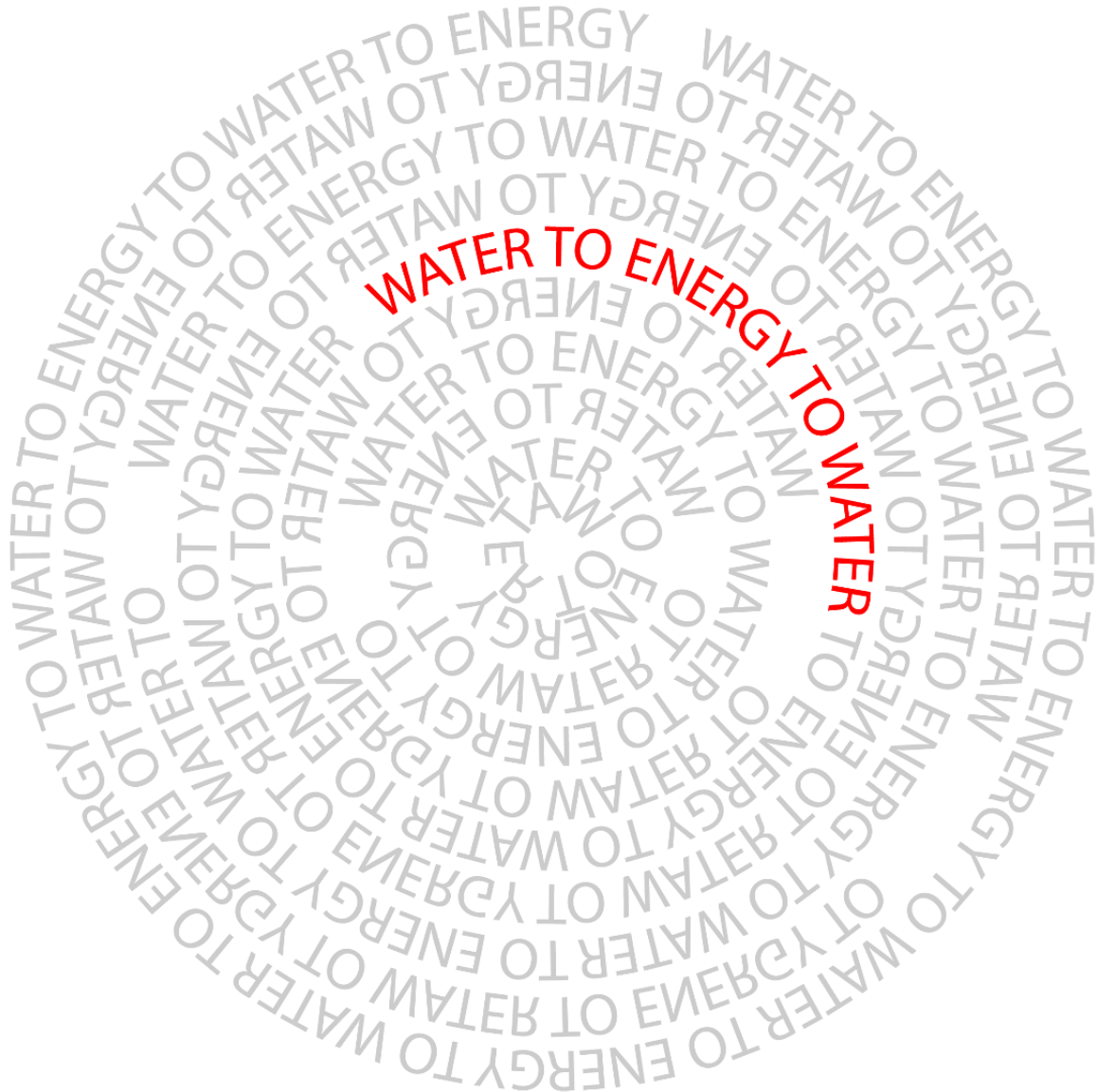


**TOWARDS THE CIRCULARIZATION OF  
HYDROELECTRICITY USING THE EXISTING  
HYDRAULIC INFRASTRUCTURE**



# A NOT SO HIDDEN TREASURE

*Mário Franca and Miroslav Marenc*



# **BASIC RELATIVISTIC MECHANICS**

**Mass**

**Momentum**

**Energy**

# MASS AND MOMENTUM ARE EXPERIENCES OF SENSORIAL PERCEPTION



# ENERGY NOT!





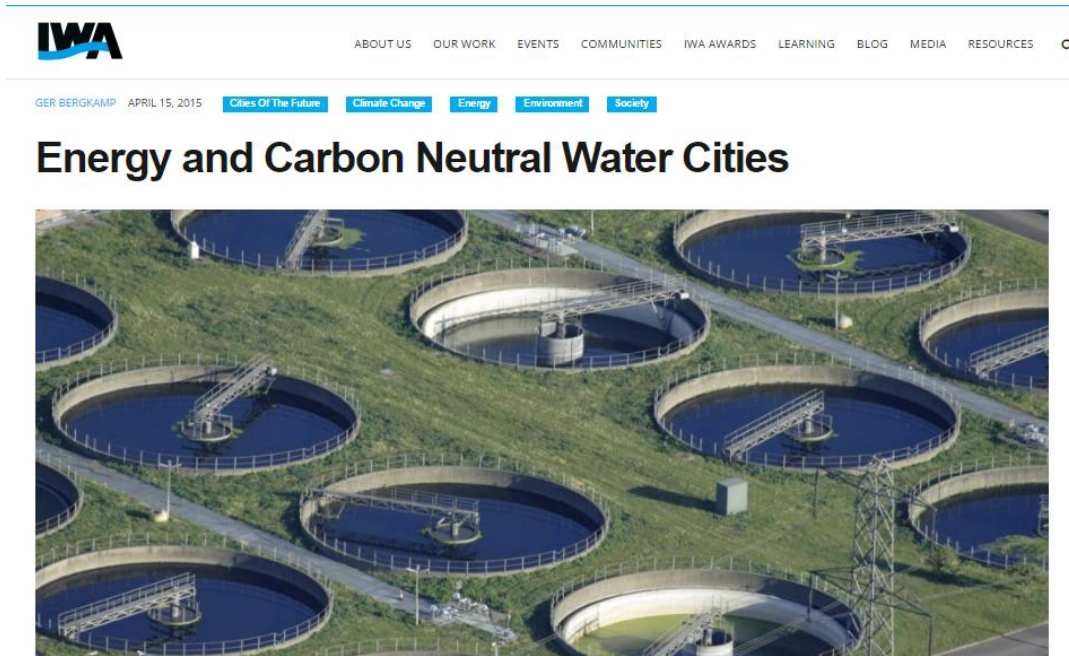
# ENERGY TRANSITION IN AN URBAN CONTEXT

*Energy to supply water and clean used water is responsible for **3-8% of global GHGs emissions***

Bergkamp, G. (2015)

*Cities produce **70% of global carbon dioxide emissions***

Wade L, (2014)



# ENERGY TRANSITION IN AN URBAN CONTEXT

*Per year, the **energy spent in pumping water** in the supply system of the city of Fribourg is about **40% of the wasted energy by the network!***

*Water* 2016, 8(8), 344; doi:[10.3390/w8080344](https://doi.org/10.3390/w8080344)

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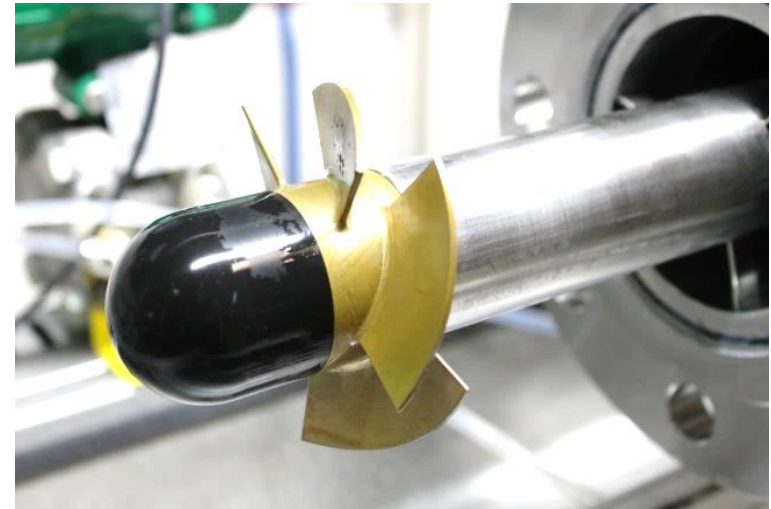
*Article*

## Energy Recovery Using Micro-Hydropower Technology in Water Supply Systems: The Case Study of the City of Fribourg

Irene Samora <sup>1,2,\*</sup> , Pedro Manso <sup>2</sup> , Mário J. Franca <sup>2</sup> ,  
Anton J. Schleiss <sup>2</sup>  and Helena M. Ramos <sup>1</sup>  

<sup>1</sup> Civil Engineering Research and Innovation for Sustainability, Instituto Superior Técnico, Universidade de Lisboa, Lisboa 1049-001, Portugal

<sup>2</sup> Laboratory of Hydraulic Constructions, École Polytechnique Fédérale de Lausanne, Lausanne 1015, Switzerland



# ENERGY TRANSITION IN A RURAL CONTEXT

*Existing irrigation infrastructures often are equipped with special devices to **break the energy** of the flow.*

*Implementation is possible in dams and irrigation channels with drops.*

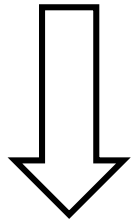
***Nexus with food production***



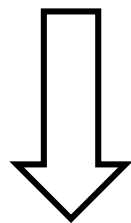
*Marence, Tesgera, and Franca. "Towards the circularization of the energy cycle by implementation of hydroelectricity production in existing hydraulic systems." EC Position paper on WEFE Nexus Dialogue and SDGs (2018).*



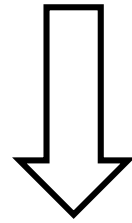
# ENERGY TRANSITION :: CIRCULARIZATION



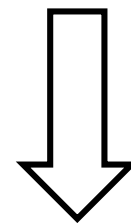
**IRRIGATION**



**INDUSTRY**

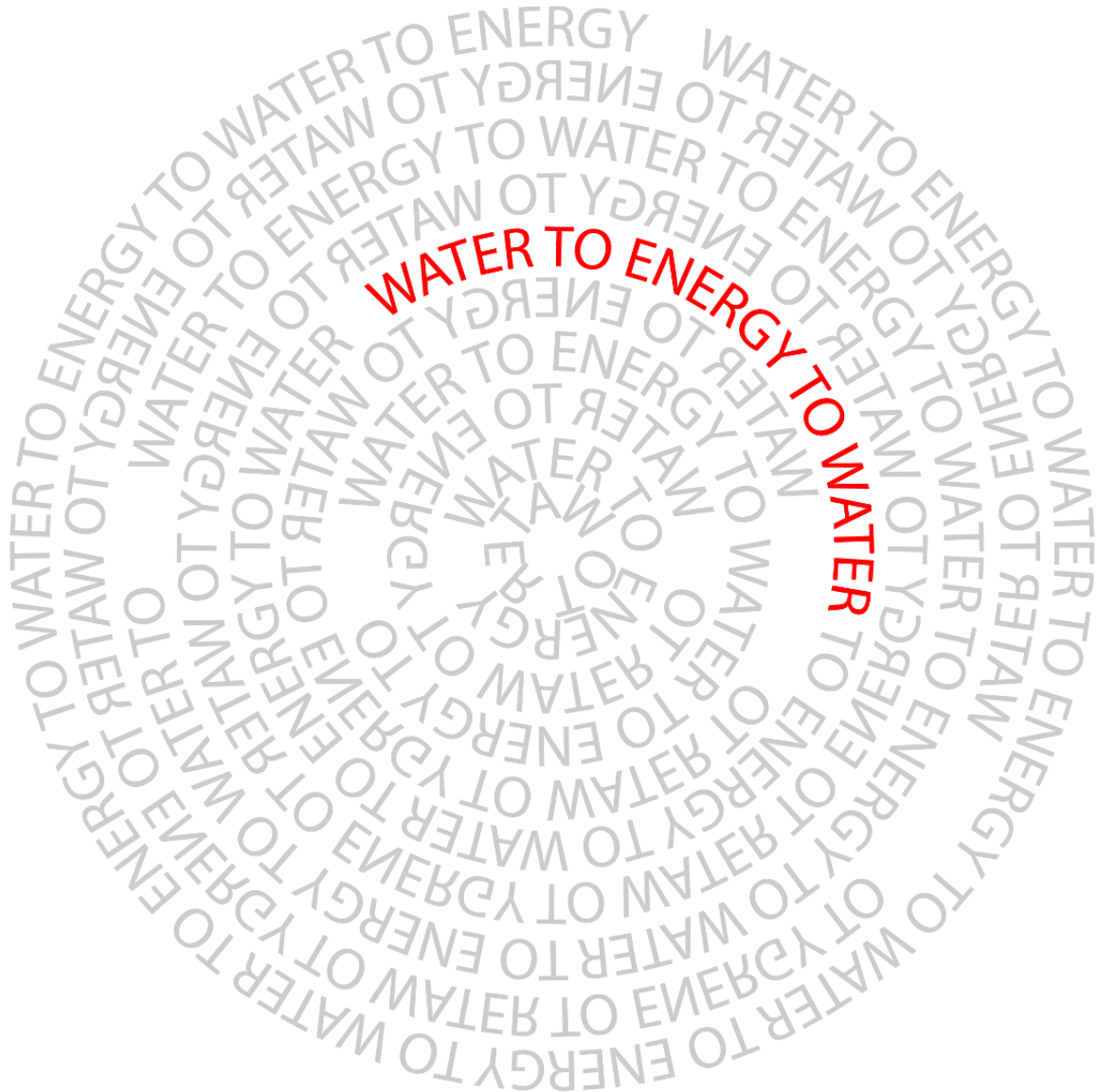


**URBAN WATER  
CYCLE**



**OTHER HYDRAULIC  
STRUCTURES**

**TOWARDS THE CIRCULARIZATION OF  
HYDROELECTRICITY USING THE EXISTING  
HYDRAULIC INFRASTRUCTURE**



## **Mário Franca and Miroslav Marenc**

IHE Delft Institute for Water Education

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## **Anton Schleiss**

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Honorary President of the International Commission on Large Dams

## **Thomas Sandberg**

Professor Emeritus at the Royal Institute of Technology in Stockholm  
Swedish Small Hydropower and European Renewable Energies Federation

## **Cesar Carmona-Moreno**

Senior Expert – Team Leader *Water Management in Developing Countries*  
European Commission – Joint Research Center

# FOOD FOR THOUGHTS

Which **technical solutions** are possible or to explore? How much can we still dare? Large-scale vs. small-scale (at building scale) projects, which are realistic?

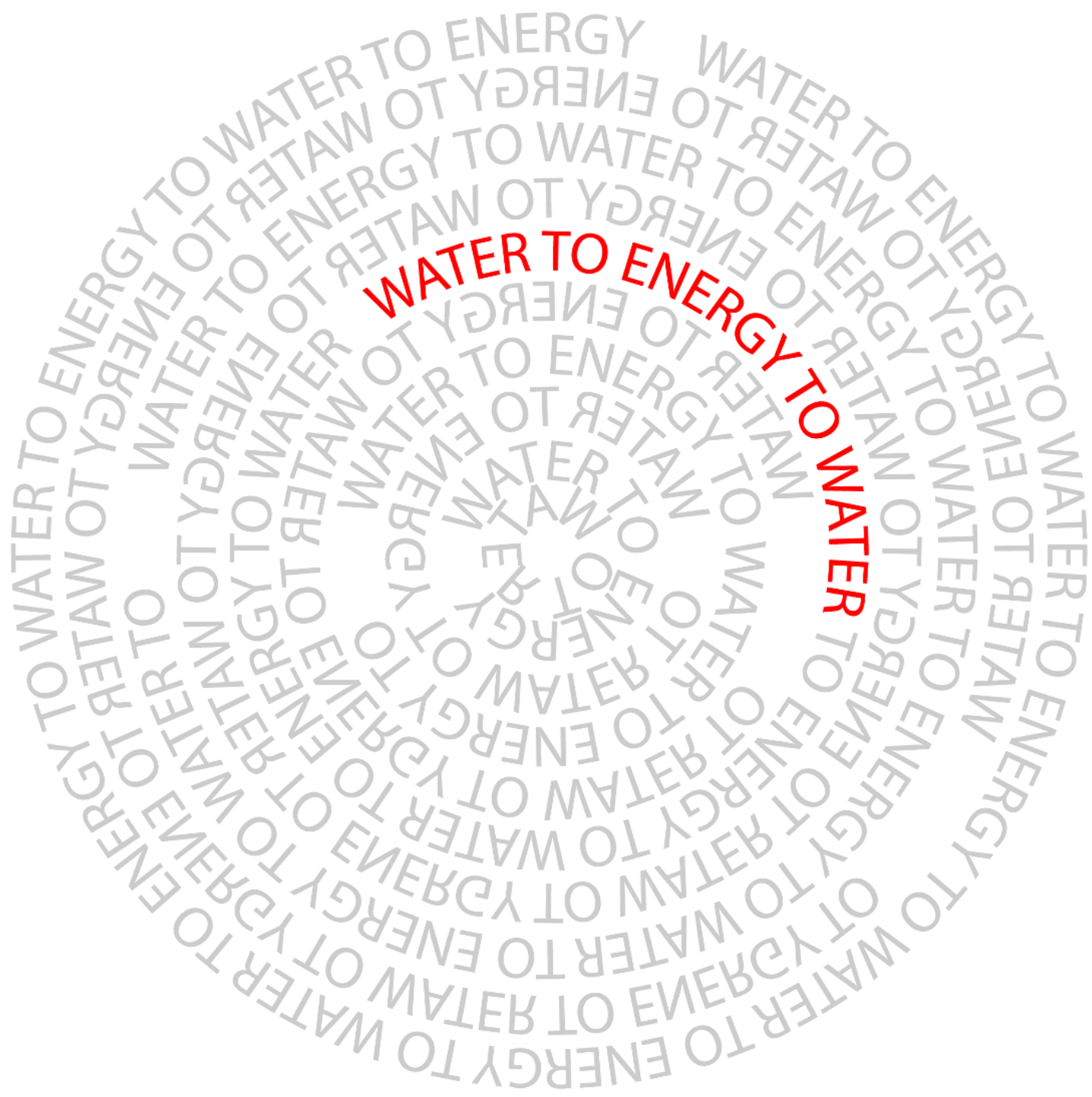
Should we make investors to explore all **available resources** before new investments. Does it make sense to use these to compensate the impact of new investments?

Should **impact inversion** (negative emissions) be quantified for feasibility of new investments.

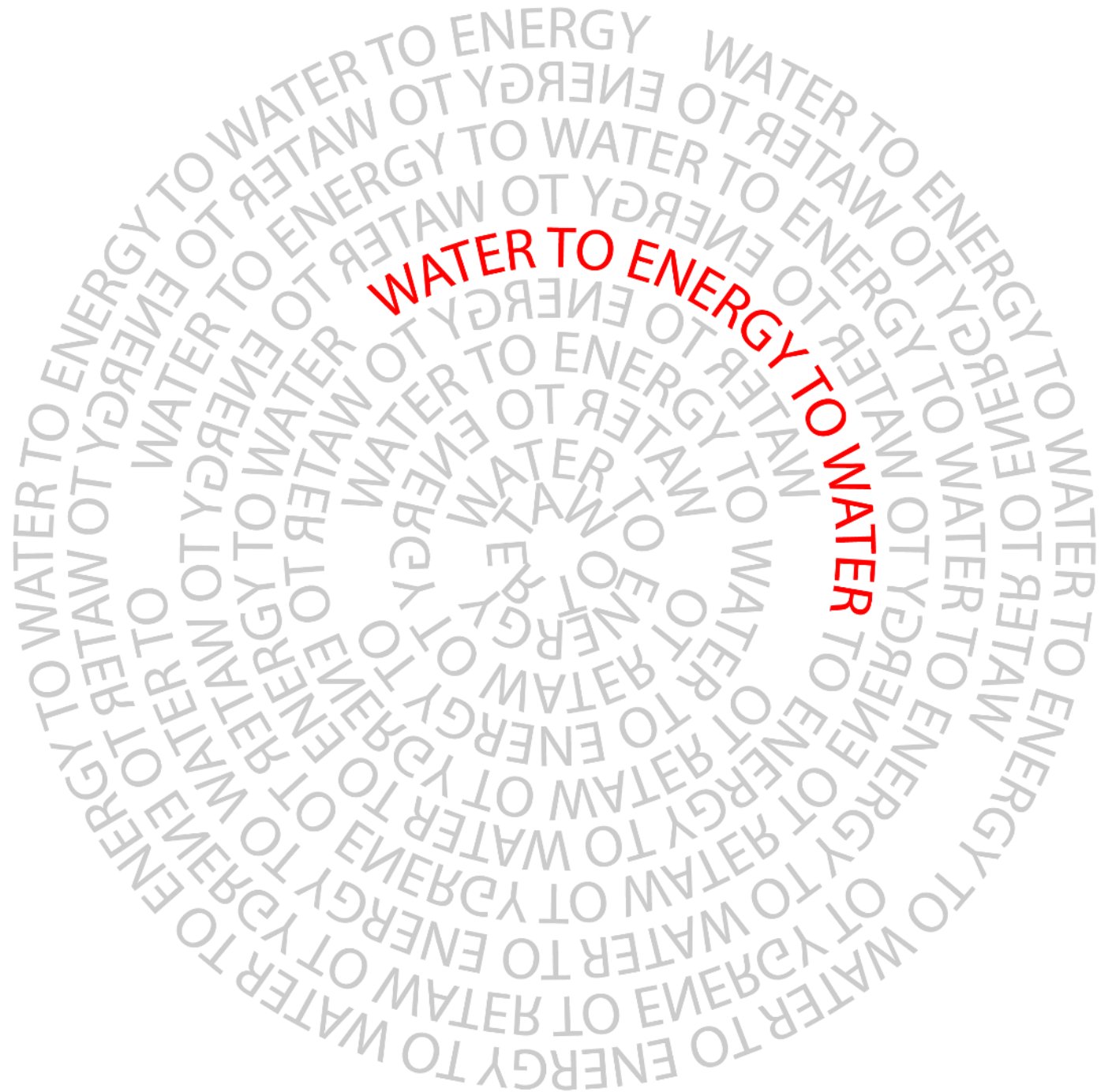
How to convince institutions to finance projects that are **not optimal** since the main function and requirements must be satisfied?

Should an **intergenerational equity rate** be considered which, depending on the exploration of the available resource, could be neutral/equal, positive or negative.





# ENGINEERING EXERCISE





# ENGINEERING EXERCISE



~ 40 m

~ 100 l/s

# DURING THIS EVENT WE COULD PRODUCE ~ 44.1 kWh, SO WHAT?

How many km's could one make with an **e-bike**?

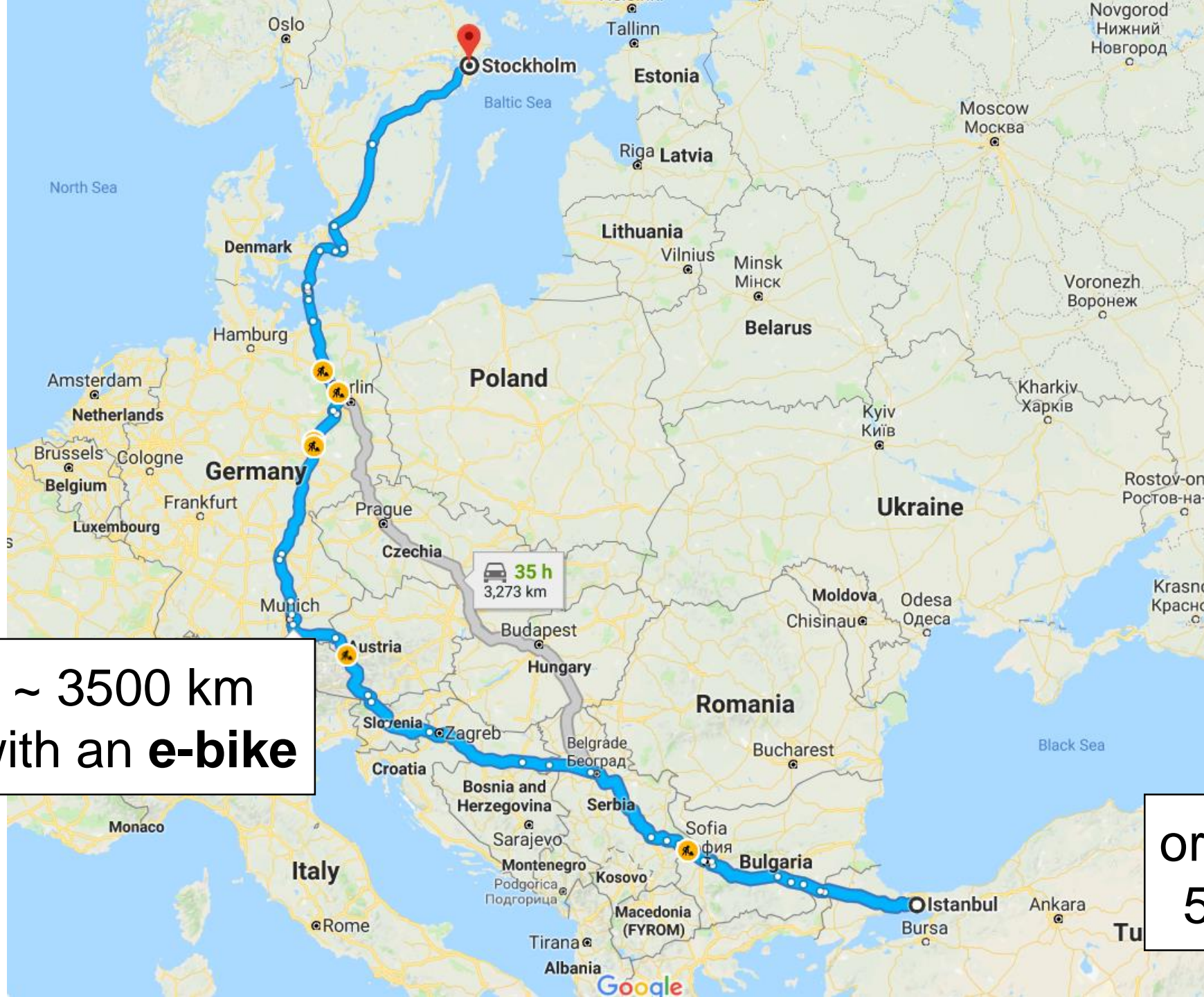
How many km's by **train**?

How many **laundry** could one wash?

How many **Rolling Stones** concerts can we have?

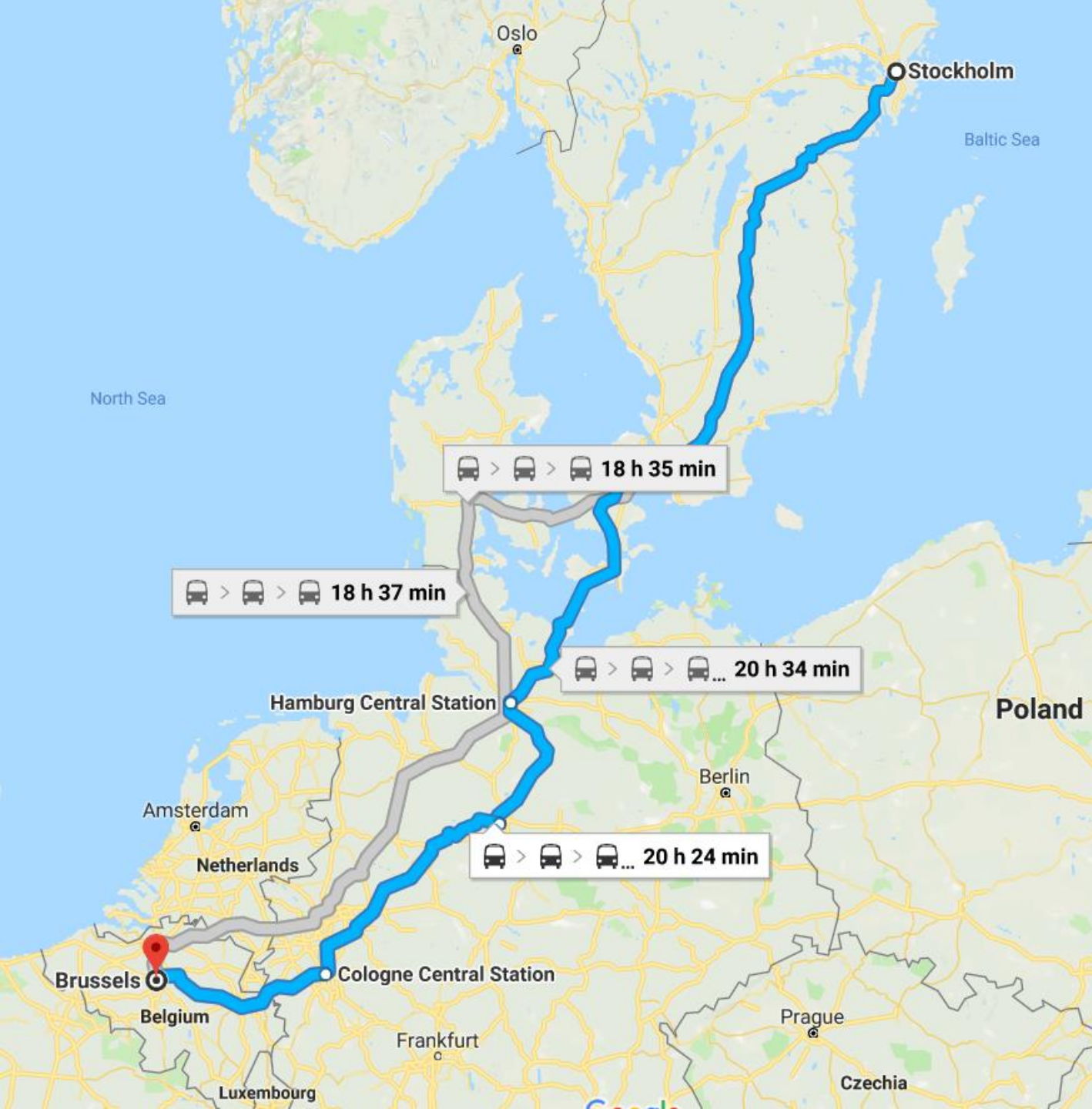
How many **CO<sub>2</sub>** emissions are we saving?





~ 3500 km  
with an **e-bike**

or ~ 700 commutes of  
5 km with an **e-bike**



~ 1500 km of one  
train passenger

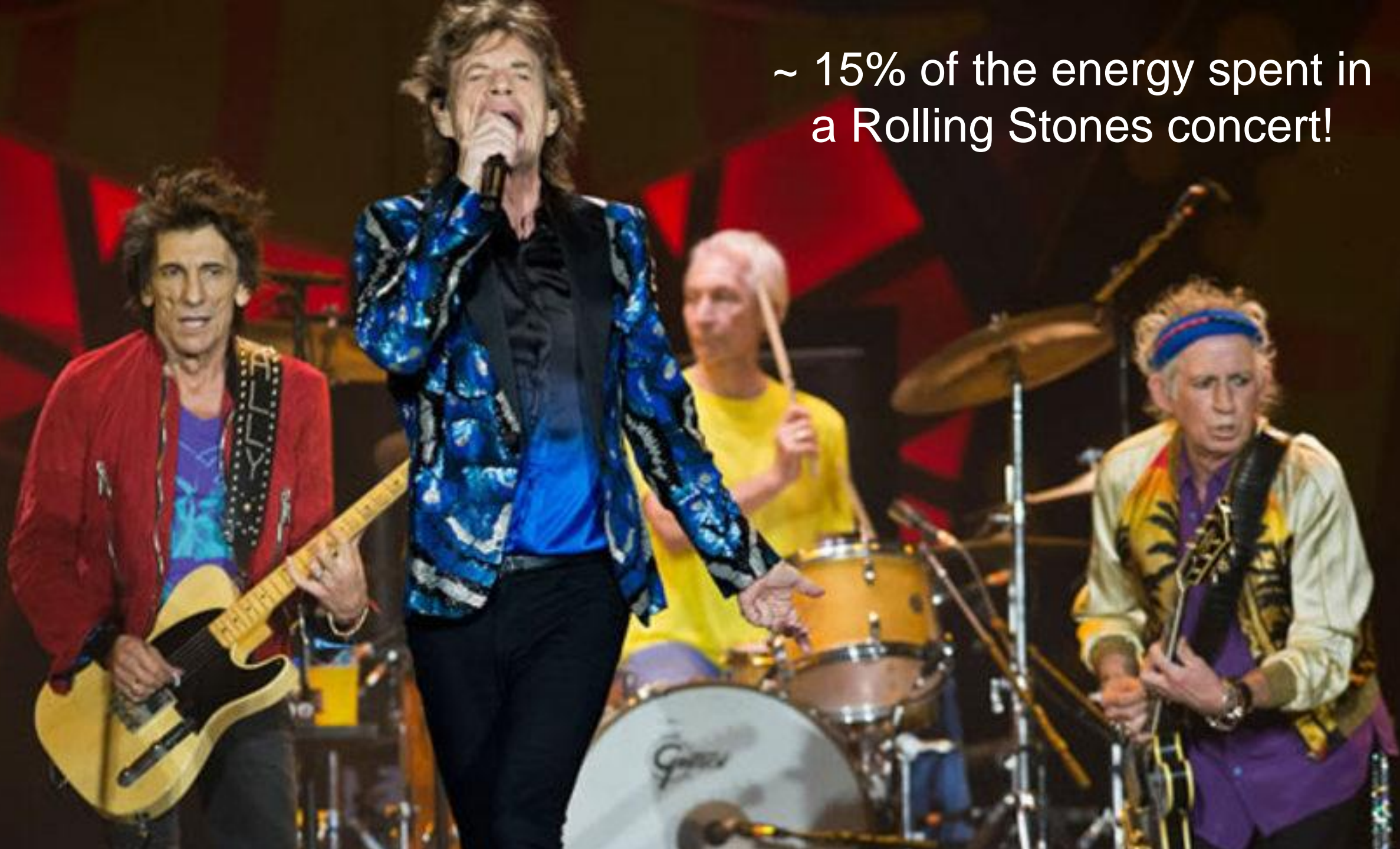




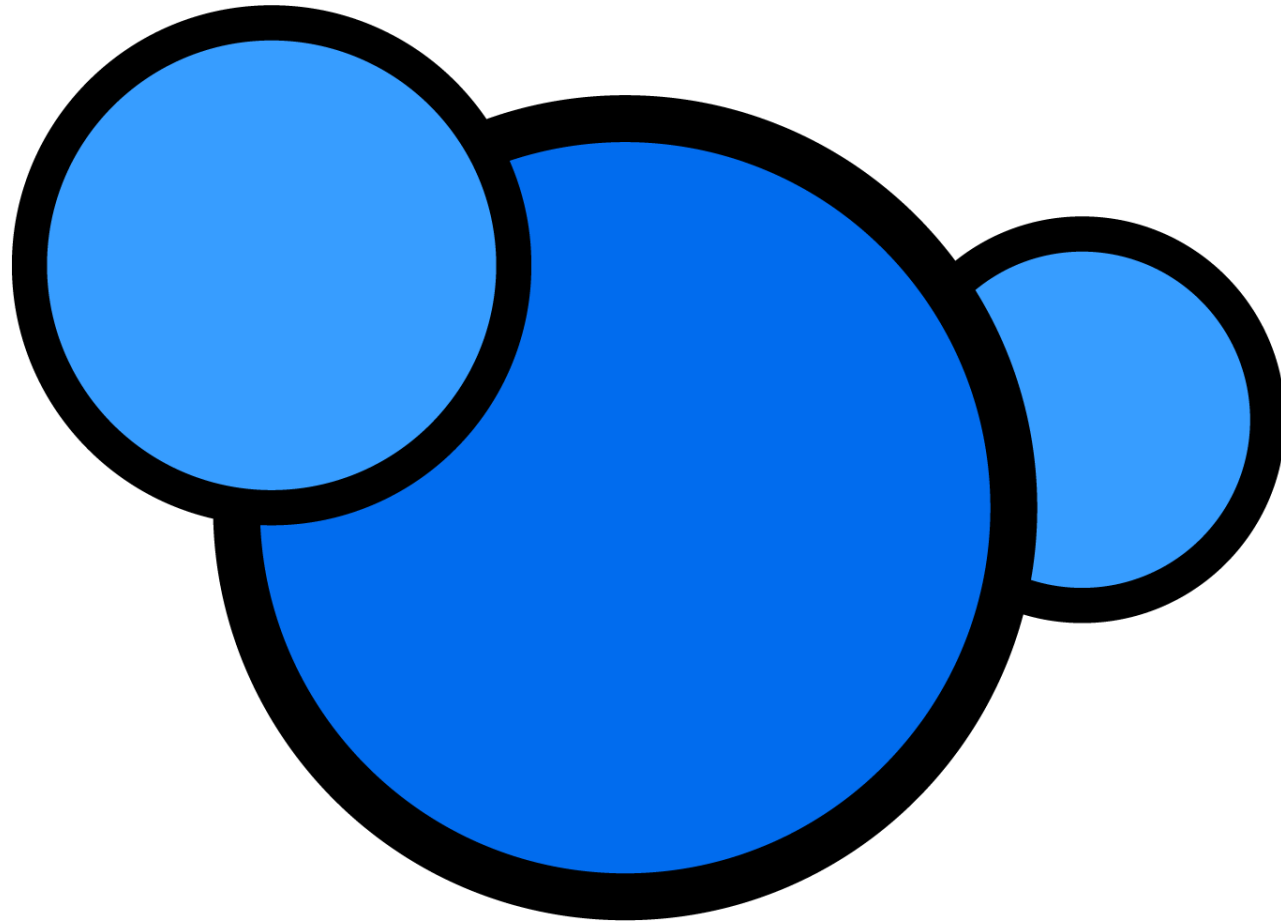
~ 430 kg of  
washed laundry



~ 15% of the energy spent in  
a Rolling Stones concert!







~ 35 kg of equivalent  
CO<sub>2</sub> produced by a  
coal power plant

