

ite infrastructures de transition énergétique

ENVIRONMENTAL ASSESSMENT OF RENEWABLE ENERGIES: TOWARDS THE INTEGRATION OF THE STORAGE ISSUES

MINES ParisTech | PSL

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ENERGY TRANSITION CHALLENGES

1. DECARBONIZE
2. REDUCE THE ENVIRONMENTAL FOOTPRINT

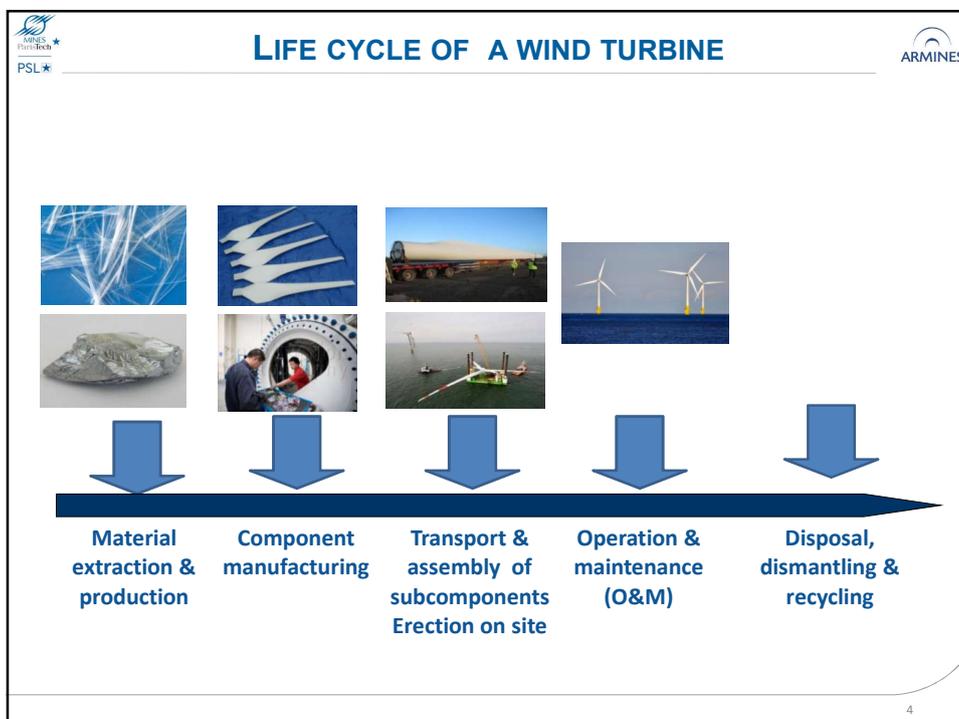
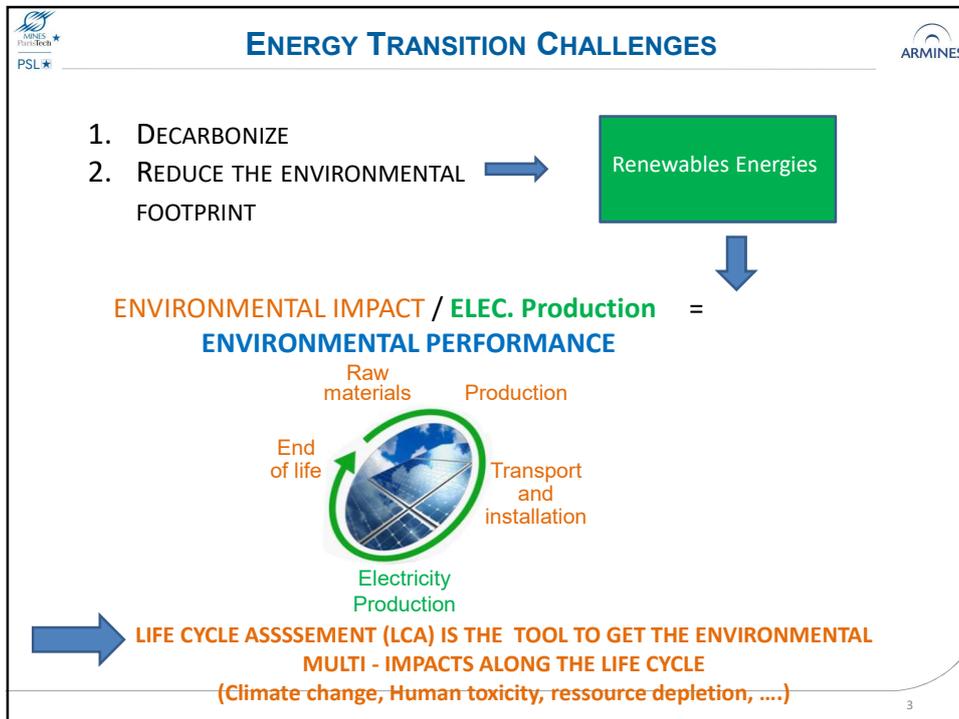
➔ Renewables Energies ZERO IMPACT ??

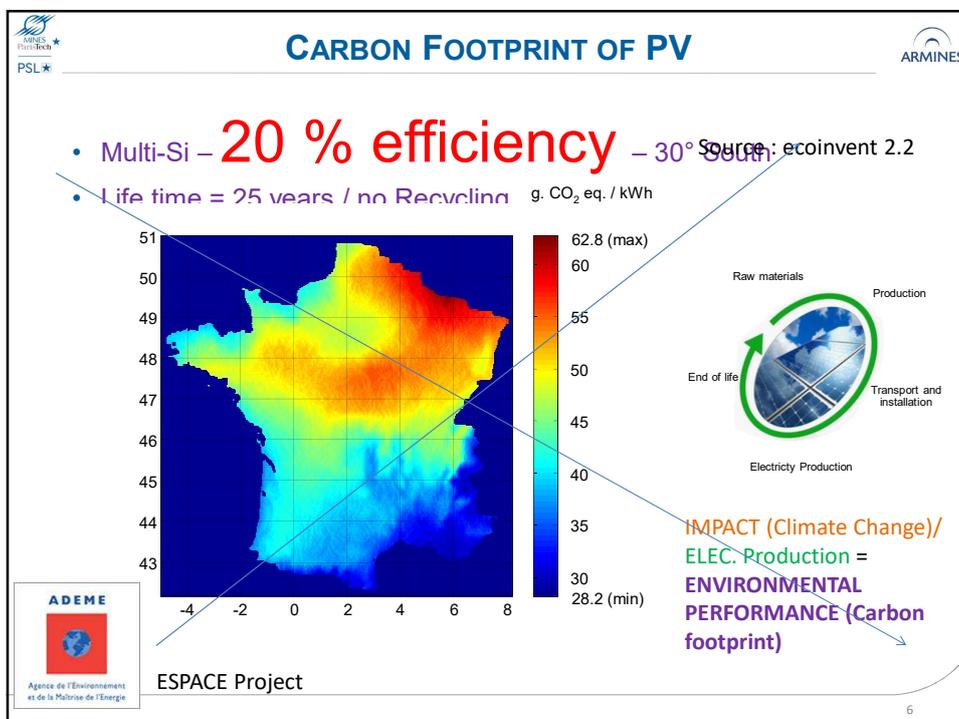
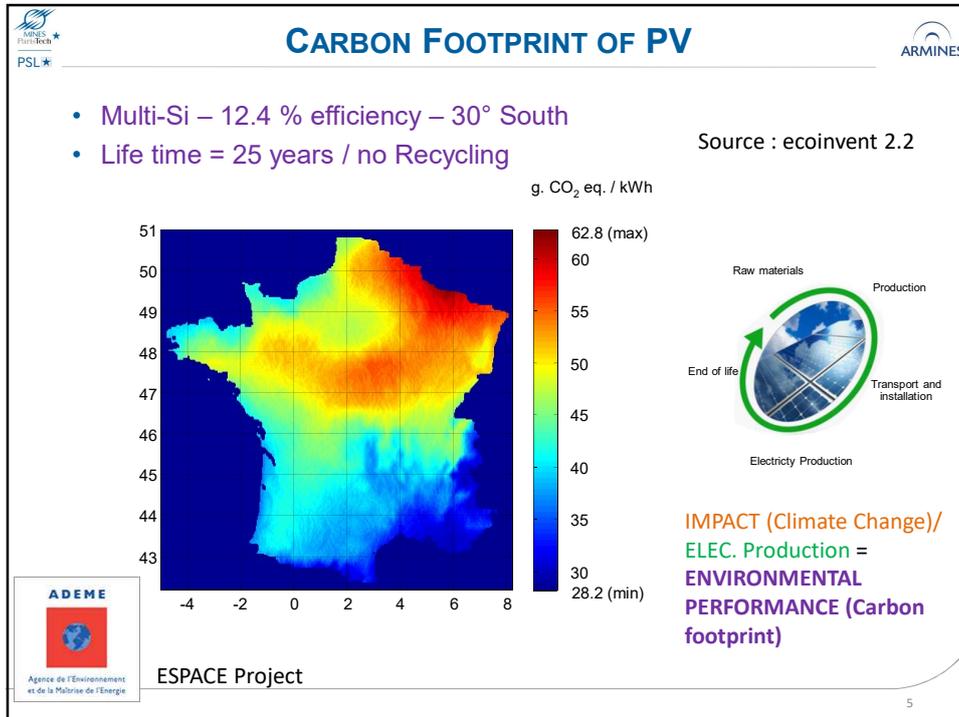
↓ NO !

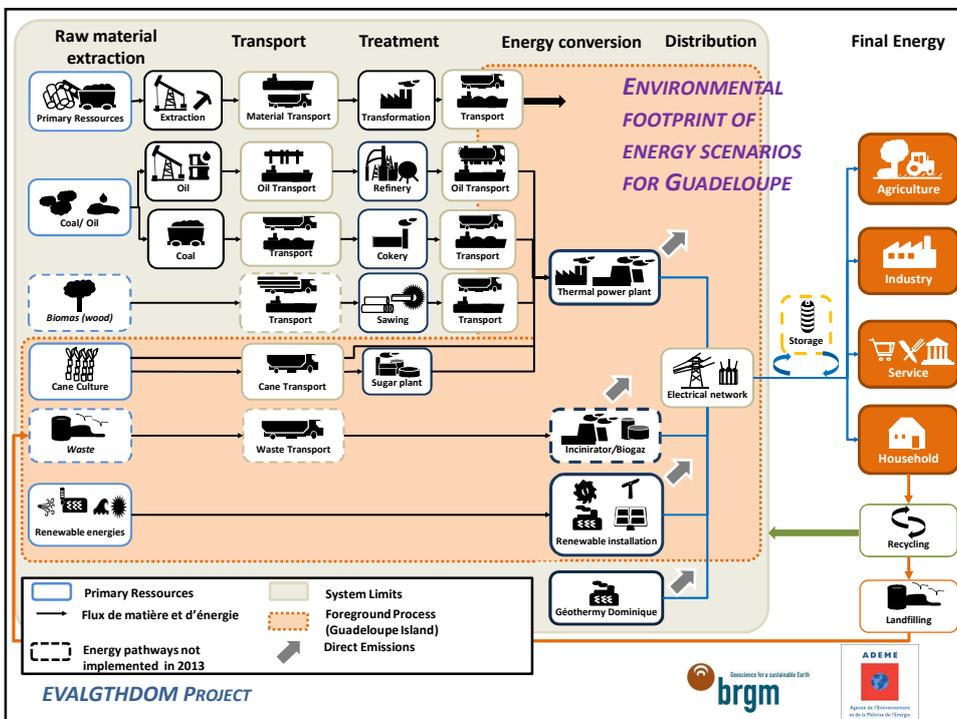
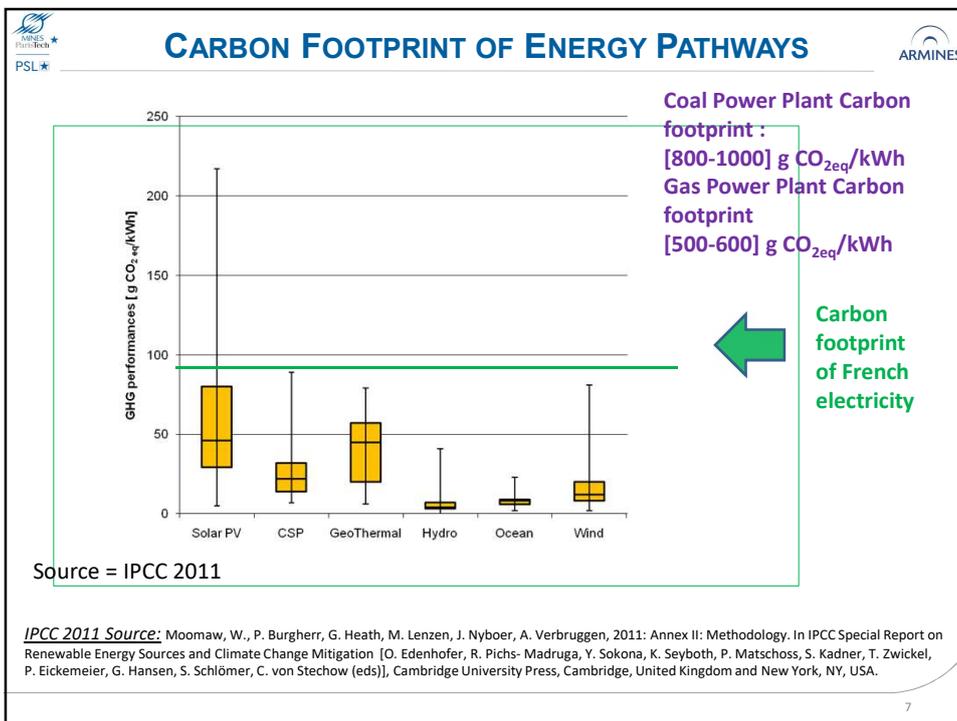
What is the ENVIRONMENTAL PERFORMANCE of renewable energies ???

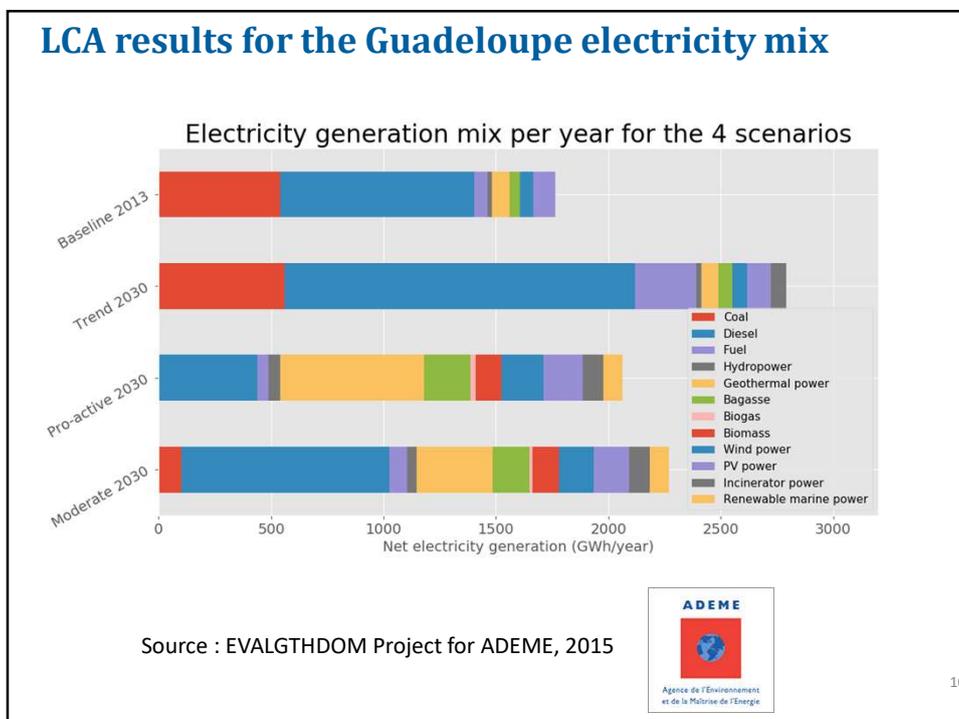
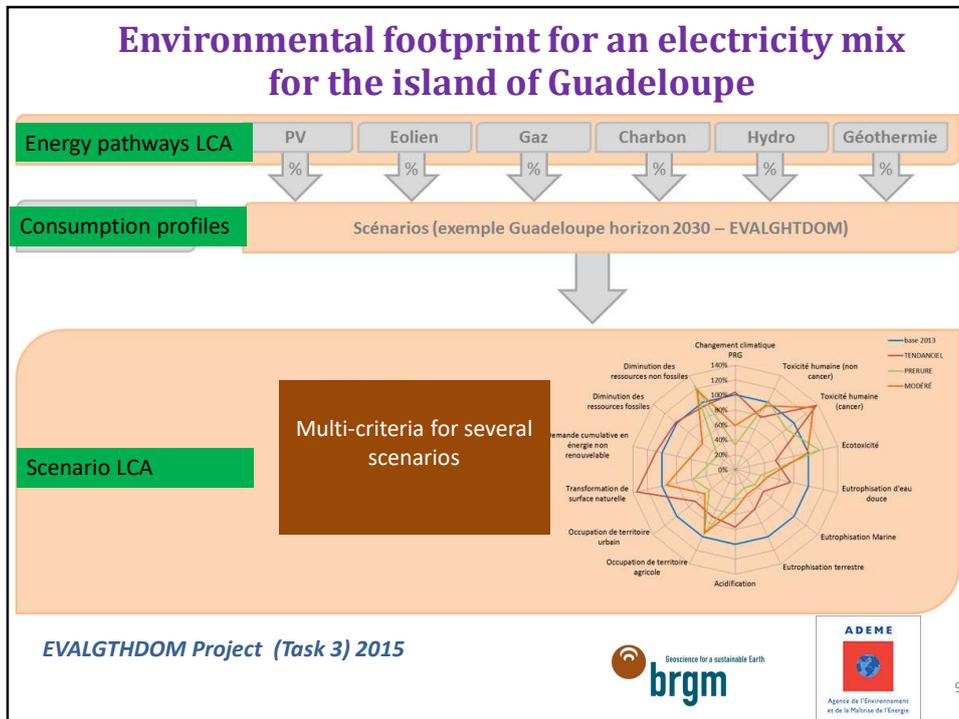
ENVIRONMENTAL IMPACT / ELECTRICITY Production

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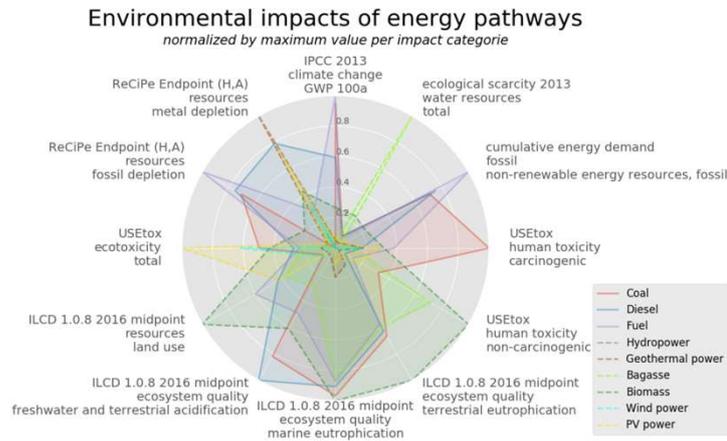






LCA results for the Guadeloupe electricity mix

Ecoinvent data / ILCD impact categories / Simapro 8.03 & Brightway²



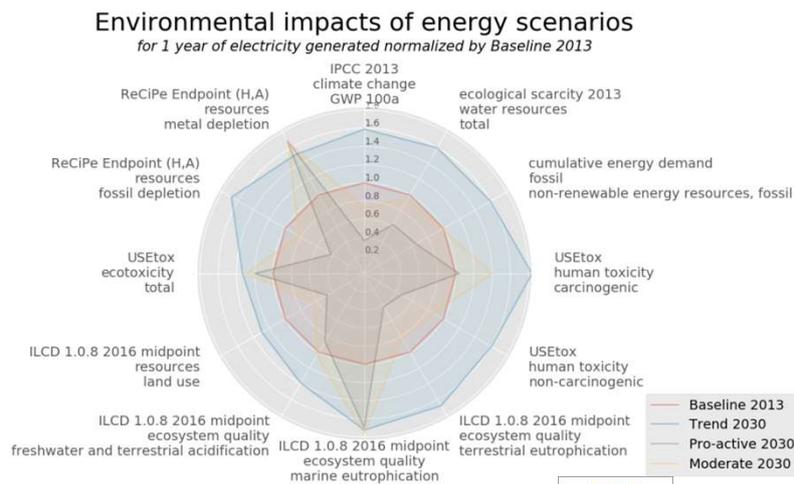
Source : EVALGTHDOM Project for ADEME
Presented at LCM 2017, Besseau et al.



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LCA results for the Guadeloupe electricity mix

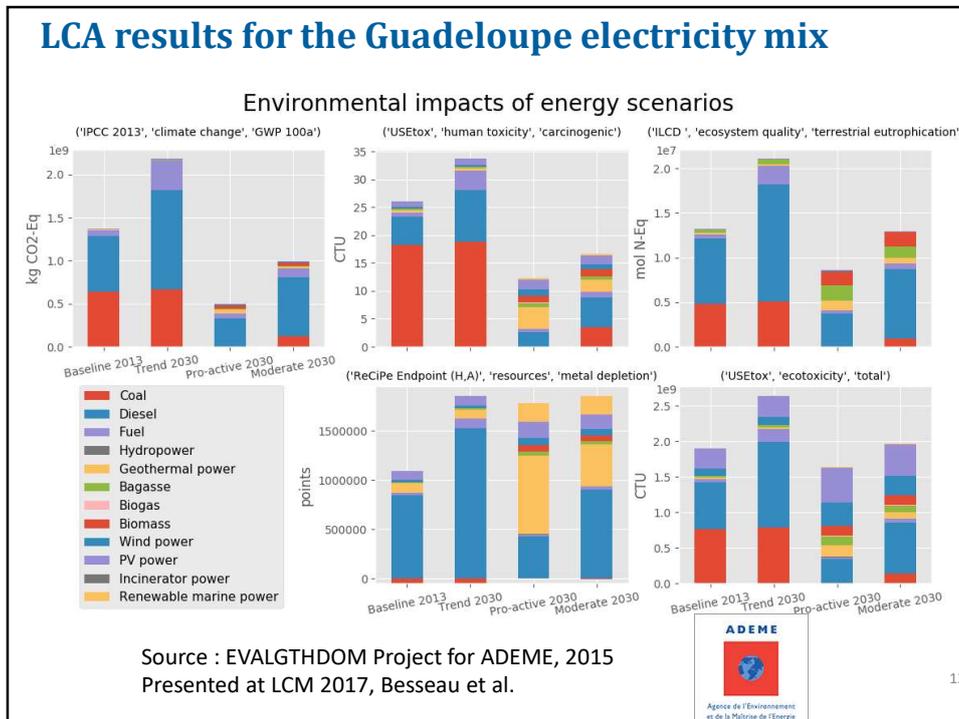
Ecoinvent data / ILCD impact categories / Simapro 8.03 & Brightway²



Source : EVALGTHDOM Project for ADEME, 2015
Presented at LCM 2017, Besseau et al.



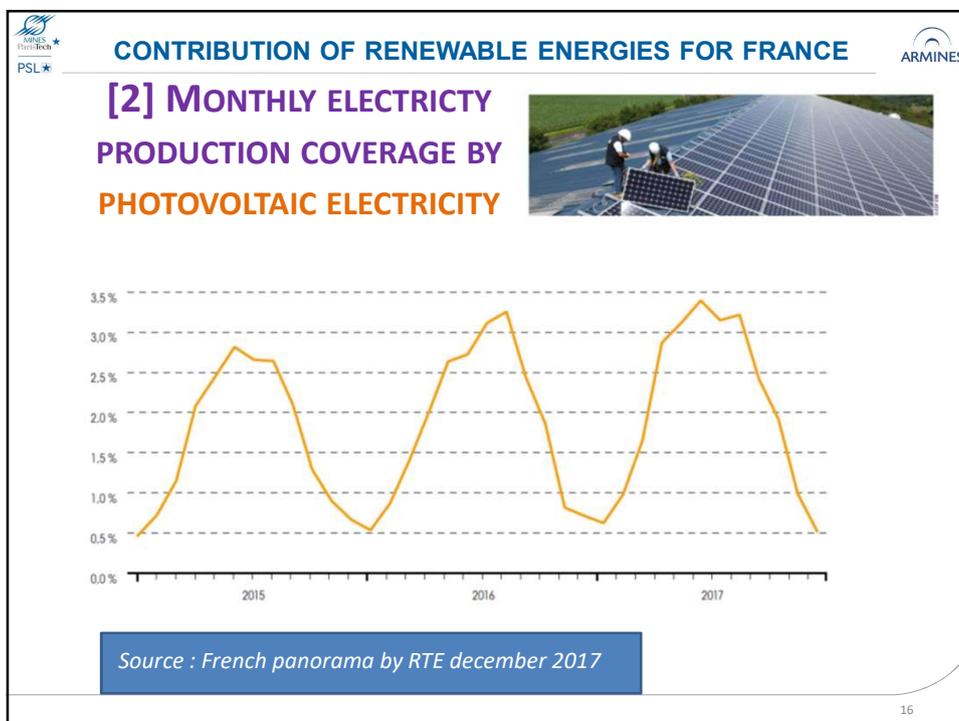
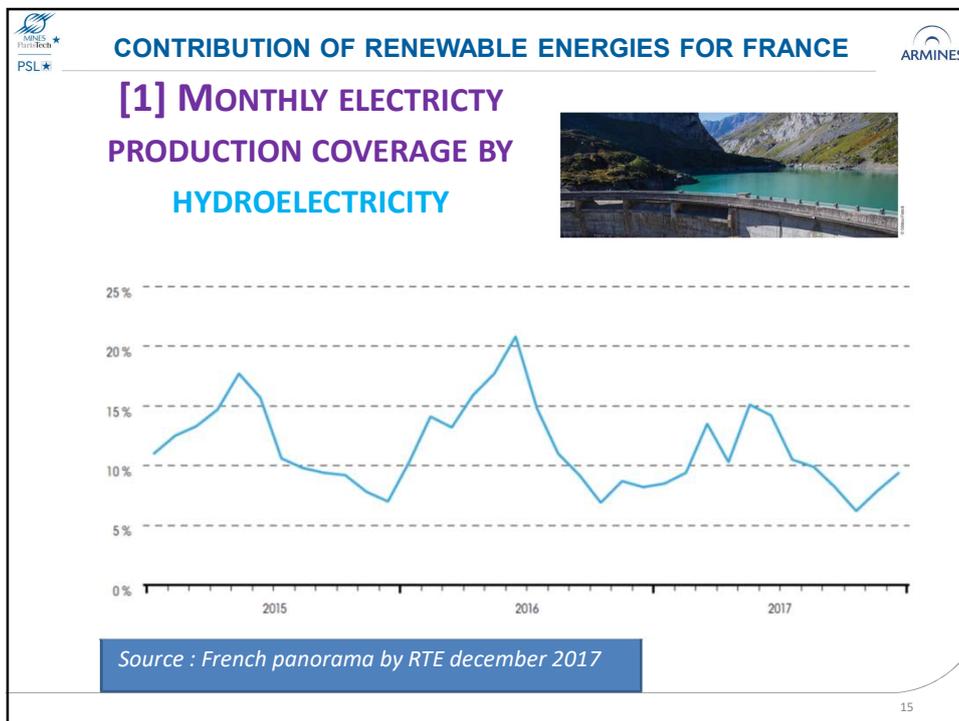
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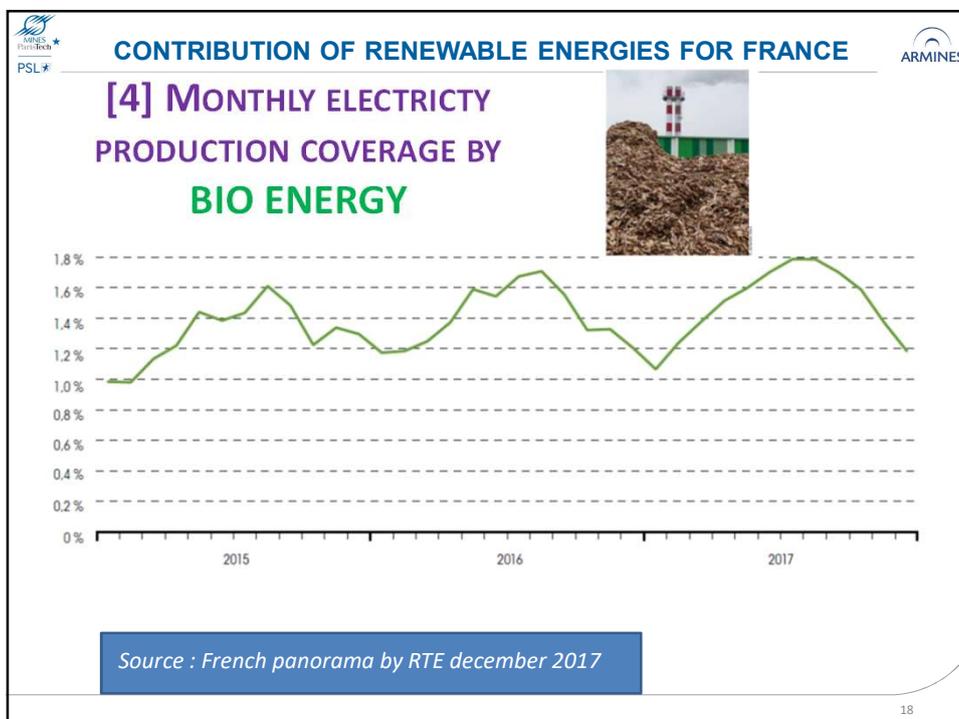
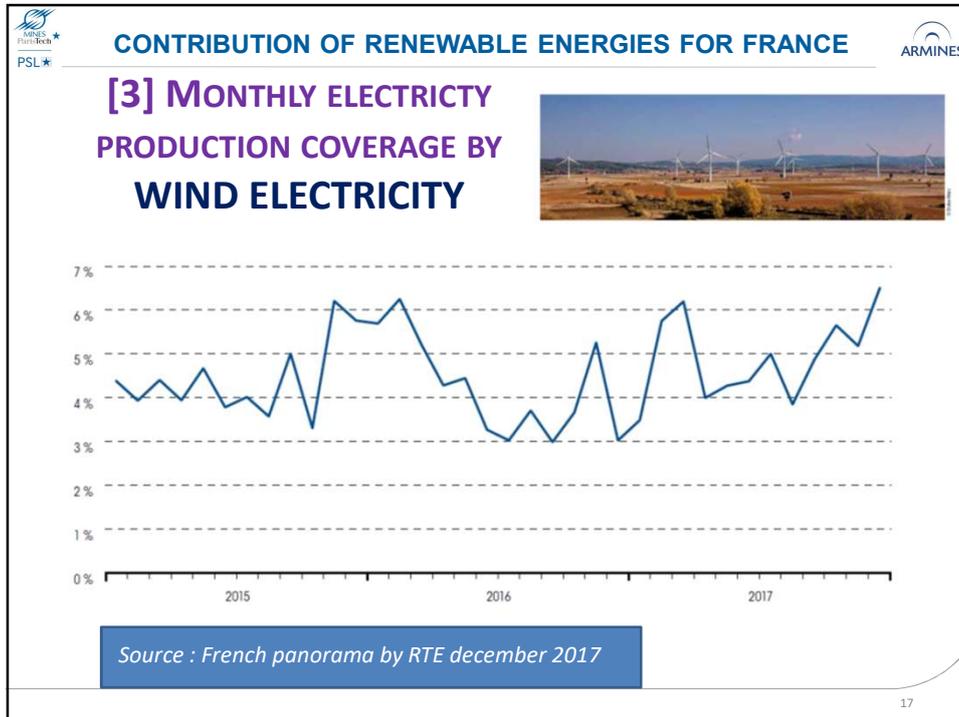


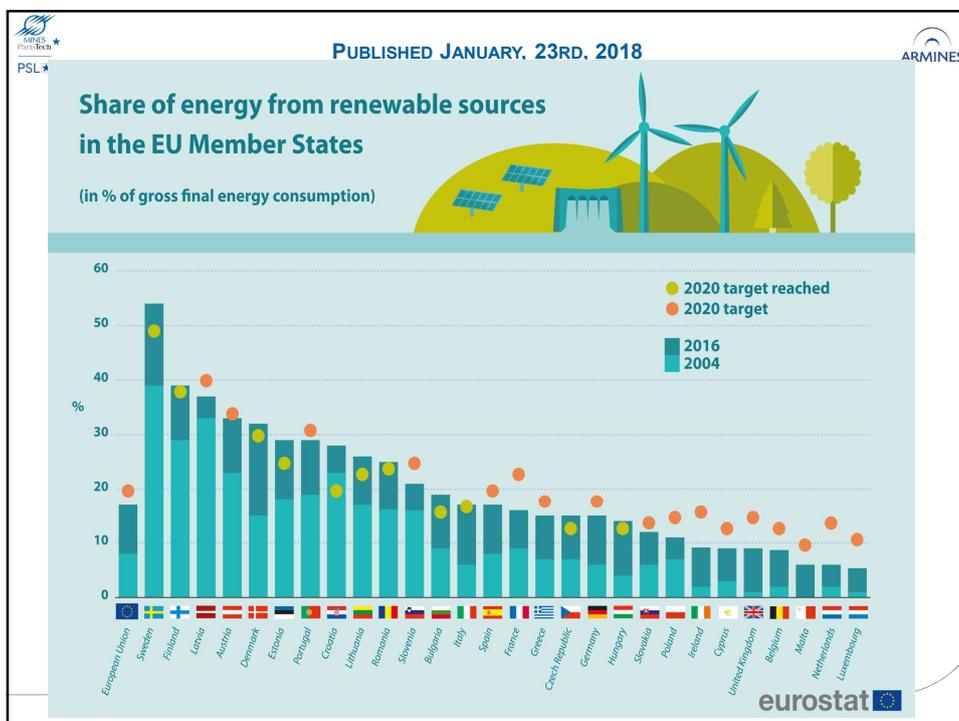
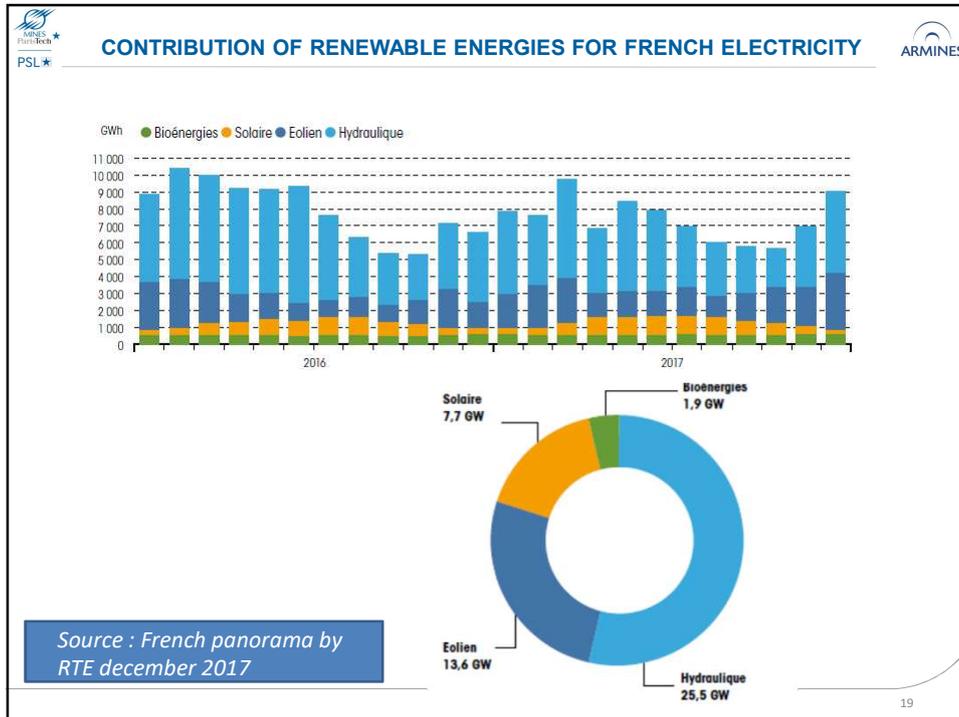
ENERGY TRANSITION CHALLENGES

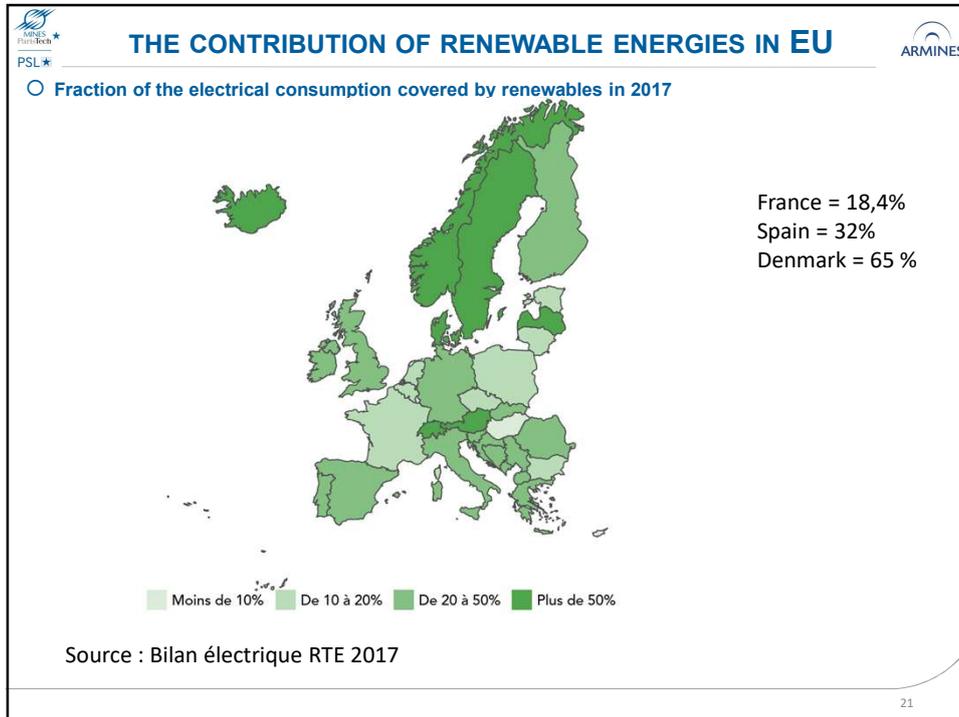
1. DECARBONIZE
2. REDUCE THE ENVIRONMENTAL FOOTPRINT
3. ABLE TO MATCH THE CONSUMPTION PROFILE ?

	Fossil fuels	Nuclear Energy	Renewable energies (PV / Wind turbines)	Geothermy, marine energy
Stability	Yes	Yes	No (intermittent energies)	Yes
Flexibility	Yes	No	No	No









A HIGH CONTRIBUTION OF RENEWABLE ENERGIES ?

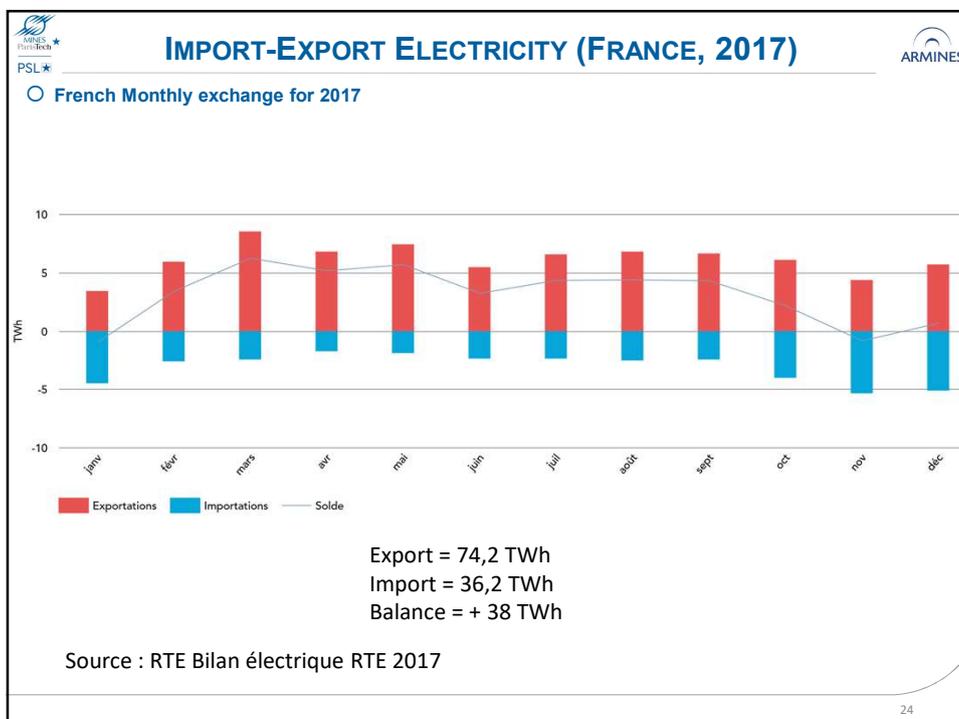
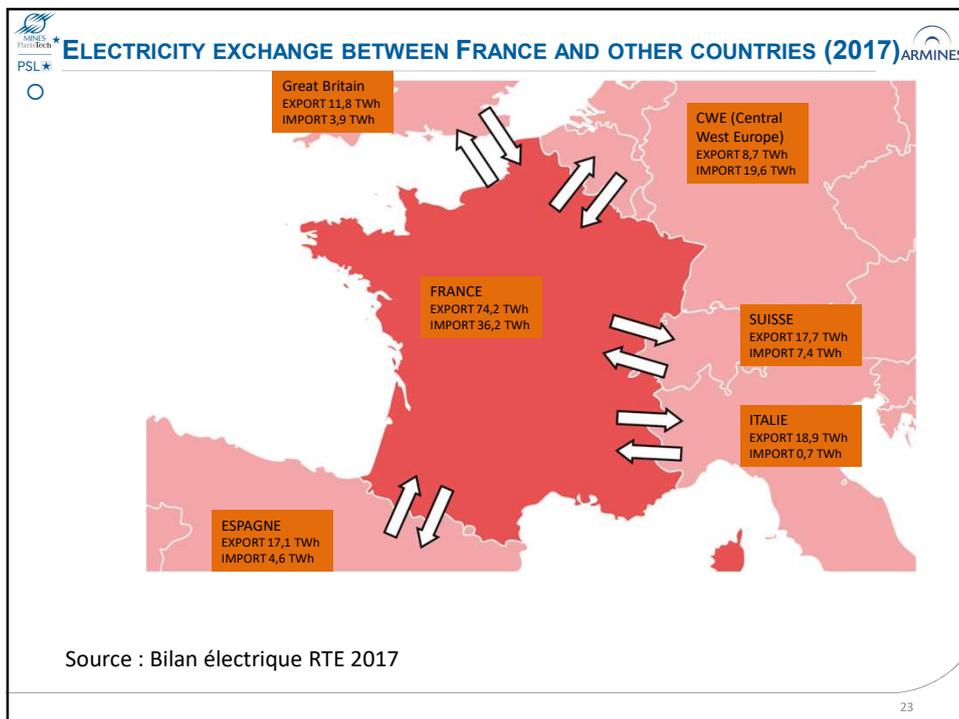
[1] HOW TO DEAL WITH A HIGH RATE OF WEATHER DEPENDANT RENEWABLE ENERGY SOURCE AND MAKE THE MOST OF THEM?

- FLEXIBLES POWER PLANT FOR « BACK-UP »
- STORAGE SOLUTIONS
- SMART-GRID
- INTERCONNEXION

→

consommation production

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FUTURE MIX WITH HIGH RENEWABLE ENERGIES RATE

[1] HOW TO DEAL WITH WEATHER DEPENDANT RENEWABLE ENERGY SOURCE AND MAKE THE MOST OF THEM ?

- FLEXIBLES POWER PLANT FOR « BACK-UP »
- STORAGE SOLUTION
- SMART-GRID
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[2] WHAT IS THE OVERALL ENVIRONMENTAL PERFORMANCE ?

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CHANGE IN THE OVERALL ENVIRONMENTAL ASSESSMENT ?

○ Include environmental assessment of additional systems 3) for LCA

Energy pathways LCA

PV, Eolien, Gaz, Charbon, Hydro, Géothermie, Carburants, Combustibles

Consumption profiles

Scénarios (exemple Guadeloupe horizon 2030 – EVALGTHDOM)

3) ACV Filière de Stockage

Smart-grid, Interconnexion, Centrale flexible, Stockage

4) Balance and stability ?

NO, YES

5) Scenario LCA

Multi-criteria for several scenarios

source : Projet EVALGTHDOM – Rapport Final - Tâche 3, 2015

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ONE SOLUTION = STORAGE

○ Different types of storage depending on the temporal need (short term, long term)

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graph TD
    Storage[Storage] --> Accumulateur[Accumulateur électrochimique]
    Storage --> Mechanical[Mechanical]
    Storage --> P2G[P2G]
    
    Accumulateur --> Lithium[Lithium]
    Accumulateur --> Others[Others]
    Accumulateur --> Flow[Flow batterie]
    
    Lithium --> Li-ion[Li-ion, LFP, Li-polymère]
    Others --> PbA[PbA, NiMh, NaS]
    Flow --> Vanadium[Vanadium RedOx Flow Battery]
    
    Mechanical --> PSP[PSP]
    Mechanical --> CAES[CAES]
    Mechanical --> Flywheel[Flywheel]
    
    P2G --> PowerH2[Power to H2]
    P2G --> PowerCH4[Power to CH4]
    
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- Lithium : (Cox and Mutel, 2018), (Vandepaer et al., 2017), (Sullivan and Gaines, 2012), (Hiremath et al., 2015).
- STEP : (Flury and Frischknecht, n.d.), (Torres, 2011).
- P2G : ((Sternberg and Bardow, 2016), (Zhang et al., 2017), (Simons and Bauer, 2011)).

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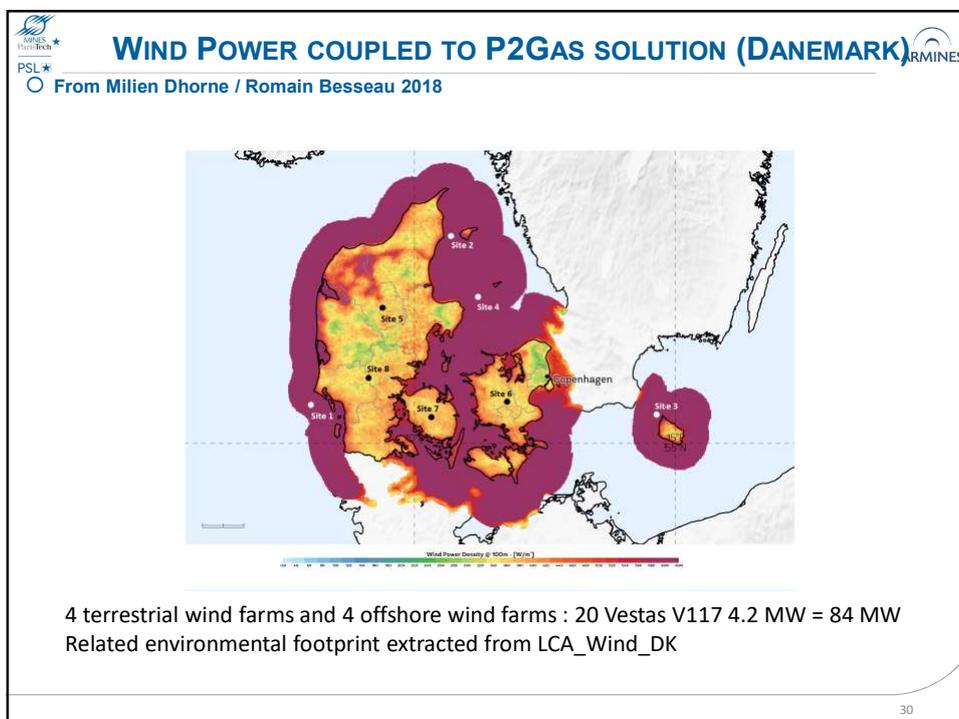
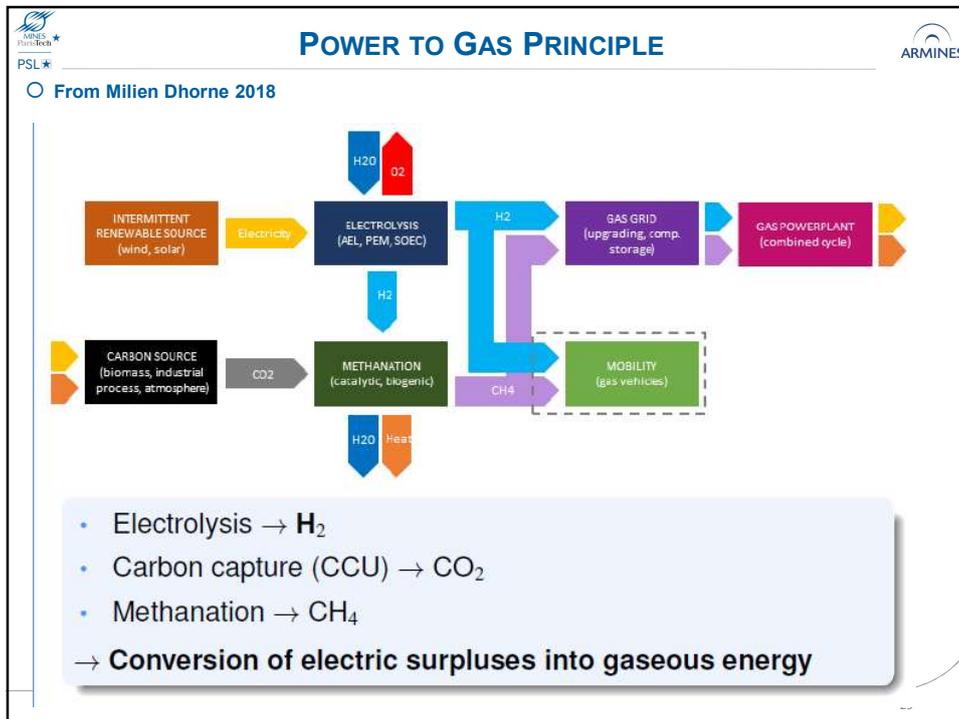
CASE STUDY FOR A REGION WITH A HIGH RATE OF RENEWABLES

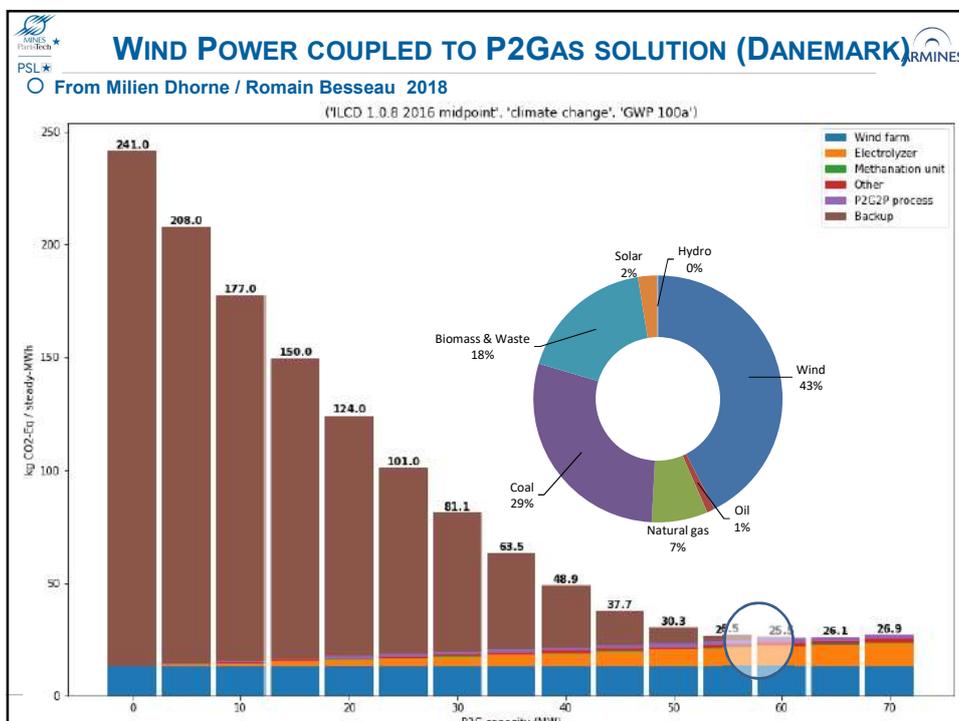
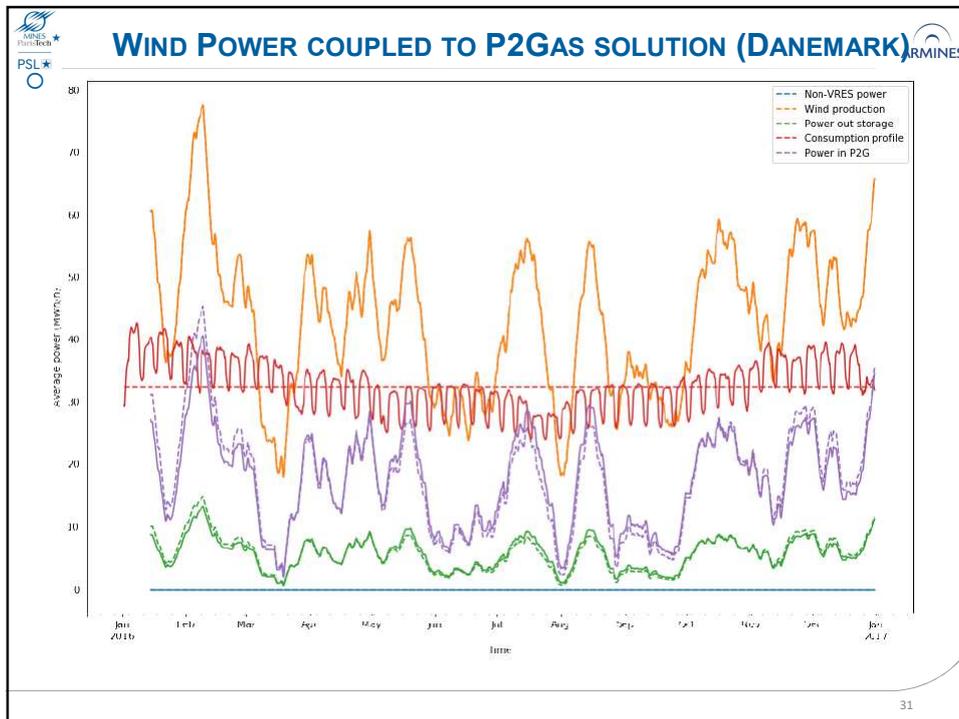
○ Power2Gas storage solution associated with Wind energy in Denmark

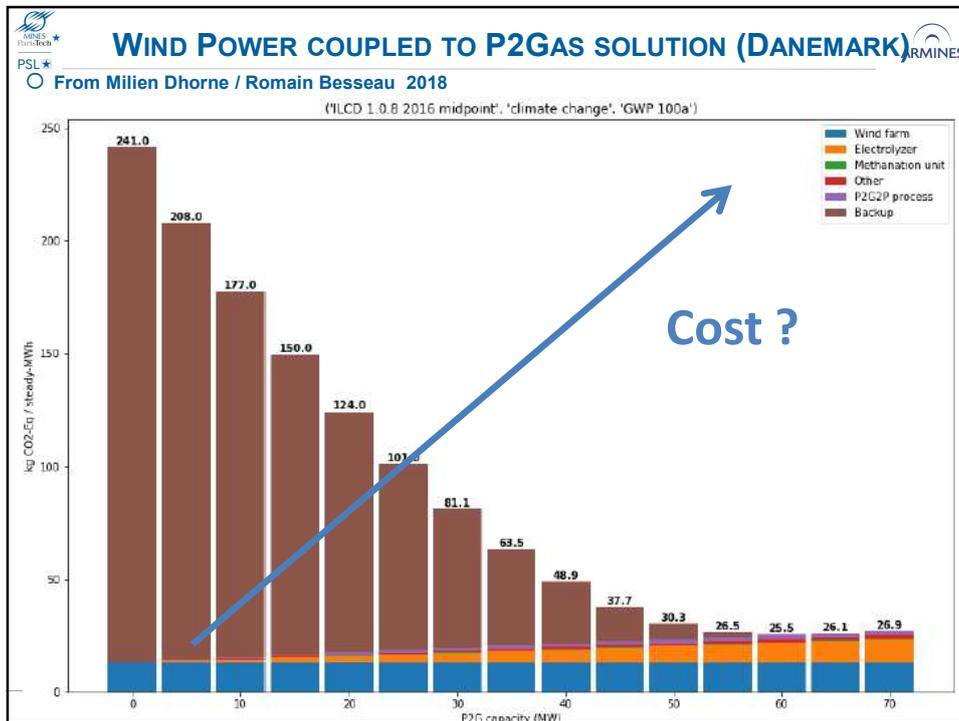
Source	Percentage
Wind	43%
Coal	29%
Biomass & Waste	18%
Natural gas	7%
Solar	2%
Oil	0%
Hydro	0%

=> WHAT IS THE ENVIRONMENTAL PERFORMANCE OF A WIND/POWER2GAS SOLUTION COMPARED TO THE CURRENT MIX FULFILLING THE SAME CONSUMPTION PROFILE?

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CONCLUSIONS & RECOMMENDATIONS

- HOW TO DEAL WITH A HIGH RATE OF INTERMITTENT ENERGY SOURCE
- AND MAKE THE MOST OF RENEWABLE ENERGIES
- WHILE MINIMIZING THE ENVIRONMENTAL FOOTPRINT OF THE ELECTRICITY MIX?

1. Use an LCA approach : a comprehensive & multicriteria environmental approach to avoid any shift in burden
2. Consider the proper system & functional unit : Move from kWh produced from each energy pathway to a balance and stable consumption vision
3. Characterise the consumption profile AND the renewable energy production profiles to adjust the temporal characteristic of the storage solution (Hourly, weekly or seasonal)
4. Couple LCA and Life Cost Analysis

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THANK YOU

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