours
- Additional benefits with a dynamic control of charging

Further analyses are required

- Toward V2G?
- Toward interday storage with a growing autonomy of batteries?

Thanks for your attention!