



Clean public transport, role of fuel cell buses

Smart Specialisation workshop on Fuel Cells and Hydrogen

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- Introduction Hamburg
- Emerging conclusions CHIC
 - Introduction / Overview
 - Emerging results – achievements and issues
- Next steps and remarks

Climate protection and mobility

Aims:

- Ambitious climate protection plans for Hamburg and region
- 40 % emission reduction in 2020, 80 % in 2050 (in relation to 1990)
- Growing use of renewable energies with focus on wind



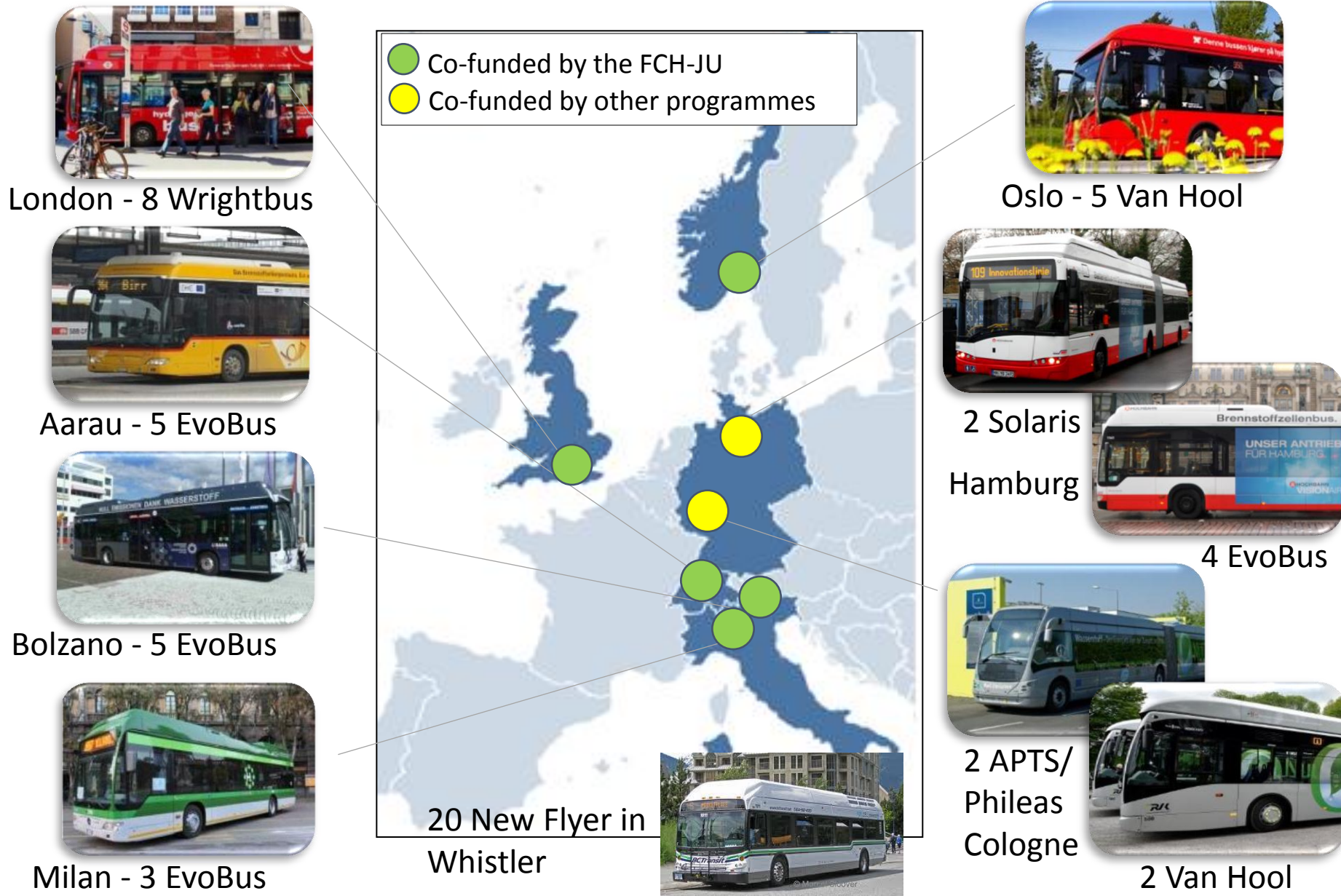
Clear Positioning

- A total of 1,200 electric vehicles for businesses and municipal fleets, industry-specific port/logistics, aviation, industrial, retail, and fleet services in place
- From 2014, new guidelines for the procurement of vehicles in municipal management and companies (*Senate directive 8th November 2011*)
- Public Charging facilities be quadruplicated until 2016, Hamburg will provide 600 public charging points
- 4 hydrogen refuelling stations realised, another one in planning
- As of 2020, only zero emission buses are purchased

- Long-term strategy to secure energy supply and avoid future risks
- Sufficient time for training of experts (technology) and in-company training
- Set up of infrastructure (workshops) only gradually possible
- Suitable for up to 20 h/day vehicle use and high capacity
- Avoid flexibility and productivity losses in line service
- Successive conversion > start-up costs most likely to be cheaper than a later direct fleet replacement
- Conversion strategy part of risk management



56 Fuel cell buses manufactured by 6 different bus OEMs in 9 different cities



The CHIC project is the first of a number of European bus demonstrations - 83 FC buses will soon be in operation



→ **83** fuel cell buses in operation or about to start operation

Current EU-funded fuel cell bus projects

● CHIC

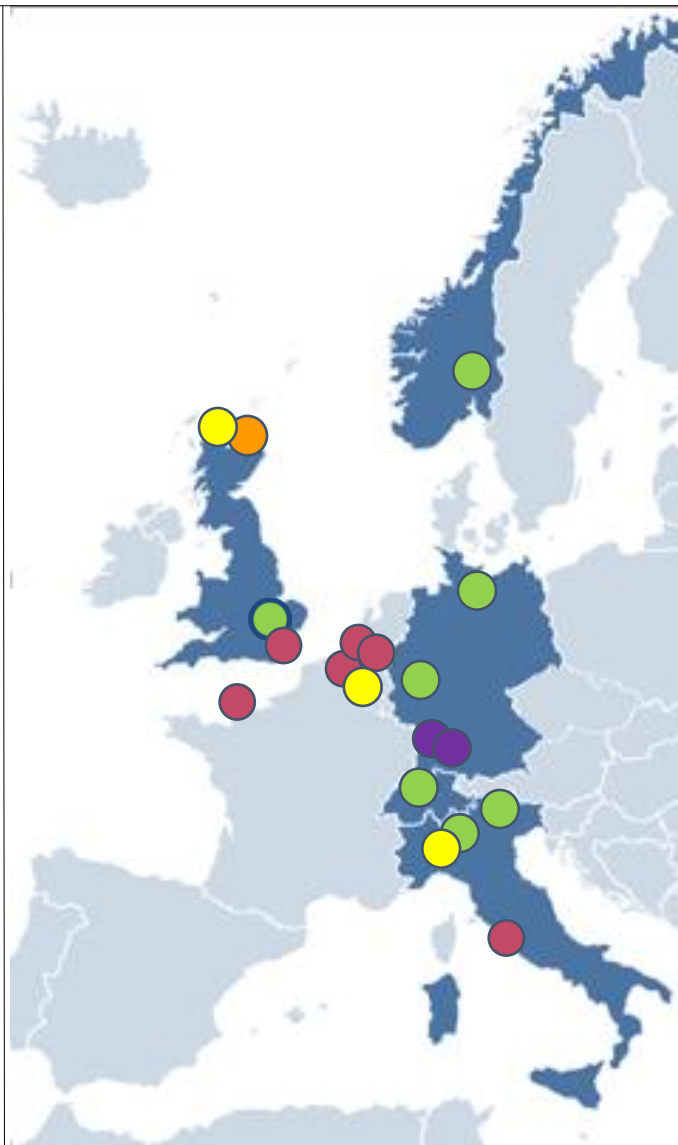
- ✓ Bolzano – 5 FC buses
- ✓ Aargau – 5 FC buses
- ✓ London – 8 FC buses
- ✓ Milan – 3 FC buses
- ✓ Oslo – 5 FC buses
- ✓ Cologne* – 4 FC buses
- ✓ Hamburg* – 6 FC buses

● High V.LO-City (operation start planned for 2015)

- ✓ Liguria – 5 FC buses
- ✓ Antwerp – 5 FC buses
- ✓ Aberdeen – 4 FC buses

● HyTransit (operation start planned for 2015)

- ✓ Aberdeen – 6 FC buses



Current EU-funded fuel cell bus projects

● 3Emotion (operation start planned for 2016/2017)

- ✓ Cherbourg – 5 FC buses
- ✓ Rotterdam – 4 FC buses
- ✓ South Holland – 2 FC buses
- ✓ London – 2 FC buses
- ✓ Flanders – 3 FC buses
- ✓ Rome – 5 FC buses

Current national/regional-funded fuel cell bus projects:

- ✓ Karlsruhe * – 2 FC buses
- ✓ Stuttgart * – 4 FC buses

Legend:

■ CHIC countries

✓ In operation

✓ Planned for operation

* Co-financed by regional/national funding sources

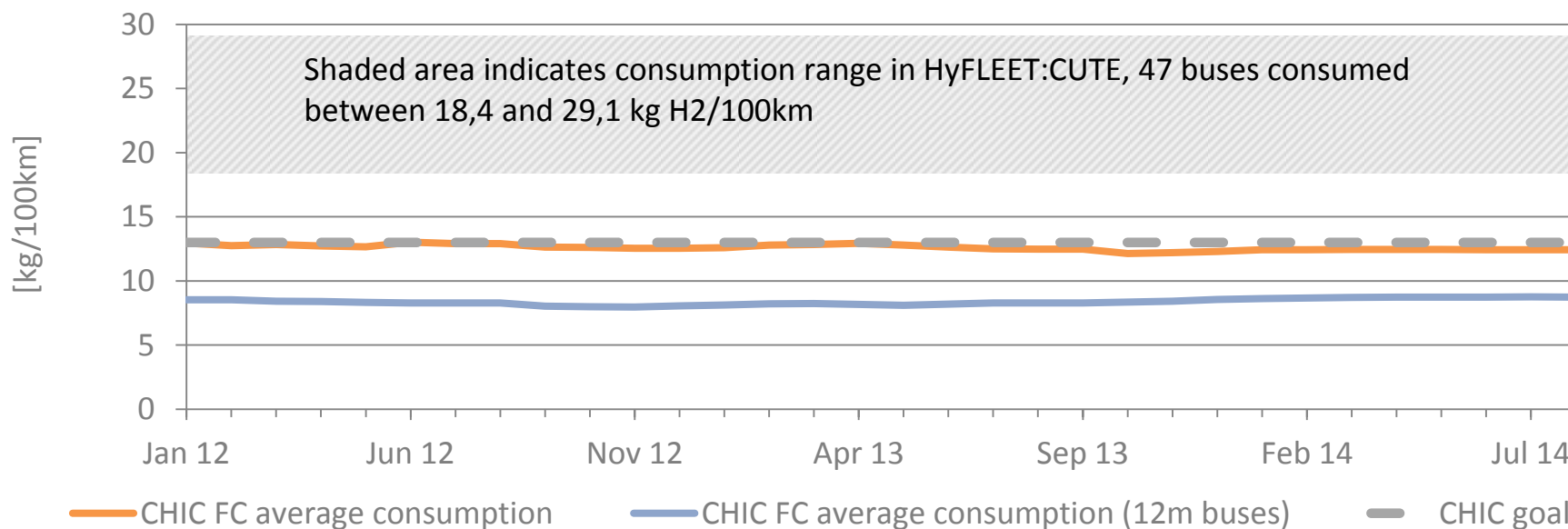
Overall project snapshot (end February 2015)



Parameter	Project total to date (including the ICE buses in Berlin)	Phase 1 cities	Project goal for the Phase 1 cities
Total distance travelled [km]	7,632,007	2,347,658	2,750,000
Total hours on FC system [h]	377,791 ¹	152,723	160,000
Average FC runtime per bus [h]	6,996 ¹	5,874	6,000
Total H2 refueled [kg]	1,059,913	223,630	-
Replacement of diesel fuel [litres]	4,021,842	961,068	500,000

- One of the most significant results of the trial program is the improvement in the bus fuel economy : **> 50 % fuel economy** compared with previous fuel cell bus generation
- Use of **fully hybridized powertrains, smaller and more-optimized FC systems**

Average consumption of the FCH buses

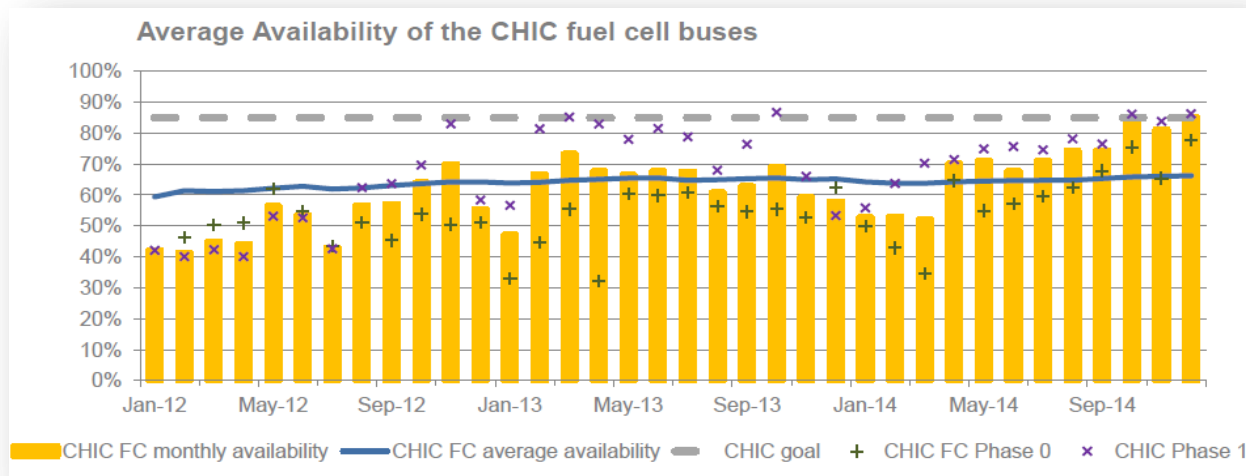


- The **availability** of stations in the CHIC project has been consistently **high**
- Average station availability is **over 95 %** at most sites, currently two exceed the target of 98 % for the stations in the trial
- This compares favourably with the HyFLEET:CUTE project, where problems with on-site production, compression and dispensers dogged the trial.

Phase	City	Availability to date (August 2014)
1	London	> 98 % ¹
1	Aargau	> 97 %
1	Milan	> 98 %
1	Oslo	> 94 %
0	Cologne	> 97 %
0	Hamburg	> 97 %
0	Whistler	> 98 %

¹Data from February 2014

- Availability of fuel cell buses has not yet consistently met the CHIC target (85%)
- As components problems and the issues of immaturity of supply chains are ironed out, availability is starting to rise towards the target (85 %)
- Reasons for poor availability include:
 - Immature supply chains – **taking a long time to understand problems and provide spare replacement parts;**
 - **Problems with management of maintenance contracts** – particularly in London, where bankruptcy of the maintenance partner led to issues,
 - **Component failures** – air compressors, DC converters etc. have caused considerable issues on some of the trials
 - **Limited pool of maintenance staff** – availability tends to dip when key personnel are on vacation

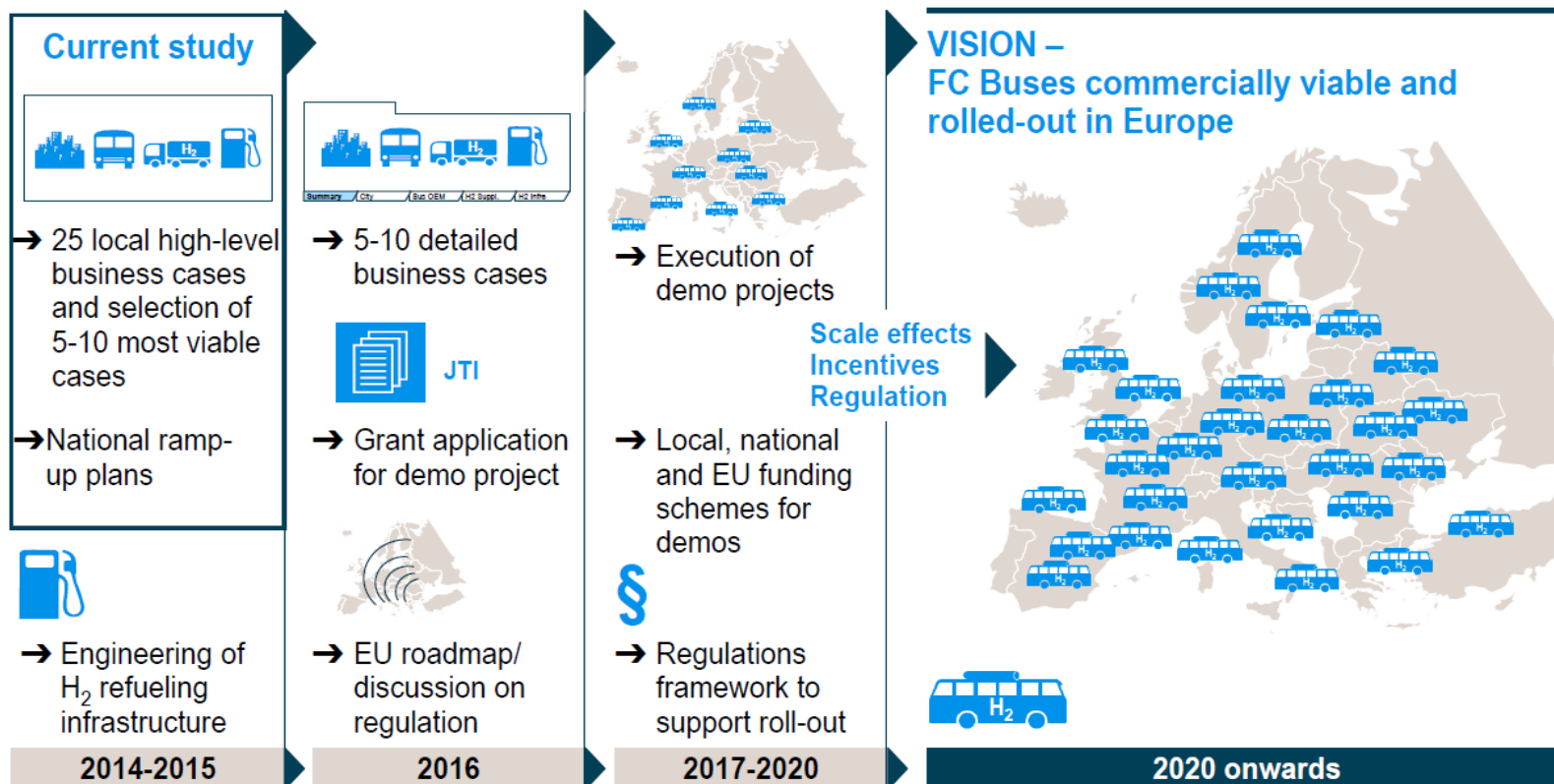


- European fuel cell bus projects demonstrate that **fuel cell buses have the potential to provide the same operational flexibility as conventional diesel buses**
- They can do this with **zero emissions**, substantial **GHG emission improvement** and **satisfying the travelling public and the drivers**

Remaining Challenges:

- **Bus availability needs to improve** over 85 % - *expected to be resolved by a) resolving the teething issues in the current trial and b) scale in the supply chain*
- **Bus prices need further reduction to enable genuine market traction** (less than € 500,000) - *resolved through the FCH JU commercialisation study*
- Depot-scale refueling solutions are still required (e.g. for 100 buses/day) – *new FCH JU backed depot engineering study*

The FCH JU and coalition follow a bold vision of commercialising FC buses in Europe through demo projects and ramp up scenarios



Cost - The bus commercialisation study approach is intended to tackle the cost barrier (scale + policy)

First results: a large coalition mobilised

- A coalition of **industry and public stakeholders** has been established
- Bus OEMs committed to the commercialisation of fuel cell buses in a **Letter of Understanding** signed on 12/11/2014



Locations participating in the coalition

Next steps

- **Price analysis** and funding available : assessment of whether the original bus target can be reached
 - **Increase the level of commitment** from both bus operators and local/regional governments
 - Set-up **regional clusters** to form **joint procurement**
 - **Dissemination of know-how** from past/ongoing projects
- The final results of the study will be made available in summer 2015
- The CHIC partners are supporting this new initiative **by collaborating on dissemination and passing on the lessons learnt**



Thank you for your attention

