

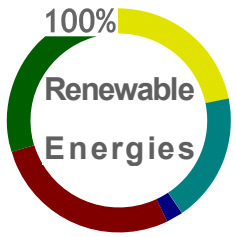
**Aggregate scenario  
for an energy supply  
exclusively from  
domestic Renewable  
Energy resources**

**E. Waffenschmidt  
W. Von Fabeck**

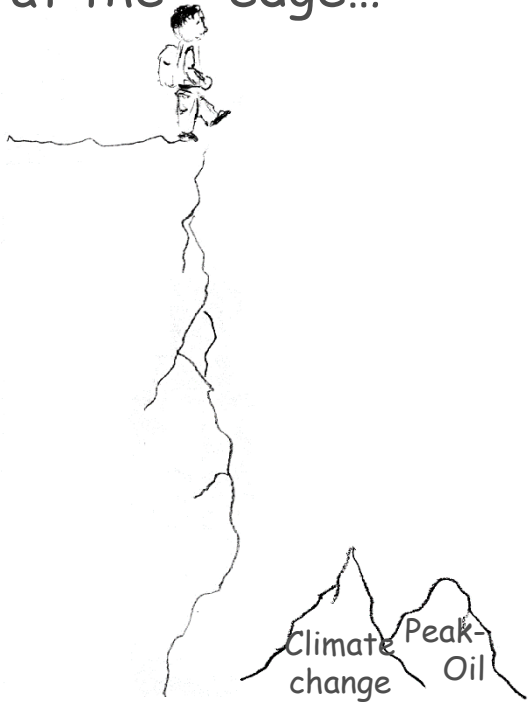
Bonn, Nov. 2007

**Solarenergie-Förderverein Deutschland e.V.**  
(solar energy promoting society of Germany)

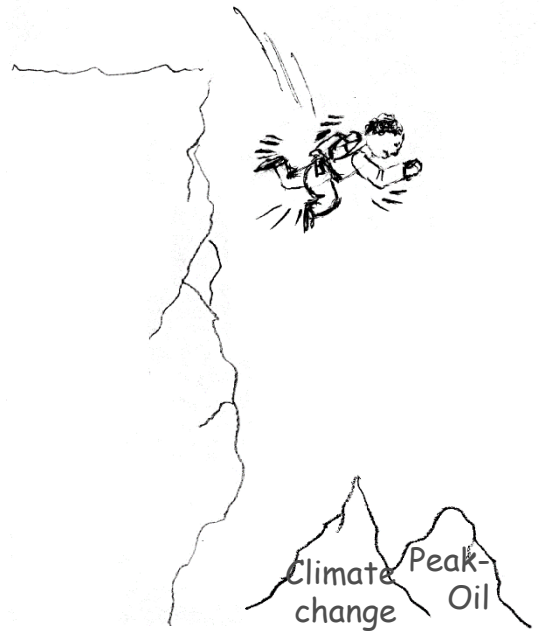


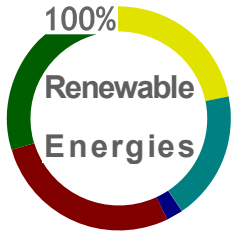


Yesterday, we stood at the edge...



Today, we are a big step further.

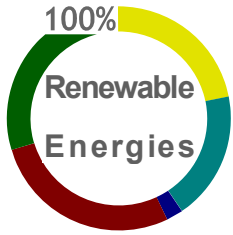




# Sustainable energy use

- Greatest technical challenge in this generation
- Change to **100% renewable energies** is the only solution

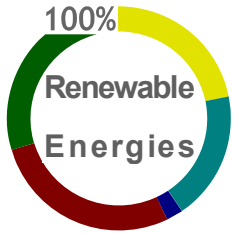




# How does „100% Renewables“ look like?

- In Germany ?
- With existing technology ?



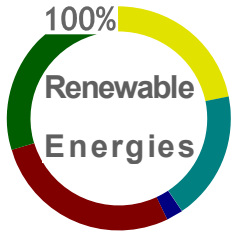


# 100% renewable energies

## The contributions:

- Savings
- Solar energy
- Wind energy
- Geothermal energy
- Bio mass





# Our use of delivered energy



Electrical applications



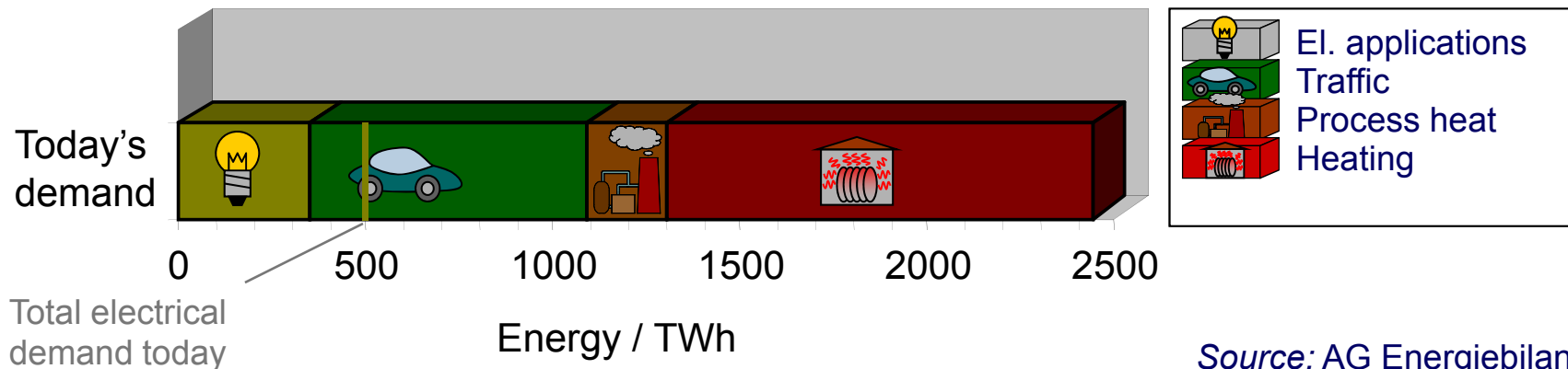
Traffic

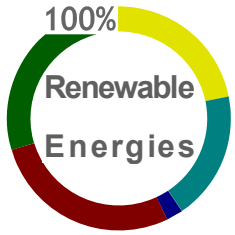


Process heat



Heating





# Savings



## Electrical applications

Stand-By and efficient lighting

## Savings

10% of electricity



## Traffic

3ltr/100km cars and goods on rail

50% of fuel



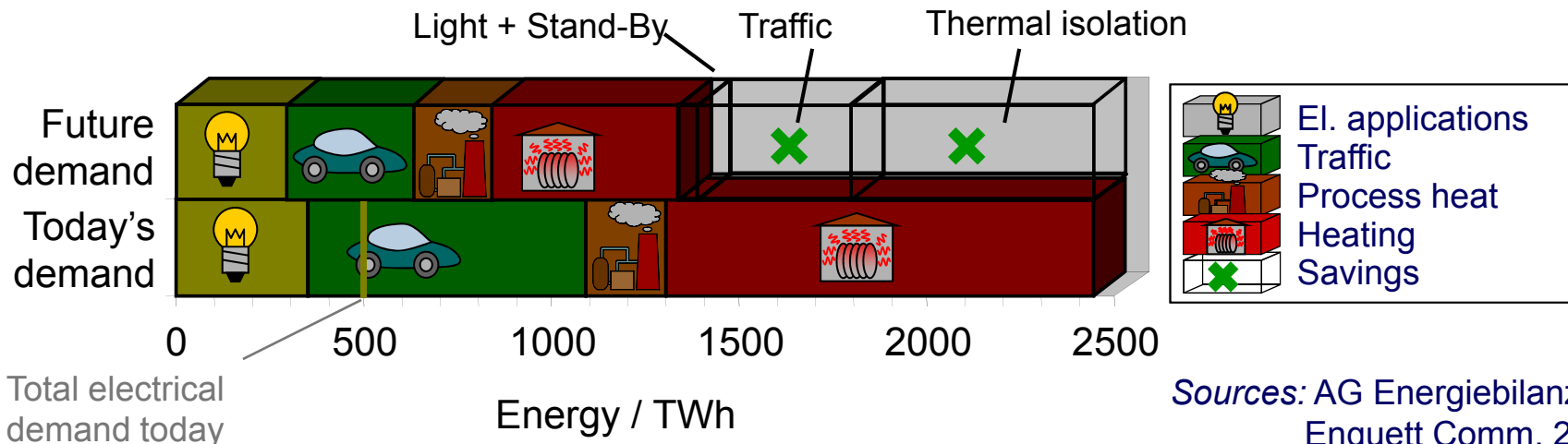
## Process heat

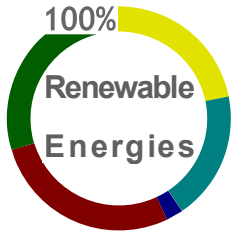


## Heating

Thermal isolation

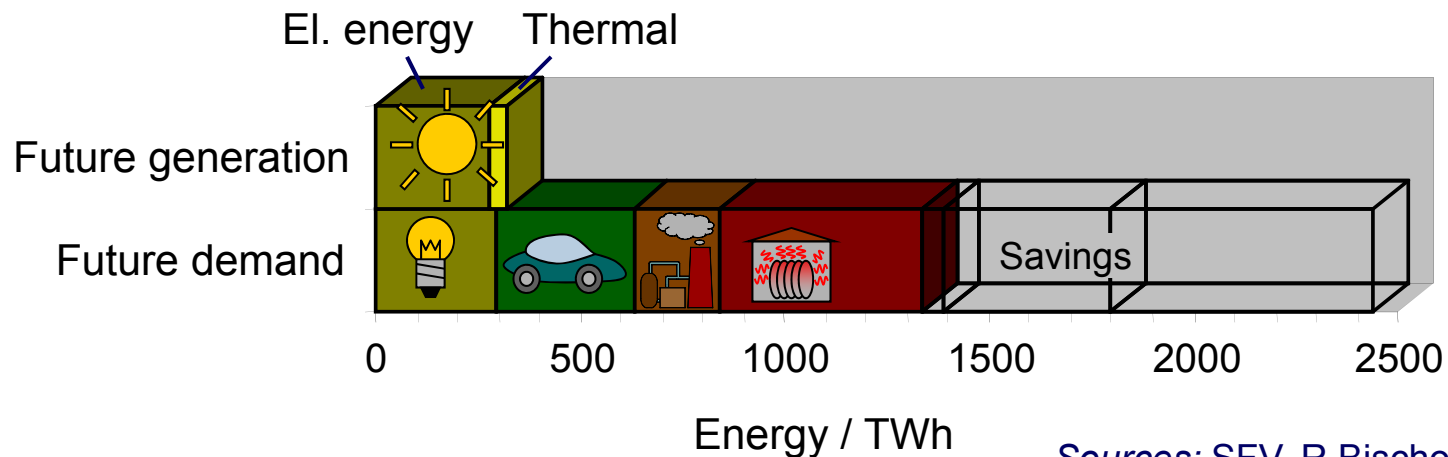
70% of heating



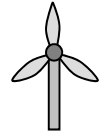
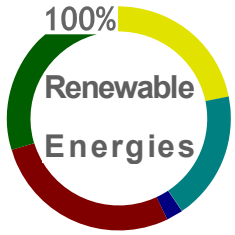


# Solar energy

- 100 kWh per year and per m<sup>2</sup>
- 2100 km<sup>2</sup> collector area on all roofs and facades
- 600 km<sup>2</sup> on sealed area
- Could generate halve of today's electricity demand





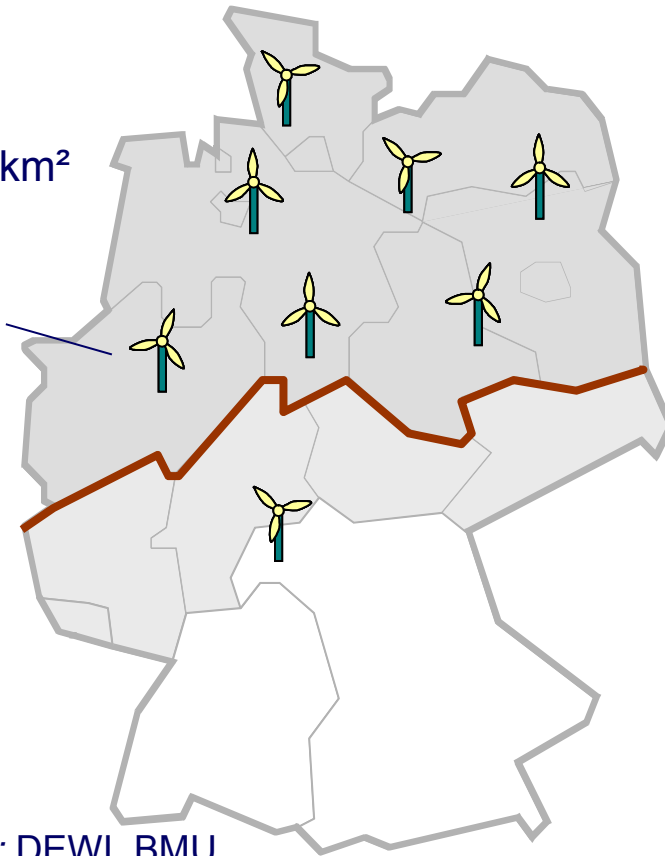


# Wind power

## Today

- 20000 wind turbines in Germany
- 1MW average peak power

>7 / 100km<sup>2</sup>  
x 1 MW:  
33 TWh



## Tomorrow

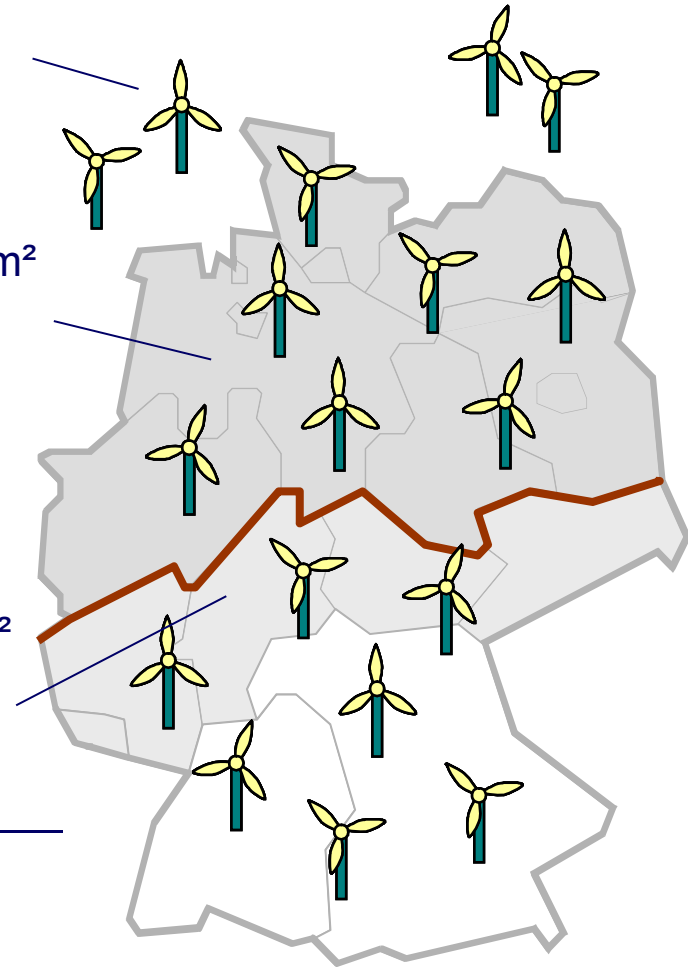
- 30000 wind turbines + offshore
- 3MW average peak power

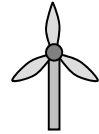
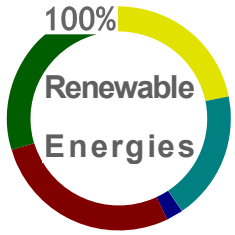
Offshore  
110 TWh

>7 / 100km<sup>2</sup>  
x 3 MW  
100 TWh

7 / 100km<sup>2</sup>  
x 3 MW  
60 TWh

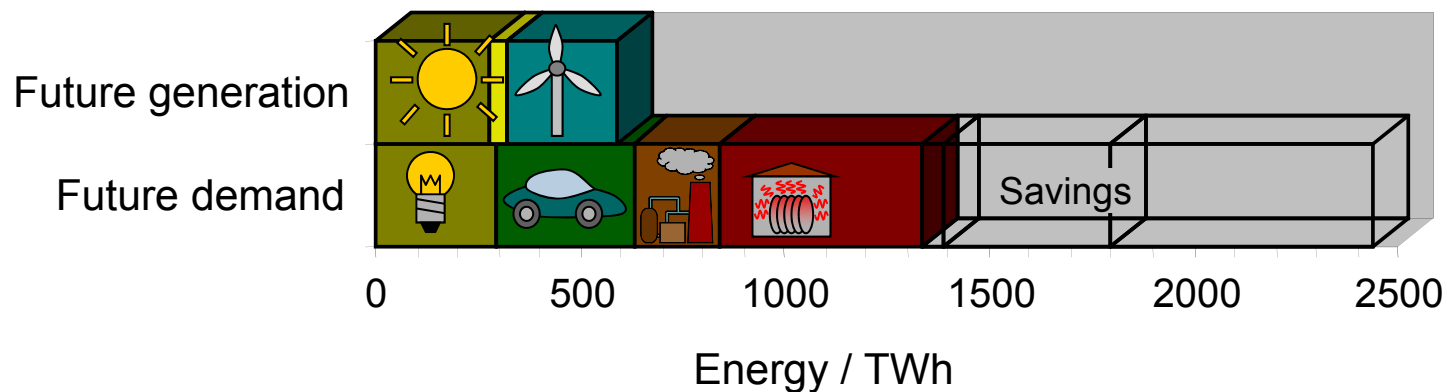
Sum  
**270 TWh**

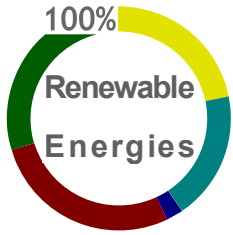




# Wind power

- Re-powering
- Extension in Southern Germany
- Offshore wind parks
- Could cover more than half of today's electricity demand

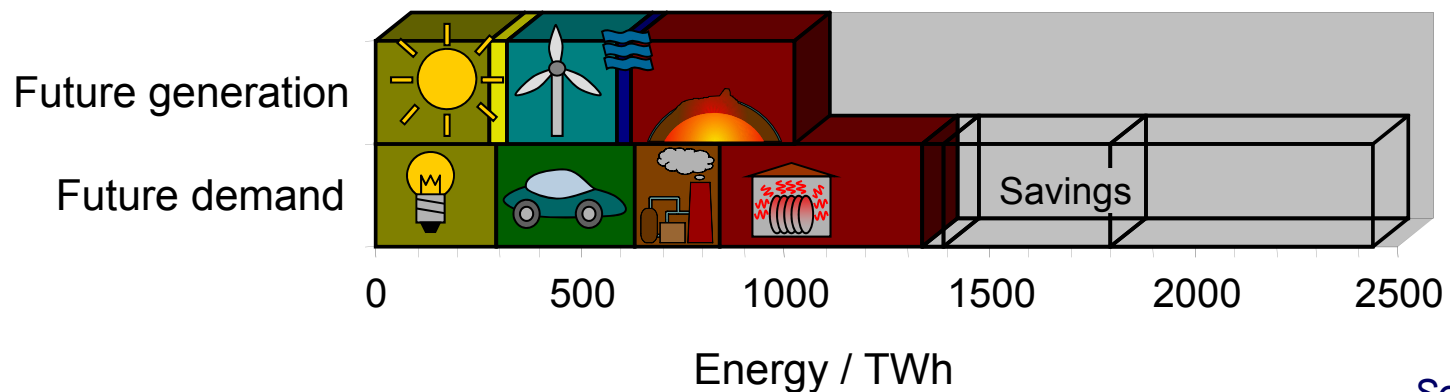


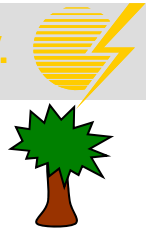
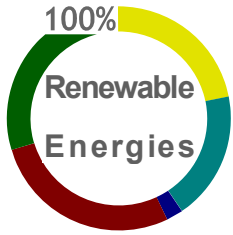


# Geothermal Energy



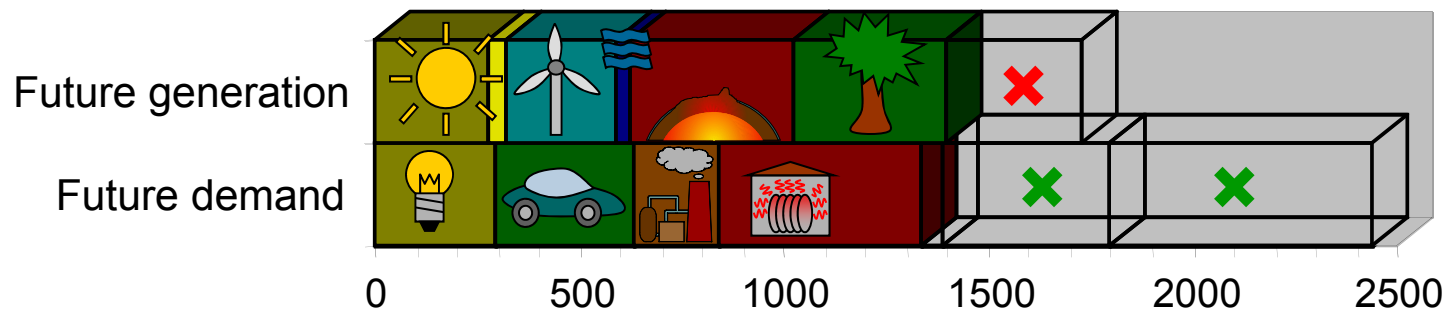
- Deep geothermal energy for
  - District heating
  - Electricity
- Decentralised heat with heat pumps
- Could satisfy the major demand for heating

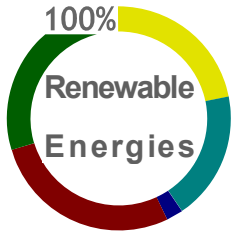




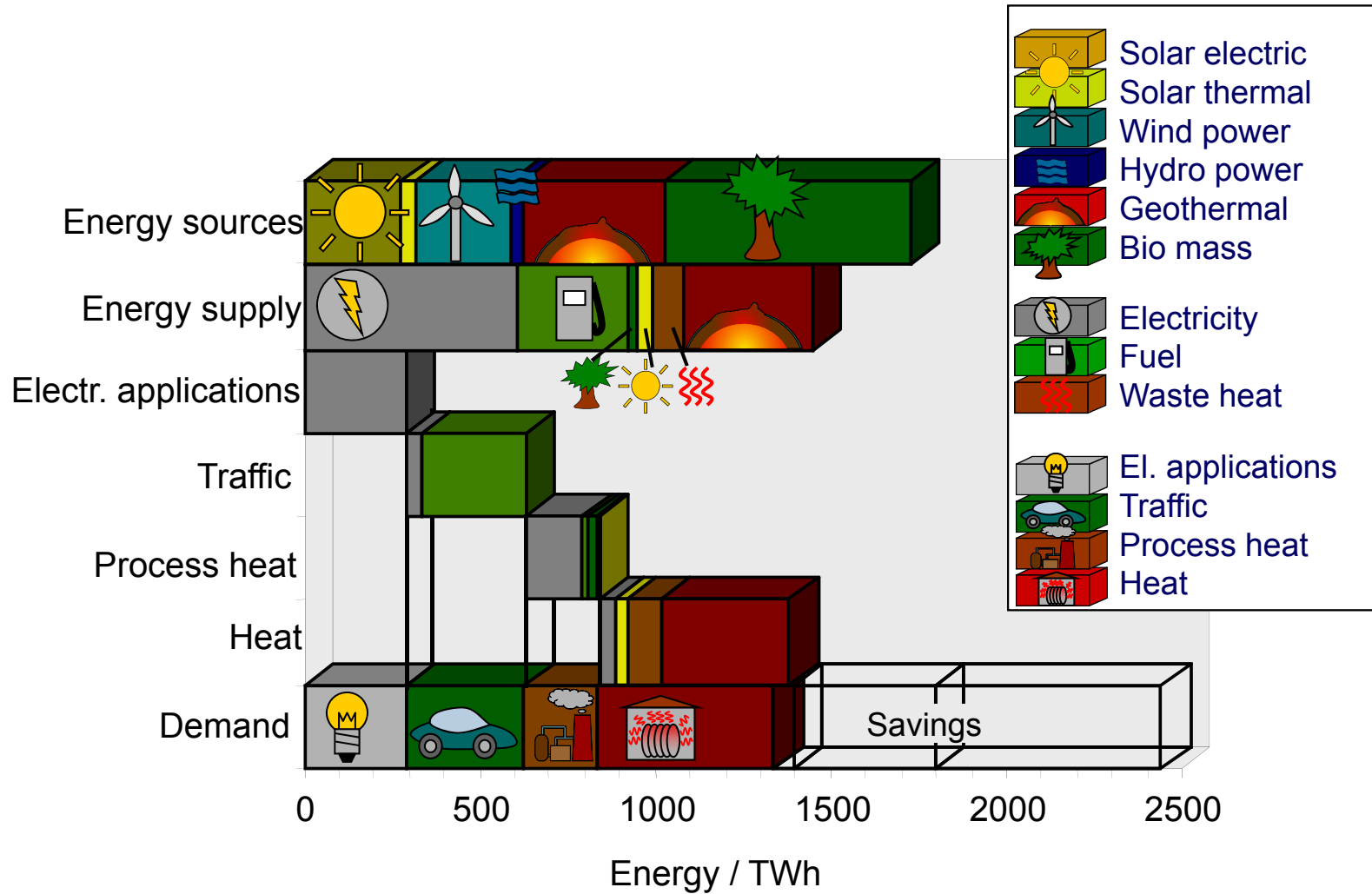
# Bio mass

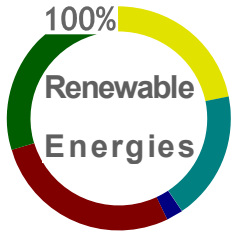
- Forrest wood 126 TWh/a
  - Today only 1.5 Mio t of 24 Mio t used for energy
  - 24.9 Mio t of 45 Mio t possible
- Waste material (but: Recycling is preferred!) 139 TWh/a
- Agricultural products 420 TWh/a
  - on 20% of the agricultural area
- Must be converted, e.g. to Biogas total 350 TWh/a
- Could cover the future energy demand of the traffic



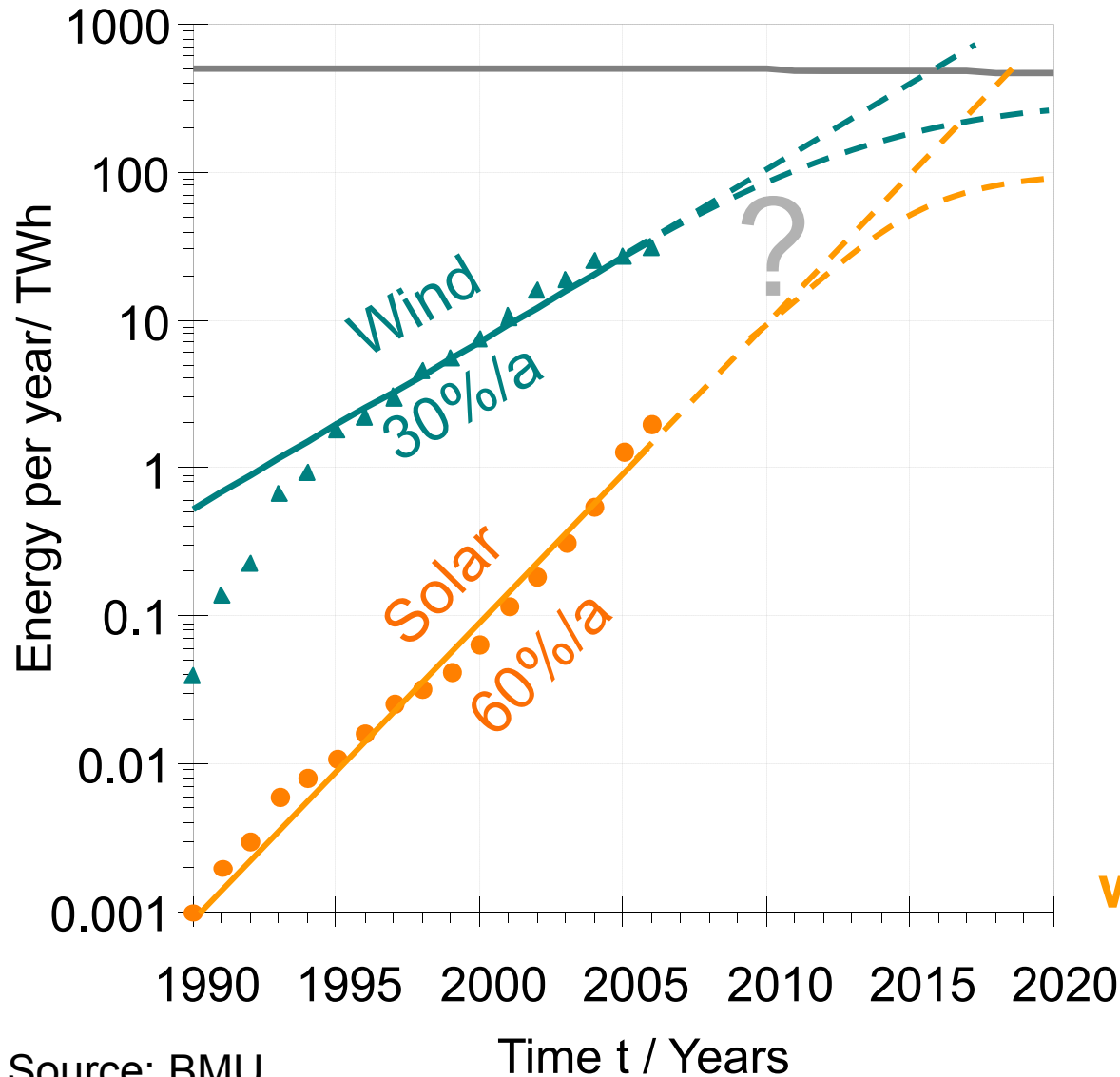


# Usage





# How long will it take?



## Consideration

- Wind and Solar
- Growth rates of last 10 years

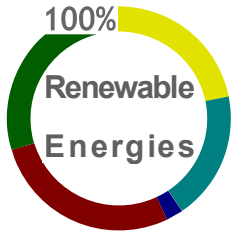
## Conclusions

- Relevant contribution of renewables within next decade

**Storage becomes relevant within next decade!**



How to generate electricity without the sun



# The contributions

## Inherent

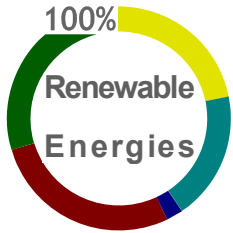
- Correlation with demand
- Compensation by sources
- Compensation by distance

## Controllable

- Load shift
- Controlled generation
- Storage
- In- and Export

Control by  
**variable tariff**  
also for end users

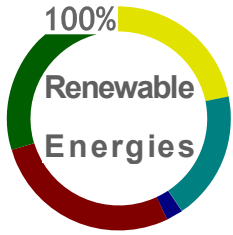




# Variable tariff

for end users

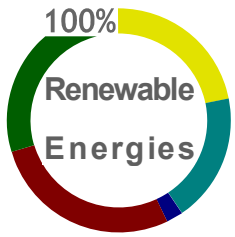
- Low demand: Cheap electricity
  - Load storage,
  - Use energy
- High demand: Expensive electricity
  - Unload storage,
  - Shift energy use
- Enables
  - Distributed storage
  - Distributed peak generation
  - Distributed load shift



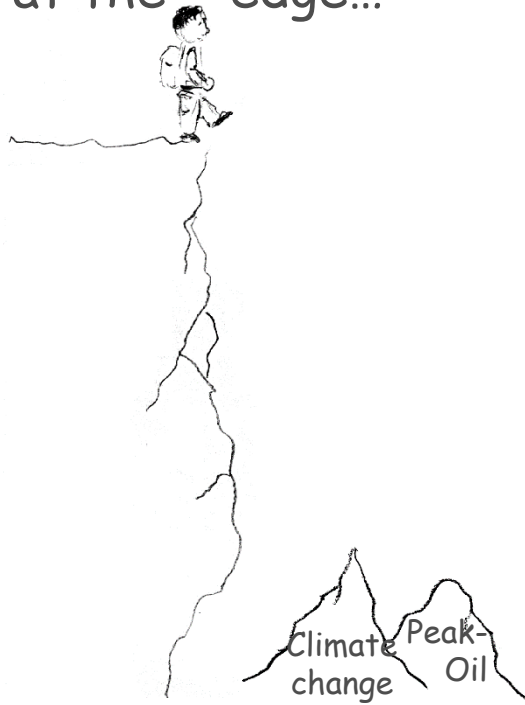
# Proposal SFV

Legal regulation containing:

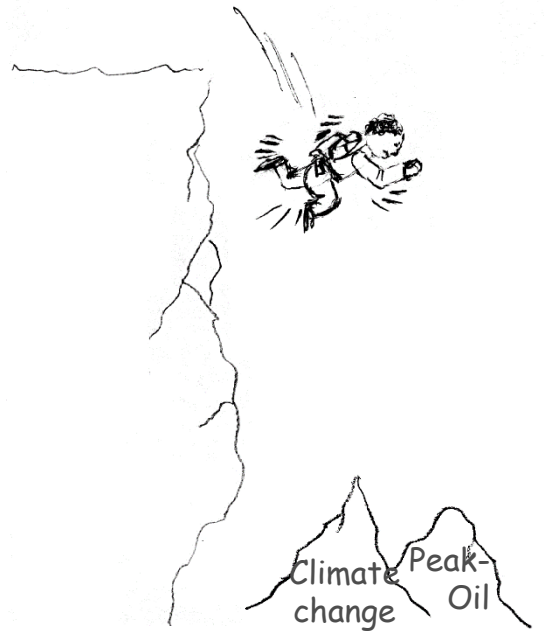
- Electricity tariff for end customers dependent on “offer and demand”
- Injection of “controllable” electricity by everybody is paid as control energy
- Grid fee is re-funded if storage energy is injected
- Details to be discussed

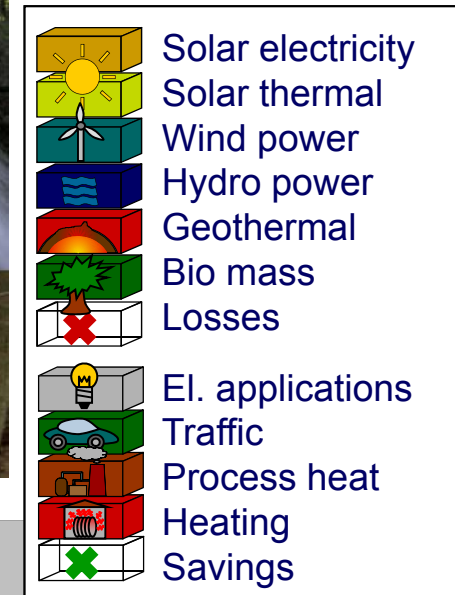
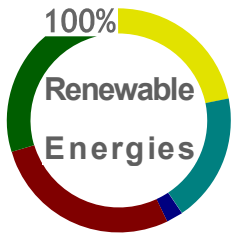


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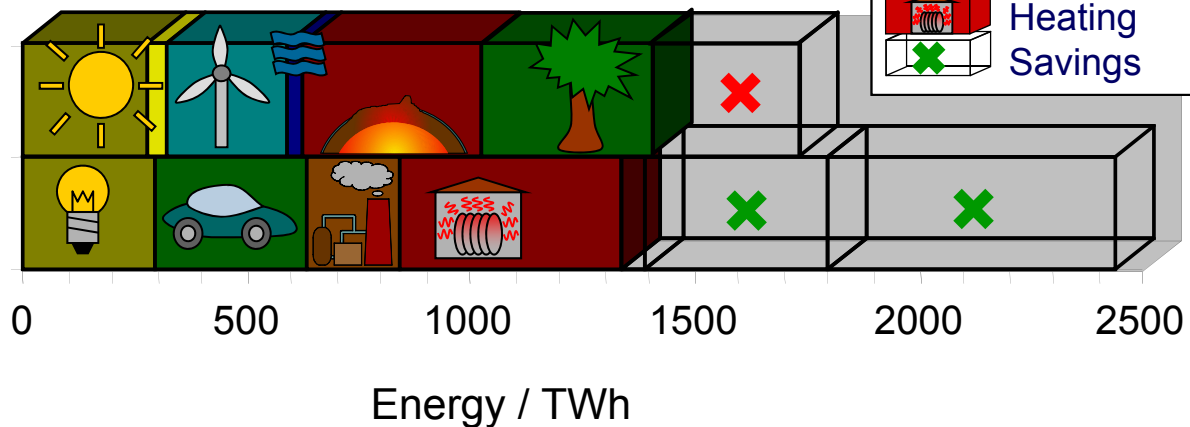
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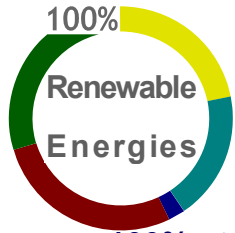




Future generation

Future demand





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## Energy consumption

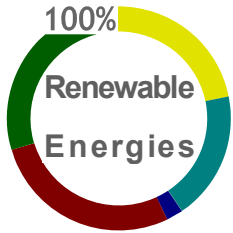
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