

# International best practice models on using biomass in the energy field

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# About me

- Professor at University of South-Eastern Norway (USN)
- Background from Information Systems
- Moved into research on Smart Cities
- From there to Smart Energy
- Worked on Biogas and societal awareness
- National competence boost for aviation
  - Sustainable air transport
  - Sustainable airports
- OptForEU - European project on forest management/ carbon capture and storage (CCS)

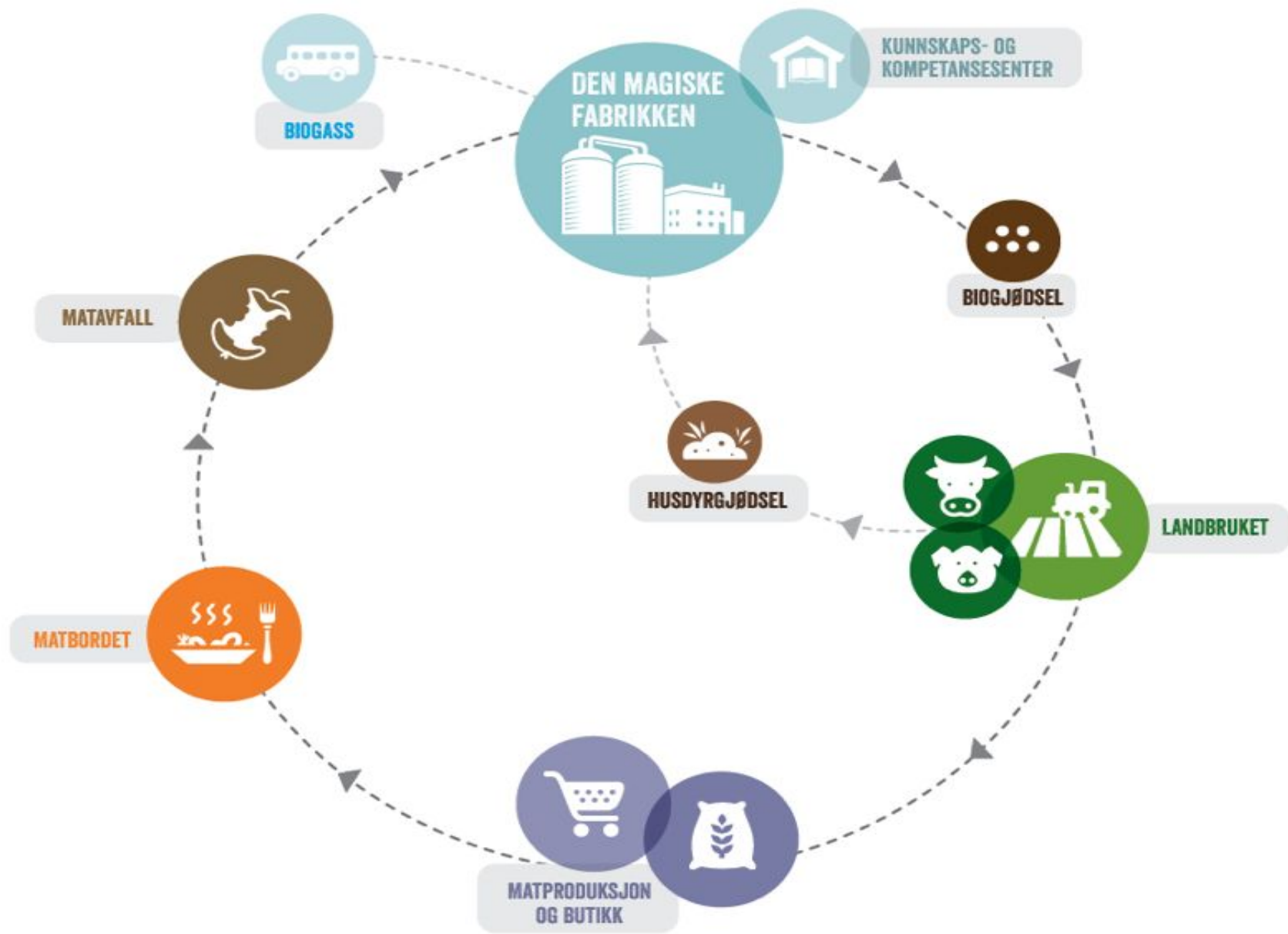






# Biogas – The magic factory







# Creating Awareness

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# Creating Awareness

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A photograph of a birch forest. The trees have characteristic white bark with dark, horizontal lenticels and vertical fissures. The leaves are a vibrant green, suggesting a spring or early summer setting. The ground is covered in lush green grass and small plants. The lighting is bright, with some lens flare visible on the right side of the image.

# Biomass



# Biomass



Trees



Plants



Food  
waste



Sludge

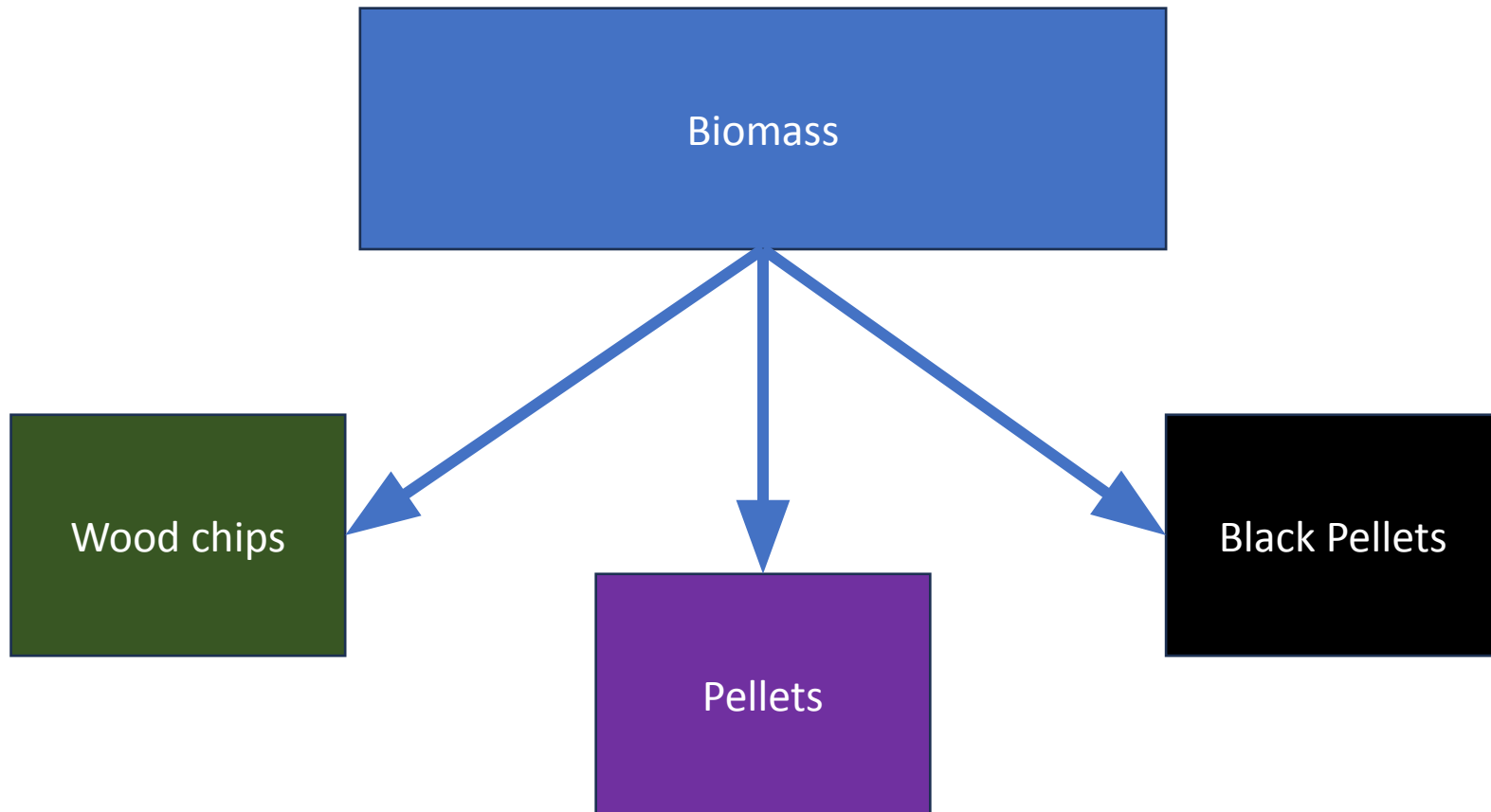
Biomass has different applications

- Energy

Biochar:

- Reduction in metallurgy
- Soil improvement
- Fodder additive

# Biomass for energy production





# Wooden chips

Used in many different settings

- Agriculture (greenhouses and livestock)
- Public buildings (schools, nursing homes, culture etc.)
- Industry and commerce (logistics/storage)
- Housing complexes

# Pellets

- Wood chips pressed together
- Alternative to wooden chips
- More density / less moisture
- Uniform shape
- Also used for domestic use (pellets ovens)





Black pellets

Torrefication

Steam explosion



# Torrefication

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- Biomass is dried and then heated to 250-300 degrees Celcius without oxygen at atmospheric pressure
- The properties of the biomass is changed
- Made into pellets





# Steam explosion

- Biomass is treated with hot steam (180-240 degrees Celsius) in a pressure boiler
- When pressure is suddenly removed, biomass fibers rupture

## 20 black pellets projects

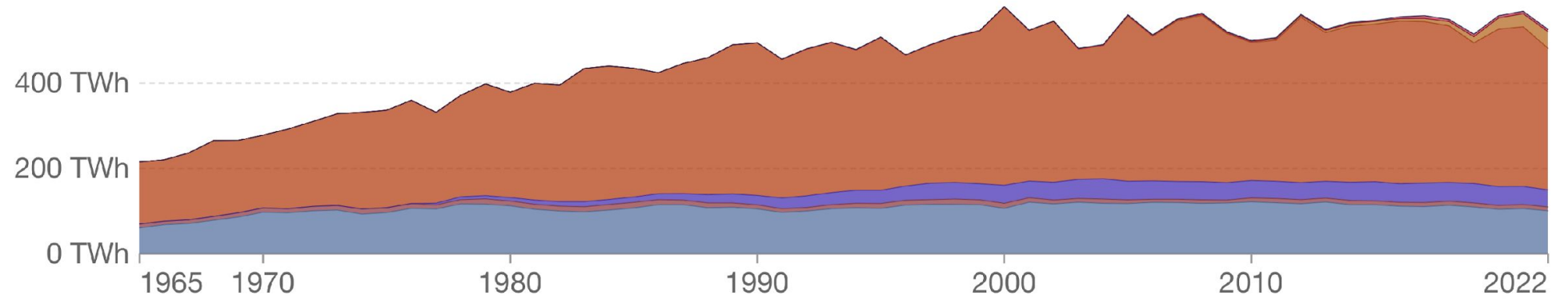
- Operating: 3
  - Under construction: 8
  - Planned: 7
- Torrefication: 14
  - Steam explosion: 6

# Energy consumption by source

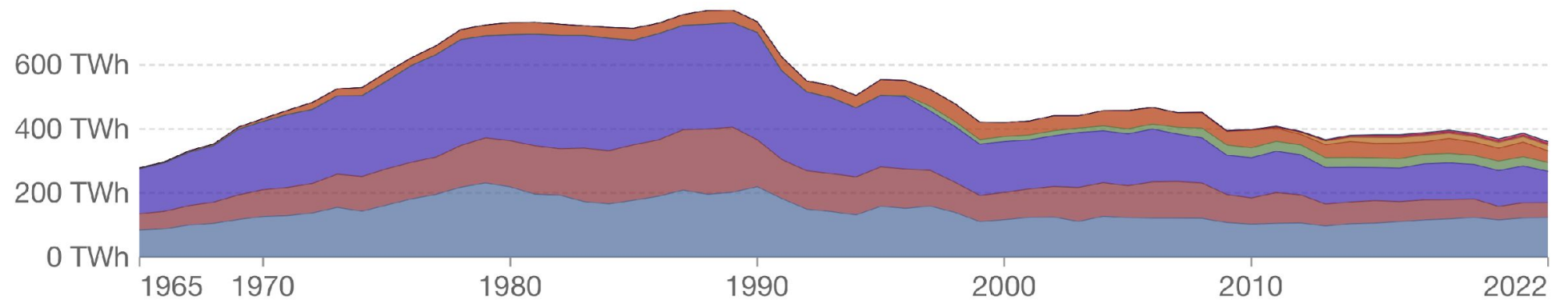
Primary energy consumption is measured in terawatt-hours (TWh). Here an inefficiency factor (the 'substitution' method) has been applied for fossil fuels, meaning the shares by each energy source give a better approximation of final energy consumption.

■ Other renewables 
 ■ Biofuels 
 ■ Solar 
 ■ Wind 
 ■ Hydropower 
 ■ Nuclear 
 ■ Gas 
 ■ Coal 
 ■ Oil

## Norway



## Romania



Energy mix  
in Norway  
vs. Romania

Source: Energy Institute Statistical Review of World Energy (2023)  
Note: 'Other renewables' includes geothermal, biomass and waste energy.

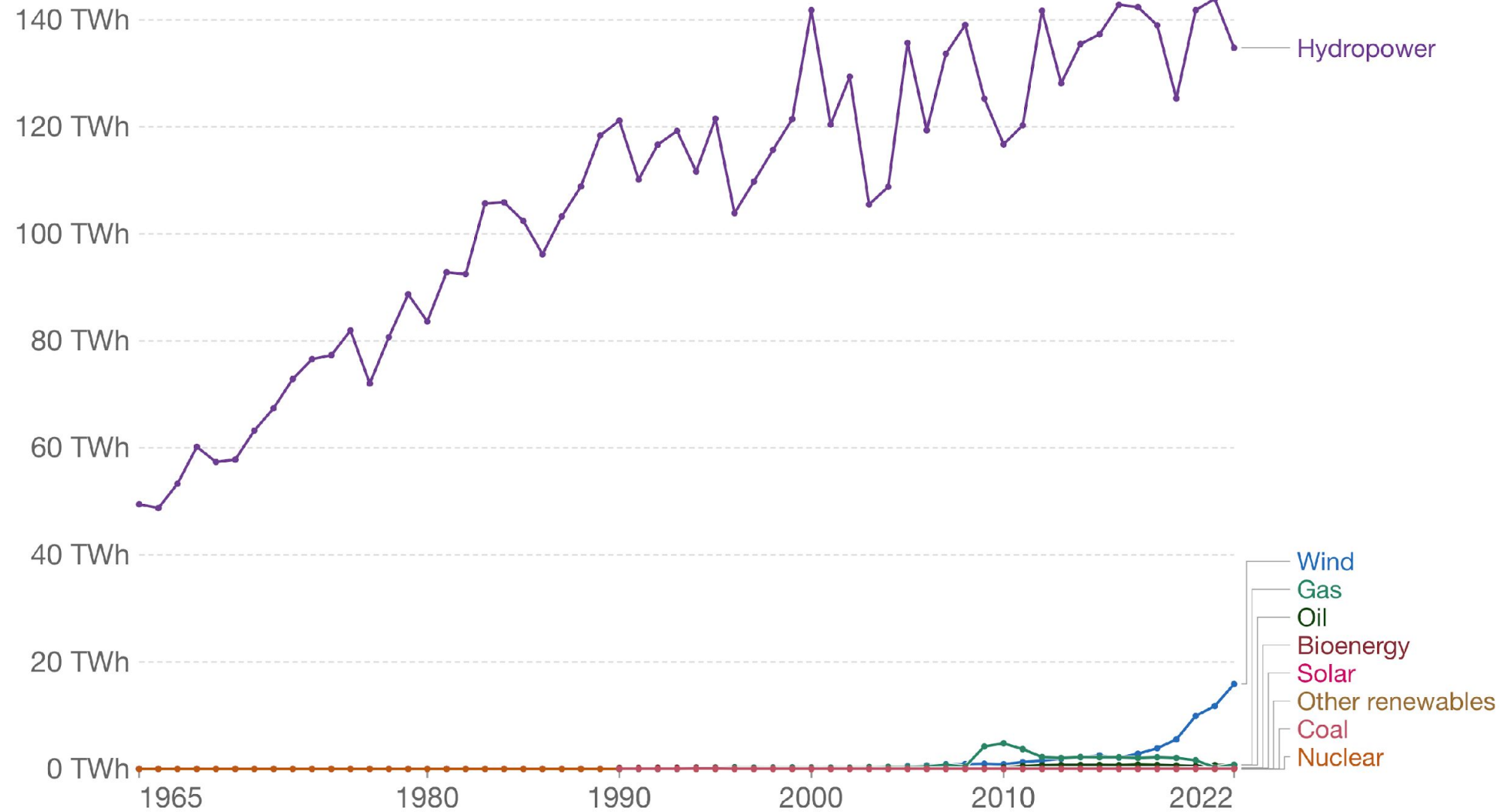


# Black pellets

- Production for export
- Reason:
  - Norway mostly uses hydropower
  - No coal-fueled power plants

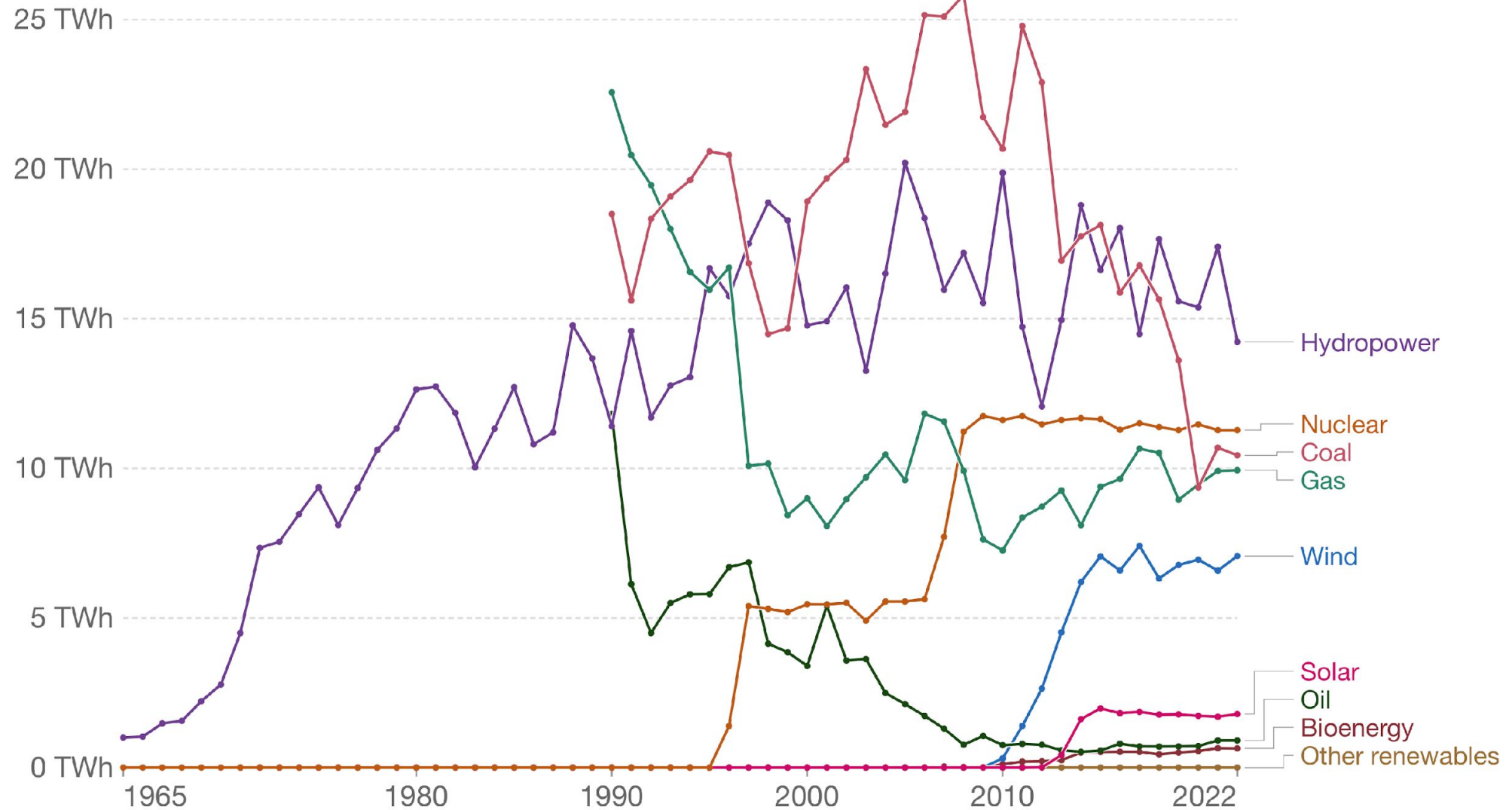


# Electricity production by source, Norway



Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy  
Note: 'Other renewables' includes waste, geothermal and wave and tidal energy.  
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# Electricity production by source, Romania



Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy  
Note: 'Other renewables' includes waste, geothermal and wave and tidal energy.  
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# Electricity generation from coal



Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy  
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# Case: Arbaflame

- Major producer of black pellets in Norway
- Producing black pellets primarily as a substitute for fossil coal in power plants
- Production estimated to be 400 tons in 2023, capacity 700 tons
- Export to modified coal plants in The Netherlands, Germany, France
- Recent contract with Romanian Ministry of Energy (Paroseni)

# Case: Arbaflame

- Arbaflame's black pellets, ArbaCore, share many of the properties of coal
- Production process: Steam explosion
- ArbaCore is hydrophobic, it repels water.
- Can be transported, stored and handled in the same way as coal.
- Existing equipment, including that for pulverising and combustion of the fuel, can still be used.
- The energy density of ArbaCore black pellets corresponds to 76 percent of the energy value of coal.
- For traditional white wood pellets this value is typically close to half of the energy value of coal.




## Case: Arbaflame

- The business case of modifying existing coal energy plants to black pellets is excellent.
- CO2 emission can be reduced by 90%.
- Changing a coal energy plant from coal to regular wood pellets costs 100 to 500 million euros.
- By using Arbacore (black pellets), the modification costs will be from 5 to 50 million.
- Transport costs for black pellets are much lower for black pellets than wood pellets.
- The modification time is also much shorter for black pellets.

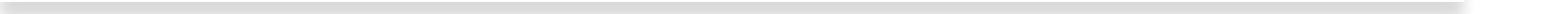
# Observations



- Increased political focus on biomass
  - Government white paper: Values in growth – Competitive forest and tree industry (2016-2017)
  - Government white paper: Climate plan for 2021-2030
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# Observations

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- Networks and clusters are important for sharing ideas and create collaboration
  - Regional Climate and Energy Networks
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- A thin grey horizontal bar is located at the bottom of the slide.



# Observations

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- Many new entrants in the biomass market
- Goes for high value: Biochar for metallurgy
  - Vow
  - Metalworks

# Thank you for listening

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# Case Studies

- Arbaflame
- Gjennestad agricultural school (wood chips)
- Stavanger airport (wood chips)



Table 3: Commercial scale black pellet projects, operating and under development

Company	Location	Nameplate capacity, kt/y	Technology	Technology provider	Status	Start-up date
Arbafame	Oslo, Norway	12	Steam explosion	Arbafame	Operating (will be replaced)	2004
Zilkha Biomass	Selma, Texas, US	60-275(?)	Steam explosion	Zilkha	Operating (partially)	2015
Bionet	Onega, Arkhangelsk, Russia	100-150	Torrefaction	Alligno	Operating	2017
Futerra Fuels	Valongo, Portugal	120	Torrefaction	Yilkins	Under construction	Q1 2020
Européenne de Biomasse	Ardennes, France	120	Steam explosion	Valmet BioTrac	Under construction	2020
UBE Industries	Yamaguchi, Japan	60	Torrefaction	Unknown	Under construction	2020
Baltania OÜ	Vagari, Estonia	157	Torrefaction	CEG	Under construction	2020/2021
Restoration Fuels	Oregon	100	Torrefaction	Restoration Fuels	Under construction	H1 2020
Unknown (former HM3 Energy plant)	Japan	50	Torrefaction	HM3 Energy	Under construction	2019?
Arbafame	Grasmo, Norway	70	Steam explosion	Arbafame	Under construction	Q3 2020
Advanced Fuel Solutions	Portugal	100	Torrefaction	Unknown	Under construction	2020
Arbafame	Rotterdam, Netherlands	25	Steam explosion	Arbafame	Permitting	Q2 2020
Biomass Secure Power	Louisiana, US	400	Torrefaction	BSP	Planned	2020/21
Boreal Bioenergy	McBride, Canada	225	Torrefaction	Blackwood	Planned	Q4 2020
Gitxsan Development Corporation/ Airex Energy	Hazelton, Canada	100	Torrefaction	Airex Energy	Planned	Q4 2021
Unknown	France	60	Torrefaction	Airex Energy	Planned	2022/23
Unknown	NB, Canada	45	Torrefaction	Airex Energy	Planned	2021/22
Active Energy	Lumberton, North Carolina	80	Steam explosion	Coal Switch	Planned	H1 2020
Bioendev	Holmsund, Sweden	60 (expansion)	Torrefaction	Bioendev	Planned	2020
Scandinavian Biopower Oy	Mikkeli, Finland	200	Torrefaction	CEG	On hold	Unknown