IfaS Institut für angewandtes Stoffstrommanagement

SVB CONSULTING SRL

cincșor transilvania case de oaspeți BY KULTUR PROJECT

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INTERCORUM

Interactive coaching for the development of three resilient villages in Romania

Agenda

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- Introduction Institute for Applied Material Flow Management (IfaS)
- “INTERCORUM" Project
- Catalogue of measures & factsheets
- Status quo analysis
- Potential analysis
- Energy and GHG balance
- Key findings of the project
- Next steps

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Institute for Applied Material Flow Management (IfaS)
Areas & Fields of Work

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MANAGING DIRECTOR

Prof. Dr. Peter Heck

DEPUTY MANAGING DIRECTOR

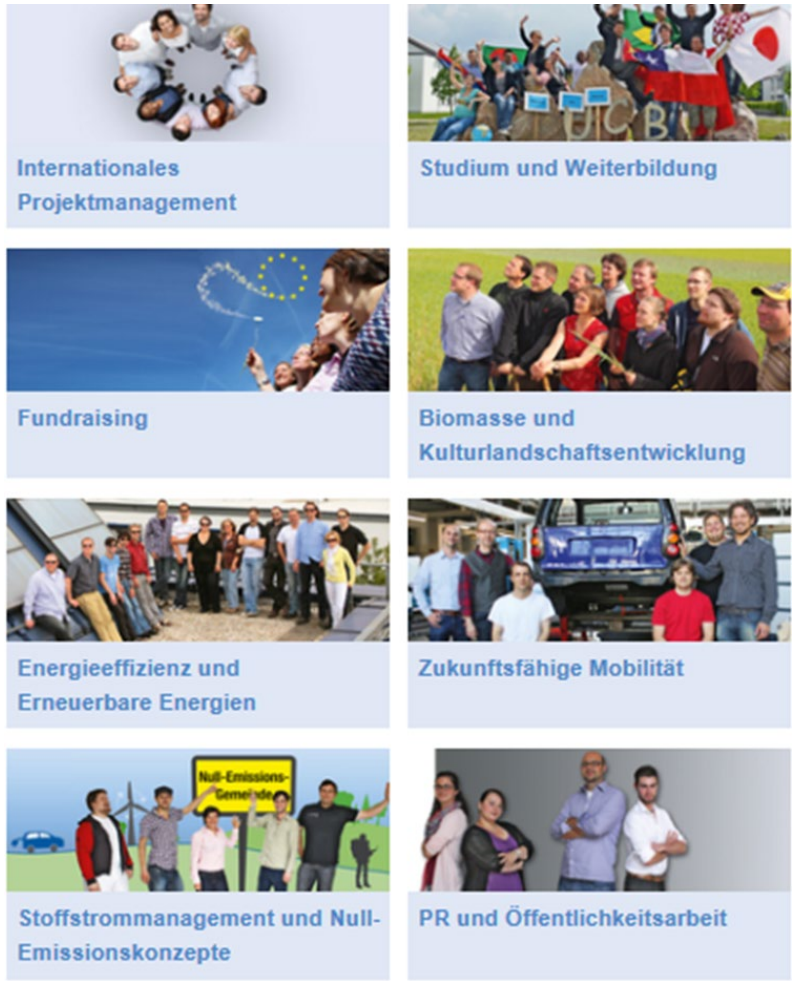
Prof. Dr. Klaus Helling

Institute of Trier University of Applied Science

- Founded end 2001
- 9 professors
- About 80 employees
- Research assistants and interns (about 20)

Key areas:

- International Material Flow Management
- Education and Training
- European Research Projects
- Biomass and Cultural Landscape Development
- Energy Efficiency & Renewable Energies
- Sustainable Mobility
- Strategic Material Flow Management and Zero Emission
- Public Relations



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Environmental Campus Birkenfeld

gefördert durch DBU Deutsche

GERMANY'S FIRST "ZERO-EMISSION CAMPUS„ AND THE MOST SUSTAINABLE CAMPUS IN GERMANY

25 JAHRE UMWELT-CAMPUS BIRKENFELD

Nachhaltigkeit. Fortschritt. Zukunft.

UI GreenMetric World University Rankings

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Increasing challenges for Romania!

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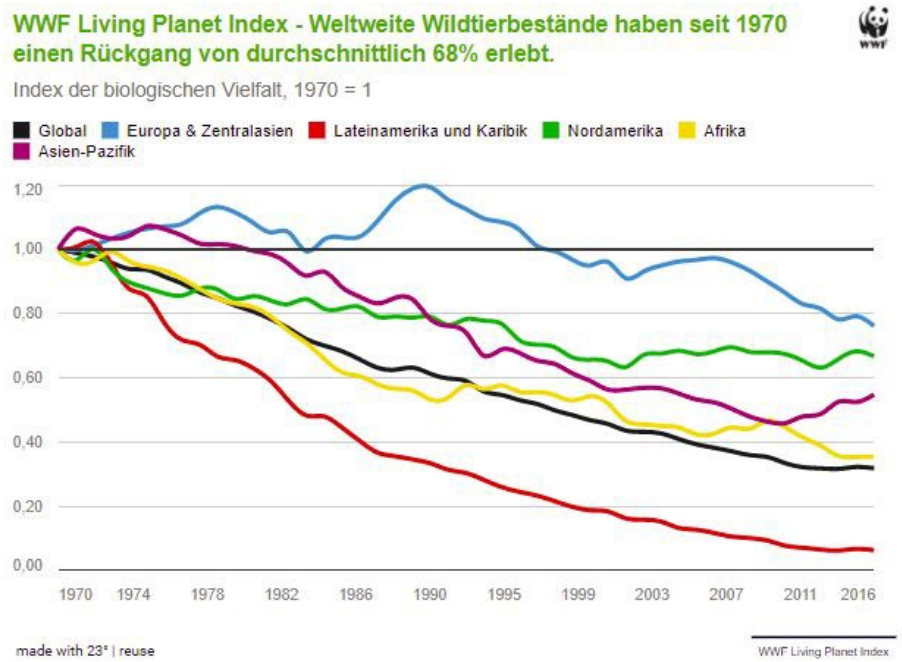
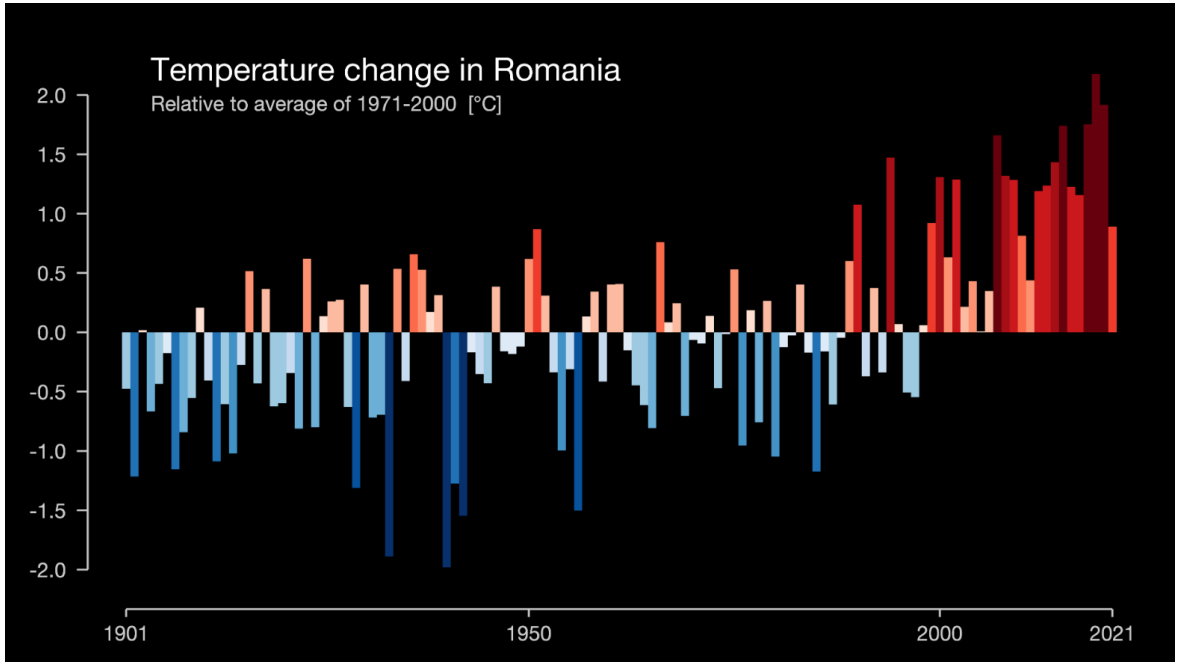




Protected species

Species protected in Romania under EU law are protected under the Habitats Directive and under the Birds Directive. The Habitats Directive has a total of 2 500 species on its list, the Birds Directive has a total of 500 species of wild birds protected.

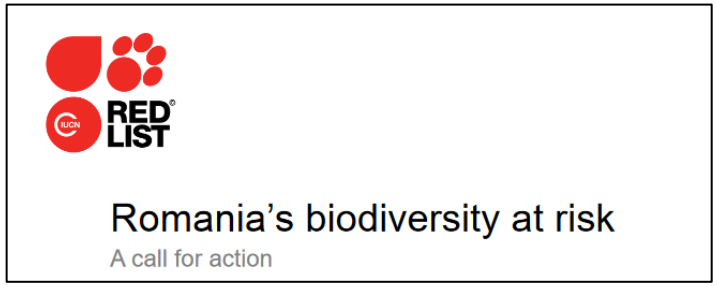
470 species protected under EU law in Romania

14 species are unique to Romania

435 species under the Habitats Directive

171 species under the Birds Directive

Quelle: www.biodiversity.europa.eu, Romania



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Goals and philosophy: material flow management and circular economy

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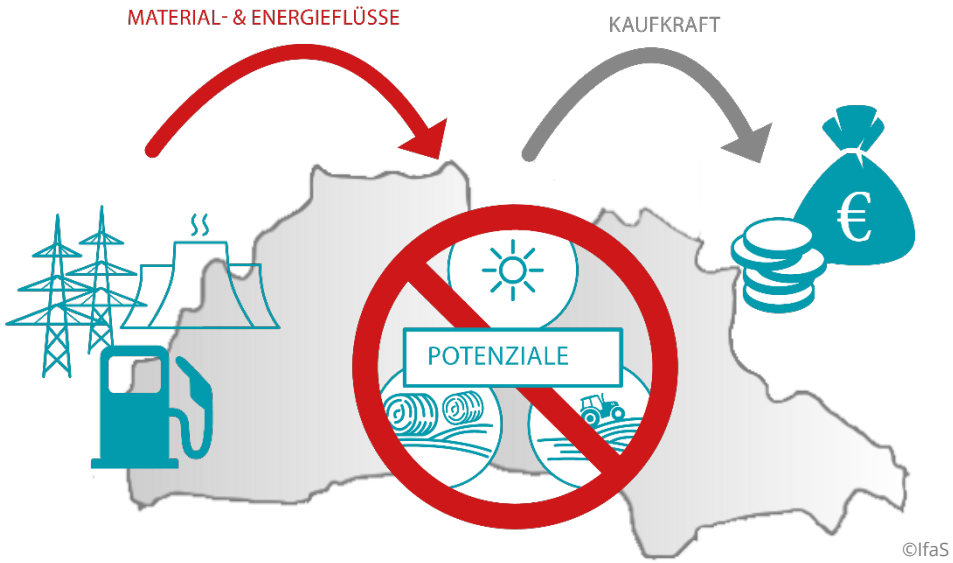
TODAY'S THROUGHPUT ECONOMY

Inefficient; Cost-intensive; High environmental impact

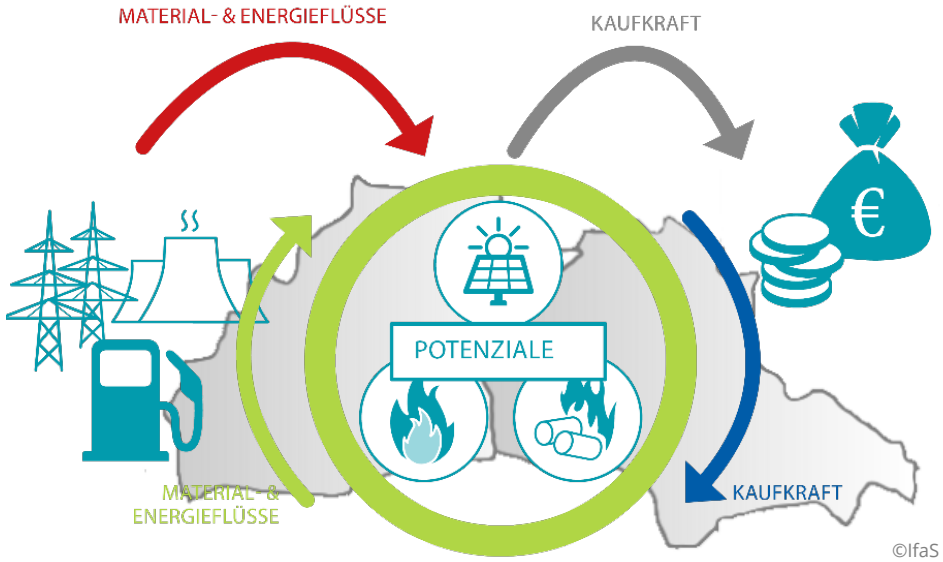


CONVENTIONAL LINEAR SYSTEM

- **Unused potential**
- **Lack of development perspective**
- **Little innovation**
- **Negative environmental impact**
- **No resource security etc.**

MODEL AND GOAL - ZERO EMISSION

Efficient; Value-creating; Future-proof



OPTIMIZATION THROUGH ACTIVATION OF POTENTIALS

- **Security of supply**
- **Price stability**
- **Citizen participation**
- **Alternative local supply etc.**

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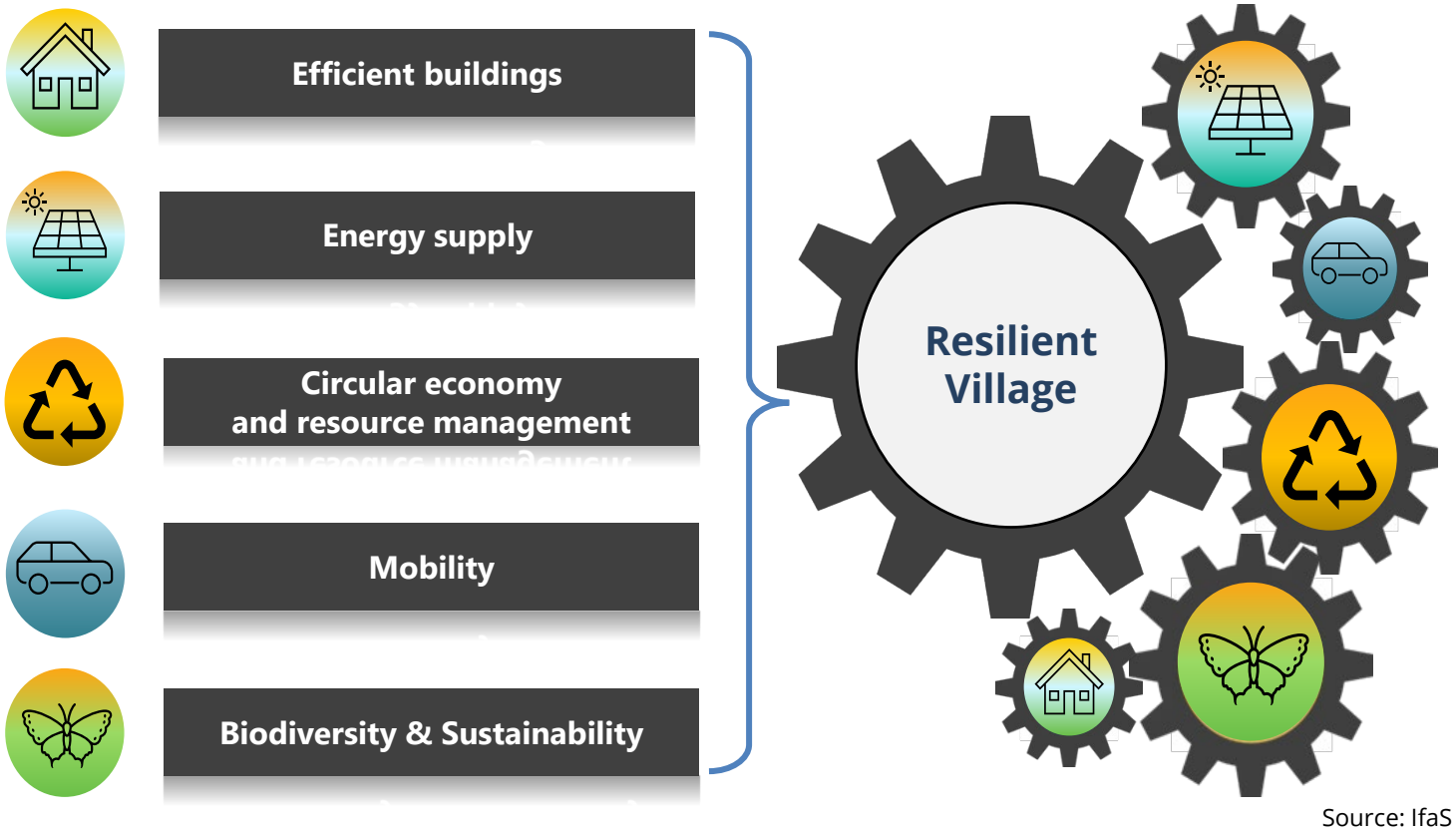
Project goal and focus

Initiate the transformation of villages into resilient villages.
Three villages as "pilot projects": Marpod, Cincșor and Viscri



Source: IfaS

No more sectoral thinking:

instead, implementation of a holistic-systemic management

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Concept - overview of the procedure in the project

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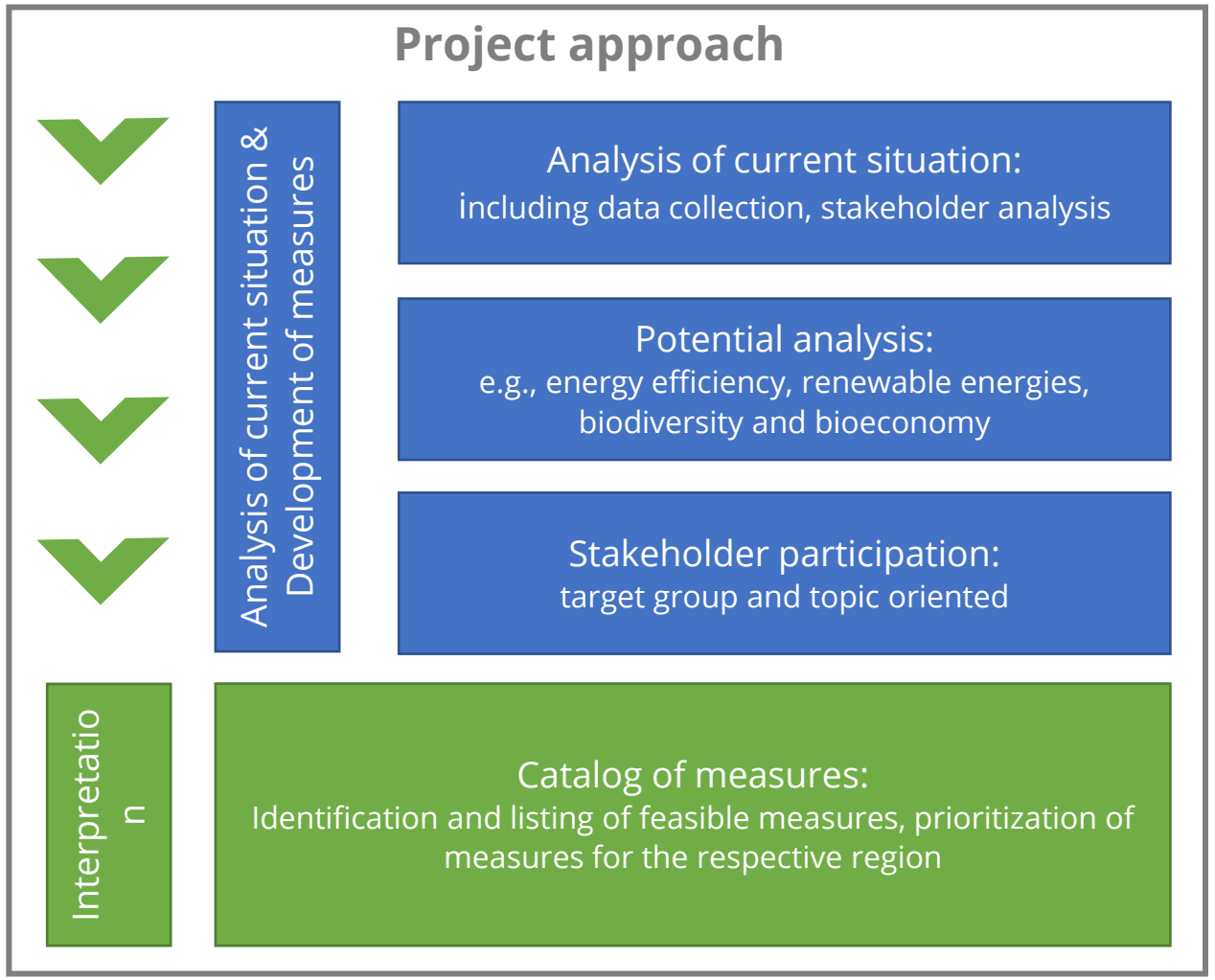

Steps in the project:

- Analysis of current situation
  - Data collection
  - Stakeholder analysis
- Potential analysis
  - Renewable energy
  - Energy efficiency
  - Biomass etc.
- Stakeholder participation
  - Identification of key actors
  - Continuous coordination
- Catalog of measures

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Catalogue of measures & factsheets

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The catalogue of measures:

1.	Photovoltaic	9 measures
2.	Building renovation	8 measures
3.	Mobility	5 measures
4.	Biomass	6 measures
5.	Water use	3 measures
6.	Tourism	5 measures
7.	Other	5 measures

Information about funding programs:

EUKI, DBU, EU life, EU INTERREG, Mercator Foundation

Fact sheets:

1. Village potentials
2. Photovoltaic
3. Building renovation
4. Decentralized heating system

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INTERCORUM

Catalog de măsuri

Coaching interactiv pentru dezvoltarea a trei sate reziliente în România pe baza energiilor regenerabile, luând în considerare potențialul biomasei într-un peisaj cultural biodivers din Transilvania

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Status quo analysis

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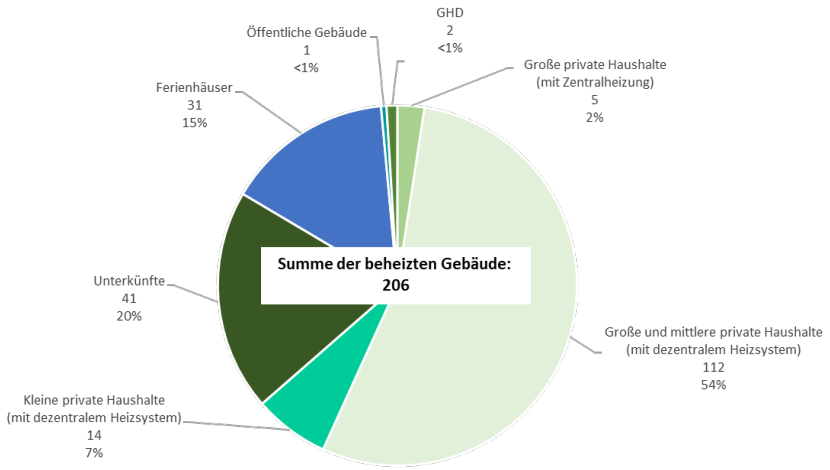
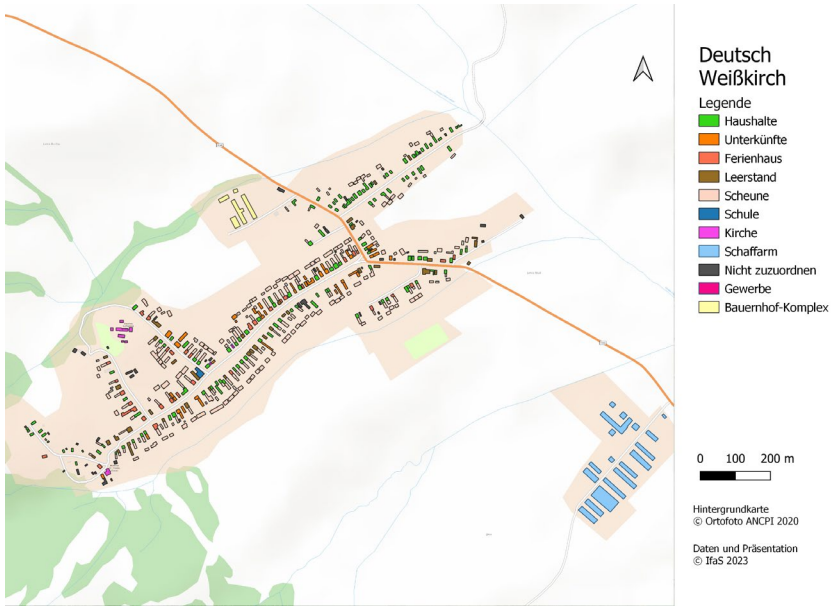
Building stock



Source: IfaS



Building stock

- Share of heated buildings ~ 38 %
- Share of other buildings ~ 62 %

Heated building stock

- Share of private households ~ 63 %
- Share of accommodation ~ 20 %
- Share of vacation houses ~ 15 %
- Share of public buildings ~ 2 %

Heating system

- Share of decentralized ~ 93 %
- Share of centralized ~ 7 %

→ **Private households are predominant heated buildings**
→ **High proportion of decentralised heating systems**

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Current energy demand and GHG emissions (2021)

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Energy sources

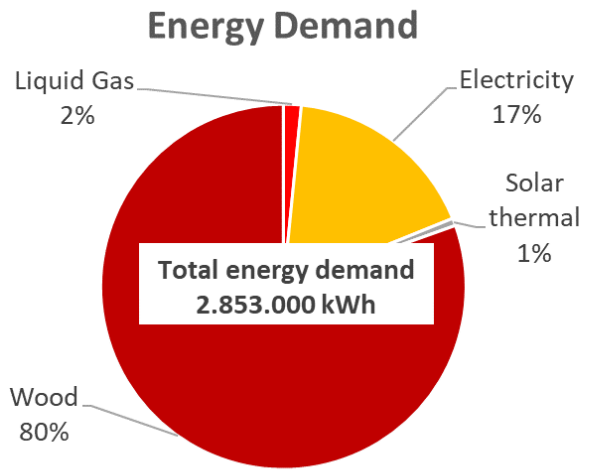
- Wood, LPG, electricity, solar thermal

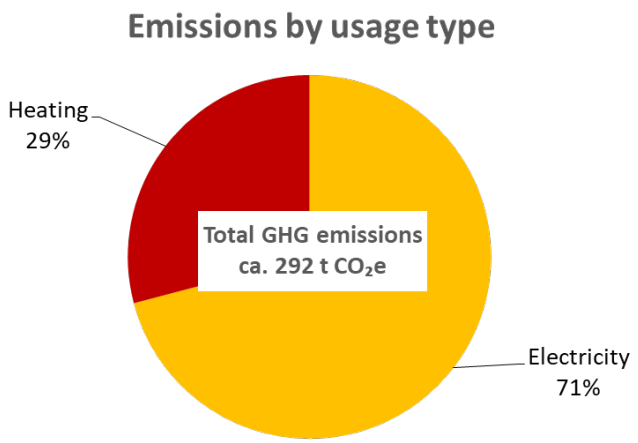
Average per household

- Energy demand 14.500 kWh/a
- GHG emissions 1,3 t CO_2e/a

→ **High share of wood usage**

→ **Electricity has the highest GHG impact**





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Current situation and goals

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Photo: IfaS

Current situation

- High energy costs due to the 2022 energy crisis
- Uncertain future energy price development
- High share of wood based heating systems
- Future stress on forestry eco-systems
- Biomass potentials are not utilized
- Historically preserved building structure and UNESCO World Heritage Site

Goal - Create villages more resilient to future challenges

- Increase the share of renewable energy generation
- Increase the resilience of the energy supply
- Utilize available biomass potentials
- New market and value chains
- Generate additional income
- Strengthen sustainable tourism
- Preserve the biodiverse landscape

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Potential analysis: Households

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Electricity supply - PV potential

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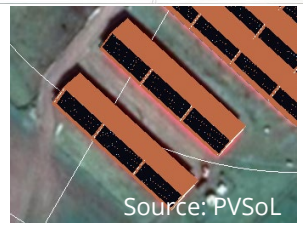
Photo: SolteQ



Particularities of the potential analysis in Viscri:

- UNESCO World Heritage Site
- Visibility of rooftop PV systems should be minimized

Potential solutions:

- PV tiles & rooftop systems
- Small size 800W photovoltaic system
- PV roof systems on the buildings of the farms:
  - Sheep Farm (Iulian Enache)
  - Transylvania on Horseback (Farm Complex)
- Carport on the existing parking lot
- Agri PV on the sheep farm Iulian Enache

Electricity

- Electricity consumption: approx. **493.000 kWh/a**
- PV production: approx. **4.614.000 kWh/a**
- Share PV: **985 %**

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Household PV systems

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Photo: IfaS

Small PV system for households

- Two modules (800 W_p) per building
- Suitable for small consumers
- Solar coverage:
  - 20 – 85 % (until 2030: quantitative balancing)
  - 10 – 25 % (from 2030: financial compensation)

Investment
3.000 – 4.000 RON

Amortization
4 – 6 years


Source: SolteQ

PV tiles for household

- 3,24 kW_p per building
- Suitable for medium or large households
- Solar coverage:
  - 60 – 100 % (until 2030: quantitative balancing)
  - 20 – 25 % (from 2030: financial compensation)

In developing phase


Source: PVSoL

Rooftop PV systems for households

3,24 kW_p per building

- Suitable for medium or large households
- Solar coverage:
  - 80 – 100 % (until 2030: quantitative balancing)
  - 25 – 35 % (from 2030: financial compensation)

Investment
20.000 RON

Amortization
8 – 12 years

→ **Special attention to the building of PV and its view from the church**

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Photovoltaic (PV) system

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How to determine the optimal PV size?

1.Determine annual electricity consumption under consideration of future energy demand
2.Determine electricity yield of PV (see graphic below)

Electricity yield

(Table does not include shadings of the roof)

Modulneigung	Süd	Ost/West	Ost	West	Nord
10°	1195	1100	1100	1095	995
30°	1285	1040	1045	1035	750
45°	1275	975	985	965	580
60°	1205	890	900	880	440
90°	885	675	680	670	320

Stromertrag in kWh pro kW_p Modulleistung und Jahr

$$\text{PV system size } (kW_p) = \frac{\text{Annual electricity consumption(kWh)}}{\text{Electricity yield } (\frac{\text{kWh}}{kW_p})}$$

$$\text{PV system size } (kW_p) = \frac{3.000 \text{ kWh}}{900\ kWh/kWp} = 3{,}33\ kW_p$$

1 kW_p requires 5-7 m² of roof area
Recommended to compare at least two offers

Building efficiency potential
(private households)

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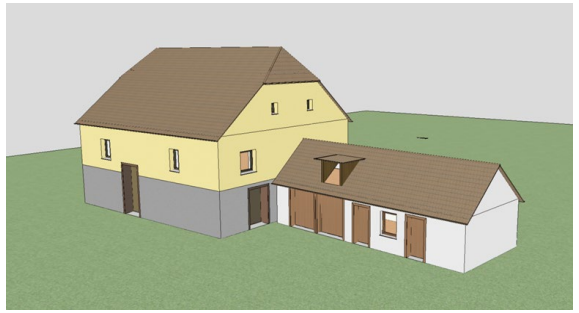

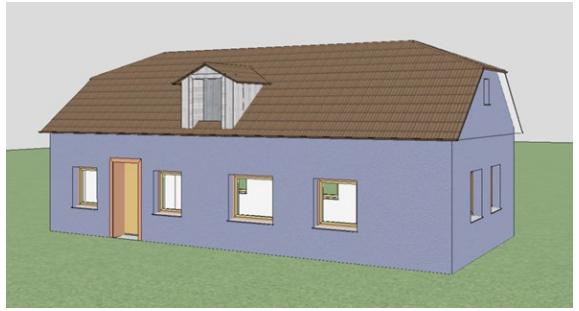

Energy saving potential

- By insulating attic and basement ceiling: **21 – 37 %**
  (simulation results with software *Solarcomputer*)
- Total energy saving potential related to building efficiency measures in 2050: **663.000 kWh**
  (only attic and basement ceiling; 4 % annual building renovation rate ≙ **6,4 buildings**)

Heat

- Heat demand: approx. **2.359.000 kWh/a**
- Efficiency savings potential: approx. **663.000 kWh/a**
- Reduction by efficiency savings: **28 %**

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Building renovation
(Private households)

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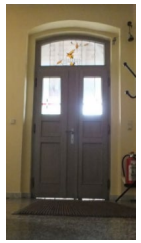
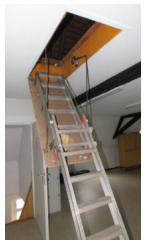
Hamp insulation
© Bezirksverband Pfalz


Photo: IfaS

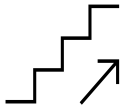



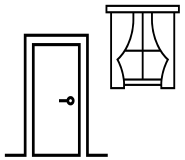
Photos: IfaS

Natural insulation materials

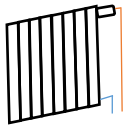
- Such as hemp, flax, sheep's wool or wood
- Contain fewer harmful substances and store CO_2
- Provide moisture control and better living comfort

Low-cost energy saving measures

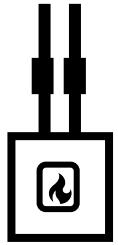

Attic stair seal


Window and door seal
Install box-type windows or window films


LED Lighting


Smart thermostatic valves (timer)
Hydraulic balancing of the heat distribution


Energy-efficient appliances


Pipe insulation
High-efficiency heating pumps

Eliminate over dimensioning of heating systems

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Household heat supply

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Photos: IfaS

Utilization of electricity potentials for heat supply by installing air conditioning units

- Air-conditioning units (air-to-air heat pump) are a decentralized solution for heating rooms
- Perfect to reduce wood fuel demand
- **Coefficient of performance (COP): ≈ 1 kWh electricity for 4 kWh heat**
- Cooling possible in the summer months
- Installing the outdoor unit on attic – ventilation of attic recommended
- Through a PV system, the additional electricity demand can be self-produced in the transitional seasons

Investment
1.750 – 4.500 RON

Savings
400 – 750 RON/a

Amortization
5 – 10 years

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Building renovation recommendation:
Large households with central heating system

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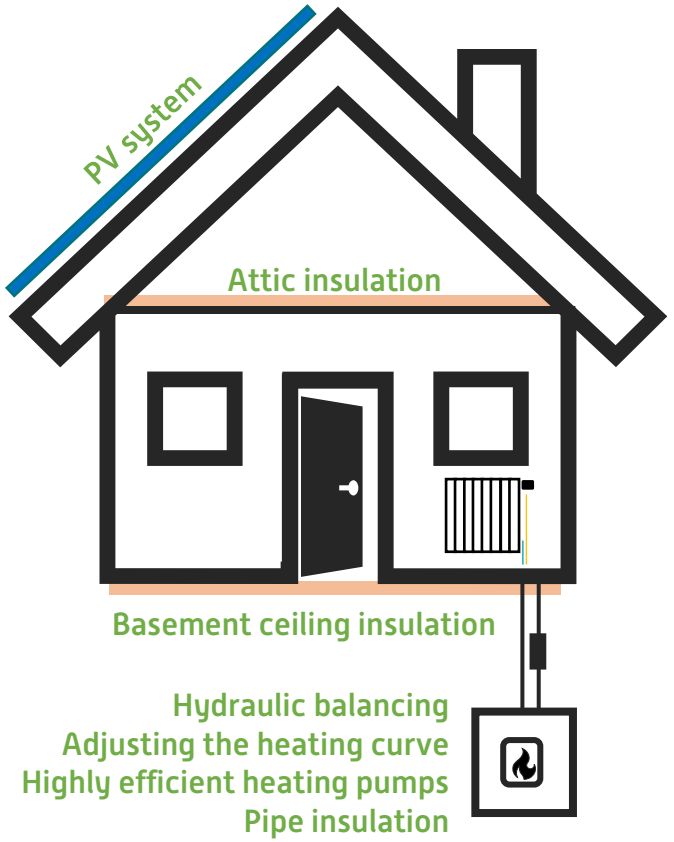

Electricity

Before:
4.000 kWh/a

After:
3.600 kWh/a (– 10 %)

Heat

Before:
48.000 kWh/a

After:
30.300 kWh/a (– 37 %)

Investment

Insulation:
21.400 – 35.800 RON

Heating system renovation:
6.000 RON

PV system:
3.250 RON (0,8 kW_p)
20.000 RON (3,3 kW_p)

Savings*

Heating: 1.700 – 4.500 RON

Electricity (with 0,8 kW_p PV): 250 RON

Electricity (with 3,3 kW_p PV): 1.000 RON

Payback period

8 – 12 years

*Assumptions: Wood price: 0,1 – 0,25 RON/kWh, Electricity price: 1,3 RON/kWh

Building renovation recommendation:
Small/medium households with decentral heating system

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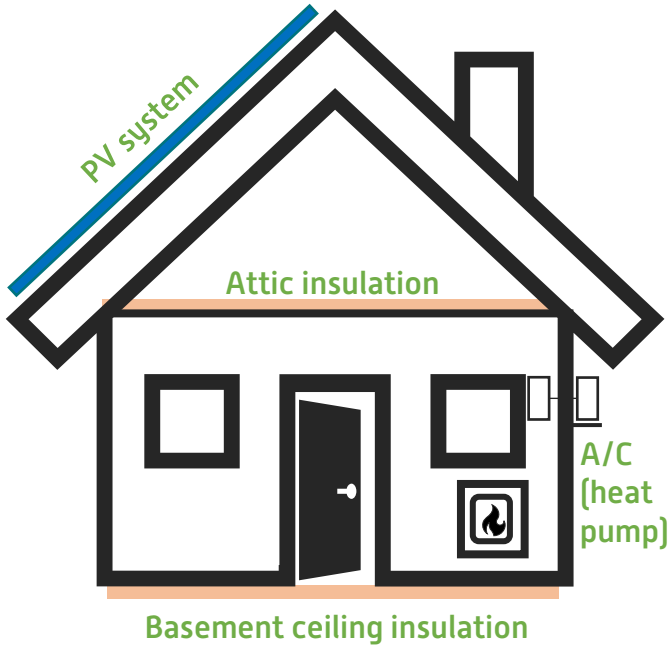

Electricity

Before:
2.000 kWh/a

After:
3.000 kWh/a (+ 50 %)

Heat

Before:
12.000 kWh/a

After:
4.700 kWh/a (– 61 %)

Investment

Insulation:
13.500 – 22.400 RON

A/C heat pump:
3.400 RON

PV system:
3.250 RON (0,8 kW_p)
20.000 RON (3,3 kW_p)

Savings*

Heating: 750 – 1.800 RON

Electricity (with 0,8 kW_p PV): 150 RON

Electricity (with 3,3 kW_p PV): 600 RON

Payback period

12 – 16 years

*Assumptions: Wood price: 0,1 – 0,25 RON/kWh, Electricity price: 0,8 RON/kWh

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Potential analysis: Village

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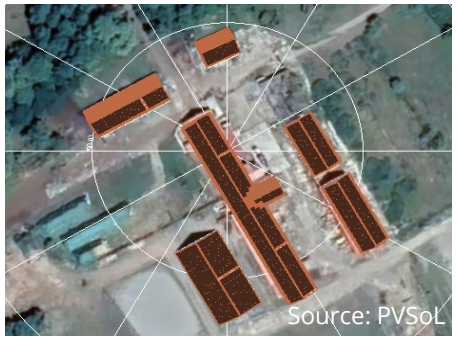
Village PV plant & carport

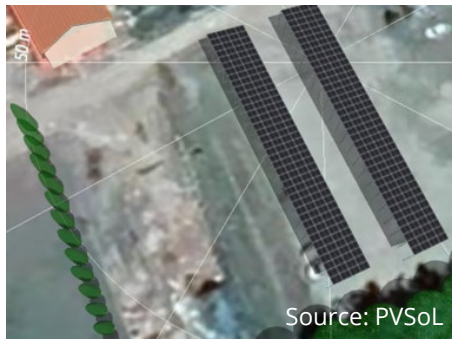
Village PV plant on the Iulian Enache sheep farm

- 1.070 kW_p
- Each resident can rent e. g. 3 kW_p (in addition to the small PV)
- Solar coverage:
  - ~ 100 % of the village electricity demand (until 2030: quantitative balancing)
  - ~ 41 % of the village electricity demand (from 2030: financial compensation)



Village PV plant on the Transylvania on Horseback

- 400 kw_p
- Each resident can rent e. g. 3 kW_p (in addition to the small PV)
- Solar coverage:
  - ~ 95 % of the village electricity demand (until 2030: quantitative balancing)
  - ~ 46 % of the village electricity demand (from 2030: financial compensation)



Carport

- 126 kw_p
- Solar coverage (example village demand):
  - ~ 26 % of the village electricity demand (until 2030: quantitative balancing)
  - ~ 25 % of the village electricity demand (from 2030: financial compensation)

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Heat supply through agroforestry systems

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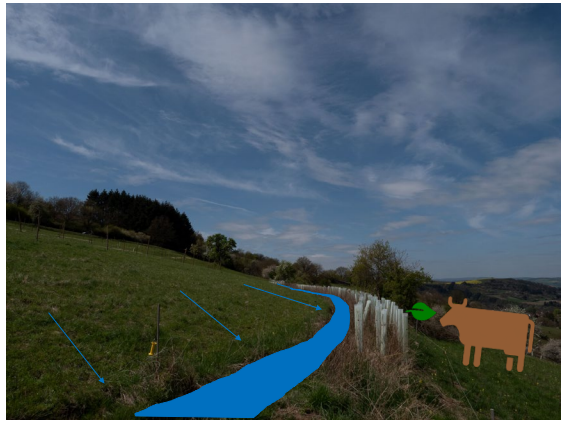

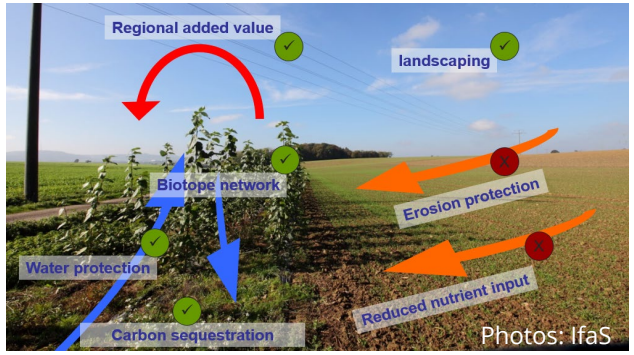

Photos: IfaS

Agroforestry system: Strip cropping

- Fast growing energy trees are combined with slow growing trees for value wood production
- Width of 6 to 25 meters
- Harvesting every 3 to 12 years
- Planting along the slopes at a distance of 20 to 100 m
- Area between the woody strips is still usable

Benefits to ecosystem

- Water management:
  - Water retention during rainfall
  - Improved water availability during dry periods
- Erosion protection (water and wind)
- Reduction of heat stress
  - Shading of the boundary area helps species threatened by climate change
- Carbon storage through increased humus build-up
- Intensification of soil life
- Biotop connection

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Agroforestry as erosion protection

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Erosion protection

- Establishment of agricultural wood strips for energy generation
- Strips are planted transversely to the slope, reducing water erosion
- To prevent wind erosion, the strips are planted perpendicular to the main wind direction


Photo: F. Wagener (IfaS)

Agroforestry system / farmland

- Available area: approx. 18 – 22 ha
- With 8 - 14 t_{DM}/ha → approx. 13$_{W20}$t/ha
- Calorific value: approx. 3.000 – 3.500 kWh/t


Photos: IfaS

Heat

- Heat demand: approx. **2.359.000 kWh/a**
- Biomass potential: approx. **930.000 kWh/a**
- Biomass share: **38 %**

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Bioeconomy – utilizing biomass potentials

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Current situation:

- The sheep wool is left in the fields and is often burned
- Maintaining grasland is depending on EU incentives
- Animal manure and agricultural residues are used as fertilizer in fields
- Unused fodder (lucerne)


Photo: IfaS

Aims:

- Reduction of nitrogen, methane and CO_2 emissions
- Energy production
- Creating new value chains, jobs and perspectives for famers


Photo: IfaS

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More values from waste
(Biomass-Resource-Center)

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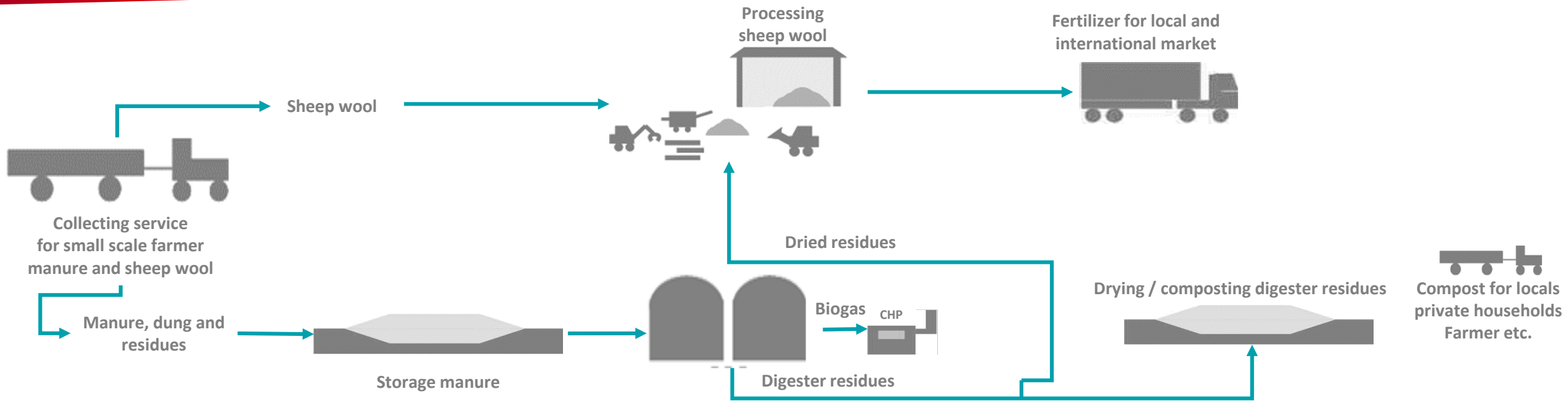
Less environmental impacts



Higher value from waste and higher income generation

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30 kW_{el} Village biogas plant

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Biogas potential

- Approx. 450 cattle, 2.500 sheep
- Cows and most of the sheep graze on pastures during the day
  → reduced biogas potential

Potential energy yield

- Biogas yield: approx. 165.000 m³/a
- Energy content: approx. 635.000 kWh/a

→ **30 kW_{el} biogas plant with a combined heat and power plant**


Photo: FNR

Electricity

- Electricity consumption: approx. **493.000 kWh/a**
- Potential: approx. **250.000 kWh/a**
- Share: **51 %**

Heat

- Potential: approx. **120.000 kWh/a**
- Heat can only be used at the point of generation

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Bioeconomy – creating new values

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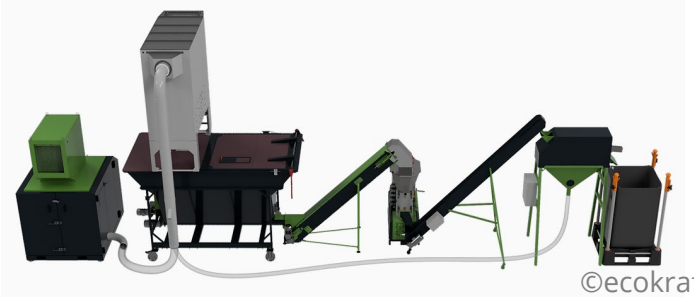

Pellets can be produced as:

- Energy source
- Fertilizer
- Animal food
- Litter

➢ Mixing the solid fermentation residues from the biogas plant with sheep wool to produce fertilizer pellets (70 % wool and 30 % manure)

➢ High quality pellets can be made from waste

Small scale equipment

- Production of 180 kg of pellets per hour
- Manure of 61 sheep + wool of 42.500 – 64.000 sheep
- Compression of 3:1 – 6:1
- Investment: 950.000 RON
- Selling price (Germany): min. 7.700 RON/t (net)

→ logistical effort to collect the wool

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Energy and GHG balance

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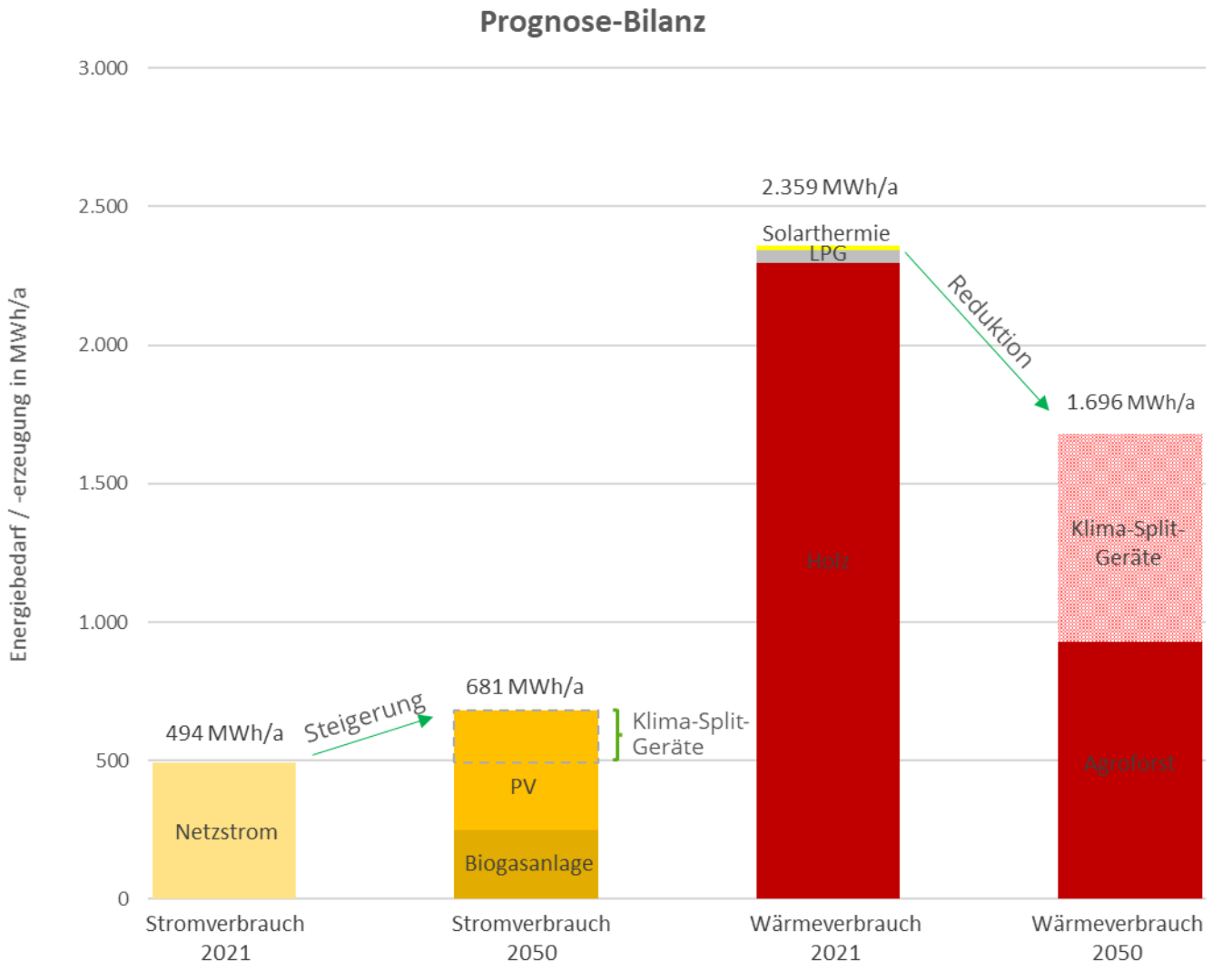
Forecast of the energy mix



Balance 2021

- Electricity 100 % grid purchase
- Heat demand
  - → 97 % wood
  - → 2 % LPG
  - → <1 % solar thermal

Diversification increases the resilience

Balance 2050

- Electricity:
  - 63 % PV- production
  - 37 % Biogas plant
- Heat:
  - 55 % Agroforestry
  - 45 % Air conditioning (PV electricity)

Forecast of the GHG emissions

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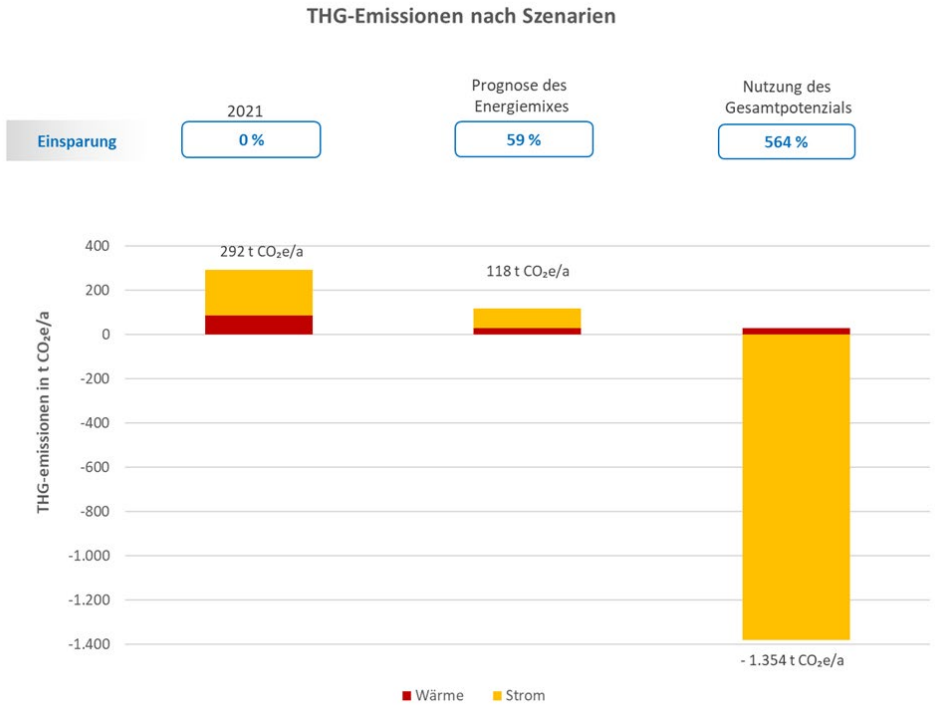
2050 | **In total the GHG emissions are around – 1.354 t CO_2e if all potentials are utilized**



Forecast of the 2050 GHG emissions

- 59 % reduction in villages GHG emissions compared to the 2021

Utilization of all potentials

- 564 % reduction in villages GHG emissions compared to the 2021

GHG emissions are calculated with scope 3

→ **Carbon neutrality is achievable**
→ **Carbon negative village is possible if all potentials are used**

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Key findings of the project

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More electricity can be produced from PV plants then the village currently needs

Current heating demand can be partially covered from locally produced wood

High energy saving potentials by insulating attic and basement ceiling

New value chains from sheep wool, animal manure and other can be created

Village can become CO_2e neutral

Village can become net energy supplier

Renewal of the village electricity grid

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Next steps

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Village Networking

- Establishment of a cooperation network between neighboring villages for knowledge sharing, future projects and joint development

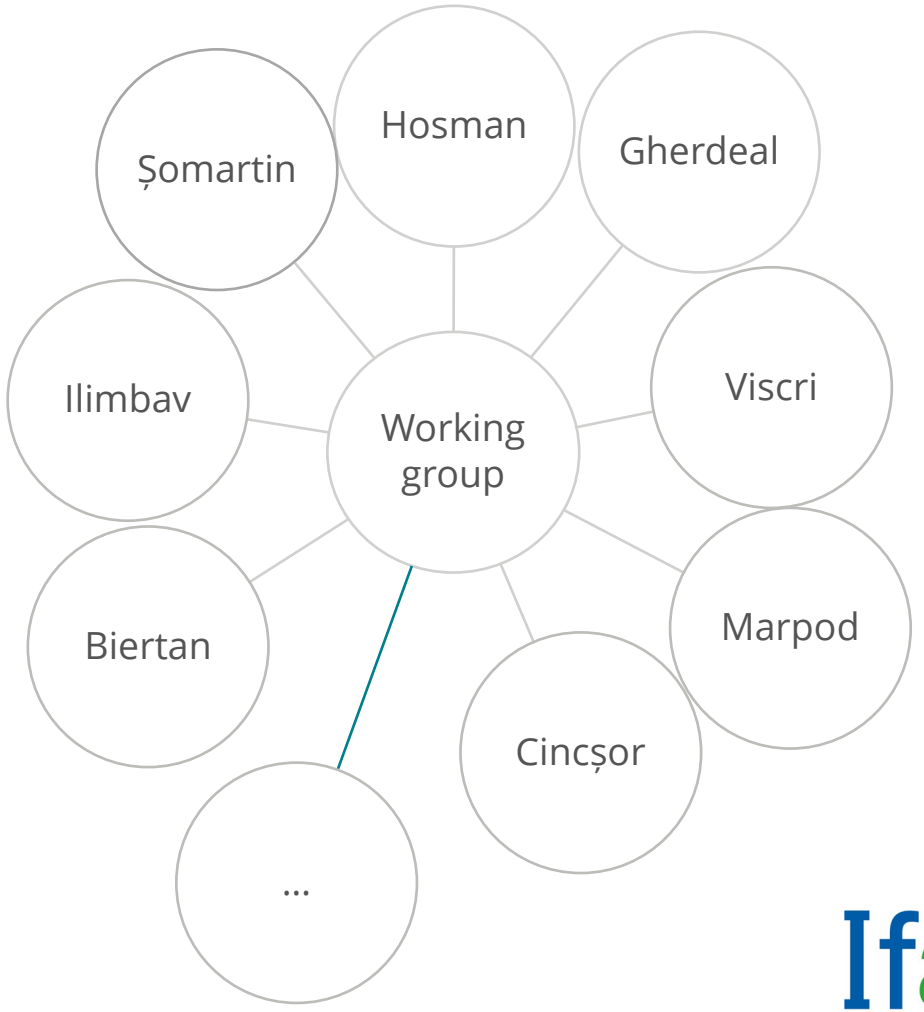
Forming working group

- local organizations, institutions (e.g. the Protestant church), village administration, active citizens to form a working group in each village

Develop new projects

- Using the provided measures and by creating new ideas

Jointly applying for funding



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