



Energy Transition Monitoring: 4 case studies

Enerdata
intelligence + consulting

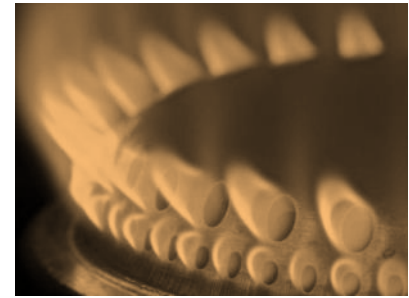
*Patrick Criqui,
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1. Observed trends, National Contributions and 2°C trajectories
2. National energy transition dashboards and indicators
3. Energy Transition Monitoring (EnerTraM)... work in progress
4. Three case studies with EnerTraM:
 - ✓ Vietnam
 - ✓ Mexico
 - ✓ Senegal

APPENDIX: France case study

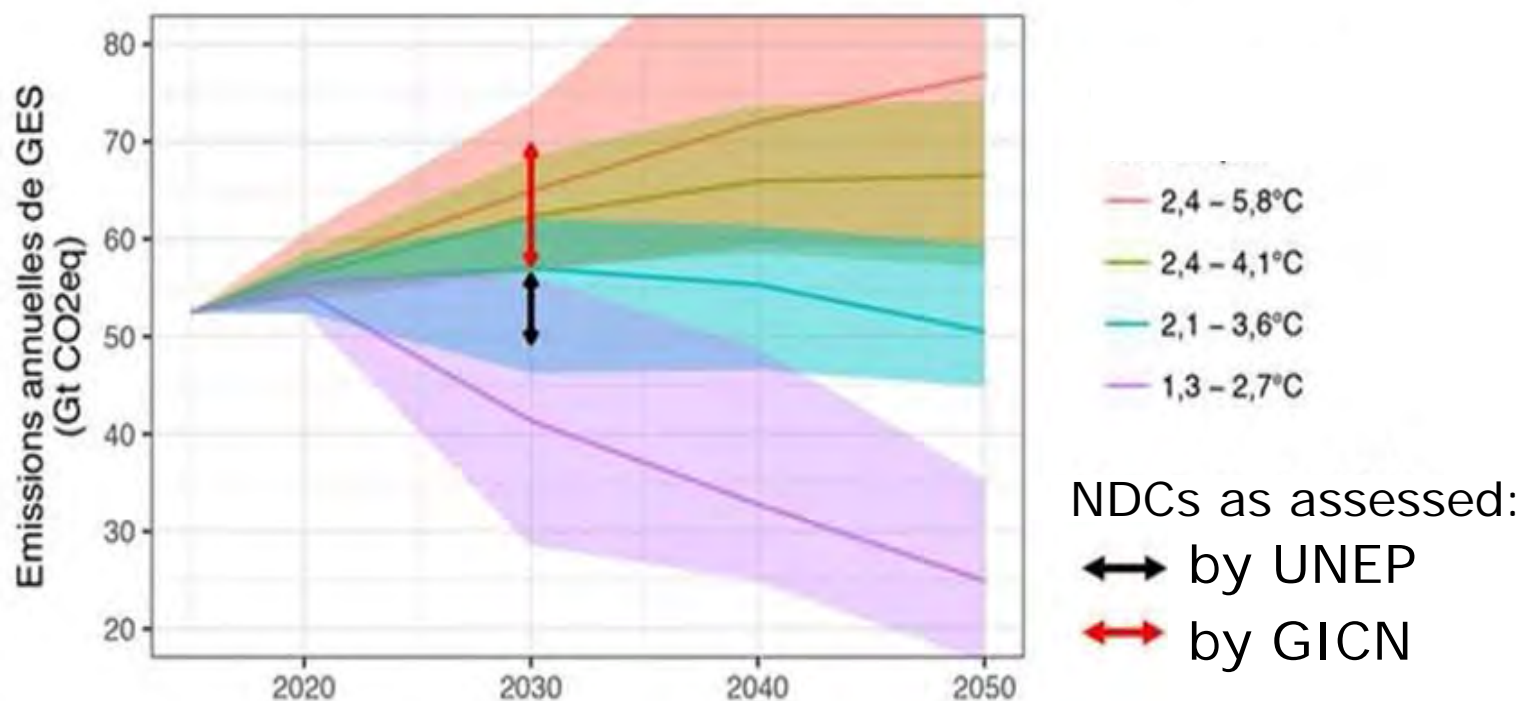
March 2018



*Observed trends,
National Contributions and
2°C compatible trajectories*

At global level: assessing the gap between NDCs and 2°C scenarios

- In France, the Interdisciplinary Group on National Contributions has performed an assessment of uncertainties in NDCs (Environmental Research Letter, 2018)

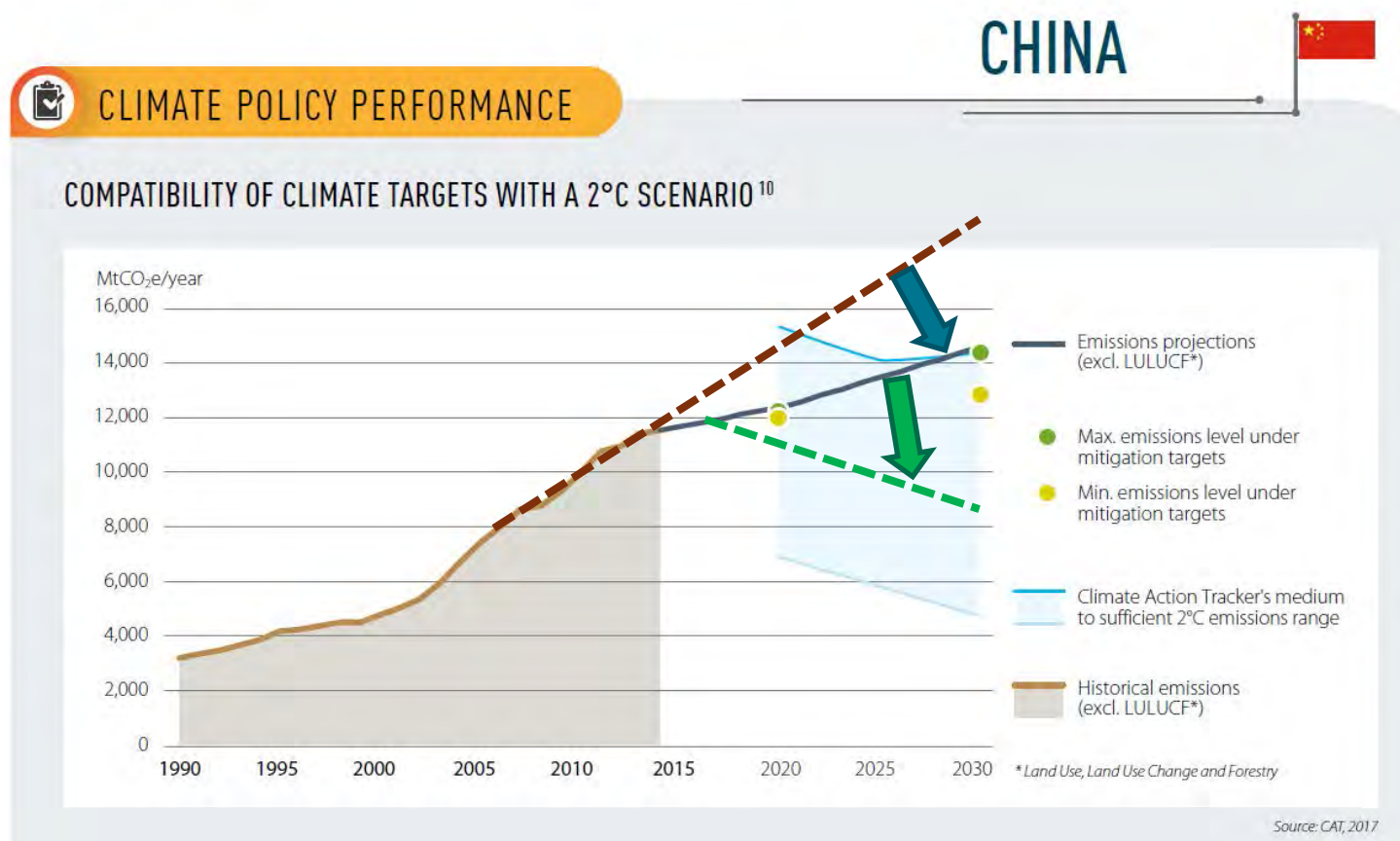


Source GICN

At country level, assessing the “double gap”:

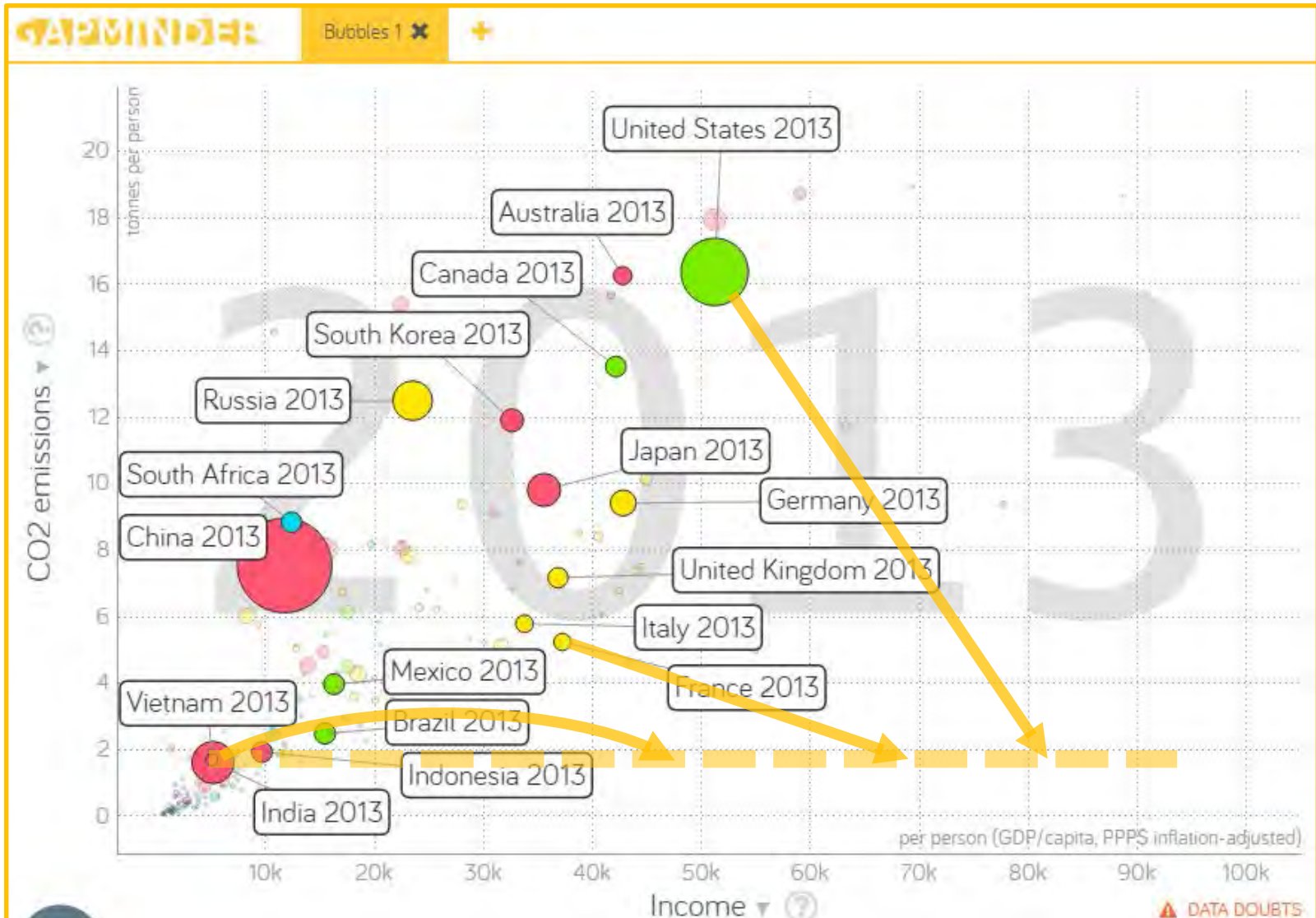
- between on-going trends and NDCs
- between NDCs and 2°C compatible profiles

BROWN TO GREEN: THE G20 TRANSITION TO A LOW-CARBON ECONOMY | 2017



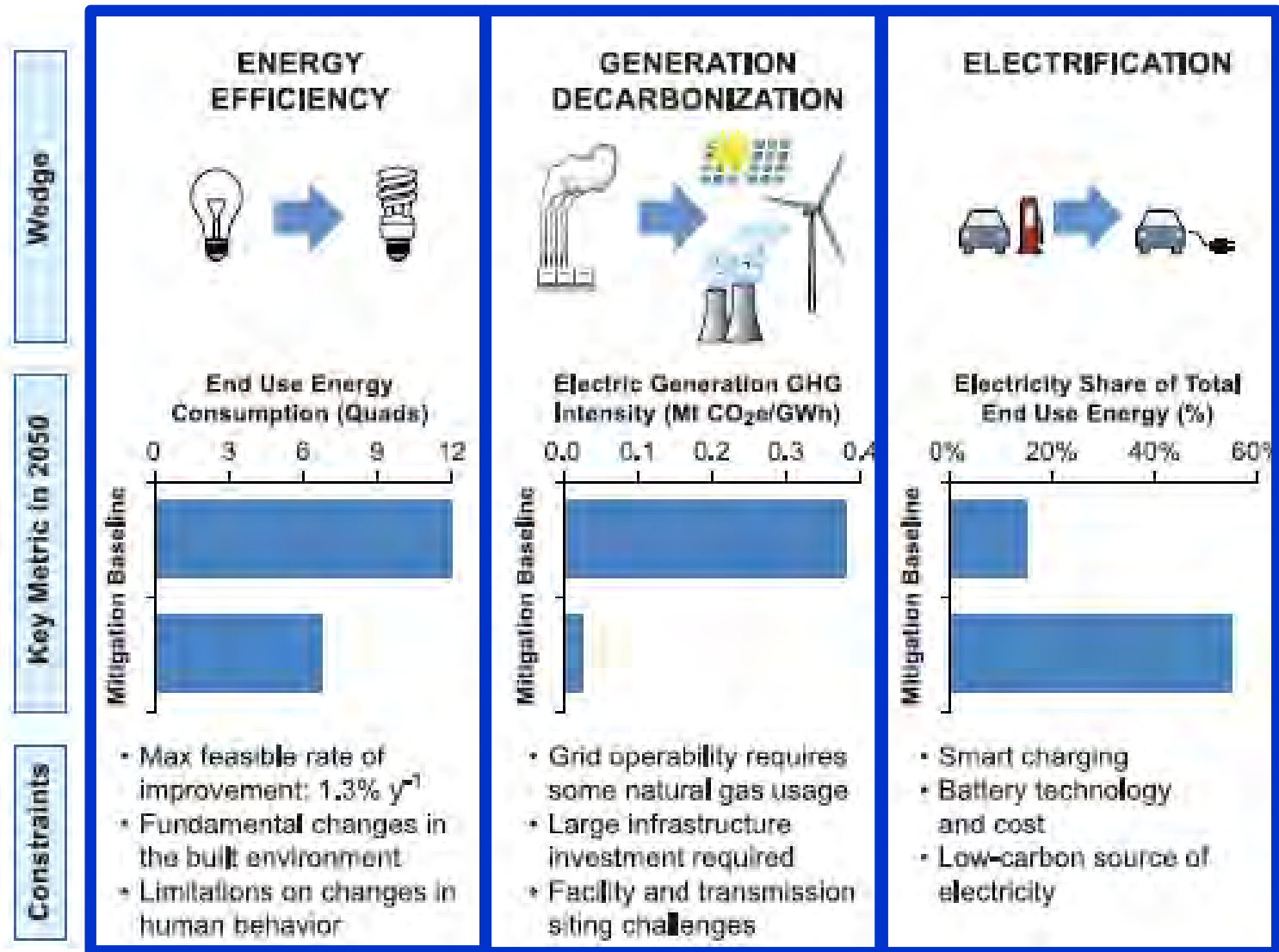
Source: adapted from Climate Transparency

DDPP study: a “focal point” of 1,7 tCO₂pc after 2050



The three pillars of decarbonization

(Jim Williams, E3 San Francisco, Science 2012)



Examples of national energy transition dashboards and indicators

Monitoring indicators: France

IN TRANSPORT



30%*

Share of transport in greenhouse gas (GHG) emissions.

The target

- Reduce GHG emissions by 29% by the 3rd carbon budget period (2024-2028) compared to 2013 and by at 70% between now and 2050.

How?

- Improve the energy efficiency of vehicles (achieve an average fuel economy of 2 litres/100 kilometres for vehicles sold in 2030).
- Speed-up the development of energy vectors with the lowest GHG emissions intensity: implementation of low-emission vehicle quotas in public fleets, including buses, and a development strategy for recharging infrastructures (electric recharging terminals, gas delivery units, etc.).
- Curb the demand for mobility (town planning, teleworking, carpooling, etc.).
- Promote alternatives to the private car (tax incentives for cycling mobility, development of public transport).
- Encourage modal shift for freight toward train and ship.

IN THE BUILDING SECTOR



19%

Share of the building sector in greenhouse gas (GHG) emissions. 27% if we include

associated emissions (production of electricity and heat for buildings).

Objectives

- Reduce emissions by 54% by the 3rd carbon budget period (2024-2028) compared to 2013 and by at least 86% by 2050.
- Cut energy consumption by 28% by 2030 compared to 2010.

How?

- Implement the 2012 thermal regulation and in a few years the next regulation which will take into account impacts on the environment based on life-cycle analyses.
- Renovate entirely the stock of buildings to high standards of efficiency in 2050.
- Speed up the management of energy consumption (implementation of eco-design, information about hidden energy consumption, identification of the least efficient appliances, development of connected smart meters, etc.).

IN AGRICULTURE AND FORESTRY



20%

Share of agriculture in greenhouse gas emissions. Also France will not neglect to take into account CO₂ emissions associated with changes in agricultural land use. The forestry and timber sector is unusual in that capture and substitution effects allow for the offsetting of 15 to 20% of the national emissions.

Objectives

- Reduce agricultural emissions by more than 12% by the 3rd carbon budget period compared to 2013 and by 48% by 2050 through the agro-ecology project.
- Store and conserve carbon in soils and biomass.
- Consolidate material and energy substitution effects.

How?

- Step up the implementation of the agro-ecology project:
 - > develop crop-growing and livestock-rearing practices with lower emissions per unit of value (reduce the national nitrogen surplus by optimising the use of synthetic nitrogen fertilisers, recover energy from effluents, etc.)
 - > deploy production techniques that are adapted to climate change (soil coverage and development of agroforestry, etc.).
- Promote a very significant increase in the amount of wood harvested to support the development of biosourced products while carefully monitoring its sustainability and the impacts on biodiversity, soils, the air, water and landscapes.

IN INDUSTRY



18%

Share of industry in greenhouse gas emissions. 75% of these emissions are subject to the European Union emissions trading scheme (EU ETS).

The target

- Cut emissions by 24% by the 3rd carbon budget period (2024-2028) and by 75% between now and 2050.

How?

- Control the demand for energy and materials per product, particularly through profitable investments and recognised, high-quality energy efficiency services.
- Promote the circular economy (re-use, recycling and energy recovery) and the use of materials that generate fewer greenhouse gas emissions, such as biosourced materials.
- Reduce the share of energy sources with high GHG intensity.

IN ENERGY



10%

Share of energy production in greenhouse gas emissions.

The target

- Keep emissions below the 2013 level during the first three carbon budget periods (-4% on average) and reduce energy production-related emissions by 95% between now and 2050, compared to the 1990 level.

How?

- Speed up improvements in energy efficiency (Factor 2) by reducing the carbon footprint of the energy mix by 2050.
- Develop renewable energy sources and avoid investing in new thermal plants which would be contrary to this policy in the medium term.
- Improve the flexibility of the system in order to increase the share of renewable energy sources.

IN WASTE



4%

Share of waste in greenhouse gas emissions.

The target

- Reduce emissions by 33% by the 3rd carbon budget period (2024-2028).

How?

- Reduce food waste in order to limit indirect GHG emissions.
- Prevent the production of waste (eco-design, extension of product life spans, re-use, reduction of wastefulness, etc.).
- Increase the resource recovery through the recycling of waste and the generalisation of the sorting of biowaste at the source by 2025.
- Reduce diffuse methane emissions from landfill sites and purification plants.
- Ultimately stop incineration without energy recovery.

Source: Stratégie Nationale Bas Carbone 2016

Monitoring indicators: Germany

ENERGY OF THE FUTURE

Commission on the Monitoring Process

Monitoring Indicators

Energy supply	Energy efficiency	Renewables	Plants	Grids
<ul style="list-style-type: none"> • Primary energy consumption by energy source • Final energy consumption by energy source • Final energy consumption by sectors • Gross electricity consumption • Net electricity consumption by sectors • Gross electricity generation by energy source 	<ul style="list-style-type: none"> • Primary energy productivity and final energy productivity (total economy) • Temperature-adjusted primary energy productivity and final energy productivity (total economy) • Electricity productivity (total economy) • Final energy productivity (industry) • Final energy productivity (commerce, trade, services) 	<ul style="list-style-type: none"> • Share of RES in gross final energy consumption and gross electricity consumption • Electricity generation, final energy supply and heat supply from RES • Special equalisation scheme • EEG levy by technology • Sum of power exchange price and EEG levy • Merit order effect 	<ul style="list-style-type: none"> • Capacity of German power plants • Capacity of RE power plants • Share of CHP electricity generation in net (total) electricity generation • Power plants by federal states • Construction and planning of conventional power plants • Pumped-storage power plants • Market share of the largest utilities 	<ul style="list-style-type: none"> • Circuit length, extra high voltage and high voltage • Grid investments • Average network charges • Costs of system services • SAIDI (electricity) • Investments in smart grids and smart meters • Physical electricity flows through cross-border capacities
Buildings	Transport	Greenhouse gas emissions	Energy prices and costs	Macroeconomic effects
<ul style="list-style-type: none"> • Primary energy demand • Heating energy demand • Renovation rate • Final energy consumption in buildings • Specific final energy consumption for space heating in private households • Building space • Investments in buildings 	<ul style="list-style-type: none"> • Final energy consumption in transport • Number of electric vehicles • Number of fuel cell vehicles • Fuel consumption of newly registered passenger cars • Volume of passenger and freight transport 	<ul style="list-style-type: none"> • Greenhouse gas emissions • Greenhouse gas emissions by source • Energy-related CO₂ emissions • CO₂ emissions of electricity generation • Greenhouse gas emissions per capita and per GDP • Avoided greenhouse gas emissions due to RES 	<ul style="list-style-type: none"> • Price development of energy raw materials • CO₂ prices • Natural gas and electricity prices by user type (incl. European comparison) • Crude oil prices • Compensation schemes for industries • Energy costs by target groups and shares of energy costs in income • Energy costs in selected industries • Share of electricity costs in GDP 	<ul style="list-style-type: none"> • Investments in RES • Reduction of imported fossil fuels induced by RES and energy efficiency • Employment effects induced by RES • Employment effects induced by energy efficiency measures • Gross employment in the conventional energy sector • Expenditure of the Federal Government in the context of the Energy Research Programme







27.02.2017

Indicators in red are quantitative targets in the Energy Concept and are regarded as headline indicators by the Federal Government.

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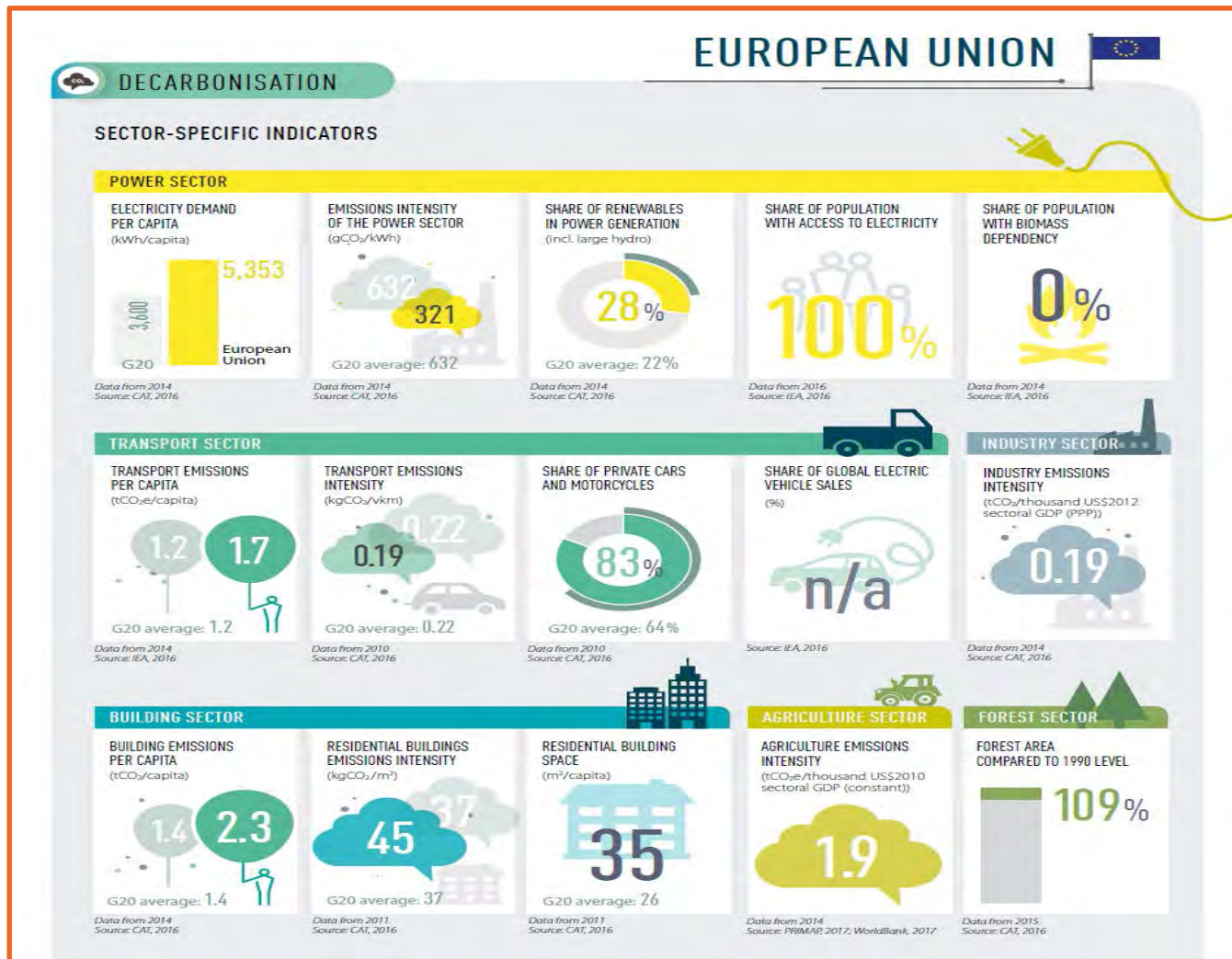
Source: Expertenkommission zum Monitoring "Energie der Zukunft"

Monitoring indicators: United Kingdom

 <ul style="list-style-type: none">Supply: Heat networks, heat pumps, hydrogen & biofuelsDemand: Insulation, efficiency & behaviour changeBy 2030s: low carbon heat in 1/7 homes, 50% comm'l. buildings	 <ul style="list-style-type: none">Supply: conventional fuel efficiency improvement & EVsDemand: mobility choices, driving stylesBy 2030: around 60% new cars & vans electric (hybrid or full)
 <ul style="list-style-type: none">Supply: wind, nuclear, CCS, interconnection, gas, storage etcDemand: smart meters & tech.By 2030s: <100 gCO2/kWh, smart demand	 <ul style="list-style-type: none">Supply: processes & energy efficiency, heat recovery & CCSDemand: new materialsThrough 2020s: apprx. 1%/yr fall emissions from measures
 <ul style="list-style-type: none">Supply: fertiliser use, animal diets, breeding, fuel efficiencyDemand: labelling, dietThrough 2020s: apprx. 1%/yr decrease emissions	 <ul style="list-style-type: none">Supply & demand: reduce & re-use, all main biodegradable waste diverted from landfill, alternatives to F-gasesBy 2030s: apprx. 50% decrease emissions from today

Source: UK – Climate Change Committee

Monitoring indicators: the *Climate Transparency* dashboard



Source: Climate Transparency

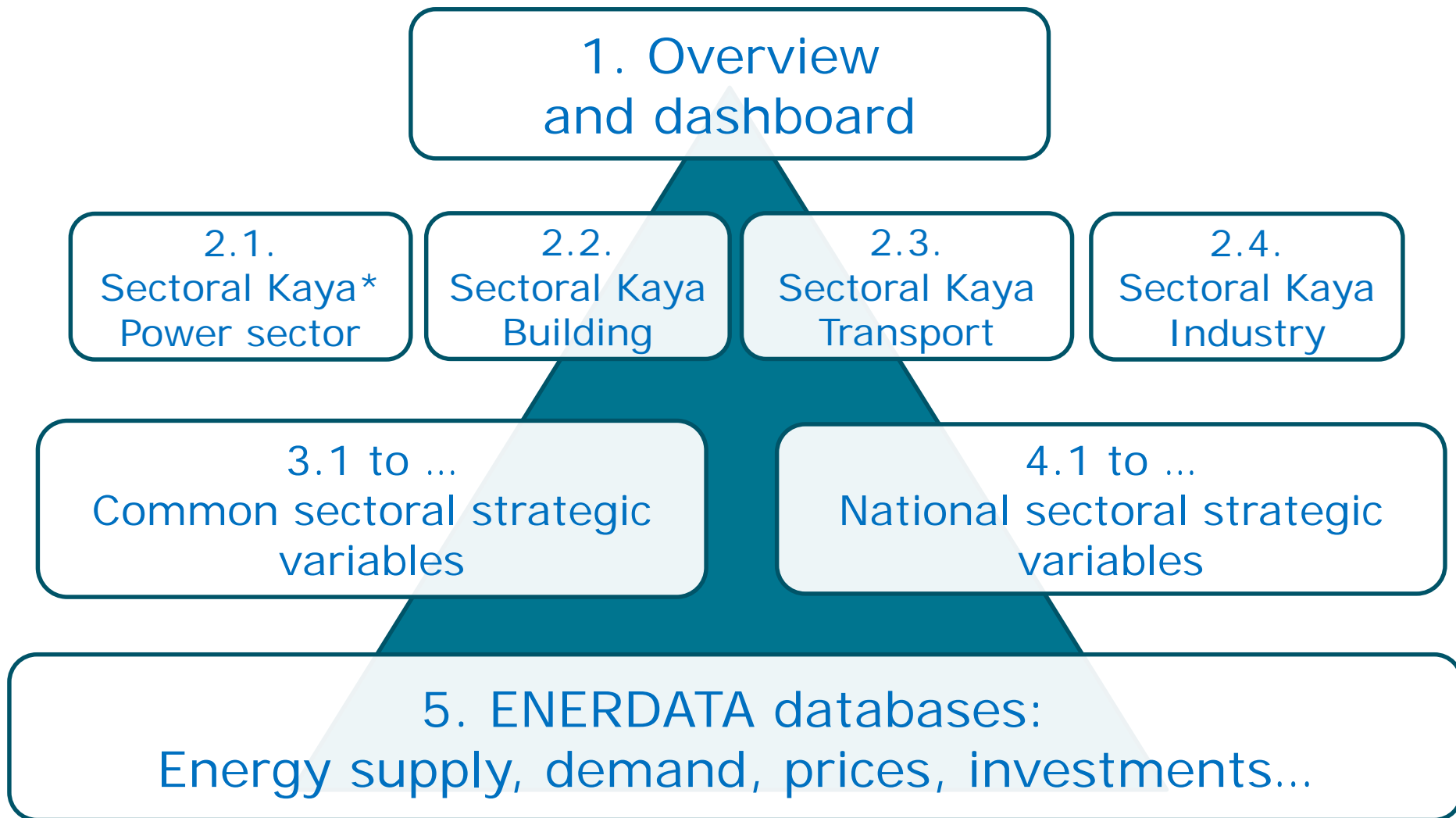
*EnerTraM:
Energy Transition Monitoring tool*

work in progress...

EnerTraM

- The goal of ENERTRAM is to **develop an information system** with dashboards on: i. on-going trends, ii. sectoral targets and iii. transformation trajectories
- The concept is consistent with the one of **Nationally Determined Contributions (NDCs)** as identified in the Paris Agreement
- It will be highly strategic in the future, with the entry into the phase of **climate policy implementation**
- Through the combination of its **international databases** and of the **EnerFuture scenarios**, ENERDATA is well equipped to ensure the international monitoring of energy transitions

EnerTraM: a set of dashboards



Level 1. A compact dashboard for sectoral strategies

EnerTraM 22 indicators Decarbonization Dashboard

Headline	GHG emissions per capita (MtCO ₂ e/cap)	CO ₂ intensity of GDP (tCO ₂ /)\$)	Carbon factor (tCO ₂ /toe)	Energy intensity of GDP (toe/\$)	Primary energy per capita (toe/cap)	Share of fossil fuels in primary energy (%)
Power sector	Electricity demand per capita (kWh/cap)	CO ₂ factor of the power sector (gCO ₂ /kWh)	Electrification rate (%)	Electrification of final energy mix (%)	Installed coal capacities (GW)	Share of renewables in power generation (incl. large hydro) (%)
Transport and industry	Transport CO ₂ emissions per capita (tCO ₂ /cap)	Private road transport CO ₂ emissions per km (gCO ₂ /km)*	CO ₂ emissions per km of new private vehicles (gCO ₂ /km)*	Kilometer per capita (km/cap)		Industry CO ₂ emissions intensity of VA (tCO ₂ e/\$)
Building, agriculture and LULUCF	Building CO ₂ emissions per capita (tCO ₂ /cap)	Residential building emission intensity (kgCO ₂ /m ²)*	Service building emission intensity of VA (kgCO ₂ /)\$)		Agriculture GHG emissions intensity of VA (tCO ₂ e/\$)	Carbon sinks capacity (MtCO ₂ e)

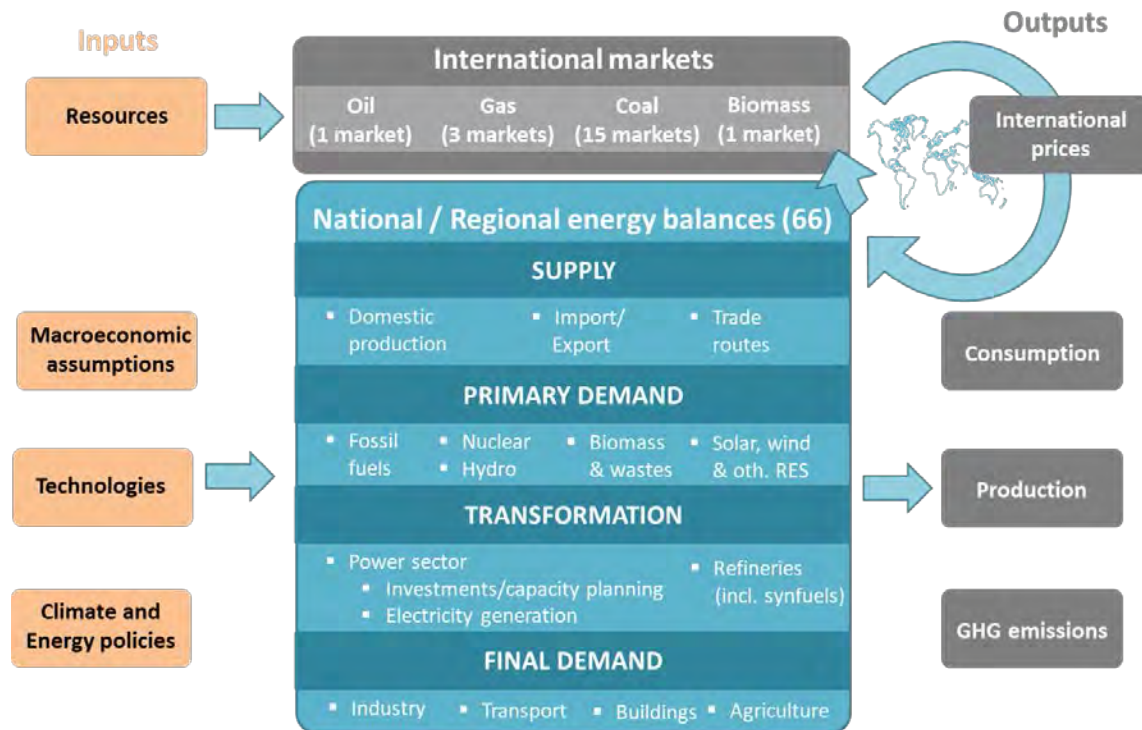
POLES: an integrated world energy model

- POLES is a world energy model initially developed for the EU Commission and currently used at CNRS, JRC-IPTS and ENERDATA
- The model represents 66 country energy models connected together through international energy market modules

- The model is used to produce ENERDATA's annual outlook **EnerFuture**

- Currently **EnerFuture** represents 3 scenarios:

- ✓ **EnerBrown**: fossil intensive
- ✓ **EnerBlue**: NDC compatible
- ✓ **EnerGreen**: 2°C compatible

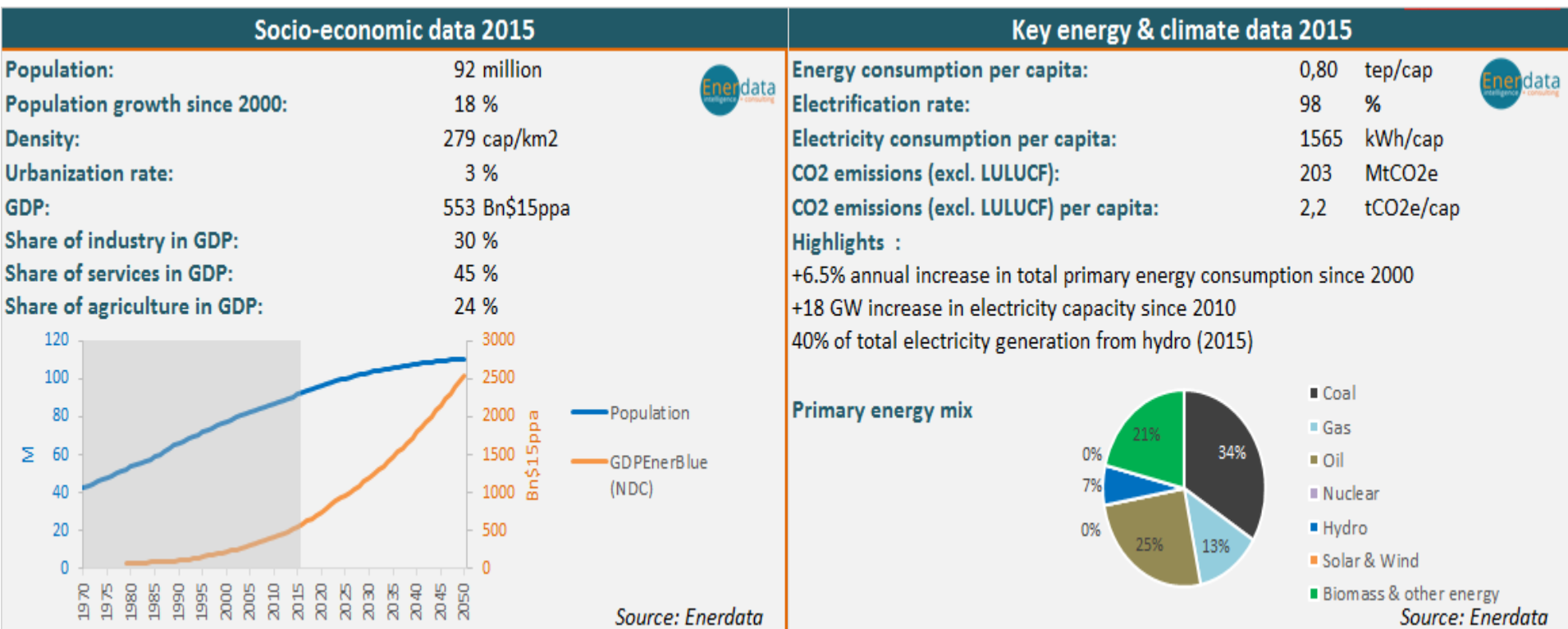


Energy transition in Vietnam:

*NDC Scenario (EnerBlue)
2°C Scenario (EnerGreen)*

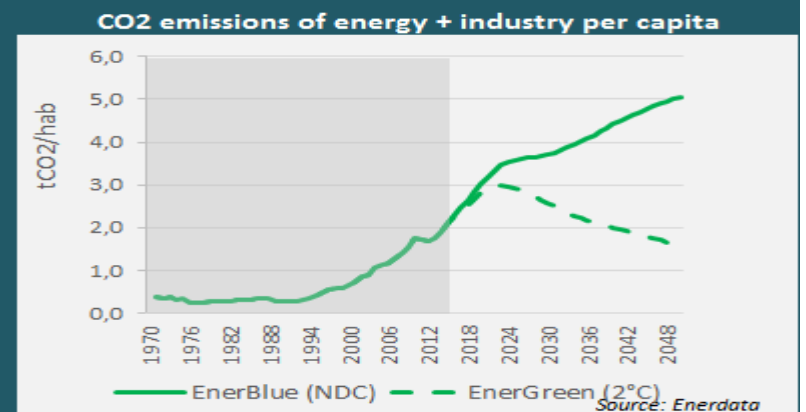
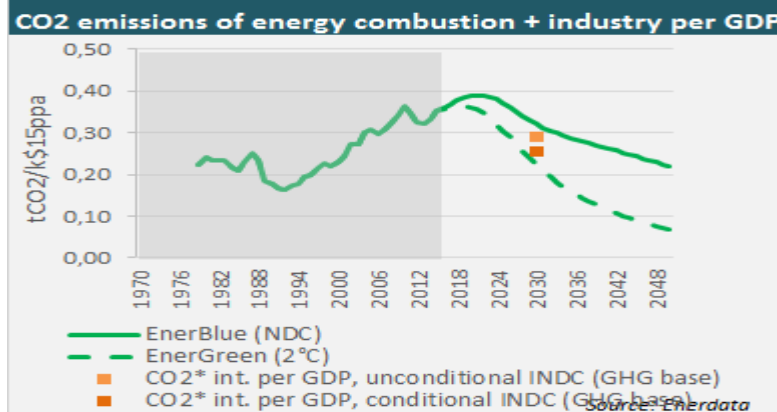
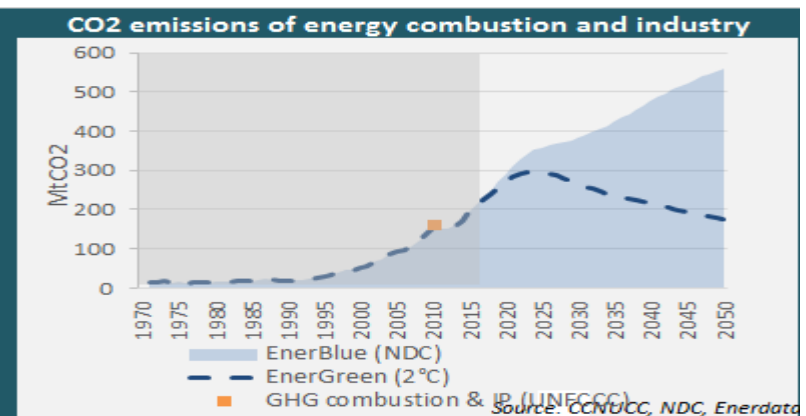
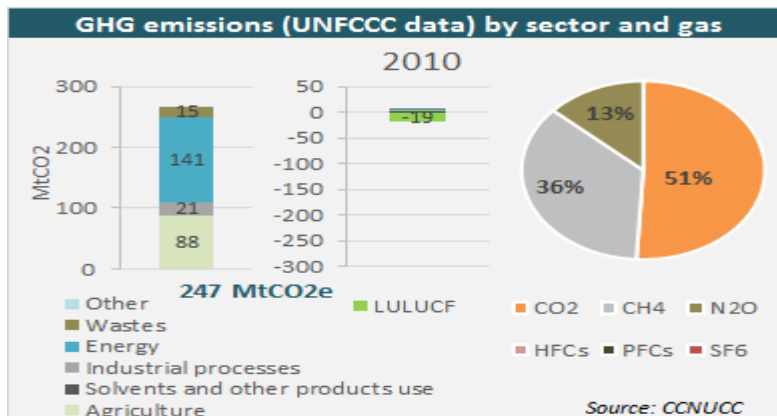
Vietnam: Overview

- Vietnam is an emerging nation with 6,4%/yr growth in the past 15 years, a still low urbanization rate, but 98% electrification rate
- This explains a high level of per capita consumption of electricity, with a growth rate of 12% in the 2000-2015 period
- Per capita emissions amount to 2.2 tCO₂, i.e. one third of world average



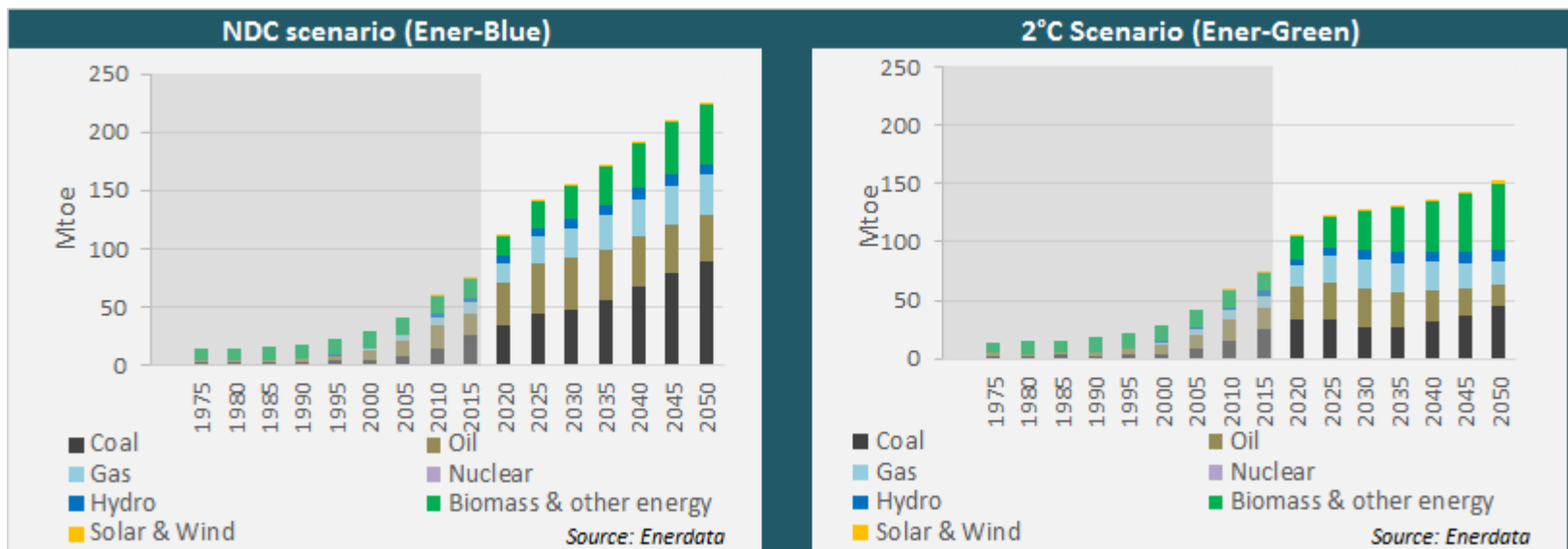
Vietnam: CO2 and GHG emissions

- CO2 represents 51% of total emissions and CH4 from agriculture 36%
- EnerBlue and EnerGreen scenarios are fit to the Vietnam lower and upper ambition NDCs for 2030, but they result in extremely contrasted emission futures in 2050: from 200 to 550-190 MtCO2 and from 2,2 to 5-1,7 t/cap



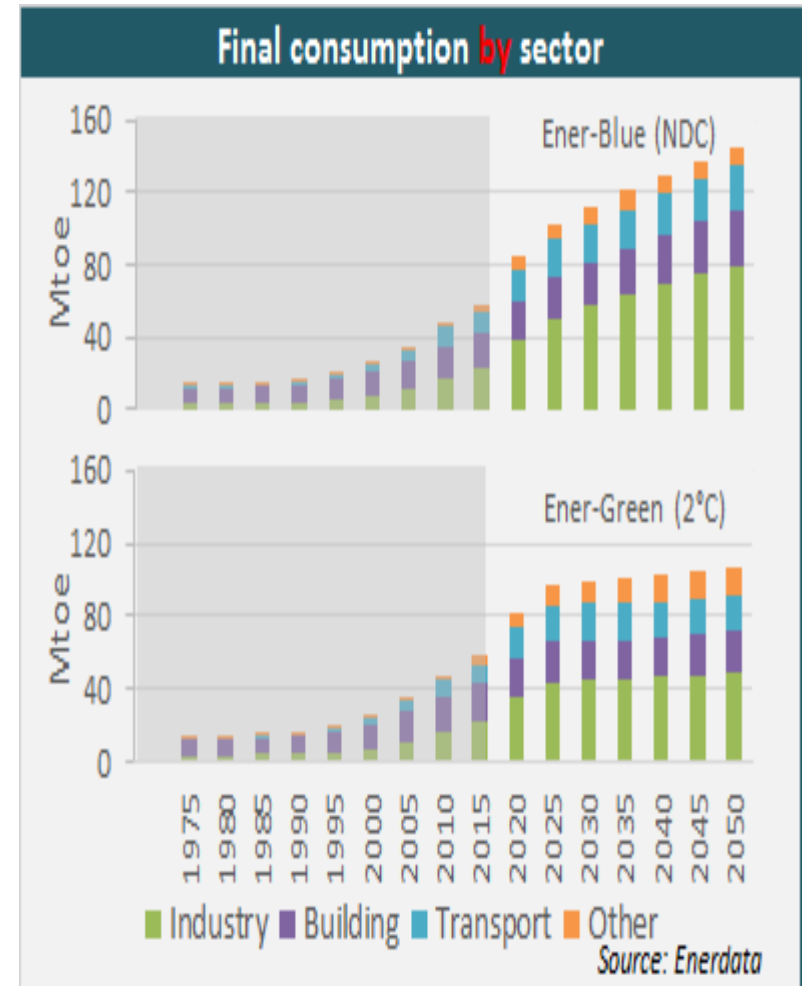
Primary energy by source

- Total primary energy supply, of 75 Mtep in 2015, triplicates in 2050 in EnerBlue (NDC), with coal representing about half of total. In EnerGreen, TPES is only multiplied by a factor of 2 in 2050, with an increased contribution of biomass and twice less coal in absolute terms
- Carbon content of energy has been increasing since 1990 while energy content of GDP remained constant since 2000. Carbon content decreases in EnerBlue and still more in EnerGreen. Energy efficiency improvements limit emissions in EnerBlue and even allow to reduce them after 2025 in EnerGreen



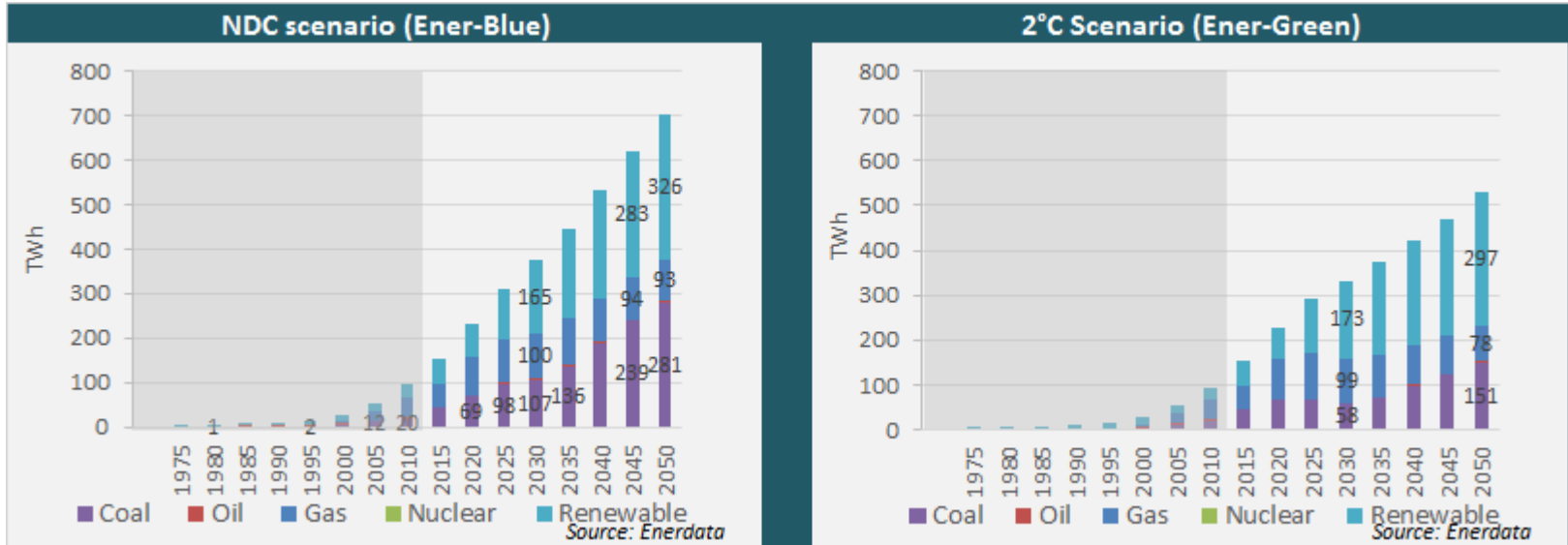
Final energy by sector

- In EnerBlue, industry consumption is expected to grow much faster than in EnerGreen, reaching almost 2 times its consumption by 2050
- In EnerGreen, industry consumption growth is limited by efficiency improvements and represents 50% of final energy consumption in 2050, Building and Transport about 20% each.



The power sector

- Compared to official forecasts (VNEO 2017), lower economic growth prospects and lower electricity demand elasticities result in much lower electricity demand in 2050, 700 and 550 TWh respectively in EnerBlue and EnerGreen (vs. 1 200 TWh in VNEO)
- In EnerGreen, CO2 emissions of the power sector are almost stabilized after 2020, while they continue to grow sharply in EnerBlue at +5,0%/year over 2015-2030



The power sector dilemma in Vietnam

- A coal-based strategy:
 - Coal power plants currently decided today will come online by 2025; they will be only at 2/3 of their technical lifetime in 2050
 - Heavily relying on coal for the 2030 horizon may induce significant capacity and infrastructure investments...
 - with a high risk of “stranded assets” if coal production were to be abandoned due to climate constraints

- A flexible renewable + gas strategy:
 - Relying more on renewables and natural gas may allow a phase-in of diversified low-carbon options
 - In the short term, gas involves twice less emissions per kWh (400 > < 800 gCO₂/kWh)
 - In the medium term, gas turbines are the perfect backup to variable renewables
 - In the long term, gas from renewable sources may represent a high share of supply

Priorities for defining a long term decarbonized energy strategy

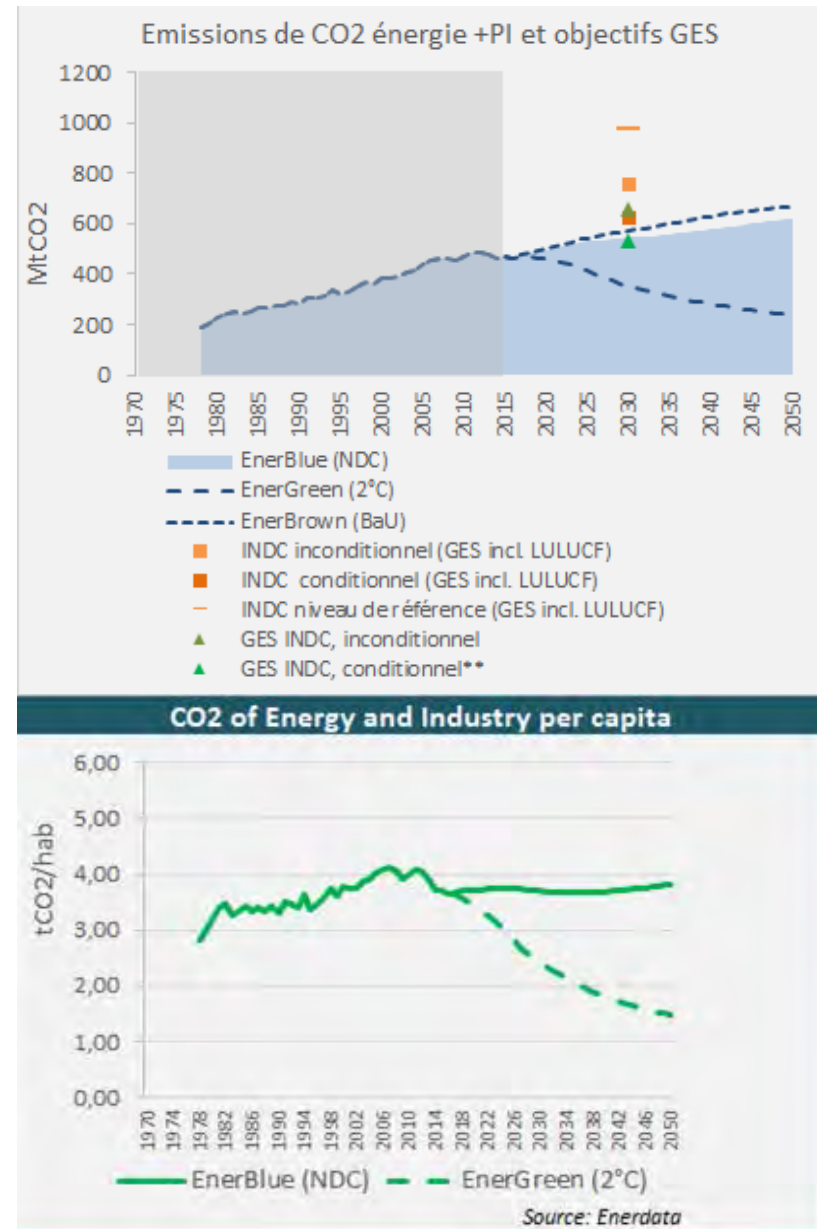
1. Identify the **right balance between supply and demand** actions:
 - In the VNEO 2017 energy savings potentials are only 10% of reference consumption in 2035 (?)
 - 1 200 TWh, for a population of 110 M in 2050, maybe a high guess (France's current consumption is stable at 480 TWh, for a population of 66 M)
2. Unless it is considered that Vietnam can ignore emission constraints in the long term, **avoid carbon intensive supply** options that may:
 - respond to short term needs
 - but induce overinvestment in dirty assets and excessive costs when CO2 price or physical constraints will be introduced (stranded assets)
3. **Prioritize flexible options** that: 1/ allow for future adjustments in the strategy and 3/ contribute to the design and deployment of an energy system that is both clean and efficient

Energy transition in Mexico

*NDC Scenario (EnerBlue)
2°C Scenario (EnerGreen)*

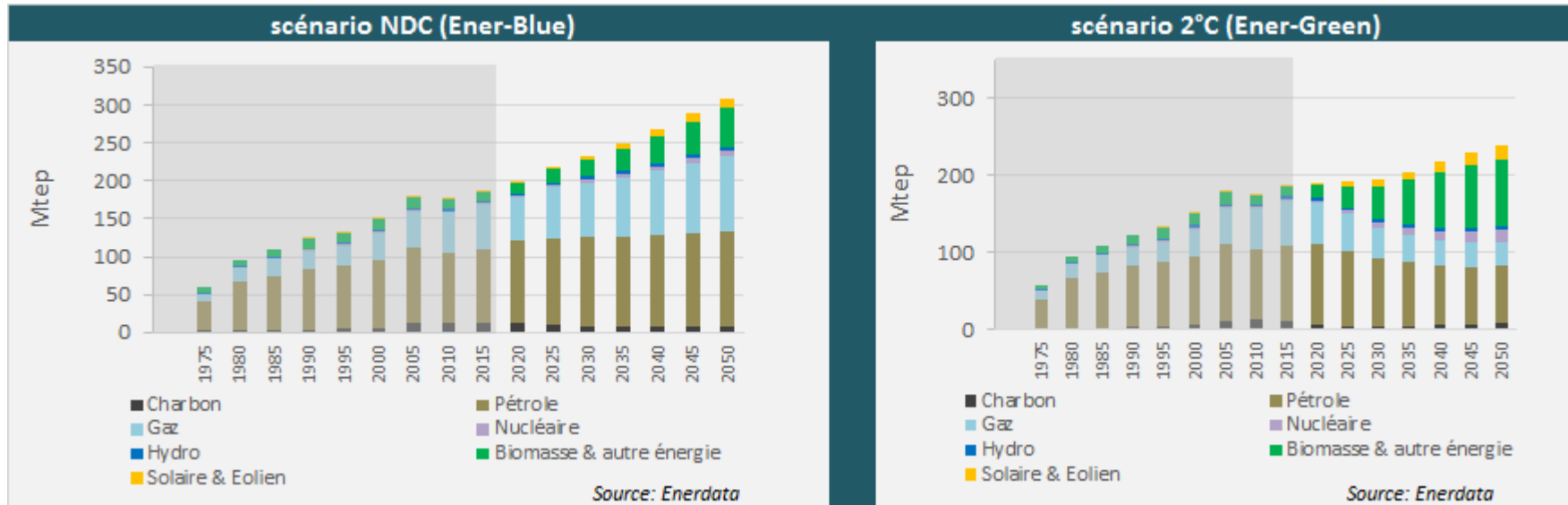
Overview

- From 2000 to 2015, Mexico's population has increased by 1.4%/yr, GDP by 2.1%/yr, Energy consumption has been stable and CO2 emissions decreased by 0.2%/yr
- This reflects a relatively low growth compared to other emerging countries
- With 4 tCO2/cap, emissions are below world average and relatively stable since 2000
- The EnerBlue scenario for Mexico extends this situation and is compatible with Mexico's NDC
- EnerGreen displays a significantly different profile with a reduction of per capita emissions down to 1,5 tCO2/cap



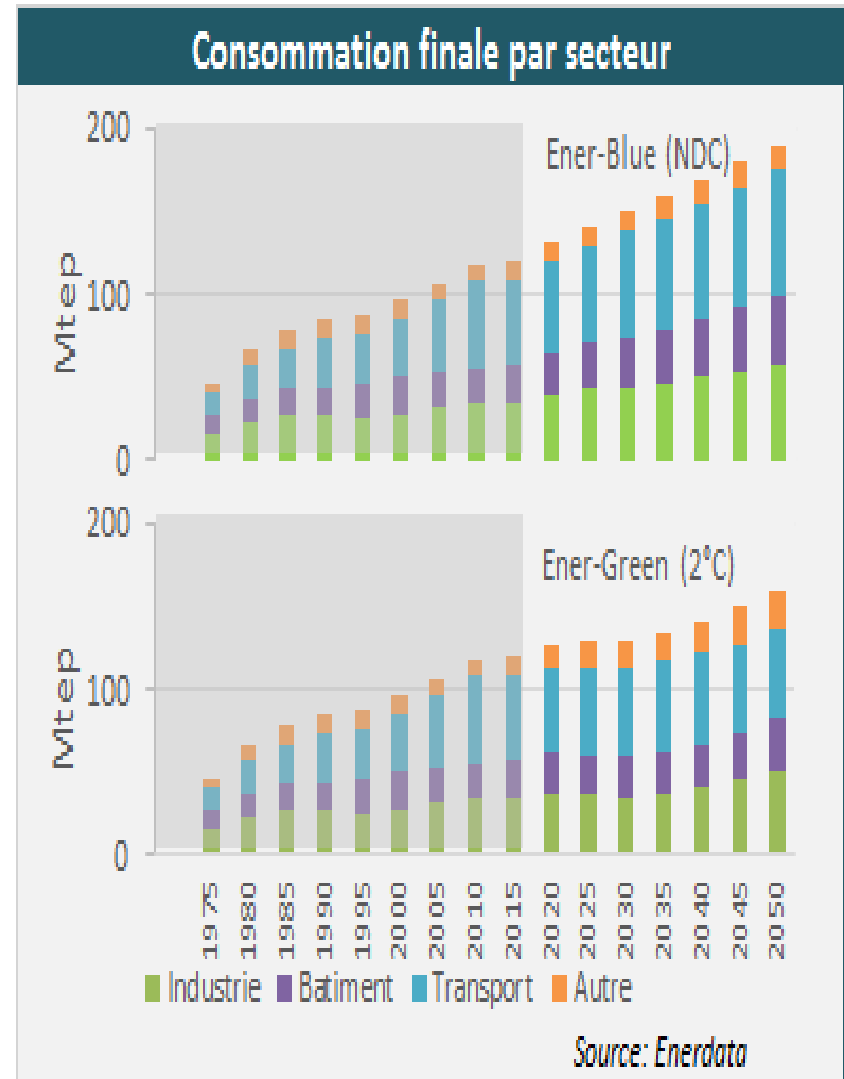
Total Primary Energy Supply

- In EnerBlue, TPES is bound to almost double in 2050, from 180 Mtoe to 300 Mtoe. In EnerGreen 2050 TPES is about 25% lower at 225 Mtoe
- The fuel mix is also very different in EnerGreen, with more than 50% of supply provided by biomass, solar and wind and nuclear



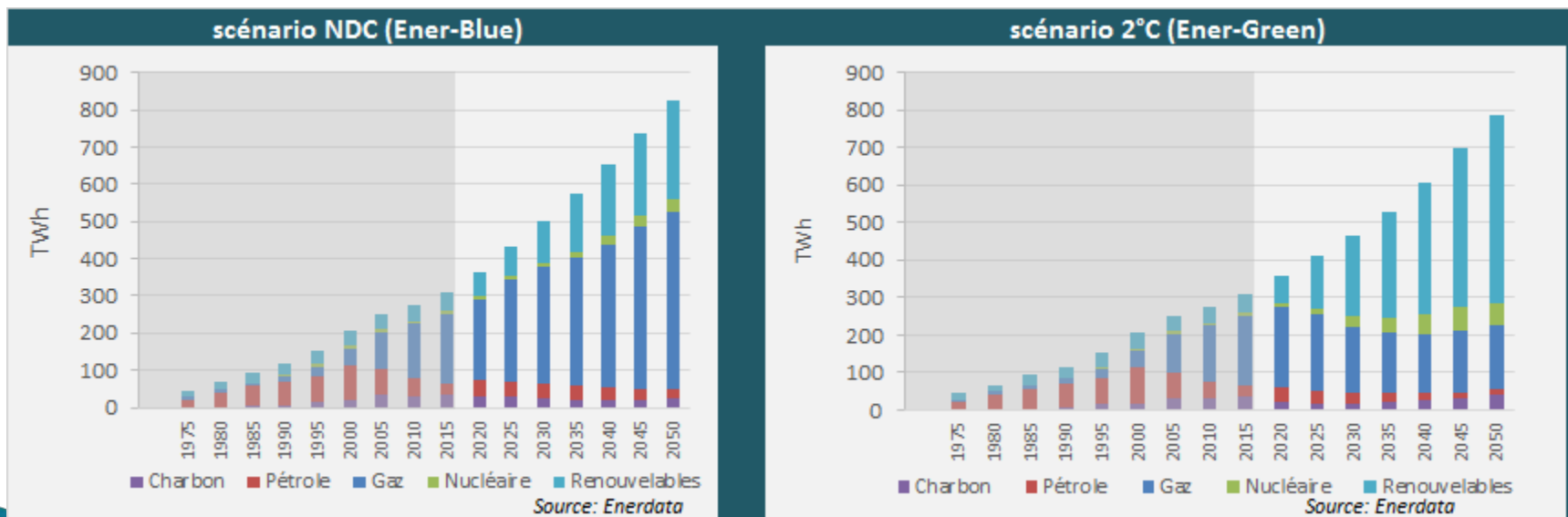
Final Energy Consumption

- Final energy consumption is bound to increase in both scenarios, although much less rapidly in EnerGreen: from 110 Mtoe to 200 in EnerBlue and 150 Mtoe in EnerGreen
- From EnerBlue to EnerGreen, industry is almost unchanged, while efficiency improvements beyond ongoing trends are observed in buildings and in the transport sector



Electricity

- Total electricity consumption is unaffected from one scenario to the other, with a yearly growth rate of about 3%/yr: increased energy efficiency in EnerGreen is counterbalanced by further electrification
- The electricity mix is very different, with natural gas representing in 2050 2/3 of total production in EnerBlue, only 1/4 in EnerGreen. In this latter case, renewable provide more than 60% of total, nuclear about 10%
- As a result, the CO2 content of electricity decreases from 450 to 250 gCO2/kWh in EnerBlue, but it is down to 80 gCO2/kWh in EnerGreen



Insights for Mexico

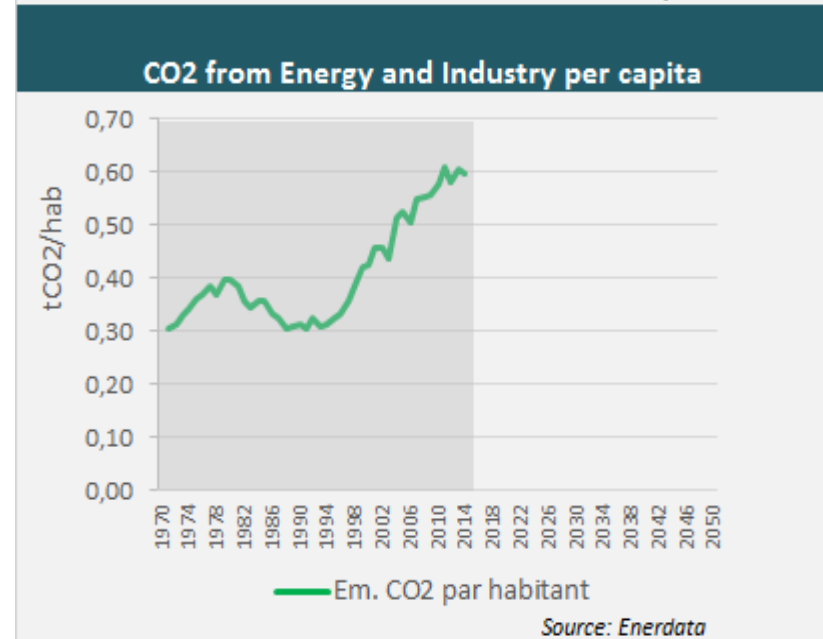
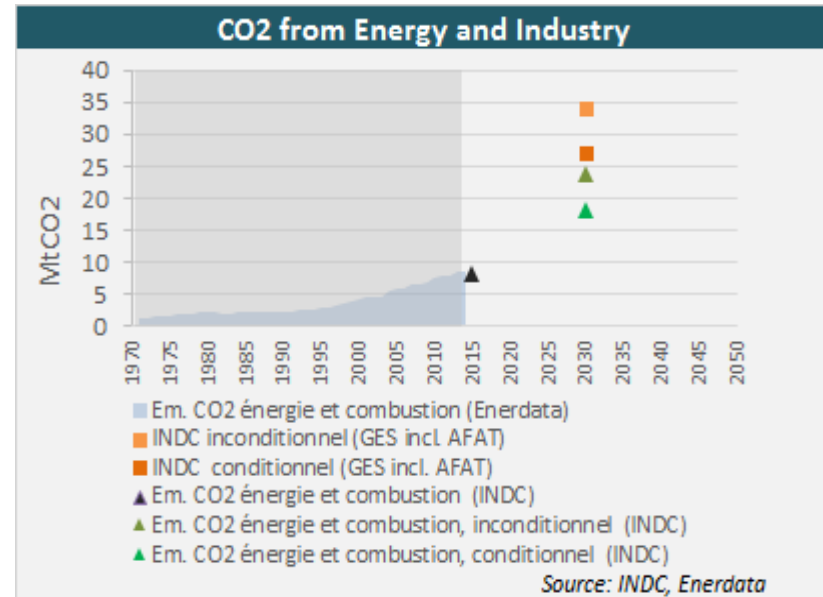
- The comparison of EnerBlue and EnerGreen for Mexico, an emerging country with a relatively moderate expected economic growth rate, shows that **current NDCs are not compatible with deep decarbonisation** (or 2°C compatible) trajectories
- In the transition, critical will be the capacity to **limit energy demand growth through enhanced efficiency** in buildings and industry and through the electrification of transports
- Critical also will be the choices in the development of the electricity sector. While no scenario incorporates a strong hypothesis for coal based electricity. But **the relative weight of renewable and gas based will be decisive**, resulting in power sector emissions of 200 MtCO₂ in EnerBlue compared to only 50 MtCO₂ in EnerGreen (from current 150 MtCO₂)

Energy transition in Sénégal:

analysis of on-going trends

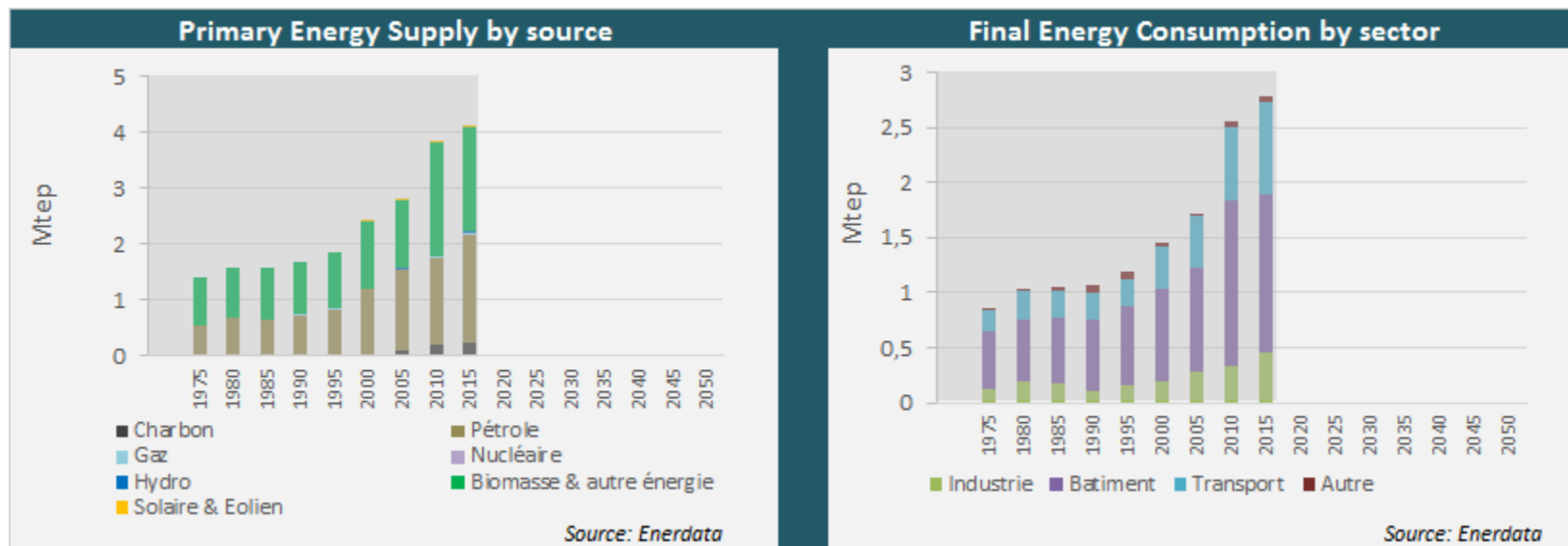
Overview

- While no detailed forecast is available for Senegal (not isolated in the POLES model) it is possible to compare ongoing trends with existing targets and NDCs
- CO2 emissions of Senegal have risen significantly since the early 90s. However they remain low in absolute terms today at about 10 MtCO₂
- Per capita emissions are also extraordinarily low at 0,6 tCO₂ per capita, i.e. one tenth of world average...



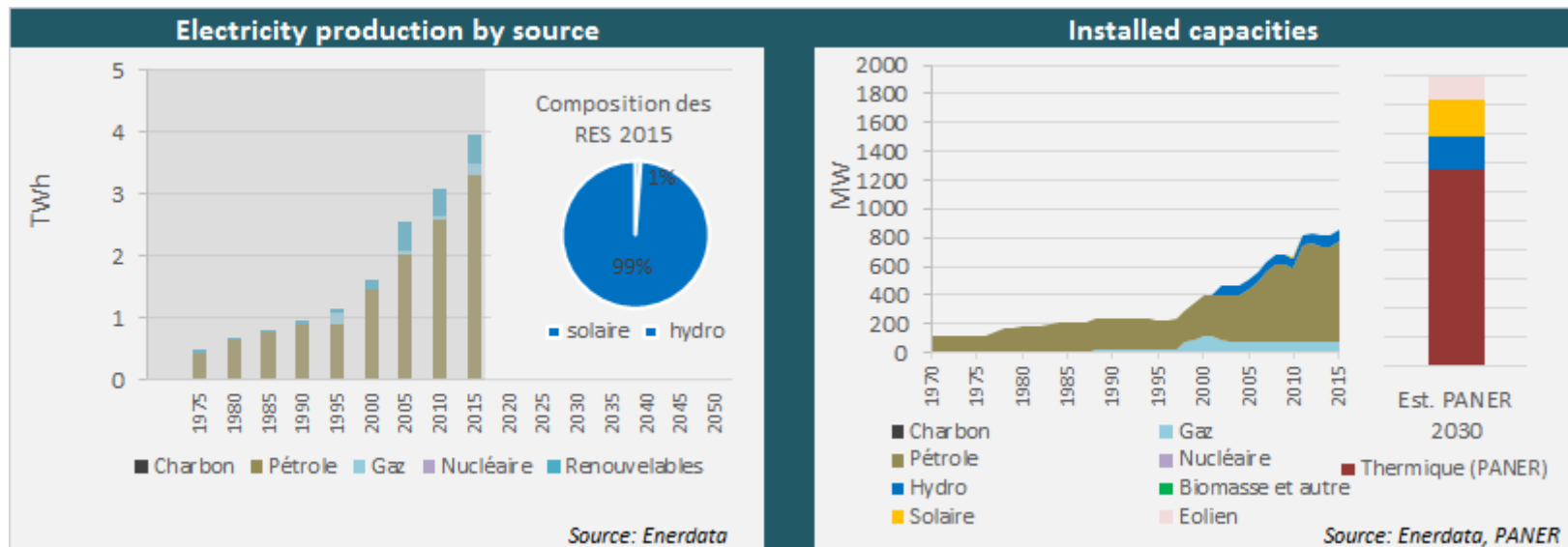
Total Primary Energy Supply and Final Energy Consumption

- With a doubling of TPES between 1995 and 2015, the structure of supply has remained remarkably stable, 50% of total energy being provided by oil and the rest by biomass energy. Small quantities of coal are however consumed in recent years
- The sectoral split of Final Energy Consumption is also relatively stable, with buildings, transport and industry incurring similar growth



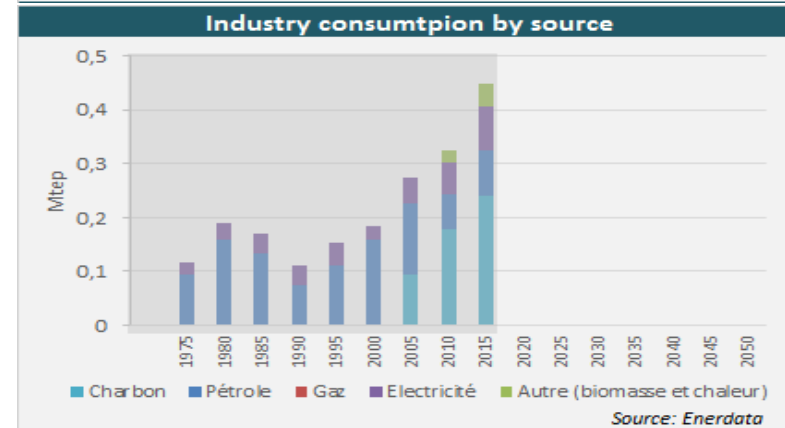
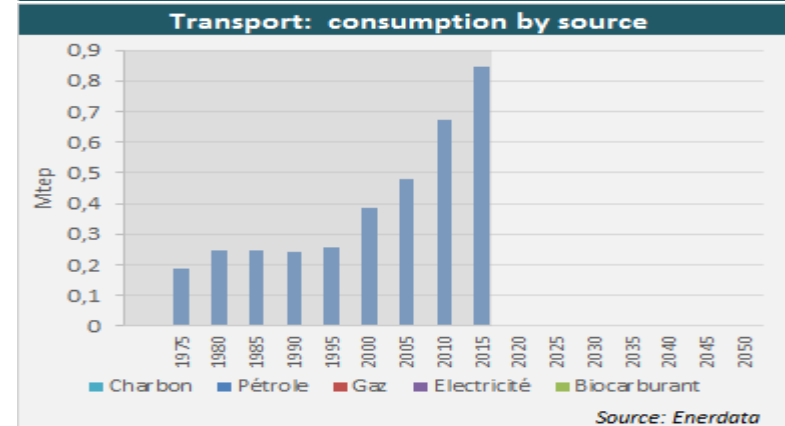
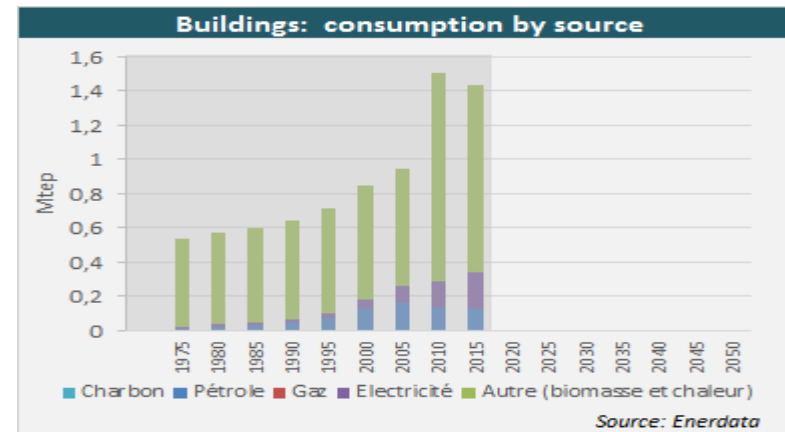
Electricity

- Electricity consumption incurred a much higher growth rate than other energies, as production has been multiplied by four in the last twenty years, compared to a doubling of TPES
- This corresponds to a rapid, although not full, electrification of the country (55% today)
- Oil provides most of total production. Since 2000 hydro and gas based production however provide one fourth of total



Sectoral consumption by source

- While the three final consumption sectors display similar growth profiles, the fuel mix are obviously different with recent changes:
 - In the building sector, the most noticeable one is the recent surge in electricity consumption
 - In transport, oil of course fully dominates
 - In industry, one can note a massive progression of natural gas, while electricity and biomass also progress



Insights for Senegal

- Senegal is an emerging country with relatively moderate economic growth (4%/yr)
- However **energy demand is expected to grow rapidly** in the near future, due to:
 - take-off of transport and industry
 - substitutions to traditional biomass in households' consumption
- **Electricity will be a key sector for energy transition** as its share will grow in energy for building, while the electrification of transport raises particular challenges in low-income countries
- **Natural gas**, both as a final carrier in industry and a primary source for electricity production will be a major issue
- **Renewables and gas** should be considered as complementary alternatives to coal in the power sector

Conclusions:

- Energy Transition Monitoring will be key in enhancing the ability of governments to develop effective and efficient climate and energy policies
- The diversity in national circumstances and priorities so as the diversity in data and modelling doesn't prevent to analyse energy transitions within a common framework and with common insights
- This is at least what hopefully comes out of the case studies presented here
- The work will go on...

Enerdata

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APPENDIX

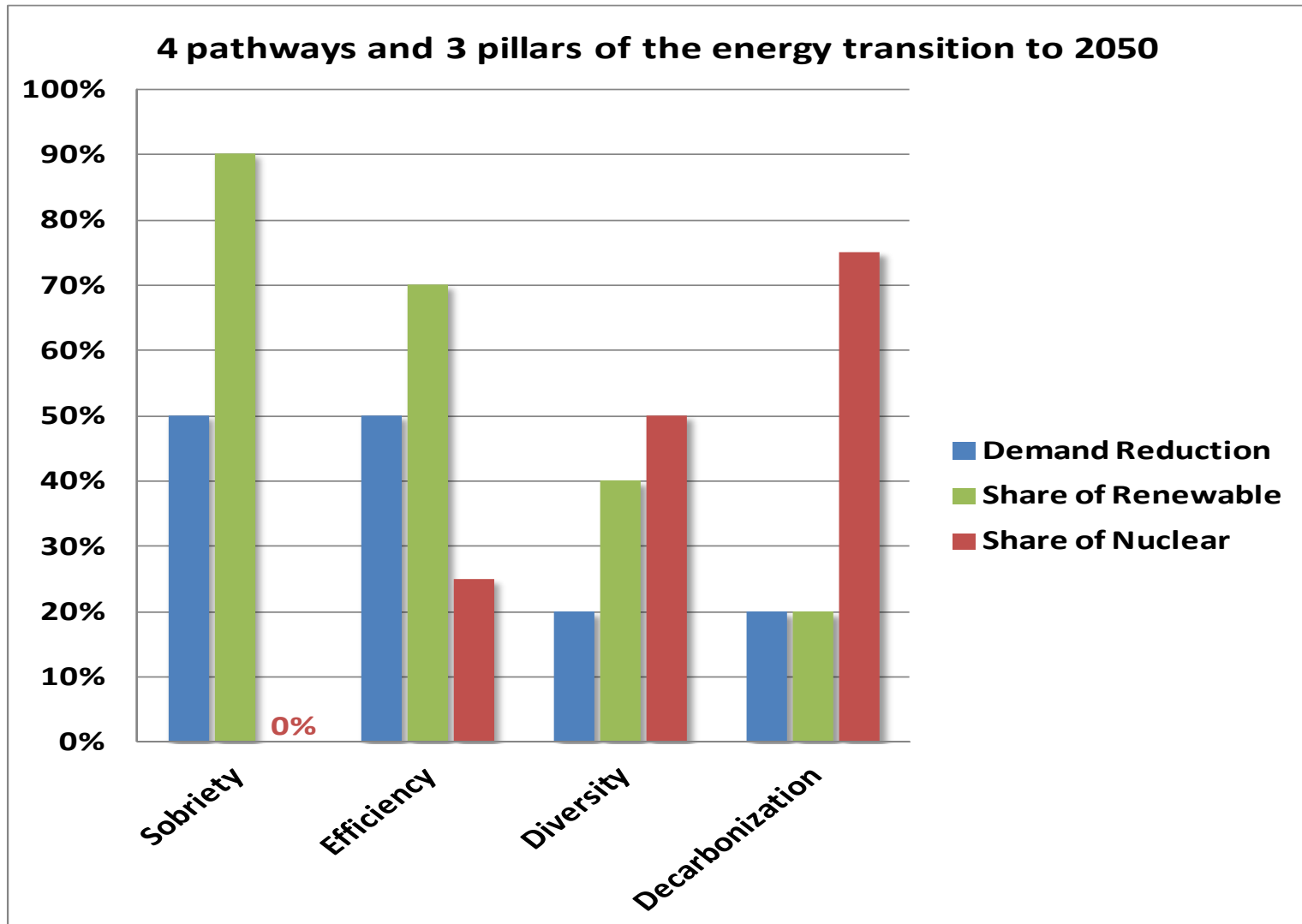
Energy transition in France:

National policy and targets

NDC Scenario (EnerBlue)

2°C Scenario (EnerGreen)

The 4 trajectories identified in the 2013 debate still reflect the different plausible futures



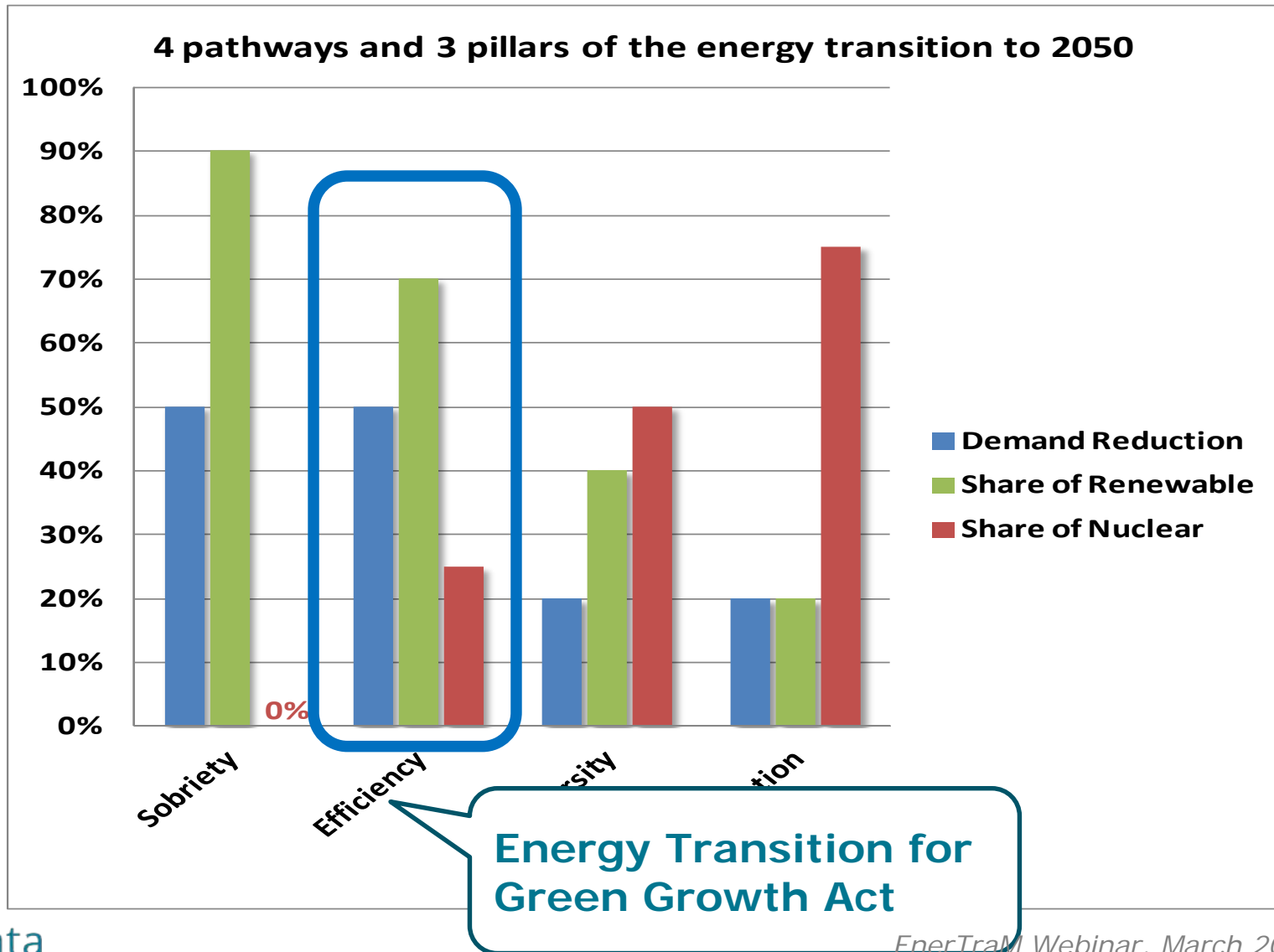
Quantitative targets of the 2015 Energy Transition Act are mostly consistent with the EFF trajectory

	Ref year	2020	2025	2030	2040	2050
greenhouse gas emissions	1990			-40%		-75%
final energy consumption	2012			-20%		-50%
fossil energy consumption	2012			-30%		
share of renewables in overall consumption		23%		32%		
share of renewables for heating				38%		
share of renewables for fuel				15%		
share of renewables for gas				10%		
share of renewables for electricity				40%		
share of nuclear power in electricity generation			50%			
loading docks for electric vehicles				7 million		
thermal rehabilitation projects per year		500,000	500,000	500,000	500,000	500,000

The 5 year Plurennial Programing for Energy (2016)

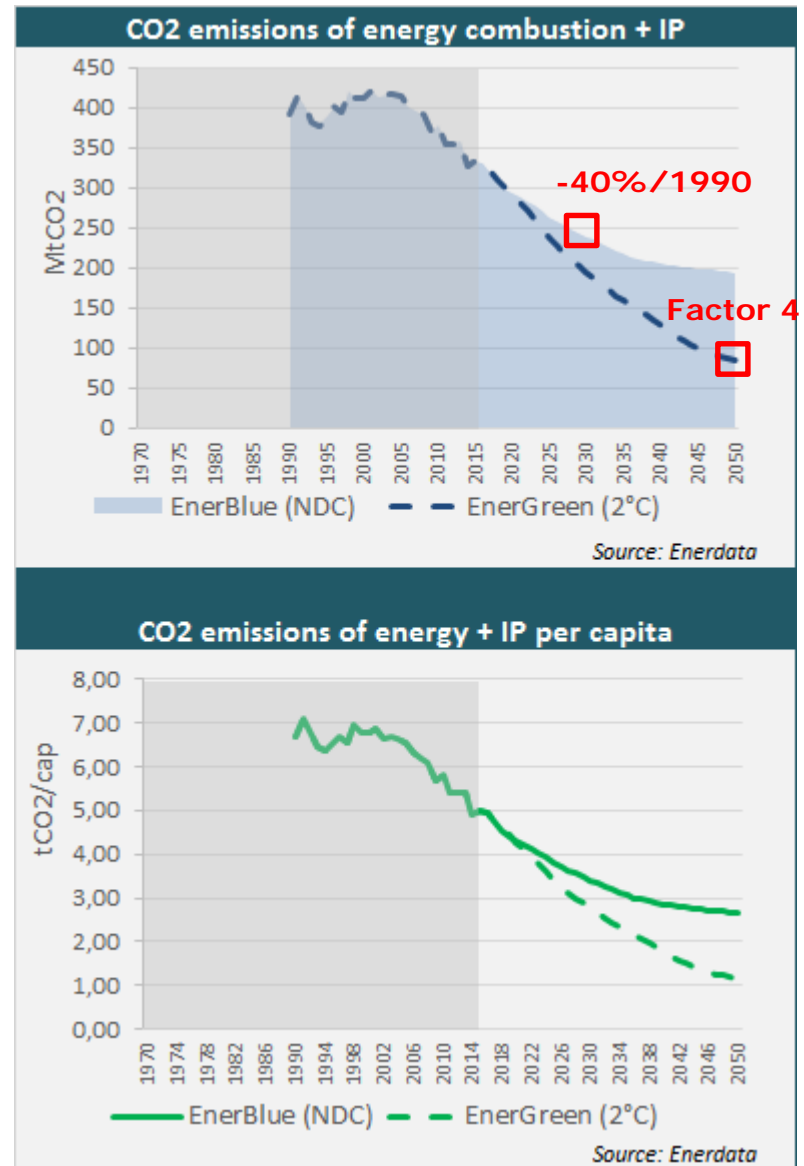
	2014	2018	2023	2023
Eolien terrestre	9 300 MW	15 000 MW	21 800 MW	26 000 MW
Solaire photovoltaïque	5 300 MW	10 200 MW	18 200 MW	20 200 MW
Hydroélectricité	25 300 MW (62 TWh)	25 300 MW (61 TWh)	25 800 MW (63 TWh)	26 050 MW (64 TWh)
Eolien en mer posé		500 MW	3 000 MW (entre 500 et 6000 MW de plus de projets engagés, en fonction des concertations sur les zones propices, du retour d'expérience de la mise en oeuvre des premiers projets et sous condition de prix)	
Energies marines (éolien flottant, hydroliennes, etc.)			100 MW (entre 200 et 2 000 MW de plus de projets engagés, en fonction du retour d'expérience des fermes pilotes et sous condition de prix)	
Bois-énergie	357	540 MW	790 MW	1 040 MW
Méthanisation	85 MW	137 MW	237 MW	300 MW
Géothermie électrique		8 MW	53 MW	
Déchets, biogaz de décharge et de STEP	~1200 MW	~1350 MW	~1500 MW	
TOTAL	41 GW	52 GW	71 GW	78 GW

The Efficiency trajectory is currently the benchmark of French energy policy



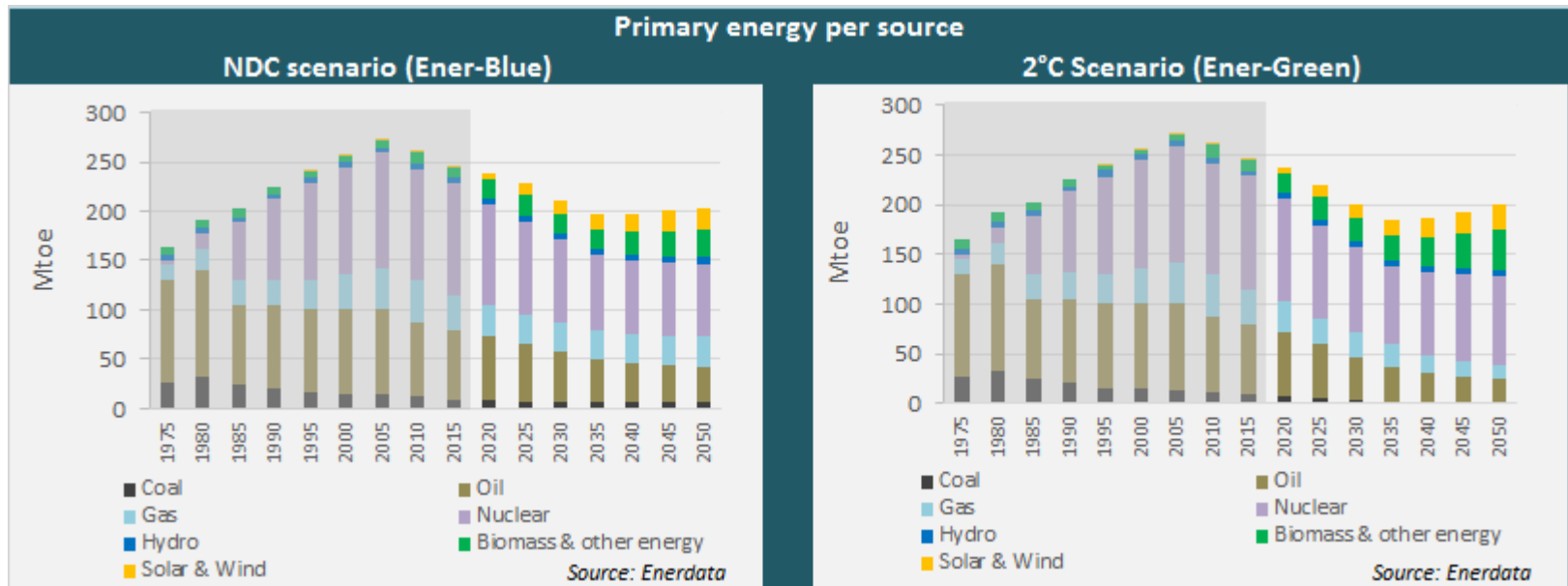
The EnerFuture scenarios for France

- EnerBlue reflects the French NDC to 2030, which is aligned with the European target of -40% emissions/1990
- EnerGreen corresponds to the “Factor 4 reduction” national target, i.e. -75% in 2050
- While per capita emissions are already low for an industrialized country (5 tCO₂) they should decrease to 3 tCO₂ and 1 tCO₂ respectively in EnerBlue and EnerGreen
- New policies aim at still lower levels to reach Zero Net Emissions in 2050



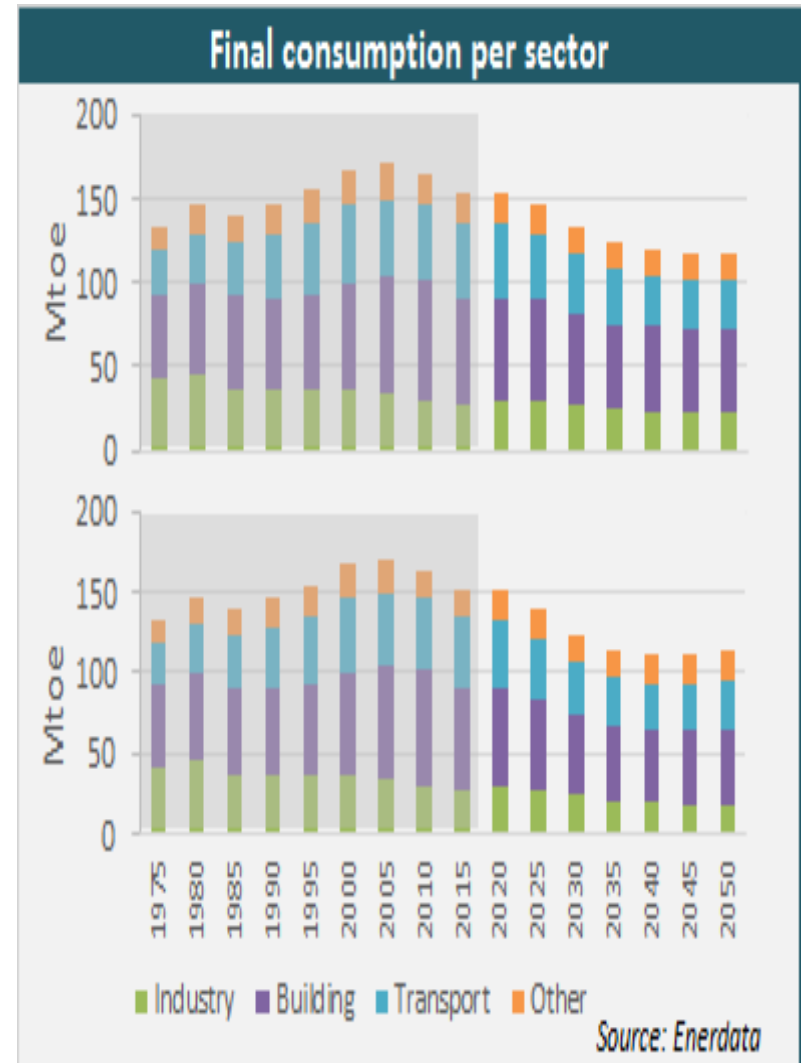
Total Primary Energy Supply

- Since 2005 trends in TPES are in line with EnerBlue and EnerGreen
- The two scenarios do not differ much in terms of level of TPES, but in EnerGreen coal phase-out is complete after 2030, while 2050 oil and gas use is two times lower in EnerGreen than in EnerBlue



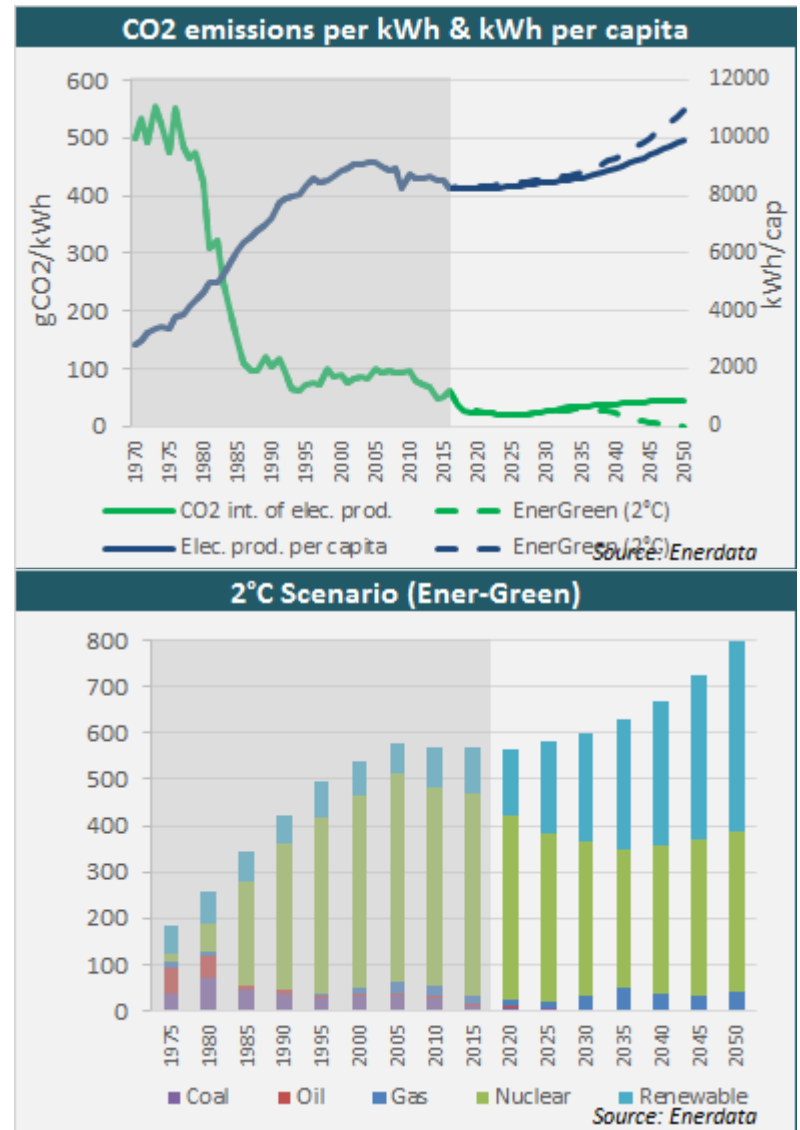
Final Energy Consumption

- In both scenarios Final Energy Consumption is 25% lower in 2050; this is a lesser reduction compared to the Efficiency official scenario
- The sectoral split is also very similar from one scenario to the other, indicating that the deeper decarbonisation in EnerGreen is largely due to a larger contribution of zero or low carbon energy carriers



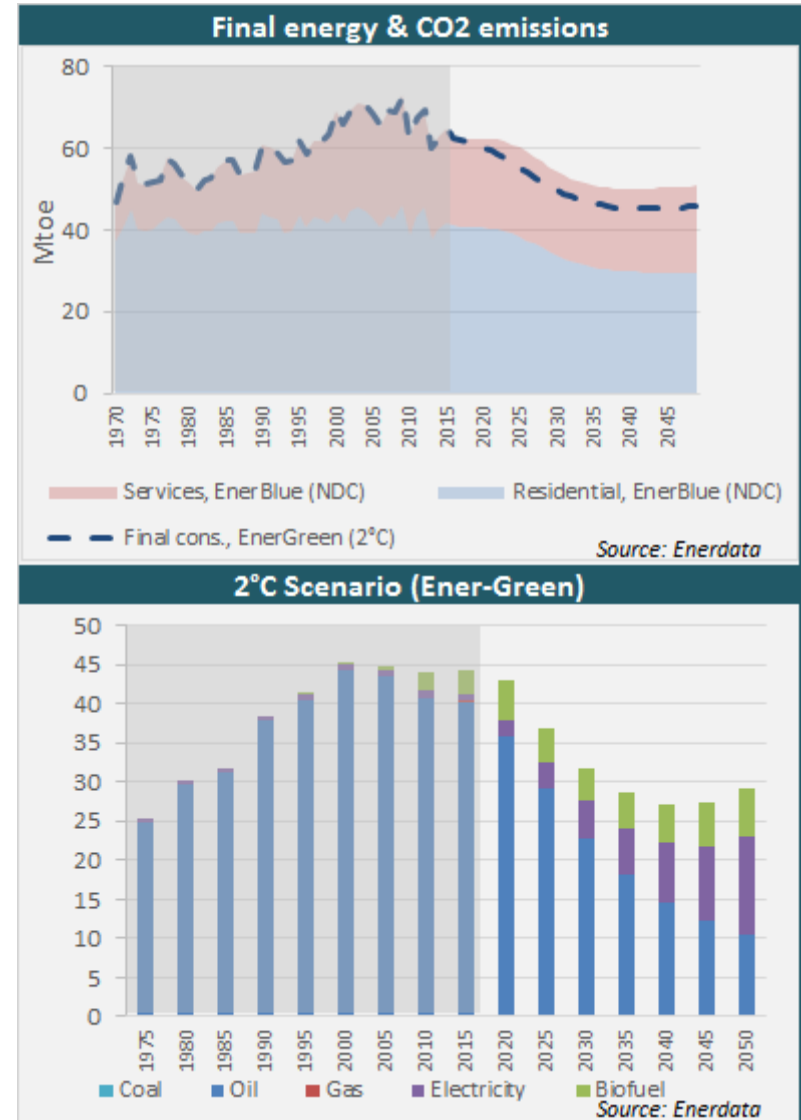
Electricity

- From the mid 70s to the mid 90s, France electricity sector has undergone a dramatic transformation process with an almost full nuclearization of the power sector
- As a result the carbon content of the kWh went down from 500 to less than 50 g/kWh
- New French policy supposes that the share of nuclear in power generation will be brought down, From current 75% to 50%
- In EnerGreen, nuclear and renewable represent almost 50% of production each, with a small residual production from natural gas



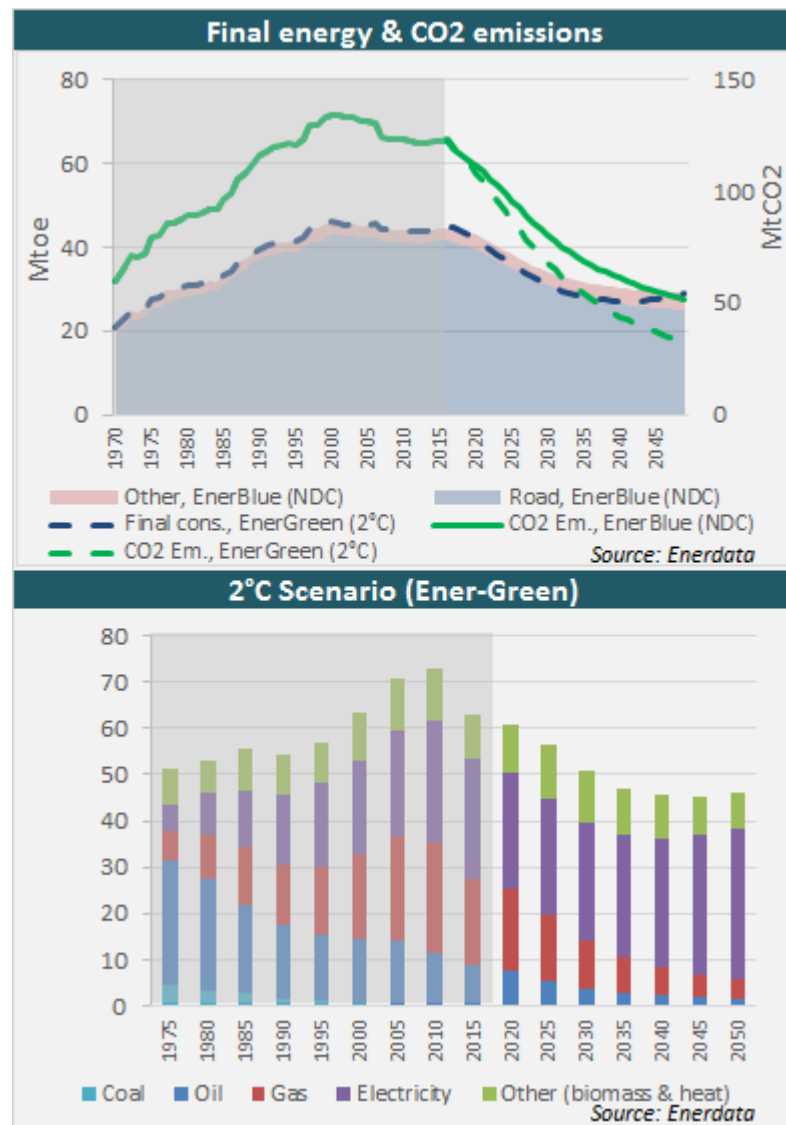
Building

- Energy consumption in buildings is already decreasing and is expected to still decrease of one third by 2030
- The official policy supposes still stronger reductions, but success in imposing deep thermal retrofit of all existing buildings is not granted
- Consequently, EnerGreen supposes an increased contribution of decarbonized carriers, electricity and biomass, for supplying energy supply in buildings



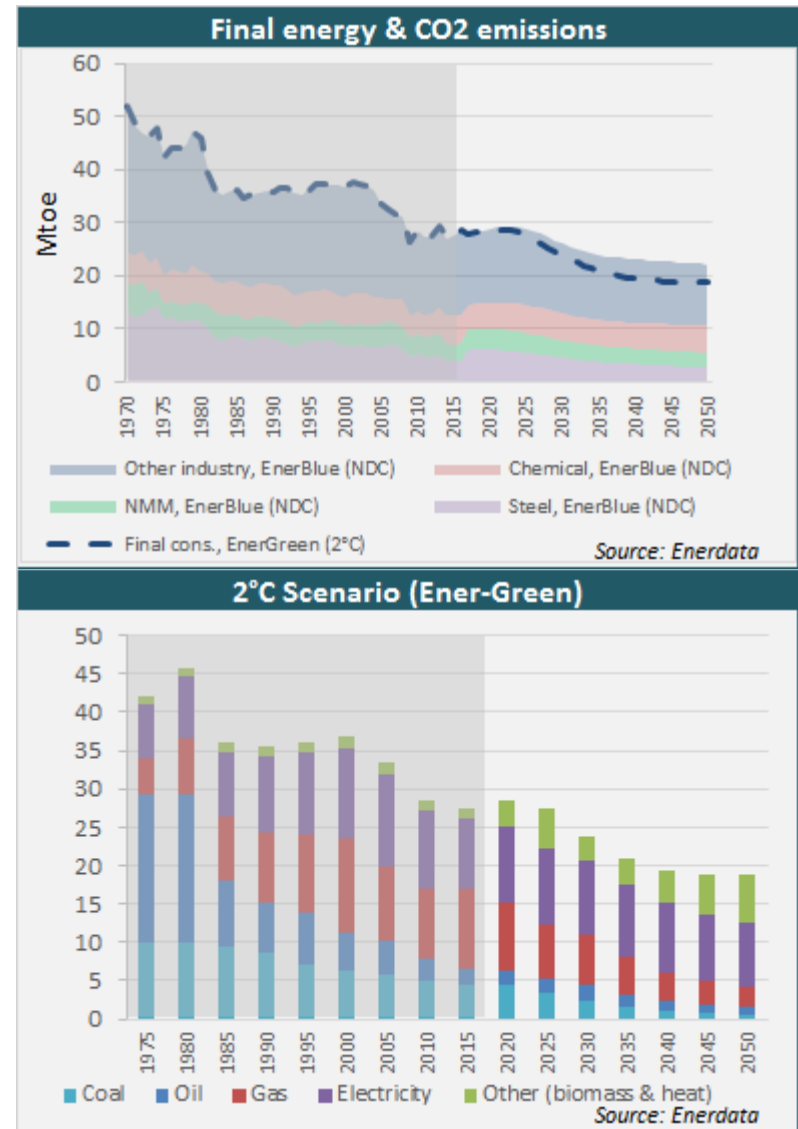
Transport

- While energy consumption in transport has levelled since 2000 the projected scenario supposes a gentle but regular reduction of consumption by 20% in 2050
- This implies a strong decarbonisation of the energy carriers: oil as a transport fuel almost disappears by 2040
- According to EnerGreen electric vehicles gain most of the market shares, while other scenarios also consider a strong contribution of low carbon gas vehicles (from bio resource or methanation)



Industry

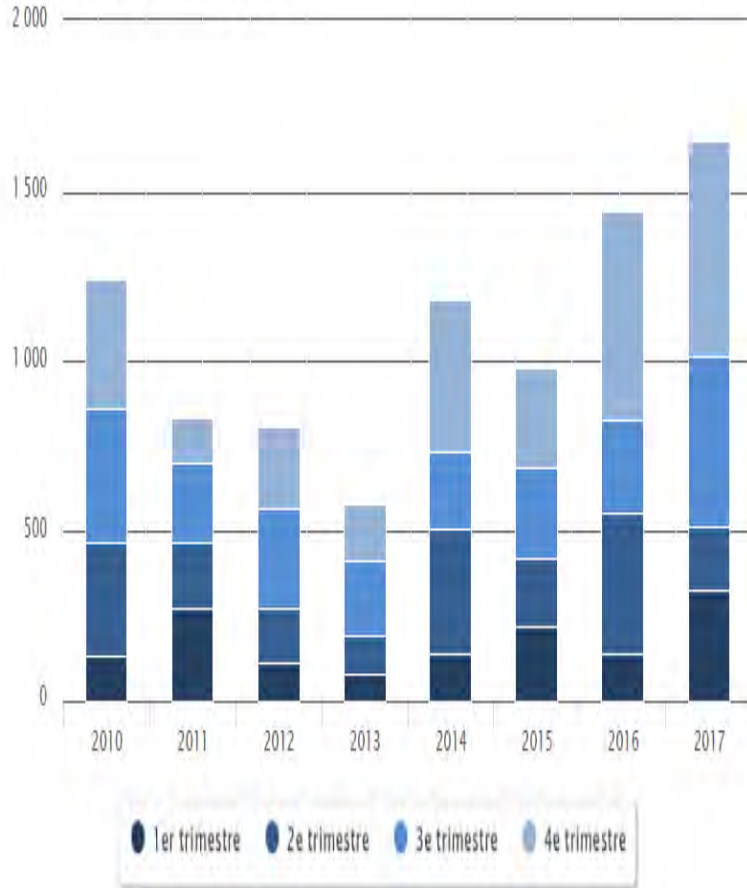
- As many European countries –maybe still more than others – France has incurred a deep desindustrialization movement in the past 40 years
- As a consequence energy consumption of industry has been reduced by 40% in the same period
- While public policies have tended to encourage reindustrialisation, the outcome is still not clear
- Energy consumption and emission reduction in the future should be considered as obtained through higher efficiency and lower carbon intensity of energy carriers
- This is what is simulated in EnerGreen with a further 30% reduction of consumption and biofuels and electricity representing more than 2/3 of supply to industry



Facts and targets-1: Wind

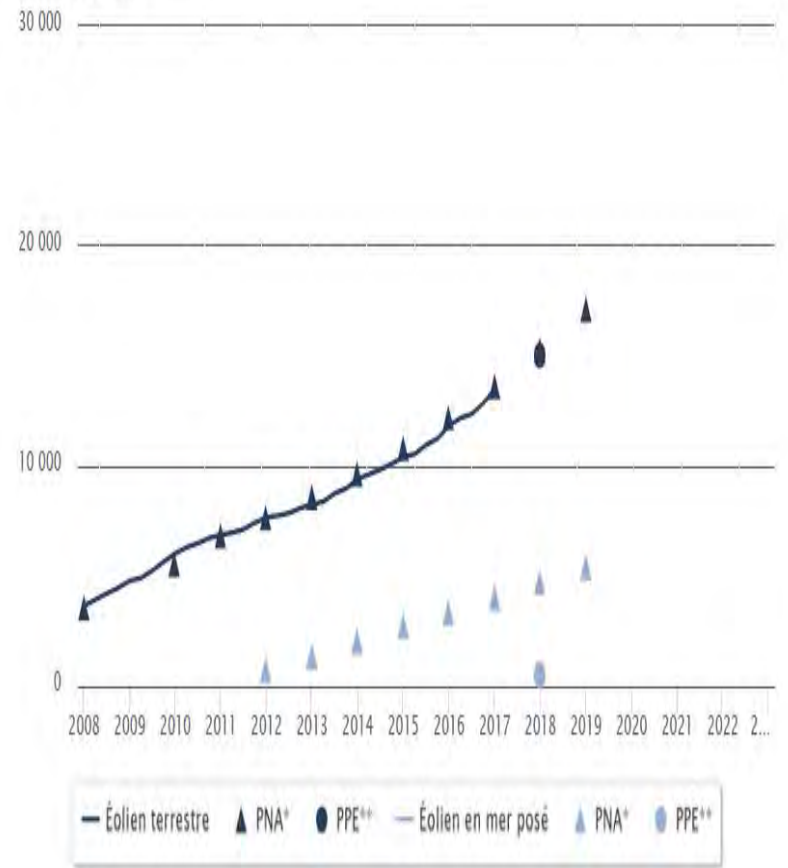
Éolien : nouveaux raccordements

Puissance raccordée par trimestre, en MW



Évolution du parc éolien

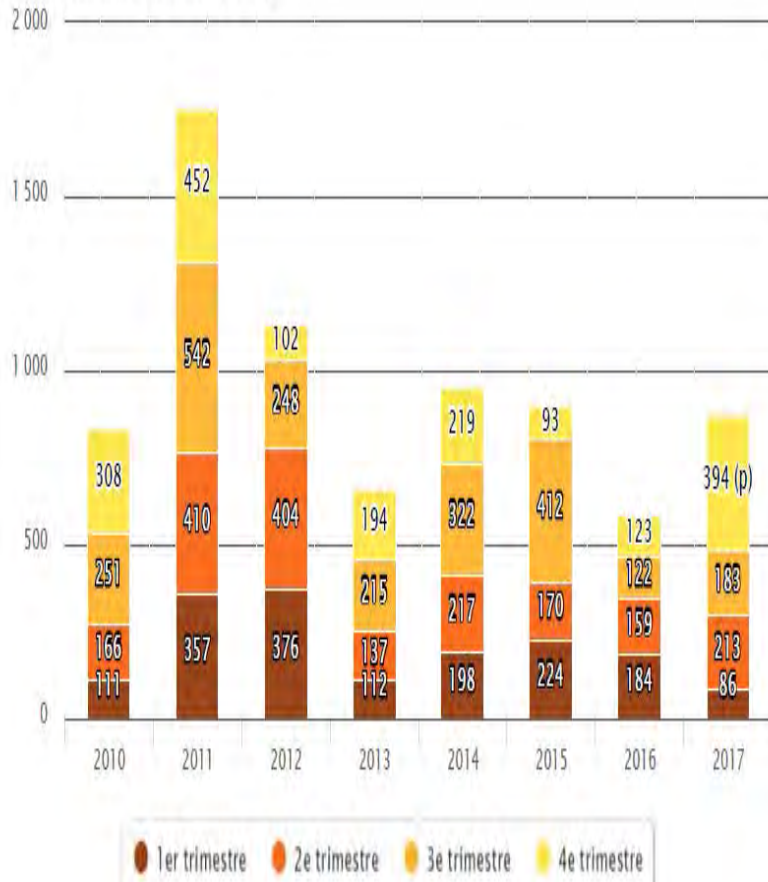
Puissance en MW



Facts and targets-2: Photovoltaics

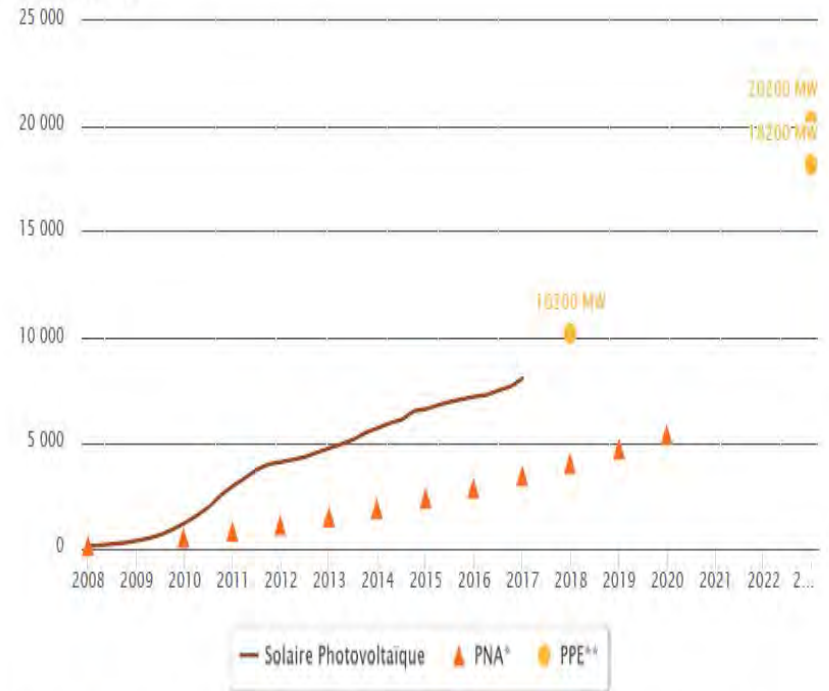
Solaire photovoltaïque : nouveaux raccordements

Puissance raccordée par trimestre, en MW



Évolution du parc solaire photovoltaïque

Puissance en MW



* Trajectoire prévue jusqu'en 2020 par le plan national d'action en faveur des énergies renouvelables (PNA EnR), dans le cadre de la directive 2009/28/CE relative à la promotion de l'utilisation des énergies renouvelables.

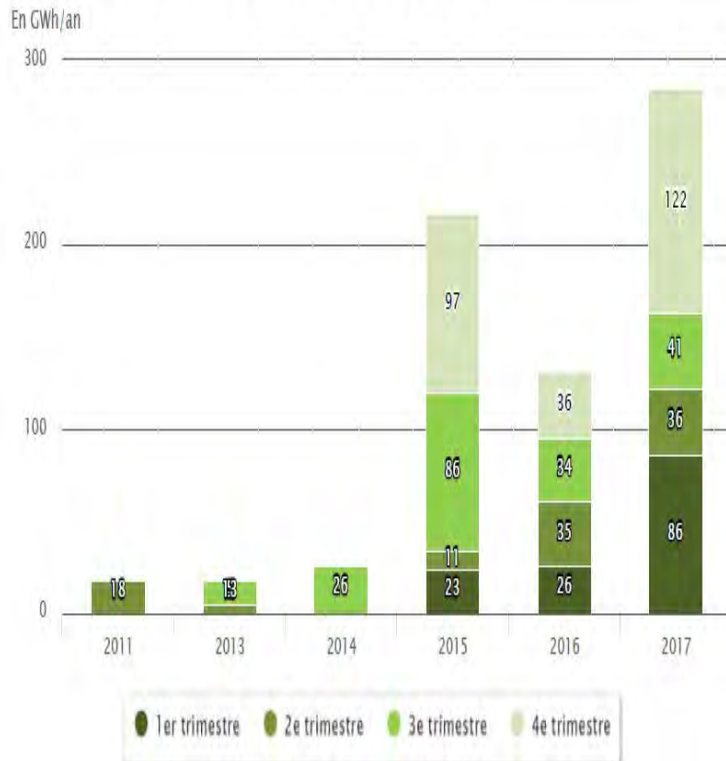
** La programmation pluriannuelle de l'énergie (PPE) prévoit un premier objectif de puissance installée pour fin 2018 et deux options (haute et basse) pour fin 2023 (cf. décret n° 2016-1442 du 27 octobre 2016).

Source : SDES d'après Enedis, RTE, EDF-SEI, CRE et les principales ELD

Facts and targets-3: Biomethane

Évolution du parc national des installations de production de biométhane

Capacité maximale de production des nouvelles installations par trimestre

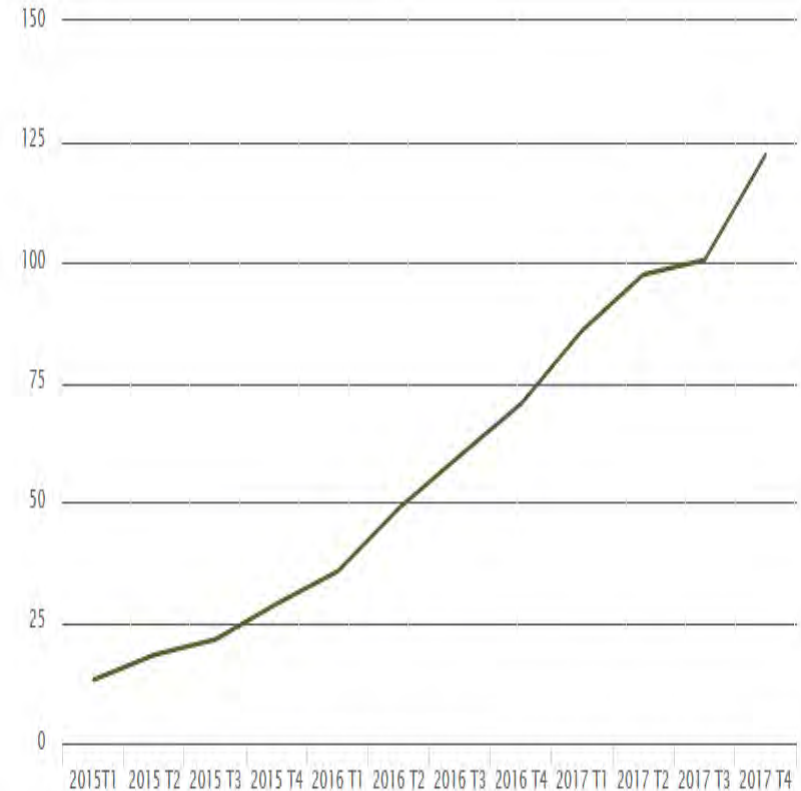


Champ: France continentale

Source : gestionnaires de réseaux

Évolution de la production nationale de biométhane

En GWh



Champ: France continentale

Source : gestionnaires de réseaux

Challenges and debates in French energy transition

- One of the most controversial issue is the **reduction of the share of nuclear energy to 50%** by 2025-2030; opponents exist from both sides: pro- or anti-nuclear
- This decision largely stems from political deal between centre-left and green parties, but it also makes sense in a technical perspective in order to diversify the electricity mix and **make room for more renewable**
- One key challenge for official policies will be the critical target of **reducing consumption by 50% in 2050**; this might be particularly difficult for the complete retrofitting of the building stock
- The most-recent debate covers the question of **failure or success of existing sectoral policies**, which is typically a monitoring issue...

ANNEXES

Benchmarking of energy transition studies: examples...

	Nom	Organisation	Couverture pays	Site Web / Rapport
1	AIRS Annual Indicator Report Series	EEA	UE	http://www.eea.europa.eu/airs
2	REI Resource Efficiency Indicator	Eurostat, EEA JRC	Pays UE	http://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources/resource-efficiency-indicators
3	EC Monitoring EU Obj.	Eurostat +	Pays UE 28	Rapport https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf
4	Odysée-MURE	ENERDATA	Pays UE 28 + Norvège	http://www.odyssee-mure.eu/data-tools/
5	Indicators for Monitoring the EU Energy System	European Climate Foundation	Pays UE 28	Rapport http://production.prestogo.com/fileroot7/gallery/DNVGL/files/original/489fe6bfc5e745d1b49ca7bce13d9586.pdf
6	Energy Transition Indicators	Insight-E	Pays UE 28	http://www.insightenergy.org/static_pages/energy_transition_indicators
7	RISE Regulatory Indicators for Sustainable Energy	World Bank	111 pays OCDE et Non OCDE	http://rise.esmap.org/indicators
8	GTF- Progress Towards Sustainability	IBRD, WB, IEA	111 par région	http://gtf.esmap.org/
9	OECD stats	OECD	35 + 9 Non OCDE	http://stats.oecd.org/
10	Global SDG Index and Dashboard	UN-SDSN	34 Official OECD + 147 Unofficial	http://indicators.report/
11	DDPP	IDDRI/SDSN	16 pays (75% des émissions mondiales)	http://deepdecarbonization.org/countries/visualization-of-country-scenarios/
12	CAT data portal	Climate Analytics, Ecofys, PIK, NCI	39 + G20	http://climateactiontracker.org/decarbonisation/intro

Global Energy Data: historical data on economy, energy, emissions

Enerfuture: demand & supply projections

Odyssee: detailed energy consumption

Austria	Greece	Slovakia
Belgium	Hungary	Slovenia
Bulgaria	Ireland	Spain
Croatia	Italy	Sweden
Czech Rep.	Netherlands	Luxembourg
Denmark	Malta	Cyprus
Finland	Poland	Estonia
France	Portugal	Latvia
Germany	Romania	Lithuania
Norway		United Kingdom

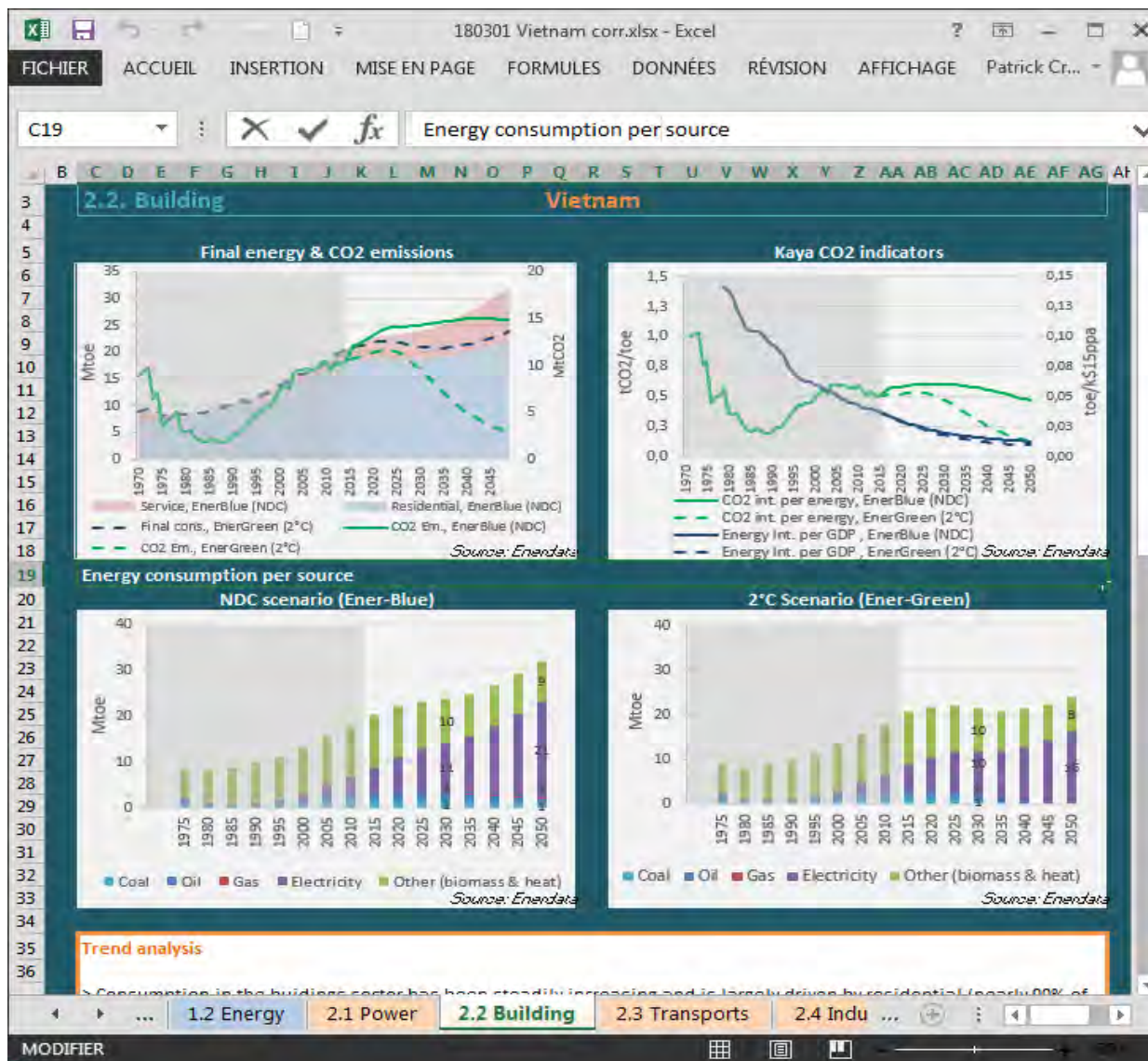
Other countries (132)

Vietnam	Iceland	Chile
	Switzerland	
	Ukraine	

China	Turkey	Mexico	United Arab Emirates
India	Russia	Argentina	
Indonesia		Brazil	
Japan			
Malaysia			
South Korea		Canada	
Thailand		United States	
Australia		Egypt	
		South Africa	
	Iran		
	Saudi Arabia		

Enerdemand: detailed energy consumption

1/ The EnerTraM excel



2/ Measuring the gaps

180301 Vietnam corr.xlsx - Excel

Patrick Criqui

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2.1 Electricity							2.2 Building						
		Ener-Blue (NDC)		Ener-Green (2°C)		Official plans			Ener-Blue (NDC)		Ener-Green (2°C)		Official plans
%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030		%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030	
Electricity cons.	13,2%	6,1%		5,2%		0,0	Final cons.	3,0%	1,0%		0,2%		0,0
Electricity prod.	12,4%	6,1%		5,3%		0,0	CO2 Em.*	3,3%	2,2%		-0,2%		0,0
CO2 Em.* of power sector	13,1%	5,0%		1,1%		0,0	CO2 int.* per energy	0,3%	1,2%		-0,4%		0,0
Electricity cons. per cap	11,9%	5,2%		4,4%		0,0	Energy int. per GDP	3,0%	1,0%		0,2%		0,0

* CO2 energy combustion Source: Enerdata

2.3 Transport							2.4 Industry						
		Ener-Blue (NDC)		Ener-Green (2°C)		Official plans			Ener-Blue (NDC)		Ener-Green (2°C)		Official plans
%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030		%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030	
Final cons.	7,7%	4,7%		4,3%		0,0	Final cons.	7,4%	6,3%		4,8%		0,0
CO2 Em.*	7,7%	3,9%		3,2%		0,0	CO2 Em.*	9,4%	4,7%		2,5%		0,0
CO2 int.* per energy	0,0%	-0,8%		-1,0%		0,0	CO2 int.* per energy	1,9%	-1,6%		-2,1%		0,0
Energy int. per GDP	1,3%	-0,5%		-1,0%		0,0	Energy int. per VA	1,2%	1,2%		-0,3%		0,0

* CO2 energy combustion Source: Enerdata

3.1 Residential							3.2 Services						
		Ener-Blue (NDC)		Ener-Green (2°C)		Official plans			Ener-Blue (NDC)		Ener-Green (2°C)		Official plans
%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030		%/year	2000-2015	2015-2030	2015-2030	2015-2030	2015-2030	
Final cons.	2,8%	0,2%		-0,3%		0,0	Final cons.	5,3%	5,1%		3,2%		0,0
CO2 Em.*	4,8%	2,2%		0,1%		0,0	CO2 Em.*	1,2%	2,1%		-0,8%		0,0
CO2 int.* per energy	2,0%	2,0%		0,4%		0,0	CO2 int.* per energy	-3,9%	-2,8%		-3,9%		0,0
Energy int. per household	1,1%	-1,5%		-2,0%		0,0	Energy int. per VA	-2,4%	-0,4%		-2,2%		0,0

* CO2 energy combustion Source: Enerdata

OVERVIEW EnerTraM 1.1 CO2 & GHG emissions 1.2 Energy 2.1 Power 2.2 Building 2.3 Transports 2.4 Industry ...