

SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society



Lars Rydén Professor Emeritus Uppsala University

Master Course on Sustainable Development and Sustainability Science For Uzbekistan by SASS and Karakalpak State University Spring 2025

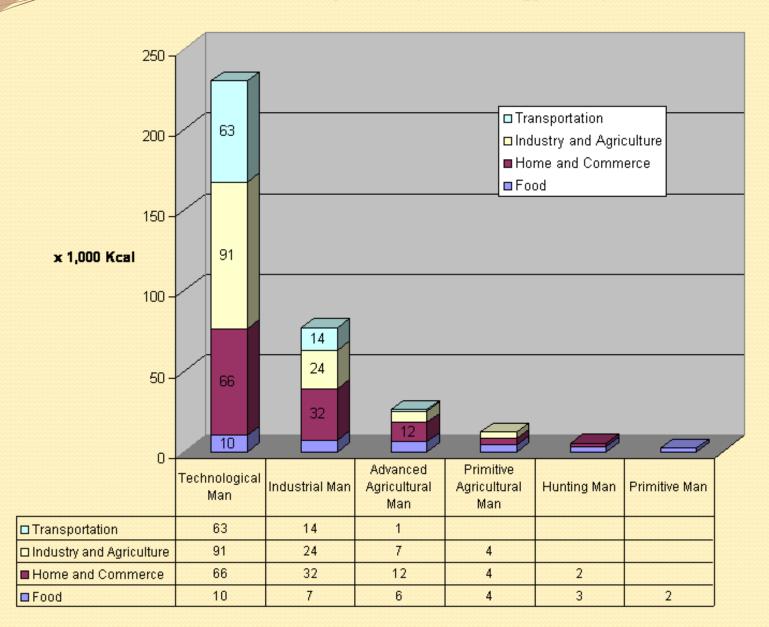
Energy use per capita in different societies

- Biological
- Gatherers, hunters
- Agriculture
- Industrial society
- Contemporary

2.4 kWh/day

- 10 kWh/day
- 25-50 kWh/day
- 50-100 kWh/day
- 250 kWh/day

Daily Consumption of Energy Per Capita



Two different kinds of energy

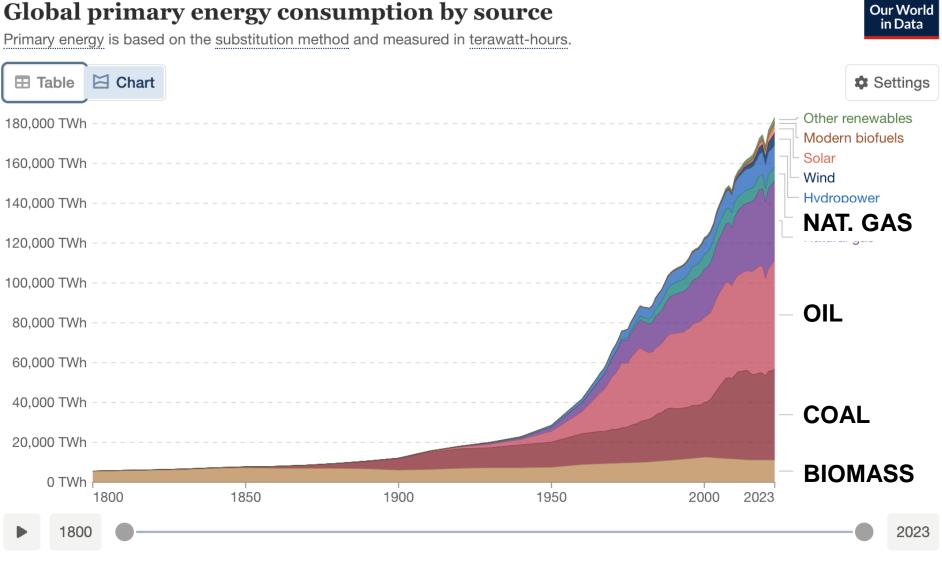
Non-renewable (fossil) energy resources

- Coal
- Oil
- Gas

Renewable – flowing - energy resources

- Biomass and other forms of bioenergy
- Hydropower
- Wind power
- Solar power

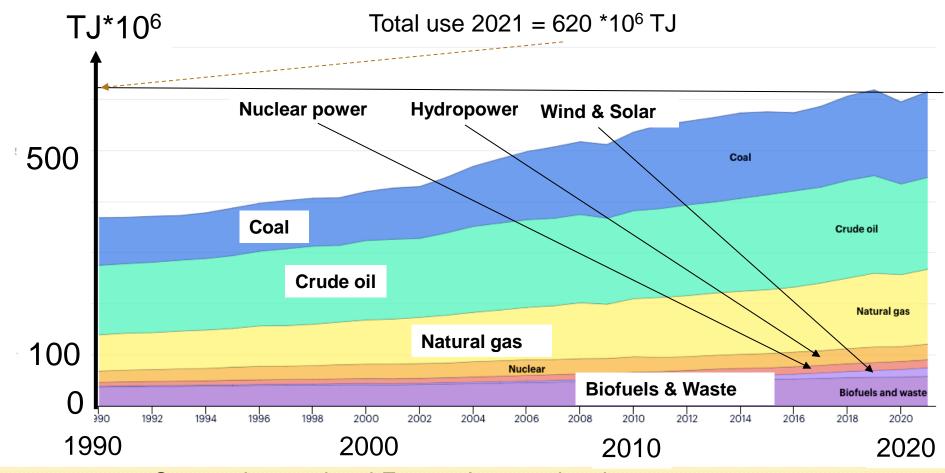
https://ourworldindata.org/energy-production-consumption



Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017) – <u>Learn more about this data</u> **Note:** In the absence of more recent data, traditional biomass is assumed constant since 2015. OurWorldinData.org/energy | CC BY

53

World total Energy use 1990-2021, TJ

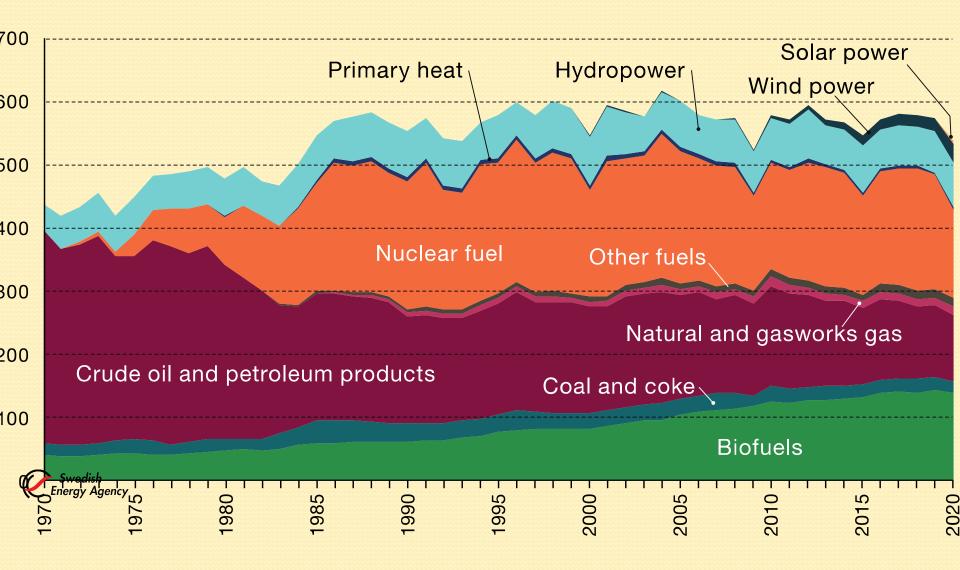


Source: International Energy Agency data browser, 2023

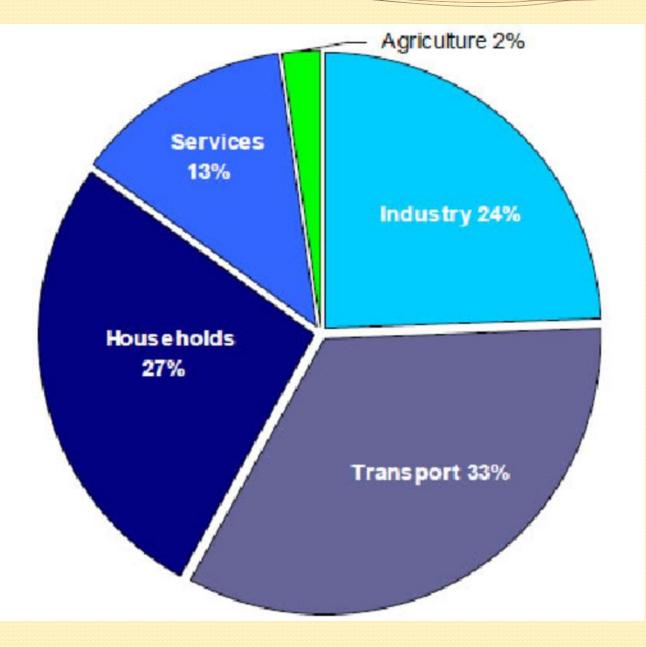


https://energytransition.org/2018/06/central-asias-green-horizons/

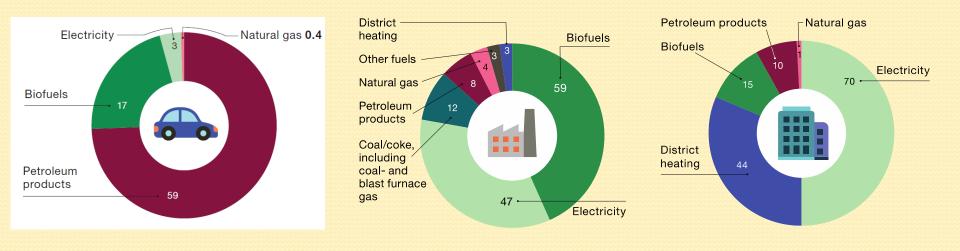
Sweden - Total supplied energy 1970–2020, TWh



Energy use



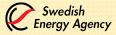
Final energy use in the different sectors 2020, TWh



Transport

Industry

Households and business

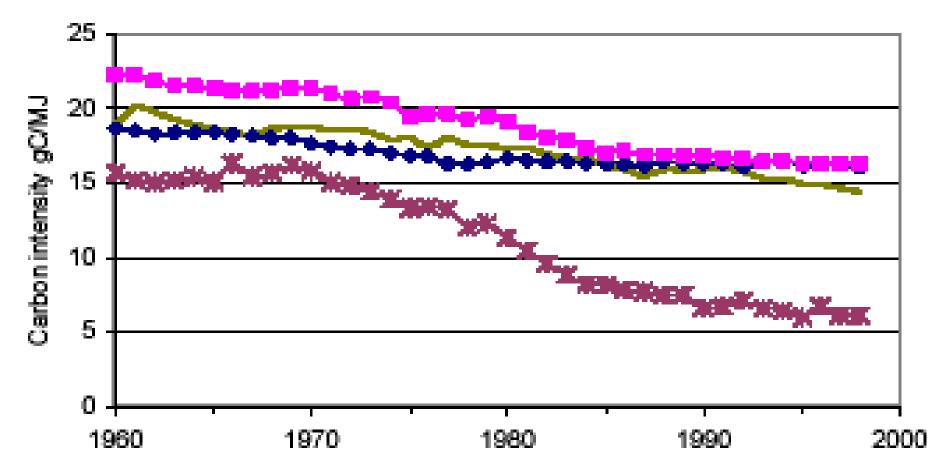


Renewable Energy supply and use

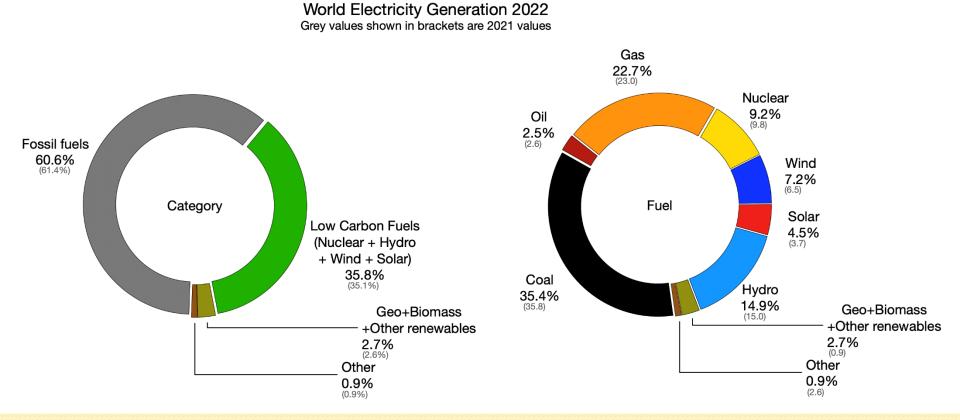
Carbon content of energy

From *Decoupling*, Azar, Holmberg and Karlsson, Chalmers University of Technology, 2002 based on IEA statistics





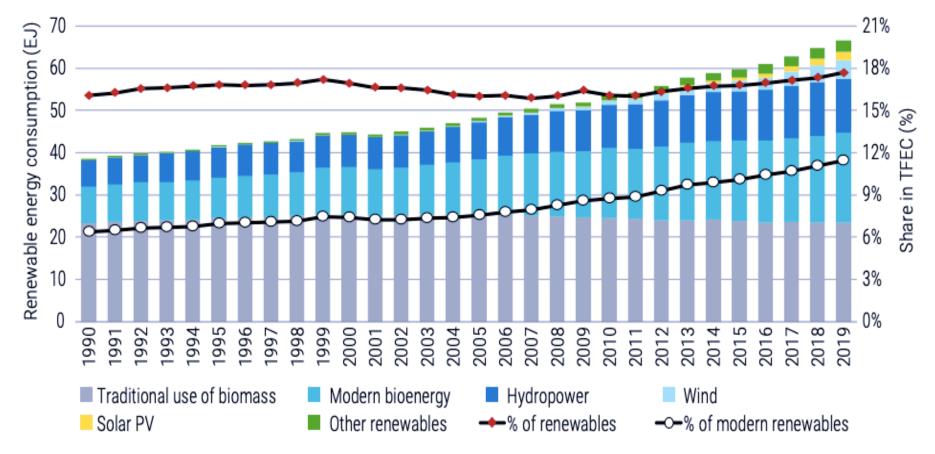
World Electricity Generation 2022



https://www.worldenergydata.org/world-electricity-generation/

Renewable Energy in the world

FIGURE ES.5 • Renewable energy consumption by technology and share in total energy consumption, 1990-2019

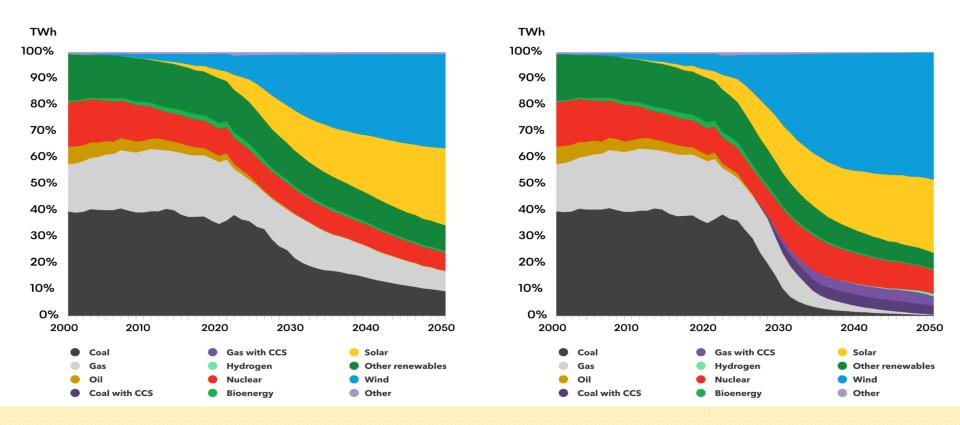


Source: IEA 2021a and UNSD 2021.

Sun and wind power dominates investments today, and will dominate in the future

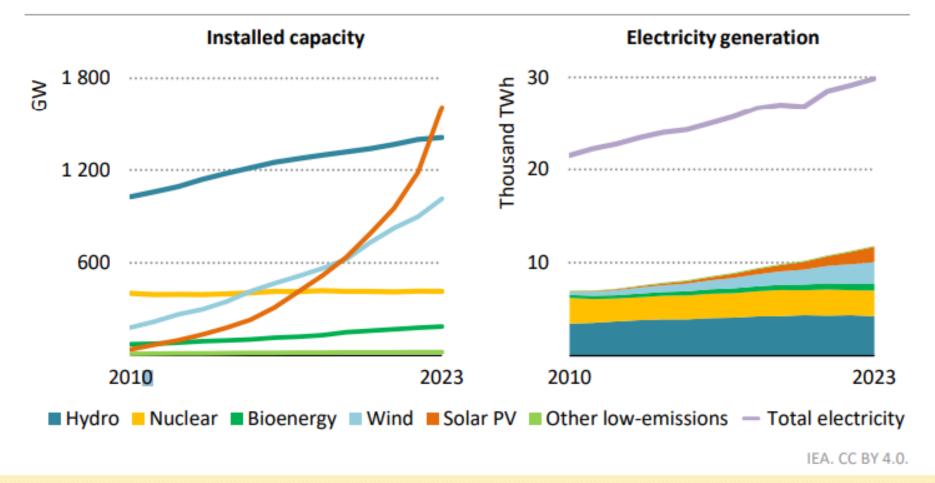
Electricity generation by technology, by scenario

Economic Transition Scenario



Net Zero Scenario

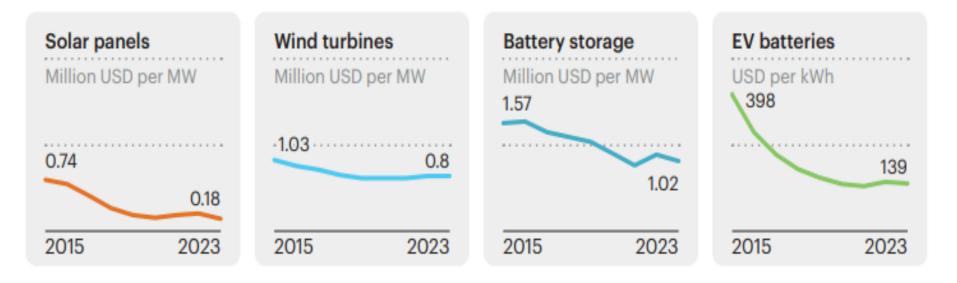
Figure 1.14 Global installed clean power capacity and electricity generation, 2010-2023



Source: WorldEnergyOutlook2024.pdf

Falling clean energy prices

Recent years have seen large overall price reductions for many clean energy technologies.



Storage of energy

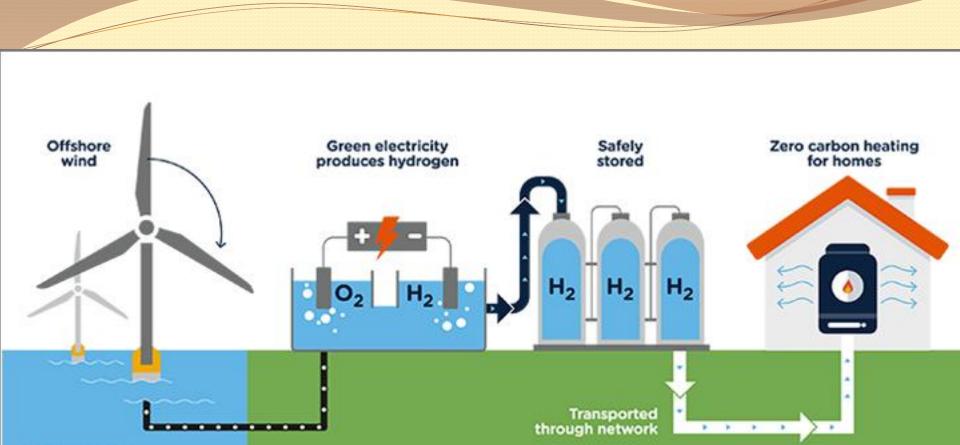


Enormous amounts of energy is stored in biomass



How can we best harvest the biomass?

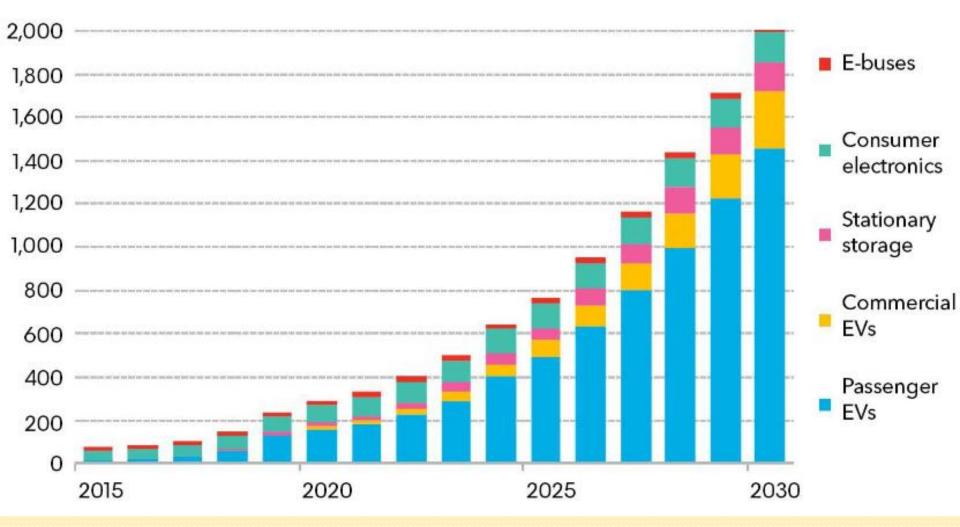
Energy is stored in the reservoirs of hydropower plants



Energy can be stored as hydrogen gas

Annual lithium-ion battery demand

GWh Energy can be stored in batteries



Source: Bloomberg NEF 2019 Electric Vehicle Outlook

Energy efficiency

Energy conservation: Insulation of pipes and covers on containers Building a passive energy house





A passive energy house

Improved technology

Torraca, Italy, has LED for all street lights

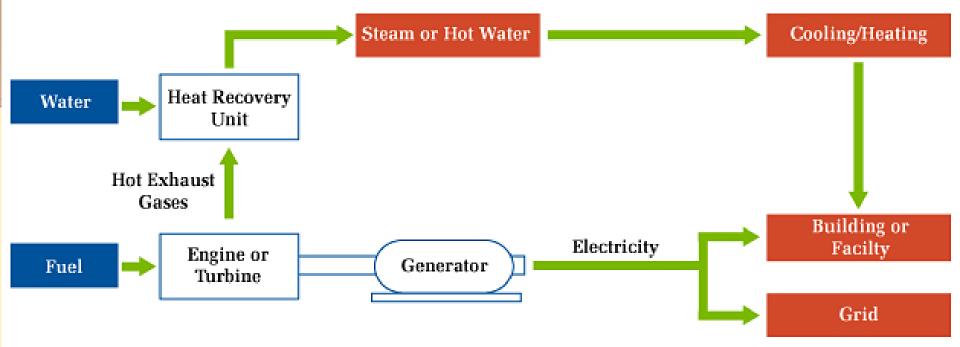




Improved technology

Electric cars

Combustion engine: 15 % of energy comes to the wheels Electric engine: 90 % of the energy comes to the wheels



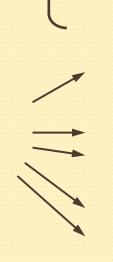
Power stations

Careful use of energy: Combined heat and power cogeneration

Energy intensity (J/h)

Very low (zero)

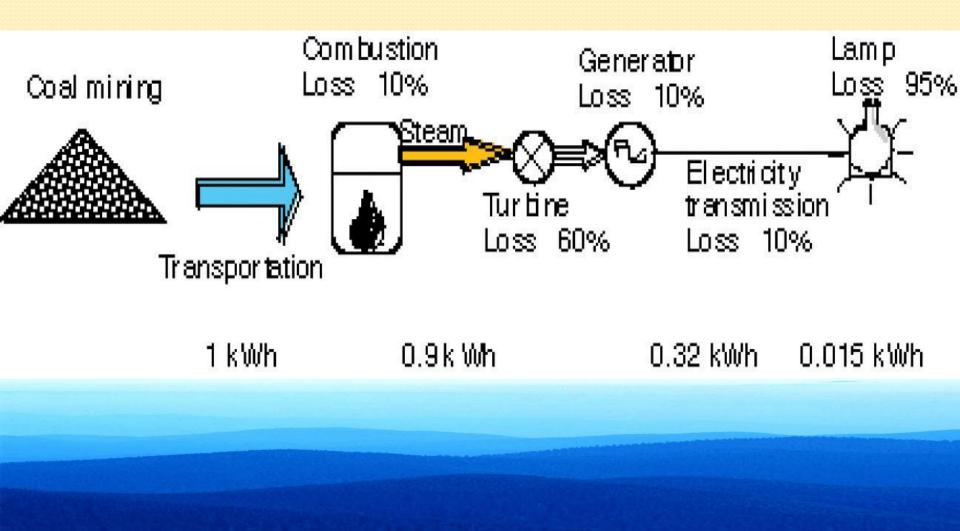
Use of appliances: medium high



Commuting: high

Activity	Happiness
Sex	4,7
Socialising	4,0
Relaxing	3,9
Praying/meditating	3,8
Eating	3,8
Exercising	3,8
Watching TV	3,6
Shopping	3,2
Preparing food	3,2
Talking in phone	3,1
Taking care of children	3,0
Computer/internet	3,0
Housework	3,0
Working	2,7
Commuting	2.6

Why demand management is better than increased production



PFE - Energy Efficiency in Large Companies Swedish Energy Authority

- 100 companies took part
- All made a complete energy use mapping
- All introduced a certified energy management system
- 1247 projects and 1.47 TWh less electricity annually
- 708 MSEK in investments
- 400 MSEK less energy costs annually
- Average return of investments 1.5 year
- Tax reductions 150 MSEK annually



Mapping Energy use, project proposals

- 1. Background
- 2. Photos
- 3. Energy efficiency proposals
- 4. Drawbacks of each
- 5. Calculations kWh, Investments,

Return on investements

#818-42 Usag Verwerk 385-By \$1867 loof bining

her her gen van gjorden vinde af anget 12 velevelt 201 var is alleg investionsament. Die plataals gevelerene Nationale de standarden fire inglesi

descination field lyn. Known orderfe

- to not diret appropriate werten being wird in the sense of the sense of the sense of the sense of the sense of
- en bieffert fil terr and a state of the second second

COLUMN TO BE terber beine all unne bitt i gerbitt Diereten eine gitte article) they with the pill asternal indices has extended and there that it is singpost and for which it has place and that it



Silve ingles

Ag upp 100 m/2 with develop out, 100 m/2 with responde 1 below and non- Table as the same with an end same samply advects a randoming or upp of our models and there are non-samply finders in the same same result of an information of the same same samply finders in the same result of an information. ling uppritting for the

Dermansen and an eligen sticker starte typpates d'har manieproting the section Marine type start foliate (fourte annuarie)

Bearinging in the strendling

Frank de autoble - Marie Catave Contago hatea al doite e rigares e latendaria e se et per

\$514.42 Using Valuence 363-By \$1527 **Uppf Name**

ter bester men er er bester vierte er er anver i die der bei bei er bester er bester er bester bei bei bei bei

aprimen installenden (FE) halv er eingenalter i by FEIT vord denem Ury FEIT ign Kinning en djertig presa Is 2008 och ens verdiender ei dieder Ridgebanden gebietenen Wie schweder. Ur is anne machteligijk and the large of the different scine with the factor is concernsition services inform

- Dieg wir all is het fei geste sterpt. Kein die nach stiept oppropriest versichlich preisig all Germany and it maars all et referati Capitornige ult din mingle i fallere til ramma agrepe

Copele investell another size into alog advantation of the interest appropri-lations representing action i agra aggragater for attempt to a full article interest.

igite gen try it would be a series of the se nd earlach i bhliana (Mille). Thag cuile bha guile ndaran i bhliana bar aint Sandain an Bhlian (Cail 14) C mha rifegalanaith ann ainte geann rigge air by fhill far ghag an Said (S



Silve ingles

May map till Staff i virke der witet och 1996 er Vir sich nach ander i Alleren. Ladien i verbiltet er Jahrlinsen 1995 an har start verb et sitte sing gescheren i materiarier i beiteren vers ett te migh af am filestin (fileme an tesing på hafter i billeres i sin or

andle für deler

Herein einsteine eiliger wirder einde teggnahn die nasiege wiegett einerfiere. Kenteringerienerfichete (Sexter auszehlt) benfe tim ber strenit in

ander medizieler "Nil en Gebeure Consignationing einitisten einigenets wielde statenten erschägen)

52 projects during 2 years

Primary improvements

Temperature adjustments Heat recovery New valves Insulation Changed routines New lighting Toilets

Secondary improvements

Reduced water use Decreased fire risks Less air pollutants Less noise

Results after 2 years

Accomplished 19 304 MWh /year Under planning 32 942 MWh /year



30 minutes

- Discuss which kind of energy you use
- Discuss which kind of energy your university uses
- Discuss how can you save energy

After 10 minutes we meet and talk together!

Increased use of renewable resources

- promoting local development
- creates new jobs
- combats climate change
- requires competence
- creates social capital
- promotes sustainable development



HYBRIT

https://sweden.se/workbusiness/business-in-sweden/ swedish-companies-take-on-thegreen-transition

HYBRIT – Hydrogen Breakthrough Ironmaking Technology Using hydrogen and fossil-free electricity instead of coal – traditionally needed for ore-based steel production – the by-product is water instead of carbon dioxide.

In 2021, HYBRIT made its first delivery of fossil-free steel to Swedish Volvo Trucks. By 2026, the company aims to deliver fossil-free steel to the market, with a full-scale solution in place by 2035.

Hzgreen steel

112

The power plant in Enköping produces heat and electricity to the town using forest rest Products.

Yield: ca 90 % Emissions: 2,99 g CO2/kwh https://www.enae.se/

S Hanrik von Klopp

Biofuel - waste

Uppsala biogas station use organic waste, including food waste from households etc to produce biogas, methane. All citybuses in Uppsala are running on locally produced Biogas.

Similar in many Swedish cities.



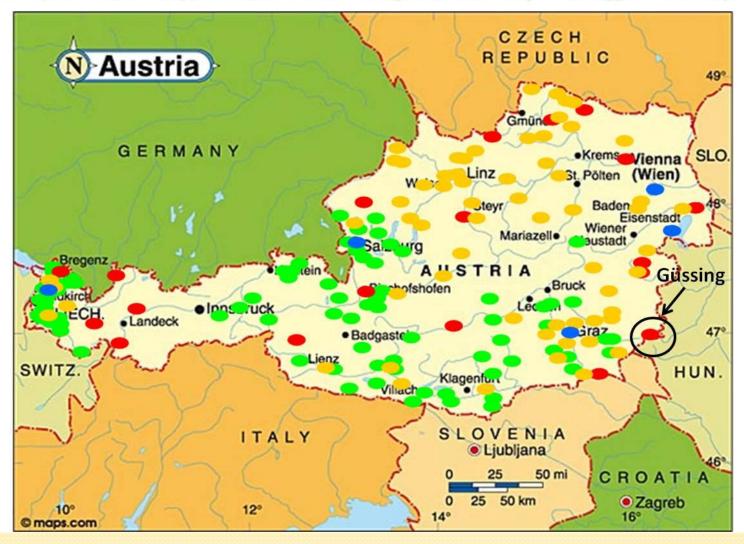
Güssing, Austria

From 1992 and in 11 years, Güssing became selfsufficient in electricity, heating, and transports. In the process 60 new companies with more than 1,500 new "green jobs" were created and commuting decreased to 40 %. On top of this Güssing now sells green energy outside the municipality to \$28 million yearly and emissions of CO2 decreased by more than 80%.

https://www.100-percent.org/gussing-austria/

Energy Independence Growing on Regional Level

Regions Independent in Electricity, Heat and/or Transportation E-Mobility Pilot Projects Regions with growing Energy Independence Regions with high Energy Efficiency standards



Networks of fossil-free municipalities in the world

- Post carbon cities, USA based
- *Local Renewables Initiative* run by ICLEI (local authorities for sustainability)
- Solar Cities network Australia
- 52 cities in Japan develops energy autonomy
- *Transition Towns* A network for munciplities with local transition initiatives to tackle the double challenge of peak oil and climate change.
- And many more!

Thank you

• Remember the whole lecture and all slides are available and should be studied again

https://www.aralsjon.nu/en/?view=article&id=180:lectures -and-presentations-2025&catid=86:sdssThe -2025