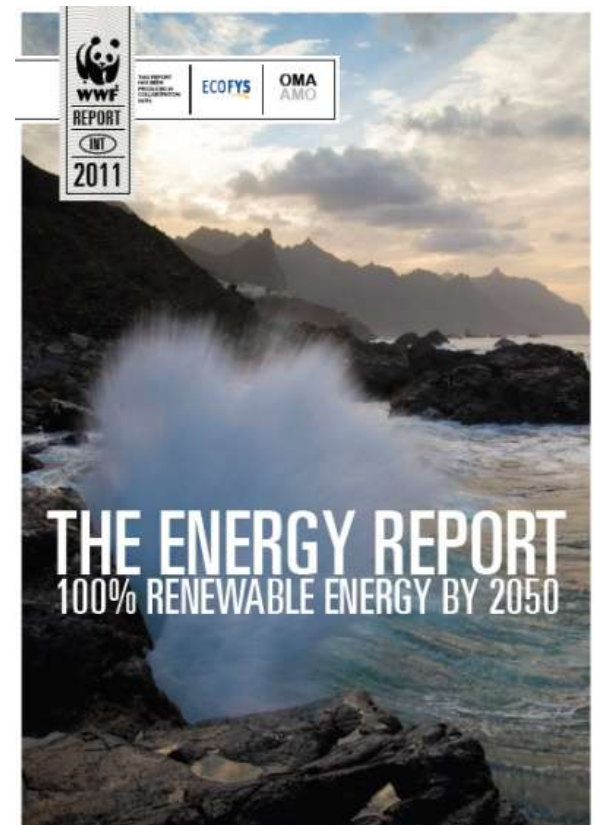


The Ecofys Energy Scenario

**Transition to a fully sustainable
global energy system by 2050**

4 Feb 2014

Yvonne Deng, Les Houches



Feb 2011

Ecofys is an international energy and climate strategy consultancy

Mission

sustainable energy for everyone

Vision

Based on our deep expertise in energy & carbon-efficiency, renewable energy, energy systems & markets, and energy & climate policy, we develop smart policies and solutions and bring them to life.

We know that, if we act now, by 2050 our global energy system can be sustainable, secure, affordable and fully based on renewable sources.

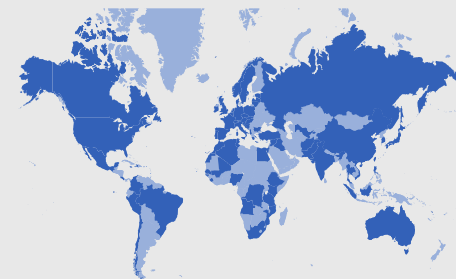
We aim to create a sustainable energy system for everyone.

Values

Dedication Originality Impact Trust

Facts & Figures

- Founded in 1984
- Over 250 professionals, 7 offices in 6 countries
- Over 500 clients served across 50 countries
- Leading experts: the Nobel Peace Prize 2007, awarded to Al Gore and the IPCC, was supported by 10 Ecofys experts
- Eneco Shareholder since 2009



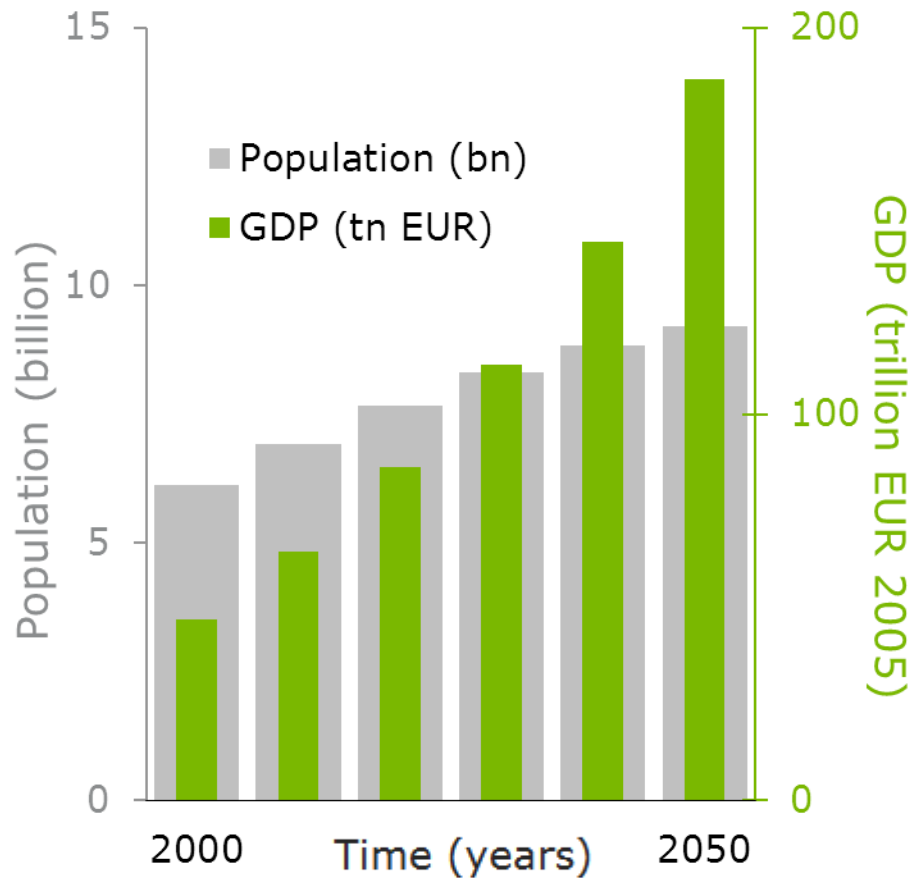
A selection of organisations that we have served



So what's the issue?

The world has an ever-increasing appetite for energy ...

Global population and GDP used as basis for The Energy Report scenario



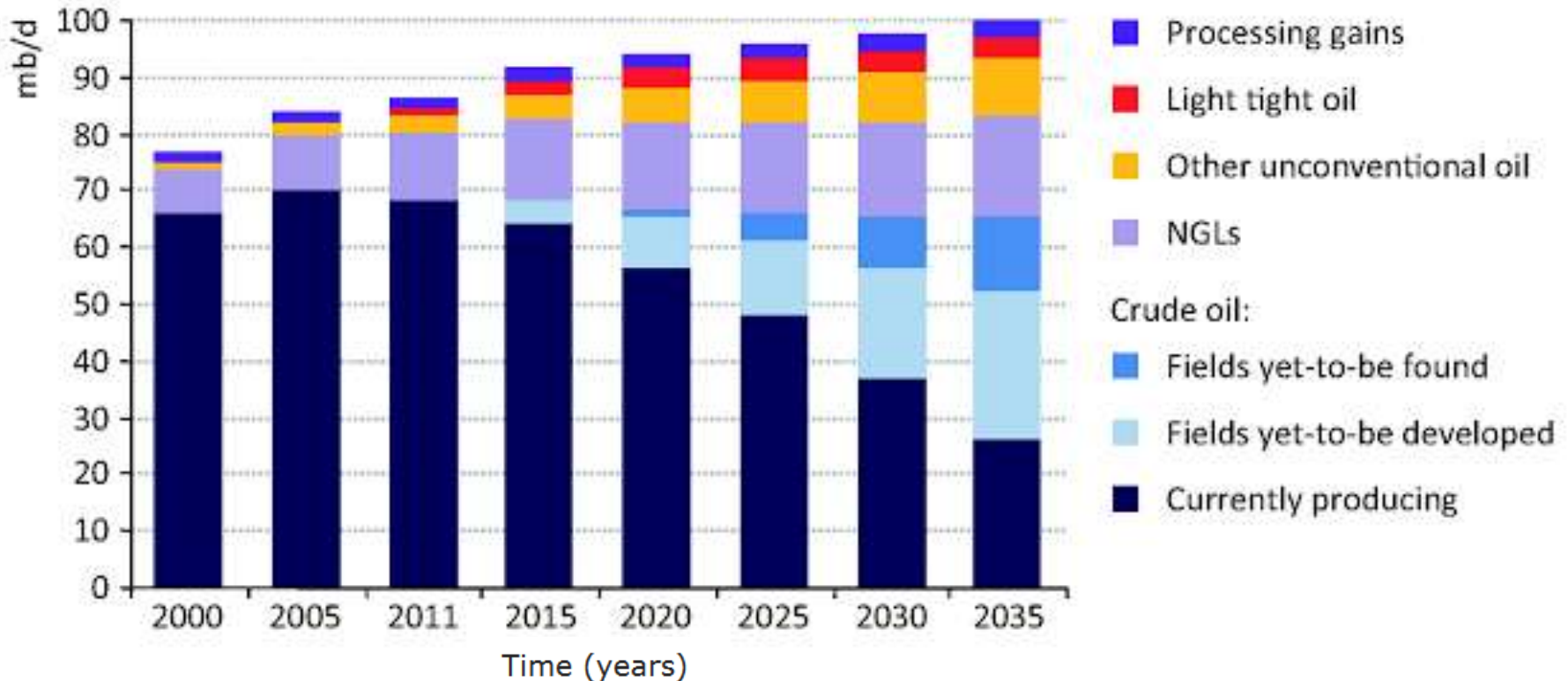
From 2010 to 2050:

- > Population +33%
- > World economy (GDP): +200%
- > Demand for energy services (industry, buildings, transportation) roughly in line with GDP growth

Source: The Energy Report, WWF & Ecofys, 2011

... but fossil fuel supplies are tightening...

World oil supply, split by type

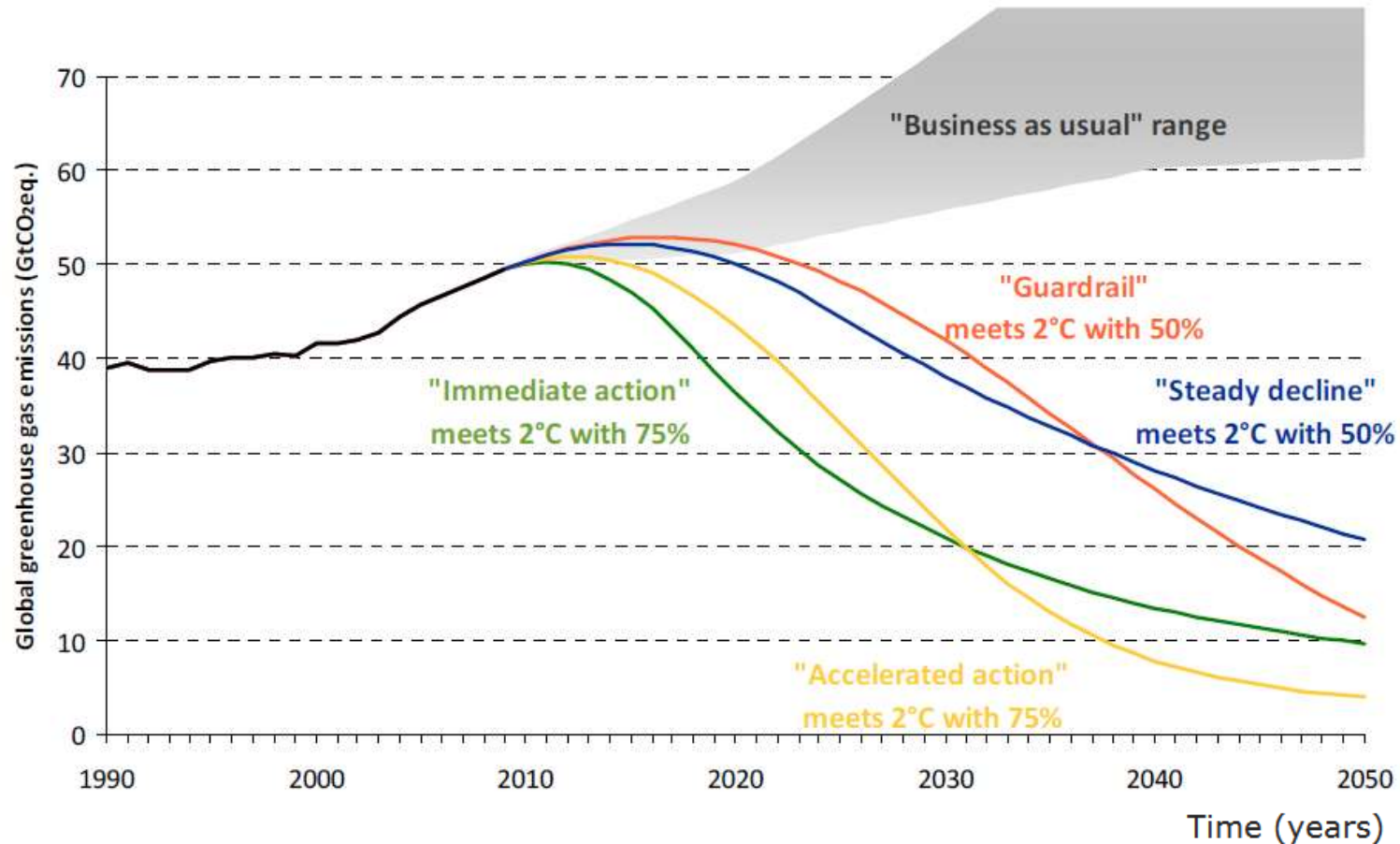


Source: IEA World Energy Outlook 2012

➔ Price increases to be expected in the medium term

...and CO₂-emissions must be reduced

Generic global emission pathways with different likelihoods of limiting global temperature increase to 2°C



Source: Emission pathways towards 2°C, Höhne et al., 2009

Key question

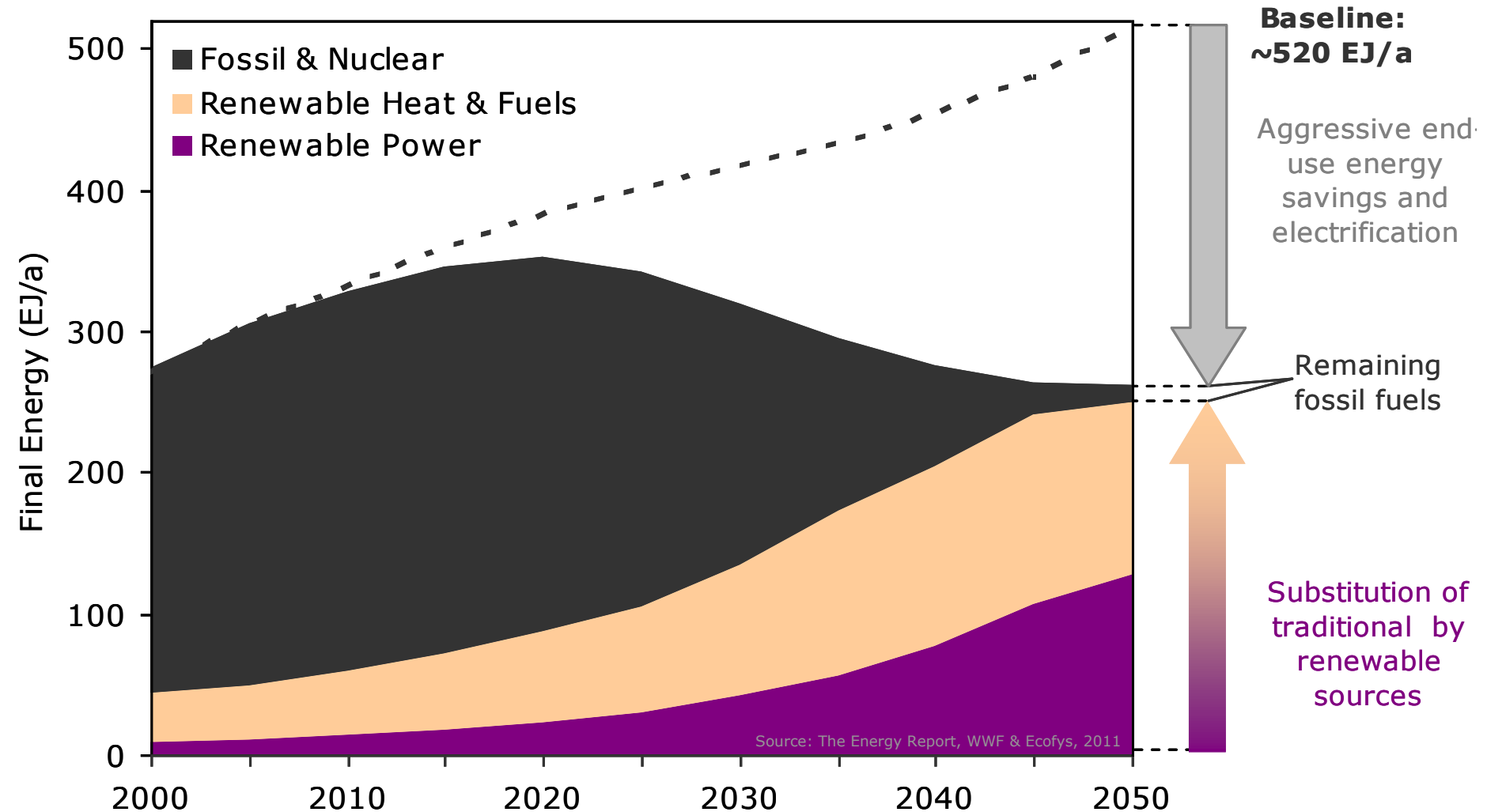
Is
a fully sustainable
global energy system
possible by 2050 ?

Answer

Yes

*And the
Ecofys Energy Scenario
shows how it can be done..*

Fossils are phased out over time as renewables take up the challenge

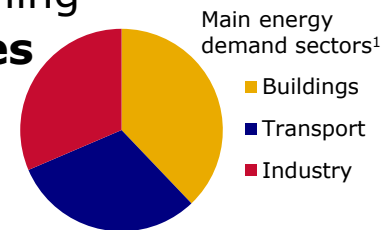


The Scenario forecasts future demand and supply by following this logic

1. Future energy demand is estimated:

- a. Future demand side **activity** is used from literature or estimated based on population and GDP growth
- b. Future demand side energy **intensity** is forecast assuming fastest possible roll-out of **most efficient technologies**
- c. Demand is summed up by carrier (electricity, fuel, heat)

$$E = \frac{E}{A}(t) \cdot A(t)$$



2. Future energy supply is estimated

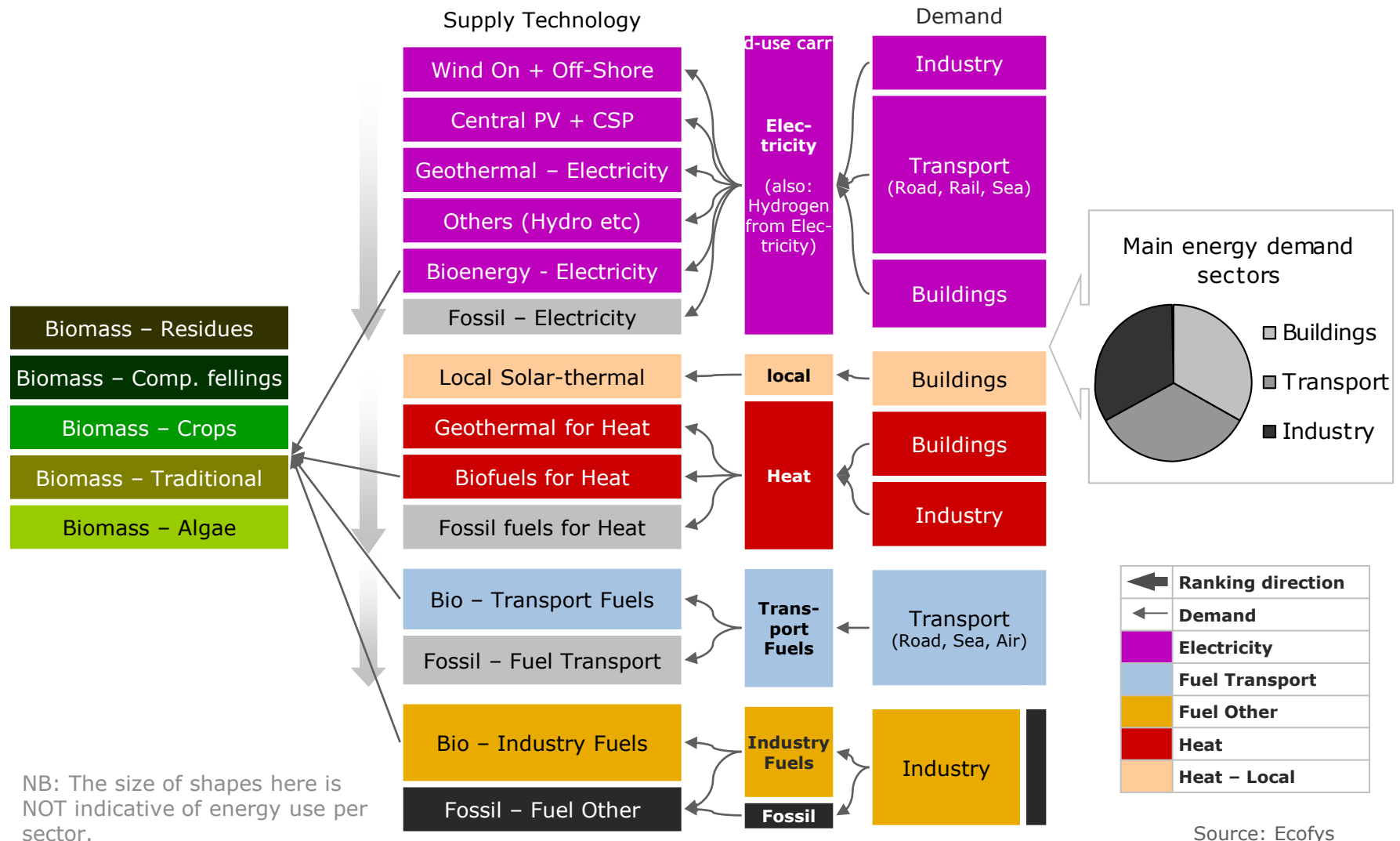
- a. The **potential** for supply of energy in the different carriers is estimated
- b. Demand and supply are matched following this prioritisation:
 - i. Renewables from sources other than biomass (electricity and local heat)
 - ii. Biomass up to the sustainable potential
 - iii. Traditional sources, such as fossil and nuclear



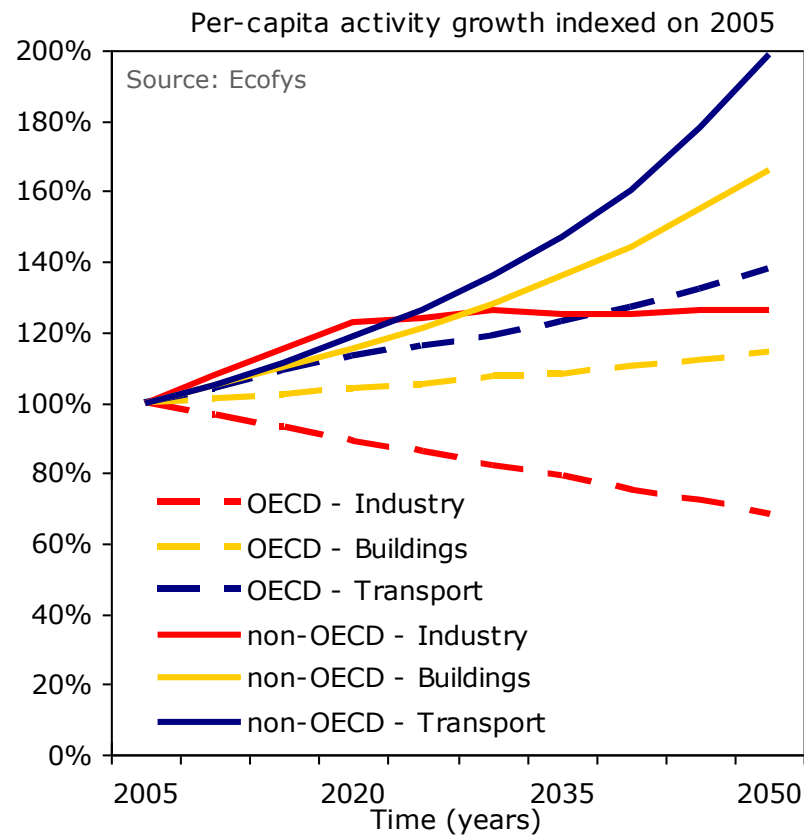
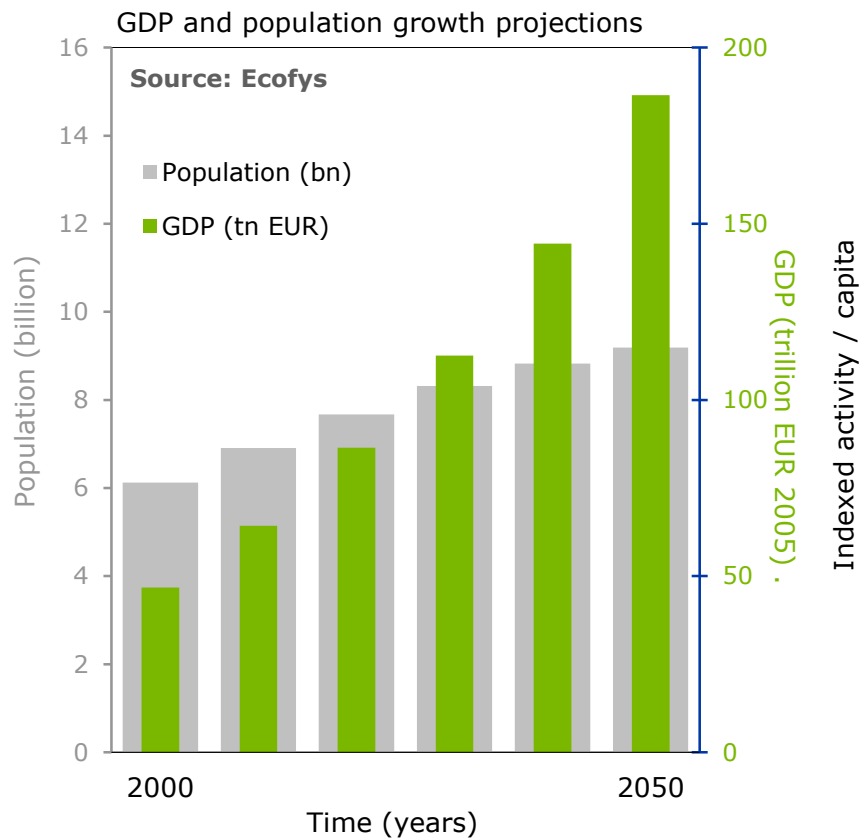
These steps are detailed further on the following slides

¹ The evolution of other sectors (Agriculture etc) which are not treated explicitly was indexed on these three main sectors.

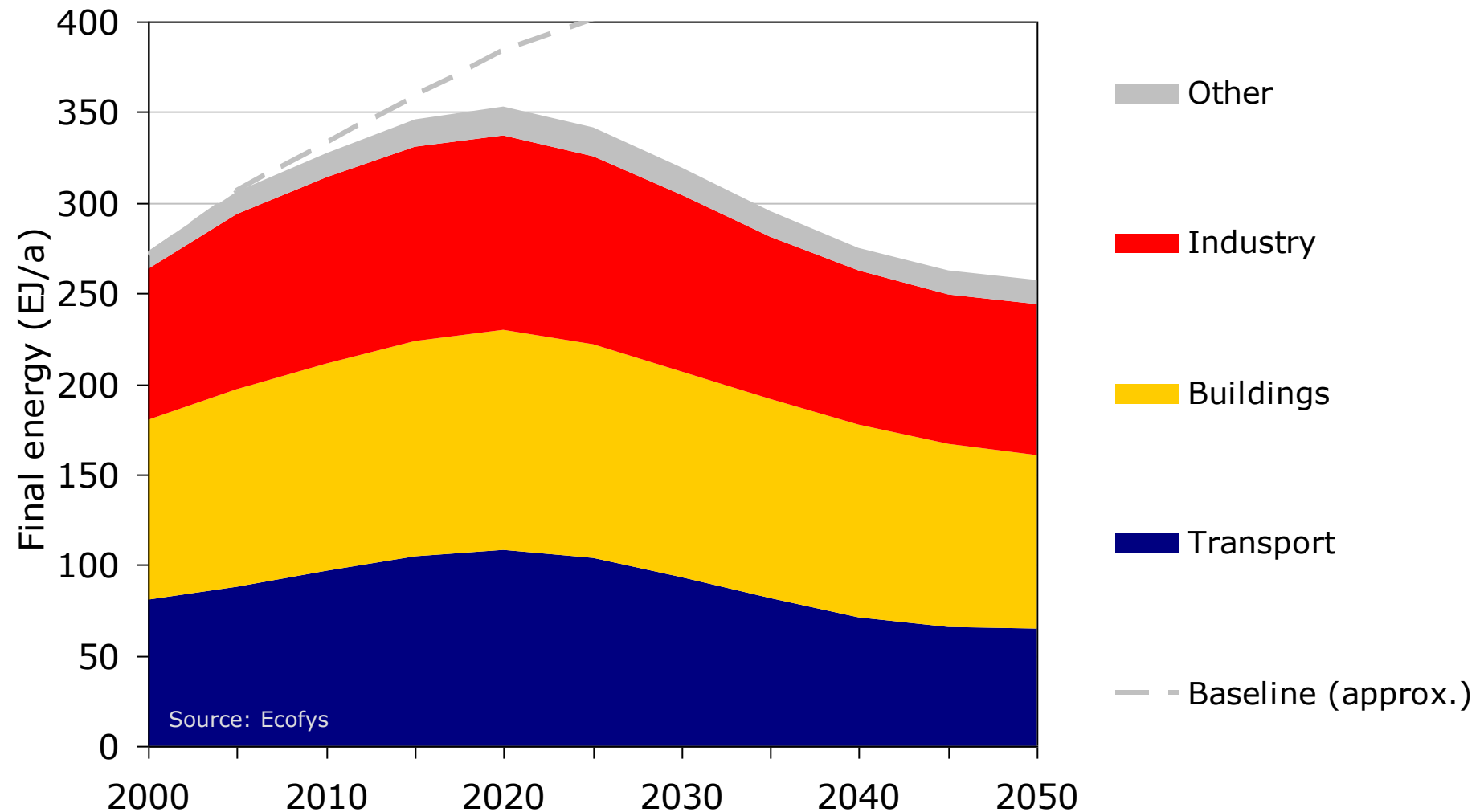
Demand side efficiency determines the total demand to be met by renewable sources



Activity increases, most strongly in non-OECD regions

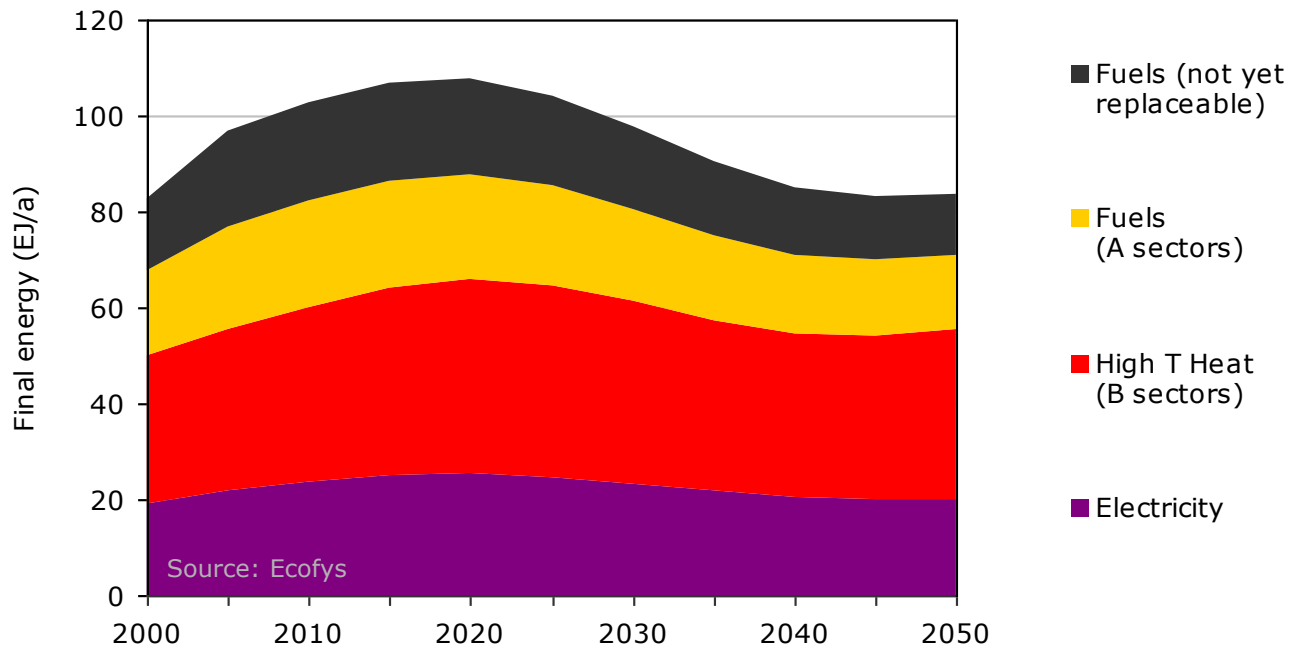


Absolute energy use can be reduced without a reduction in energy services



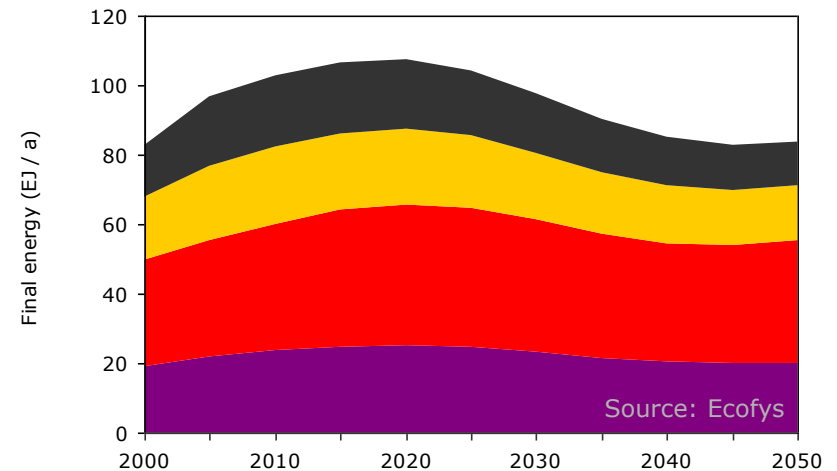
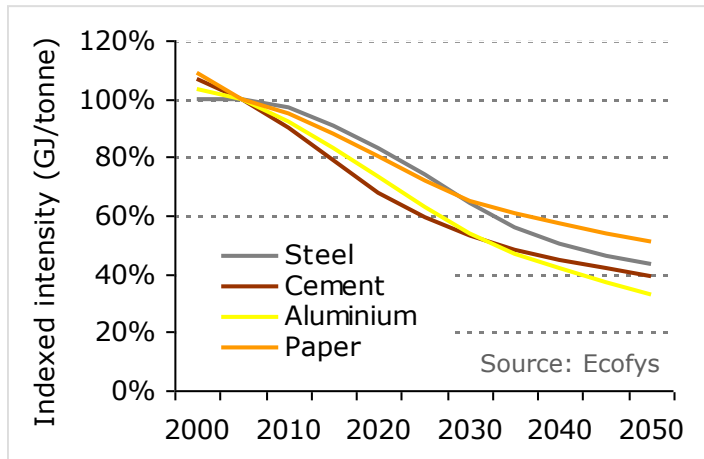
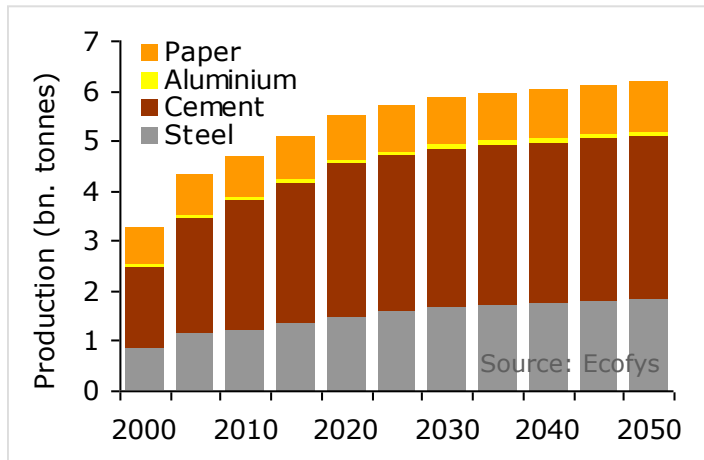
Reduced demand for raw materials and increased efficiency are key in industry

- > Material efficiency
- > Shift to current most efficient technologies
- > Alternative production pathways and recycling



'A' sectors = steel, cement, aluminium, paper; 'B' sectors: chemicals, food, other

Stabilisation in energy demand in industry through ambitious efficiency improvements



Activity and intensity graphs are only shown for Steel, Cement, Aluminium and Paper sectors for illustration. Other sectors are based on GDP growth projections

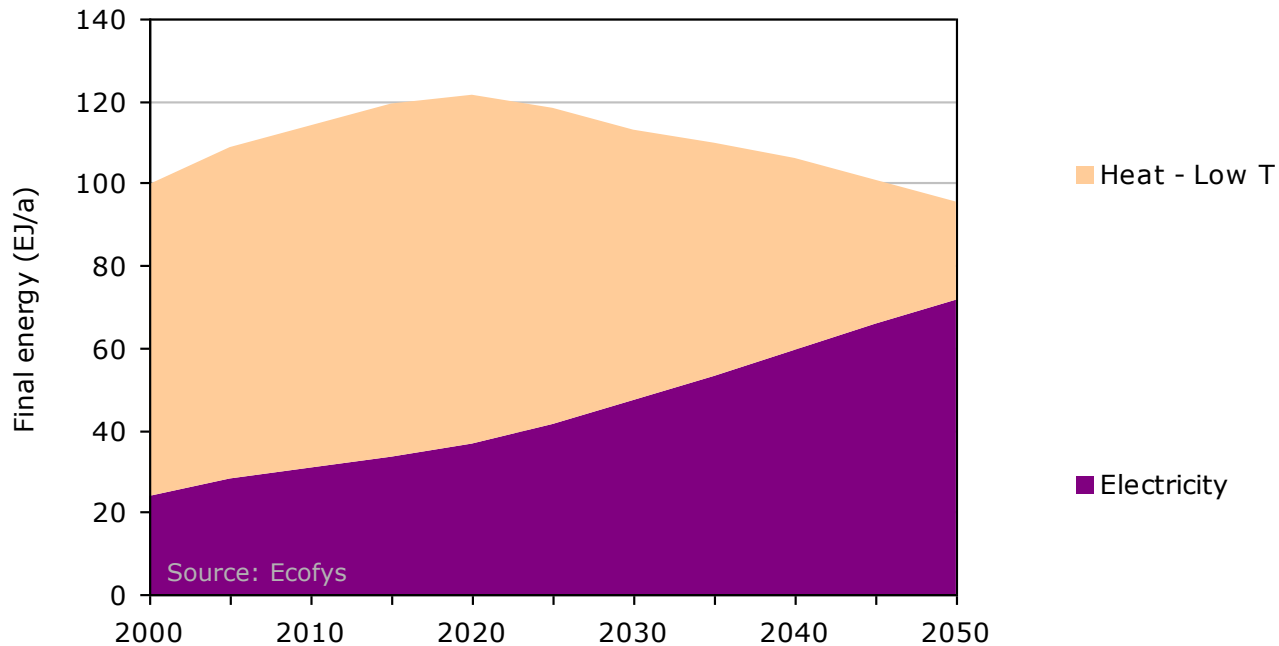
Buildings: strongly reduce heat demand, increase electrification

Heating & Cooling

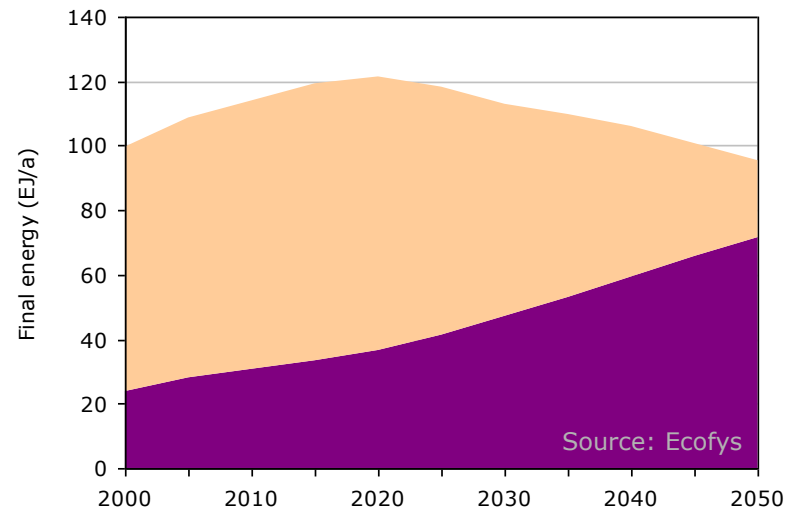
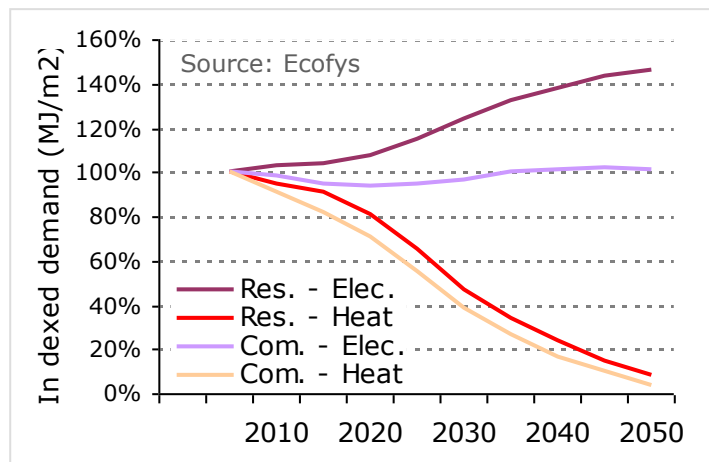
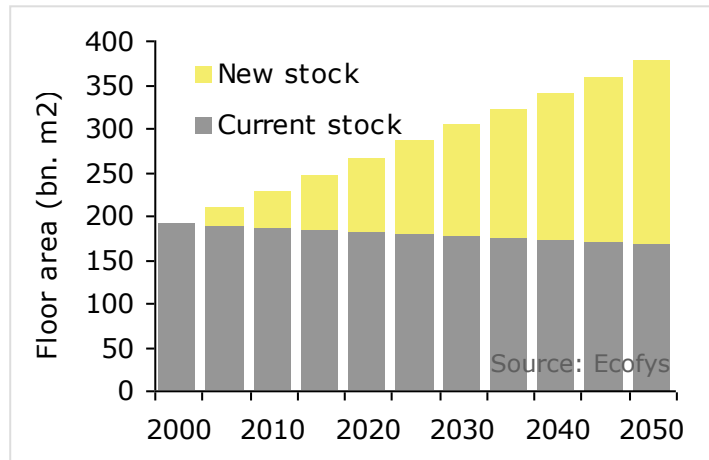
- New buildings: **near-zero energy** use
- Existing buildings: **retrofitted** at an **ambitious** rate
- Cooling: provided with renewable / local cooling solutions

Local solutions

- **Solar water heating** systems will provide half of all water needs
- Electric **heat pumps** will replace fuel use with renewable electricity



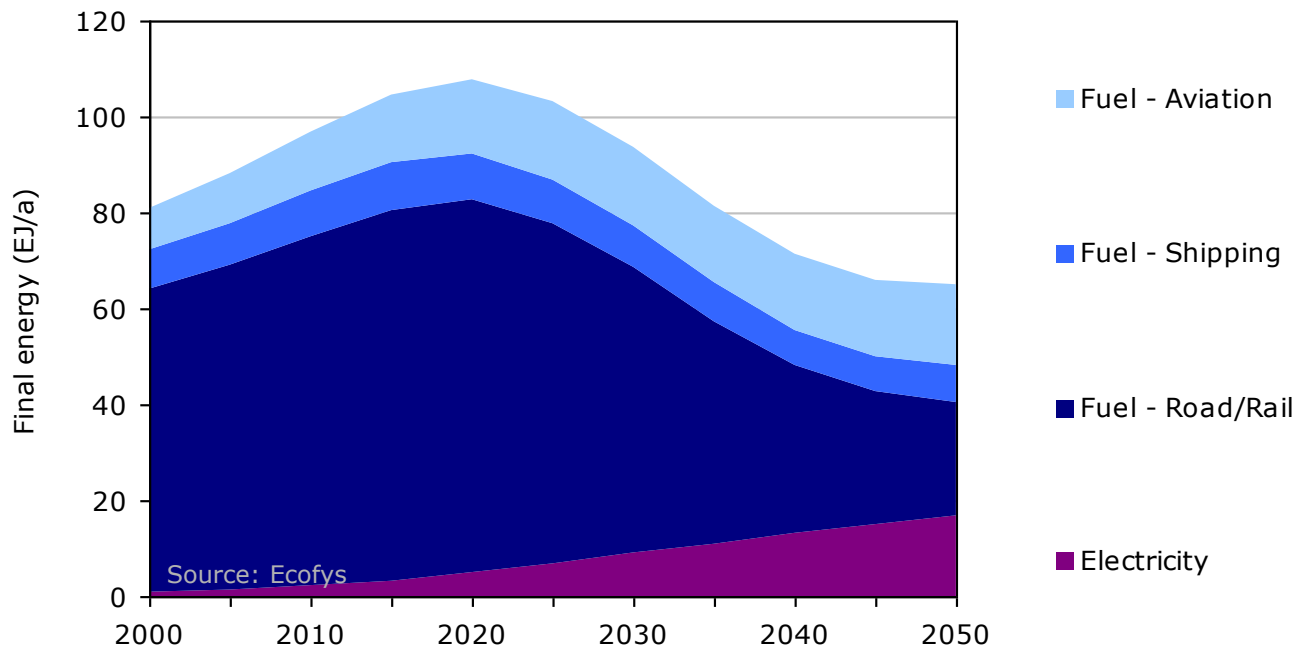
Stabilisation in buildings results from ambitious energy efficiency improvements



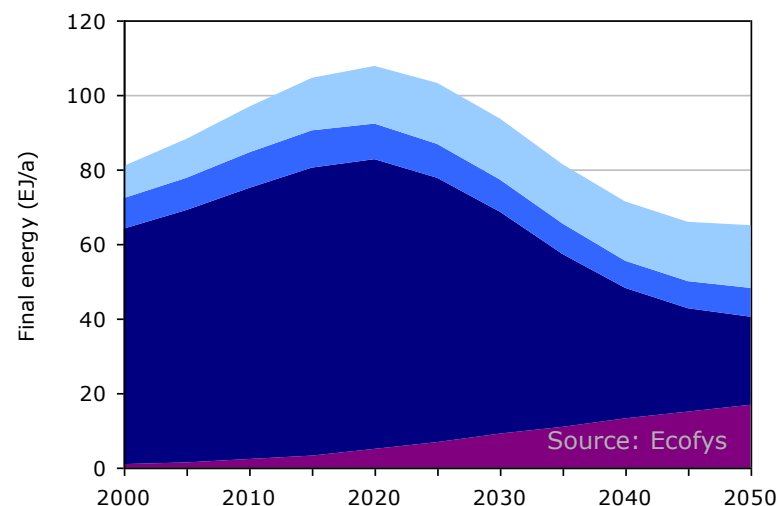
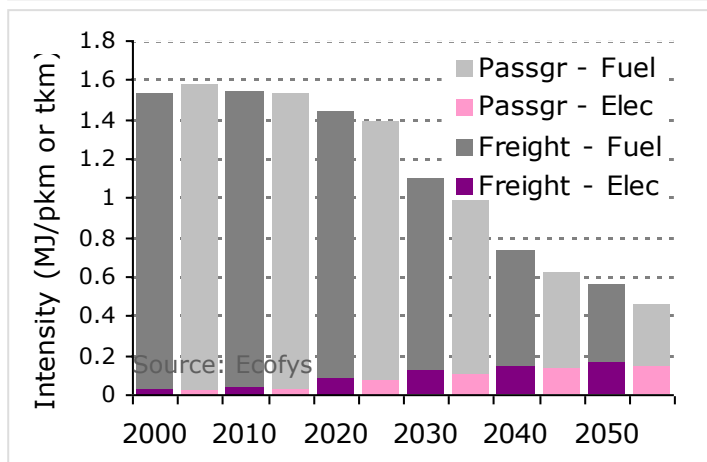
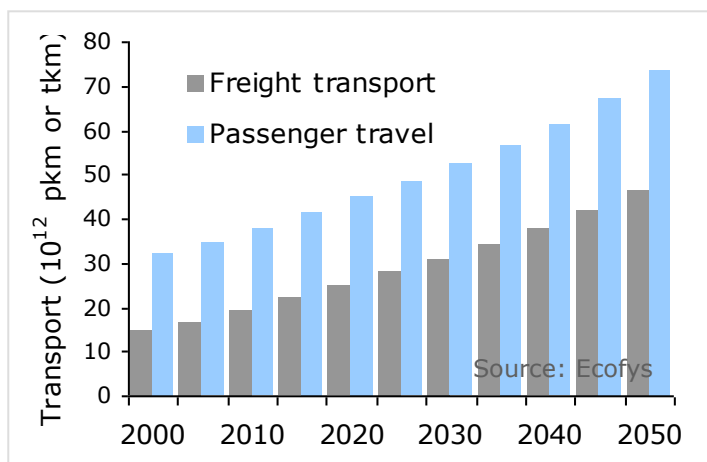
Floor area and specific energy use are shown for Residential sector only for illustrative purposes.

Electrification is key to sustainability in transport

- > No major reduction of **travel volume**
- > Ambitious **modal shifts** towards efficient transport modes, e.g. from car to rail
- > Ambitious assumptions on **efficiency** improvements in existing technologies
- > Decisive shift to **electric** forms of **transport**
- > **Renewable fuels**

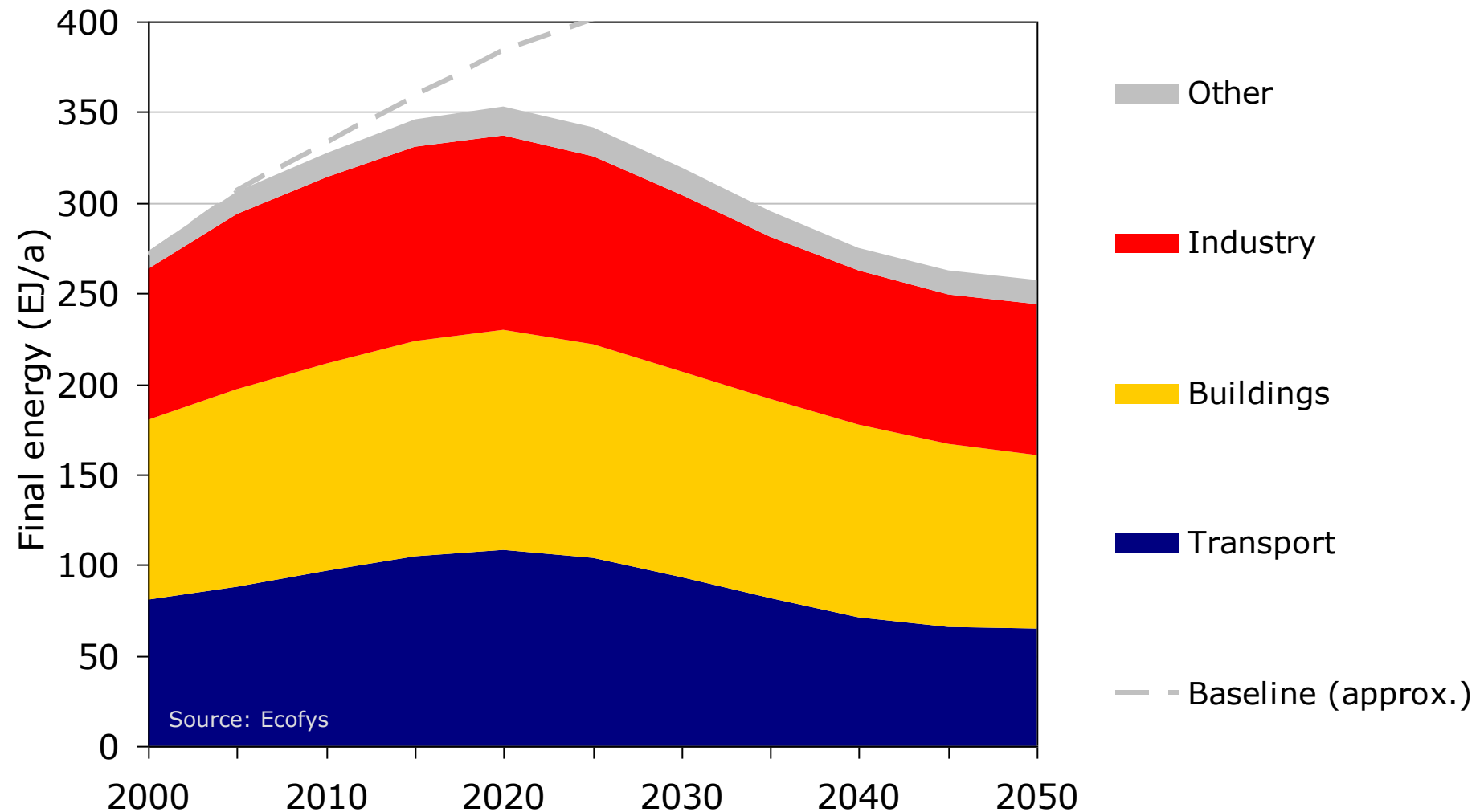


Stabilisation in the transport sector through ambitious energy efficiency improvements

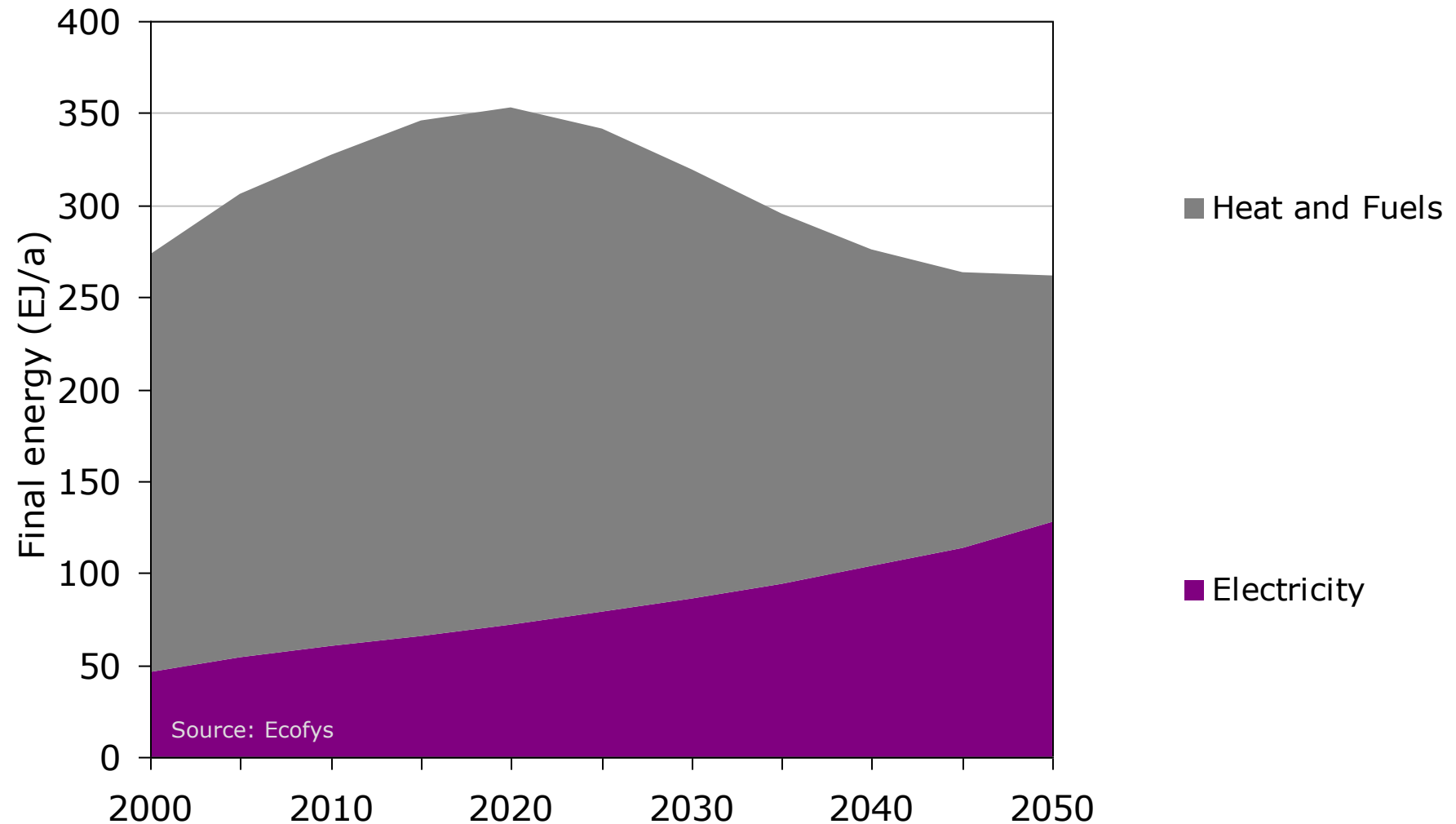


Activity graph excludes shipping. Shipping energy demand is based on GDP growth and relative efficiency savings in line with other modes.

Absolute energy use can be reduced without a reduction in energy services

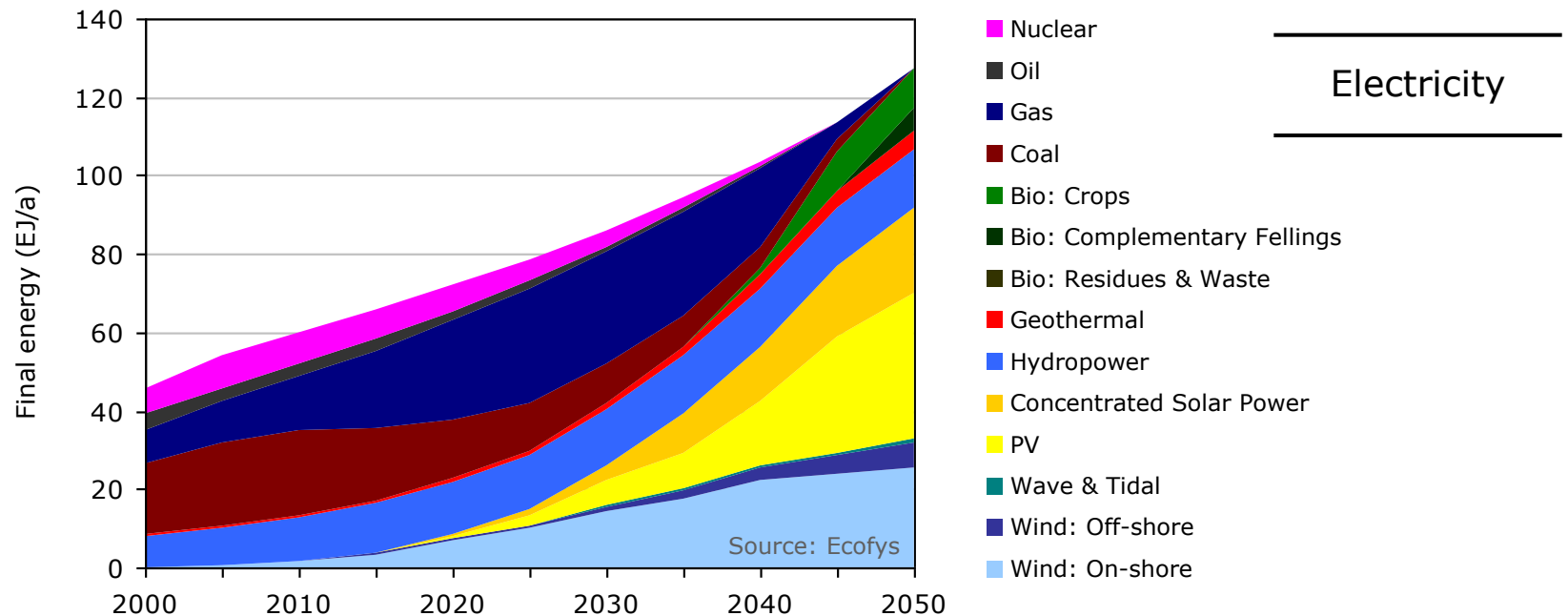


The ambitious electrification allows us to make maximum use of solar, wind, hydro etc.

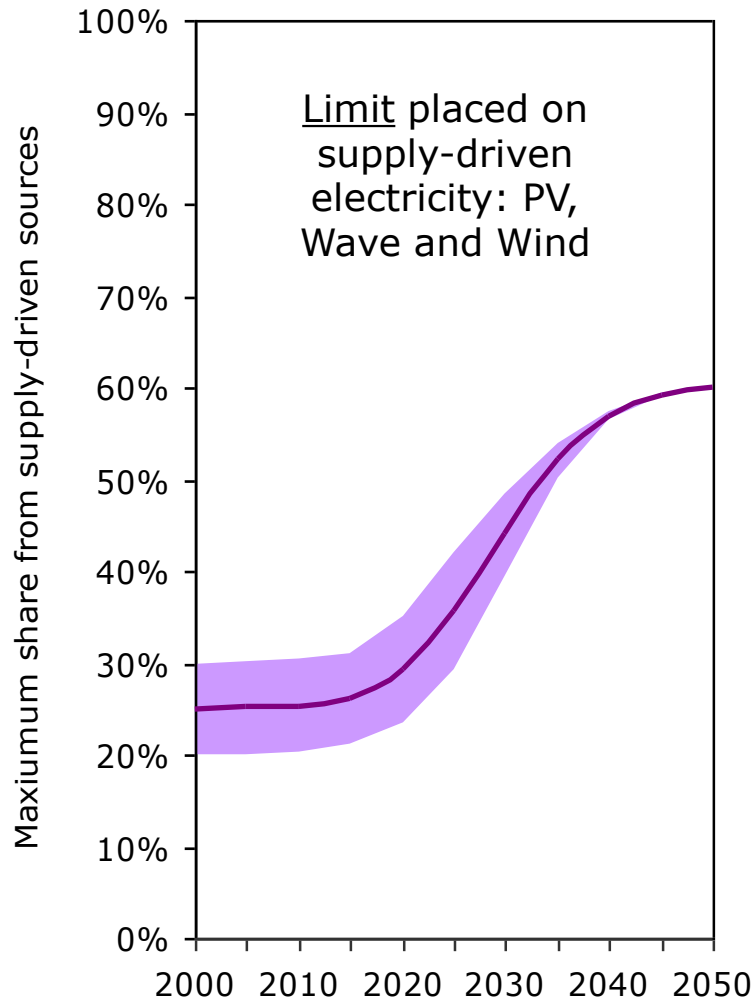


100 % renewable electricity by 2050

- > Renewable electricity so abundant that options will compete
- > Supply-driven sources limited by grid capacity in later years
- > Hydro, geothermal, CSP* and bioelectricity provide demand-driven electricity

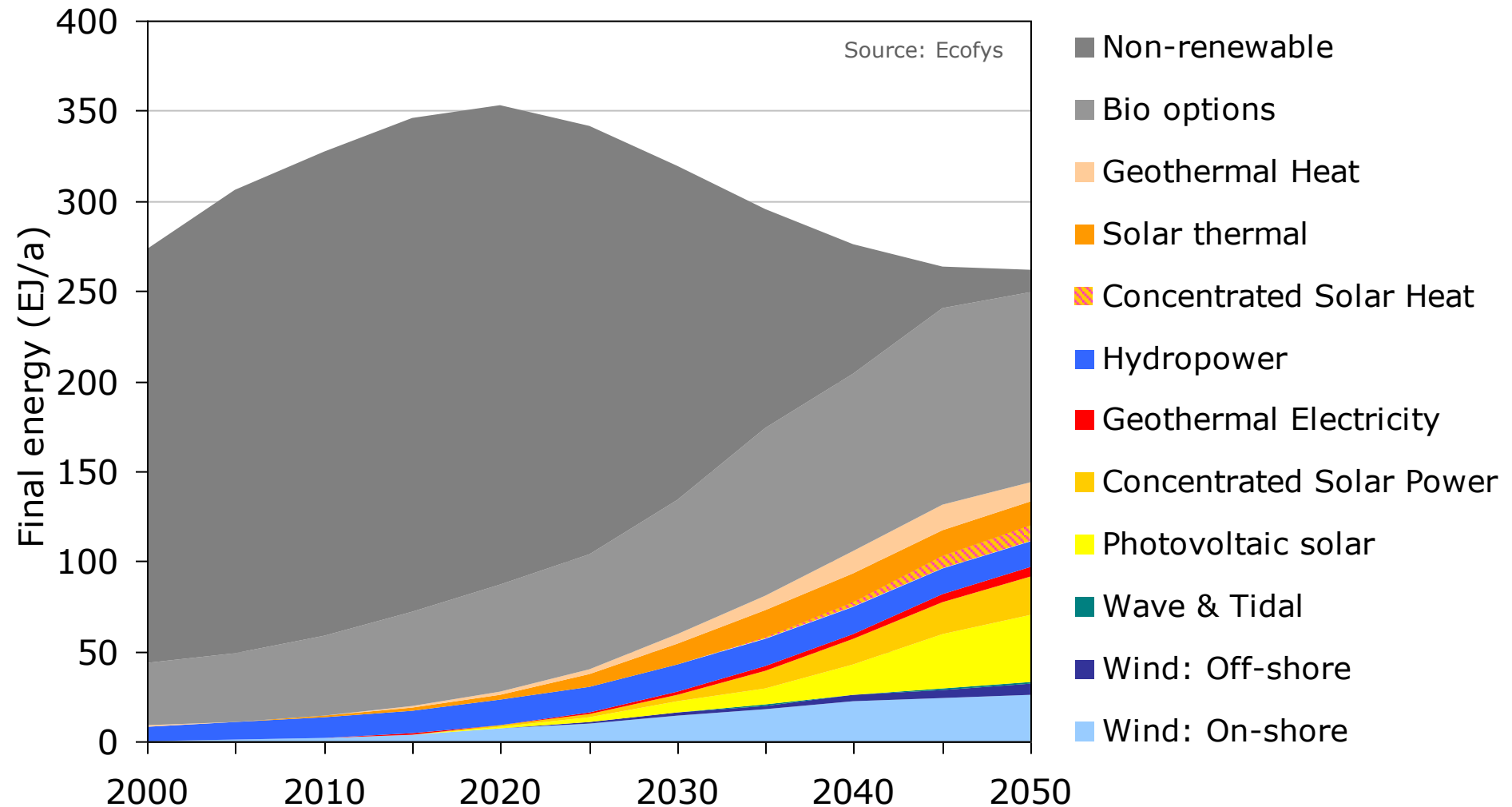


Electricity grids need to be upgraded and extended for maximum RES power



- > Grids should be well-connected regionally; need to increase
 - capacity
 - range of transmission lines
- > Need R&D, e.g. for better grid stability
- > For ultra-high RES shares beyond 2030 require:
 1. Grid improvements
 2. Demand side management
 3. Storage

Non-bio RES options are deployed first



Bioenergy is an important element of the energy supply in the Scenario

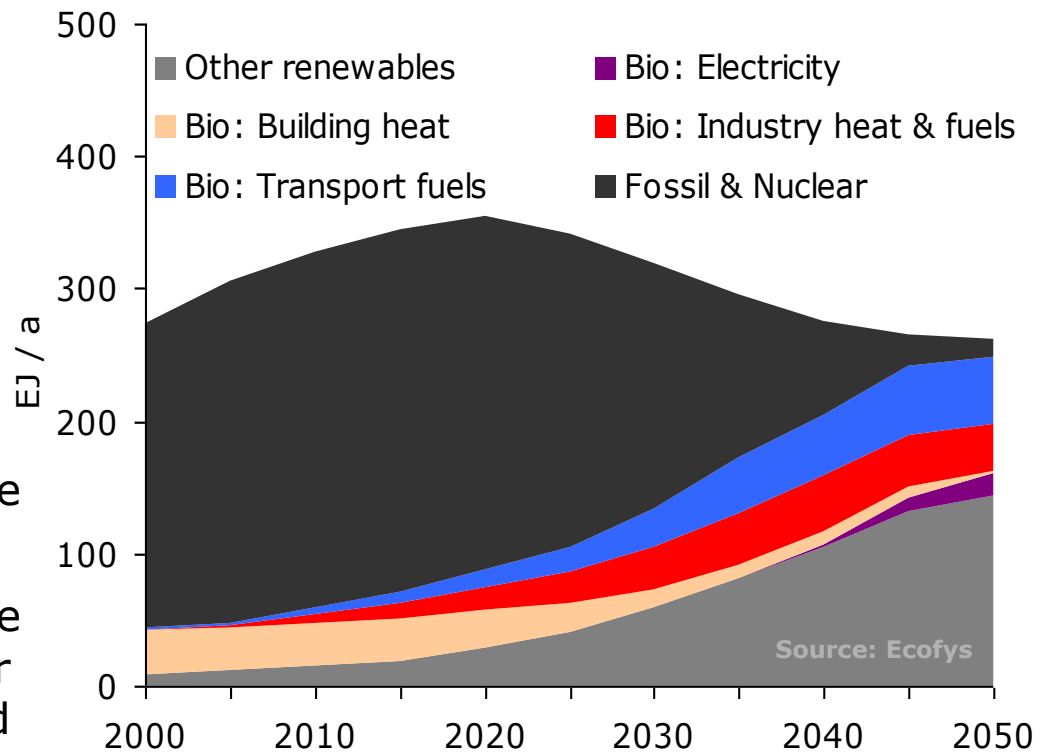
Bioenergy can fill energy demands where other renewables provide no or no complete alternative, e.g.:

> **Transport fuels; especially:**

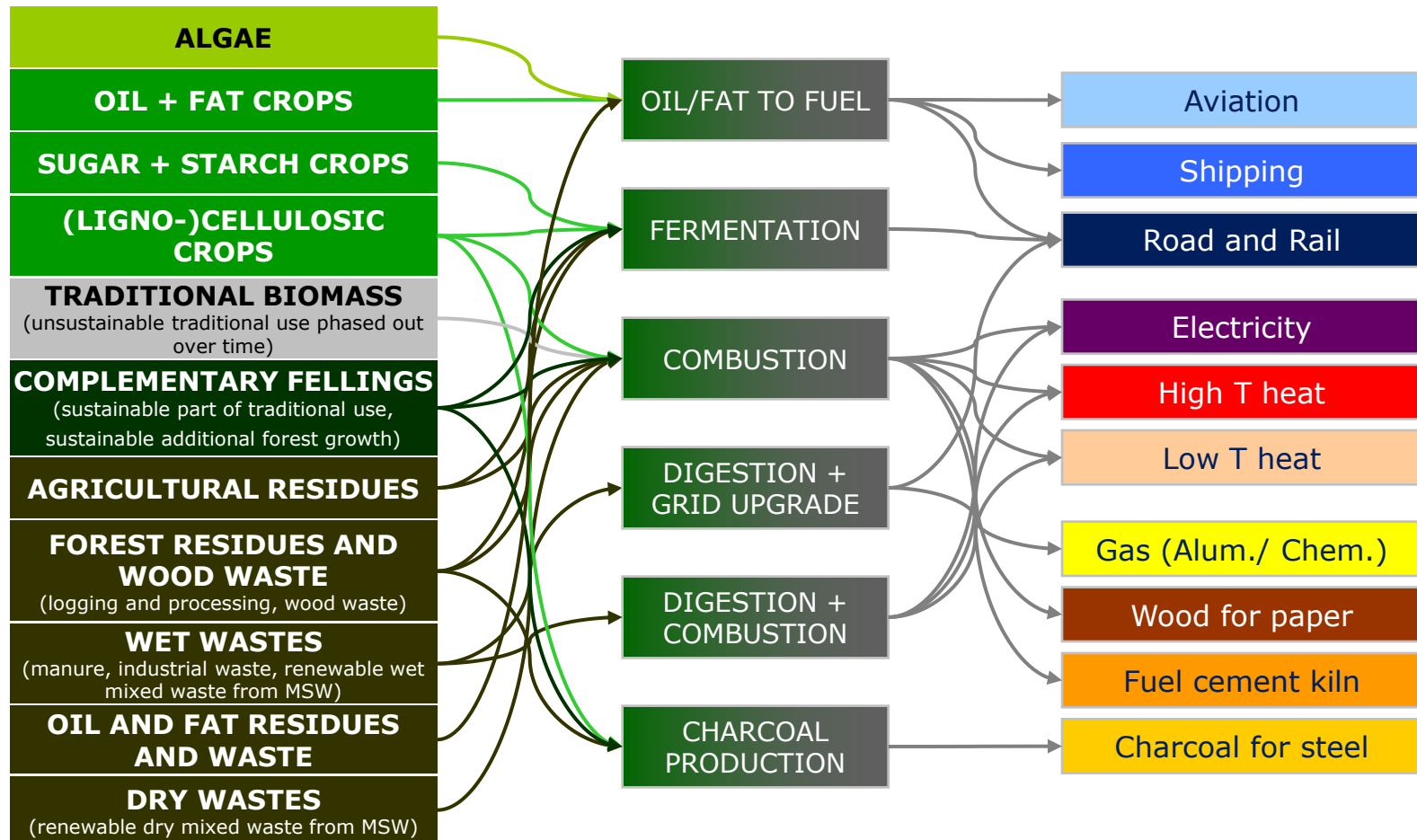
- Long distance road transport
- Aviation
- Shipping

> **Industrial fuels; especially:**

- Applications that require very high temperature
- Applications that require a specific energy carrier (e.g. gaseous fuel, solid fuel)

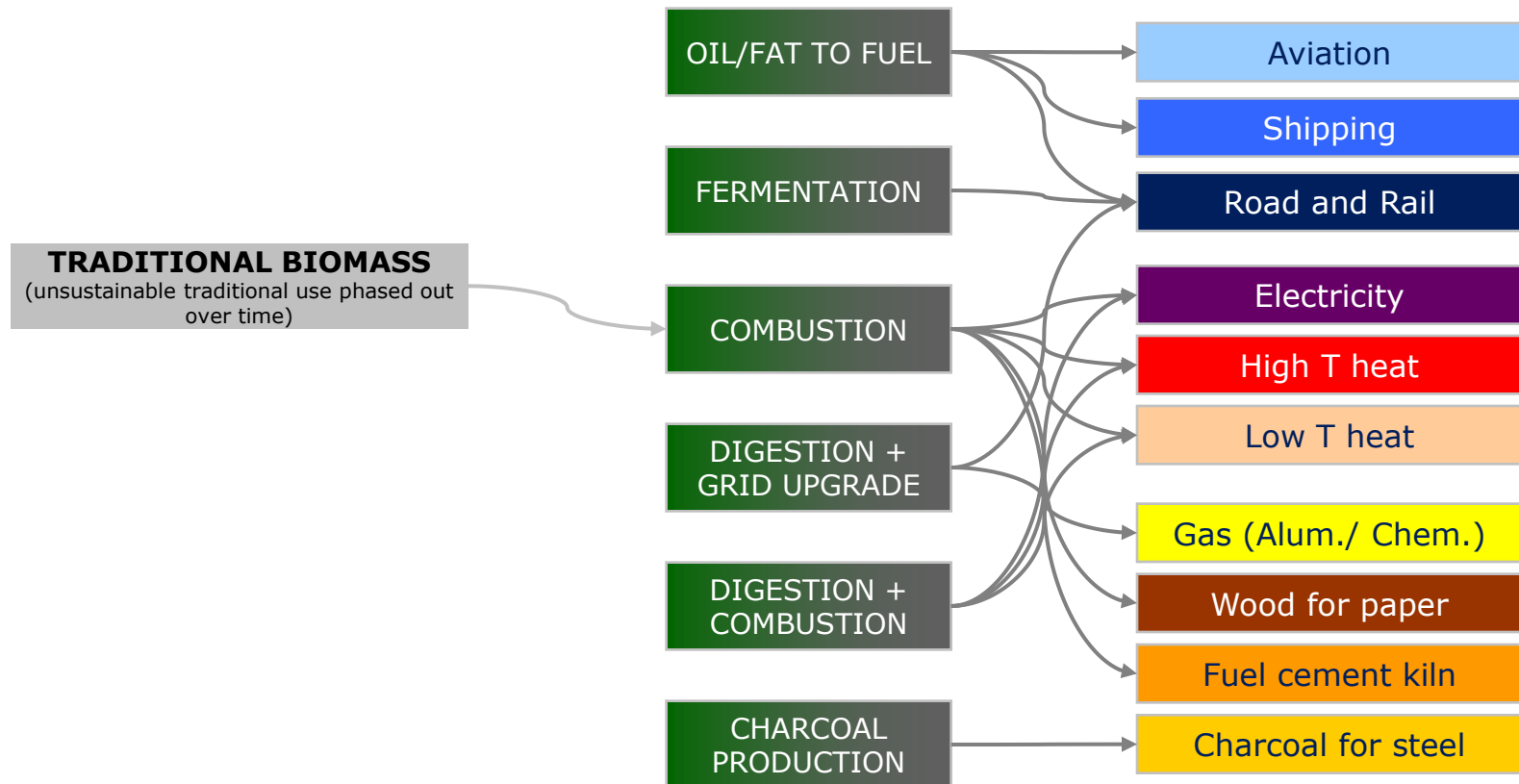


Bioenergy: Once all other renewables have been exhausted, bioenergy is split by demand type



In the following slides, we will explain this approach along its different steps and their priority

Bioenergy: First, existing traditional biomass use is modeled. The Scenario phases this use out towards 2050

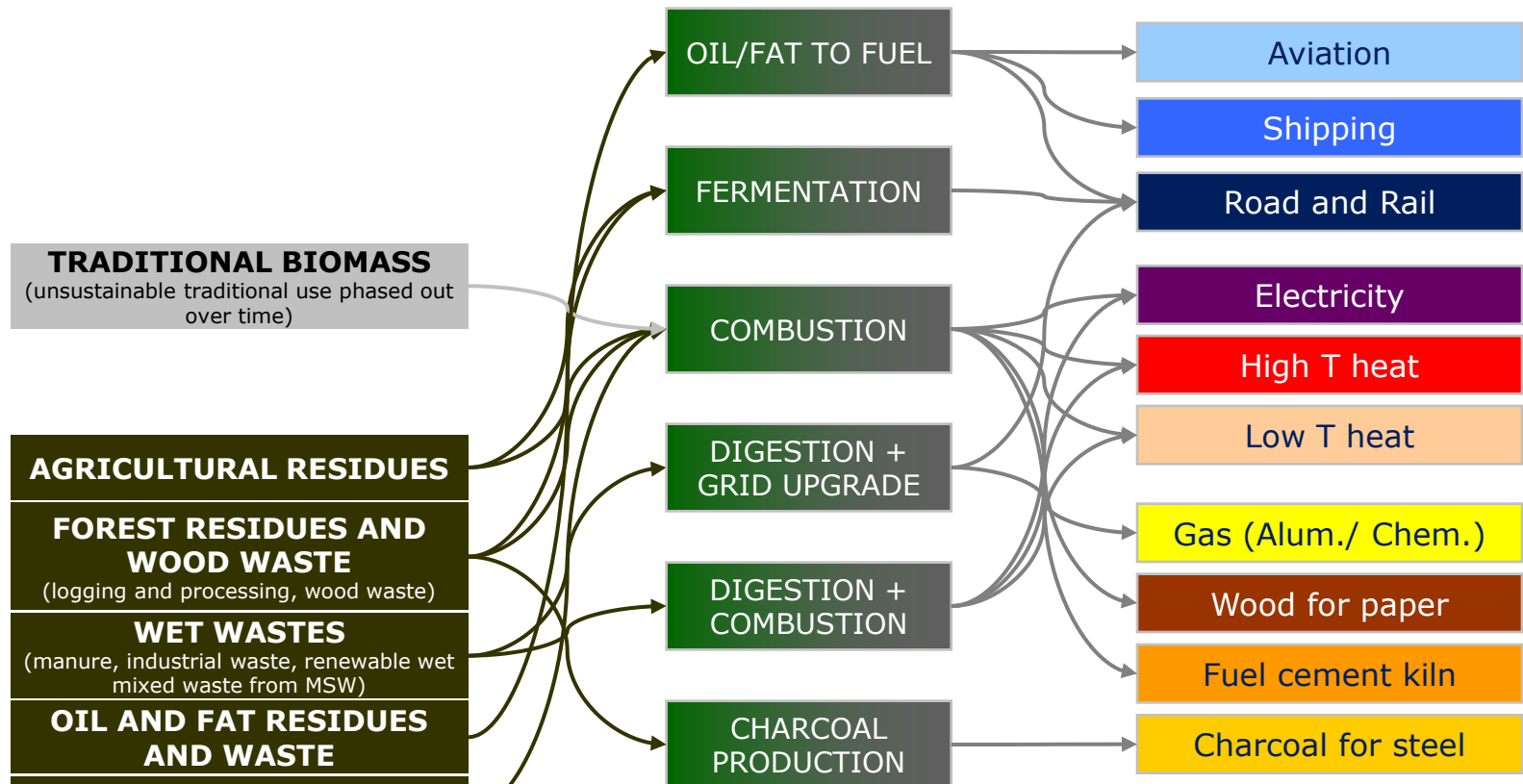


Notes:

1. Traditional biomass only supplies low temperature heat

NB: The size of shapes here is NOT indicative of the size of the categories in the Scenario.

Bioenergy: Second, all residues are fully used

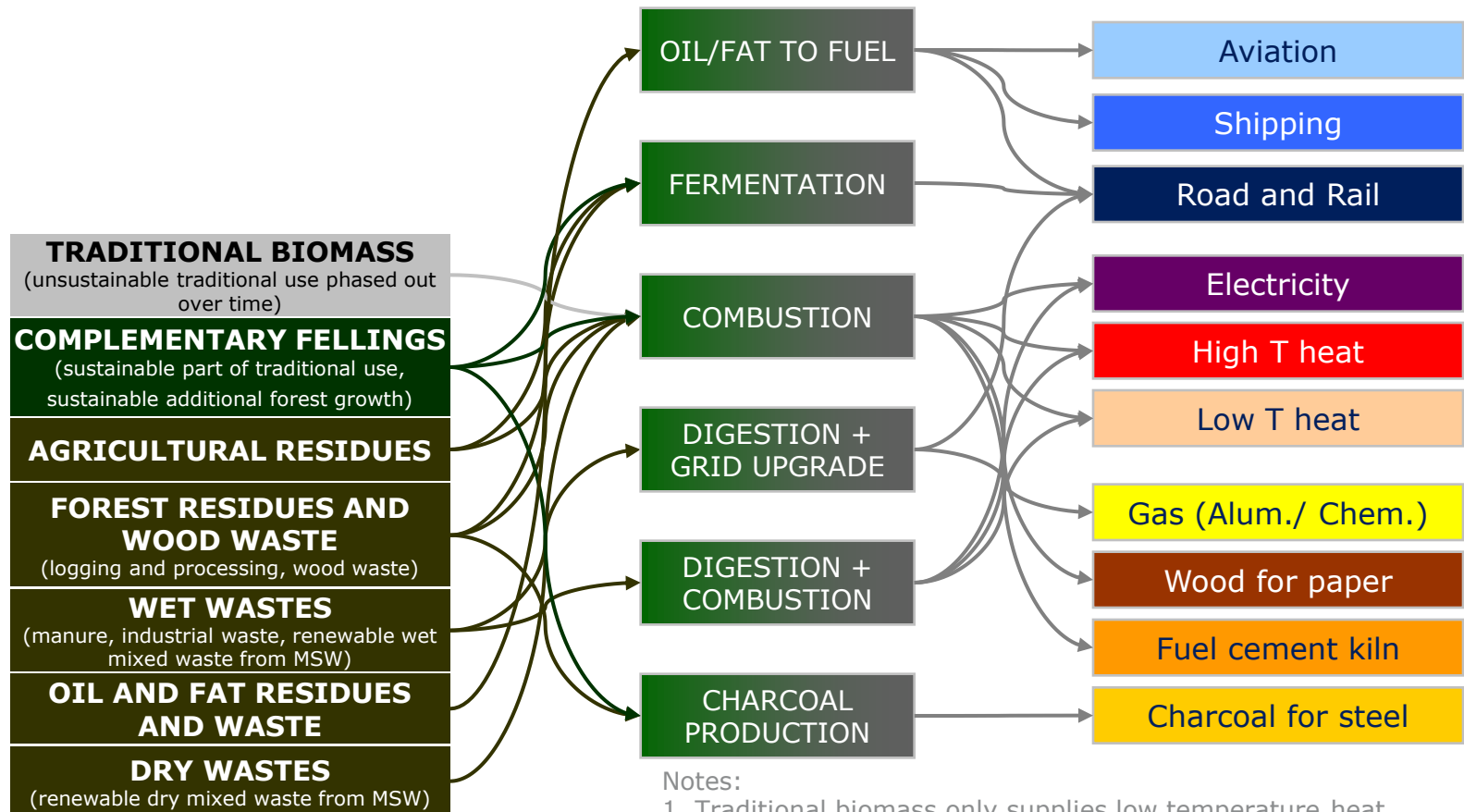


Notes:

1. Traditional biomass only supplies low temperature heat
2. Wood for paper can only be supplied from lignocellulosic crops, forest residues or complementary fellings

NB: The size of shapes here is NOT indicative of the size of the categories in the Scenario.

Bioenergy: Third, complementary fellings are used

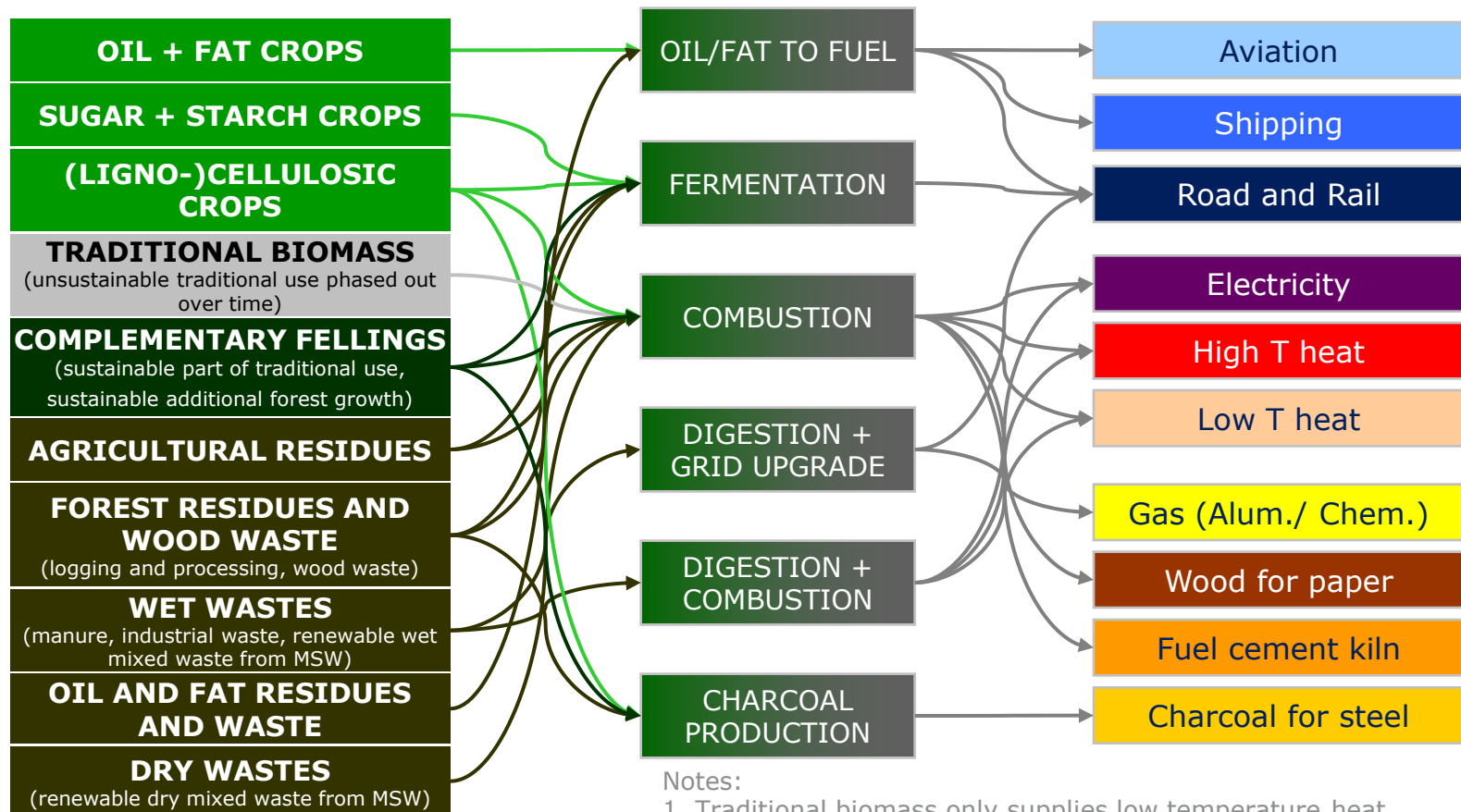


Notes:

1. Traditional biomass only supplies low temperature heat
2. Wood for paper can only be supplied from lignocellulosic crops, forest residues or complementary fellings

NB: The size of shapes here is NOT indicative of the size of the categories in the Scenario.

Bioenergy: Fourth, all energy crops and their residues are used

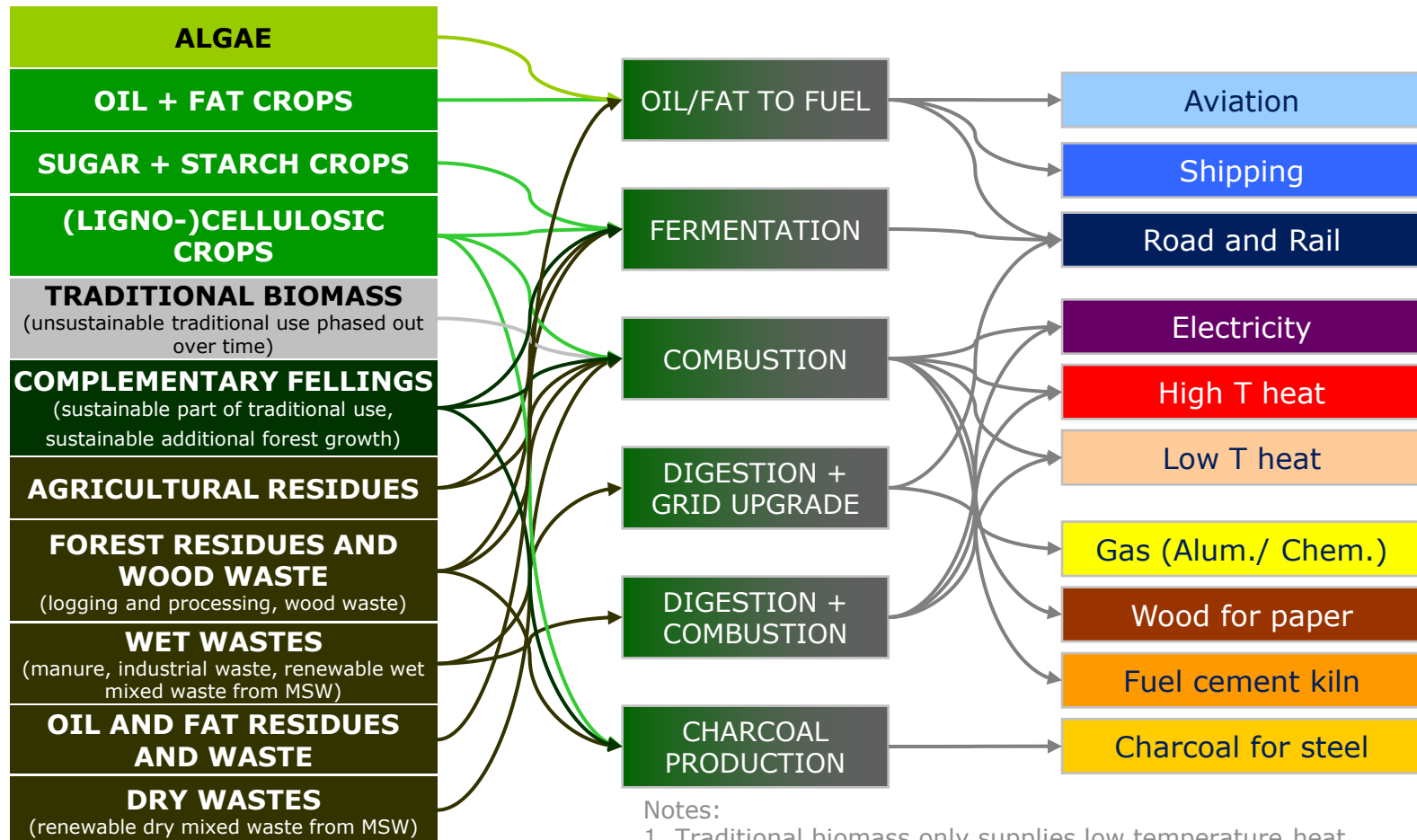


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Notes:

1. Traditional biomass only supplies low temperature heat
2. Wood for paper can only be supplied from lignocellulosic crops, forest residues or complementary fellings
3. Residues coming from transport fuel processing are used in routes separate from but similar to the residue routes

Bioenergy: Finally, algae are used to fill the remaining demand in the oil routes

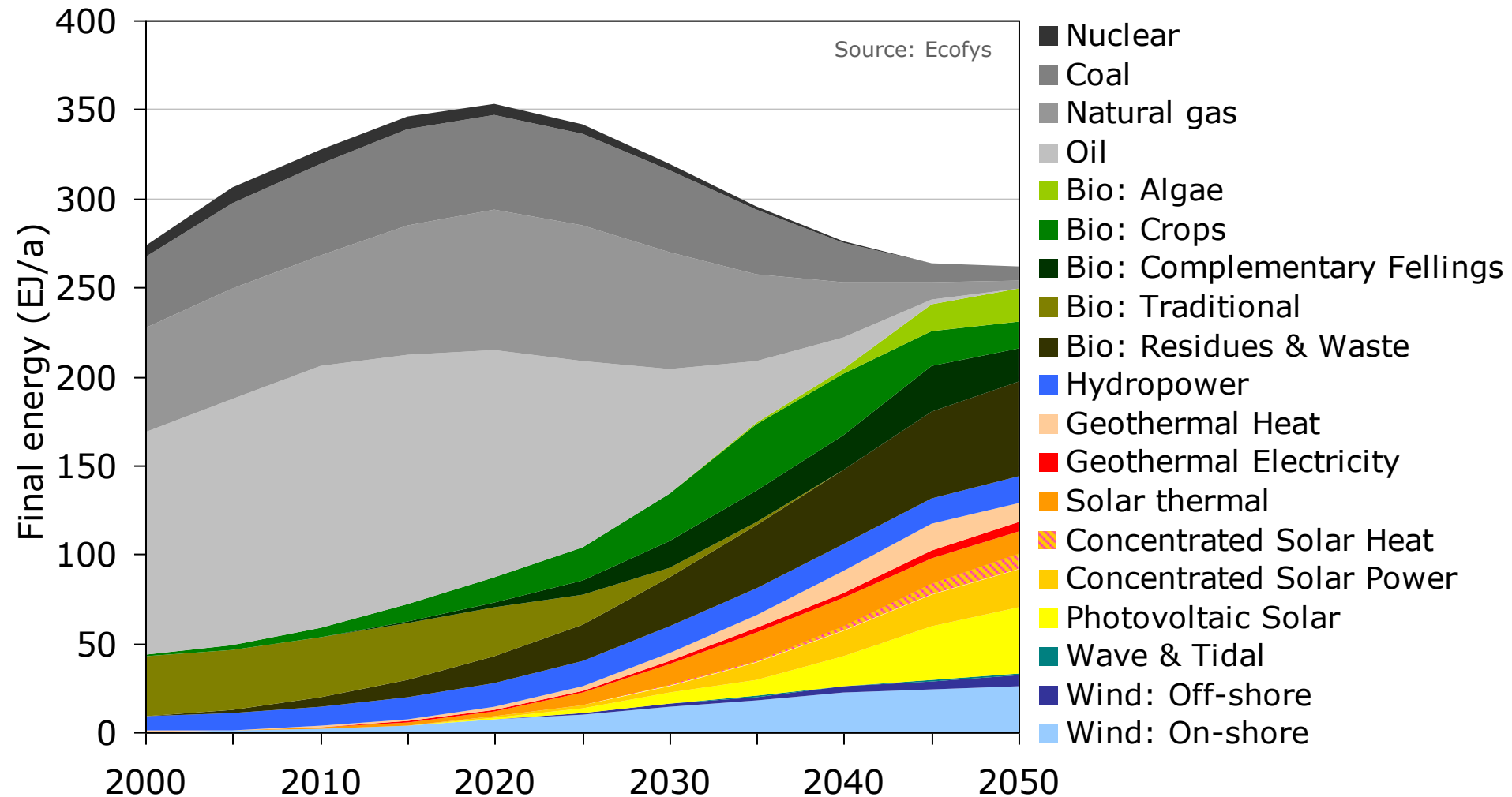


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Notes:

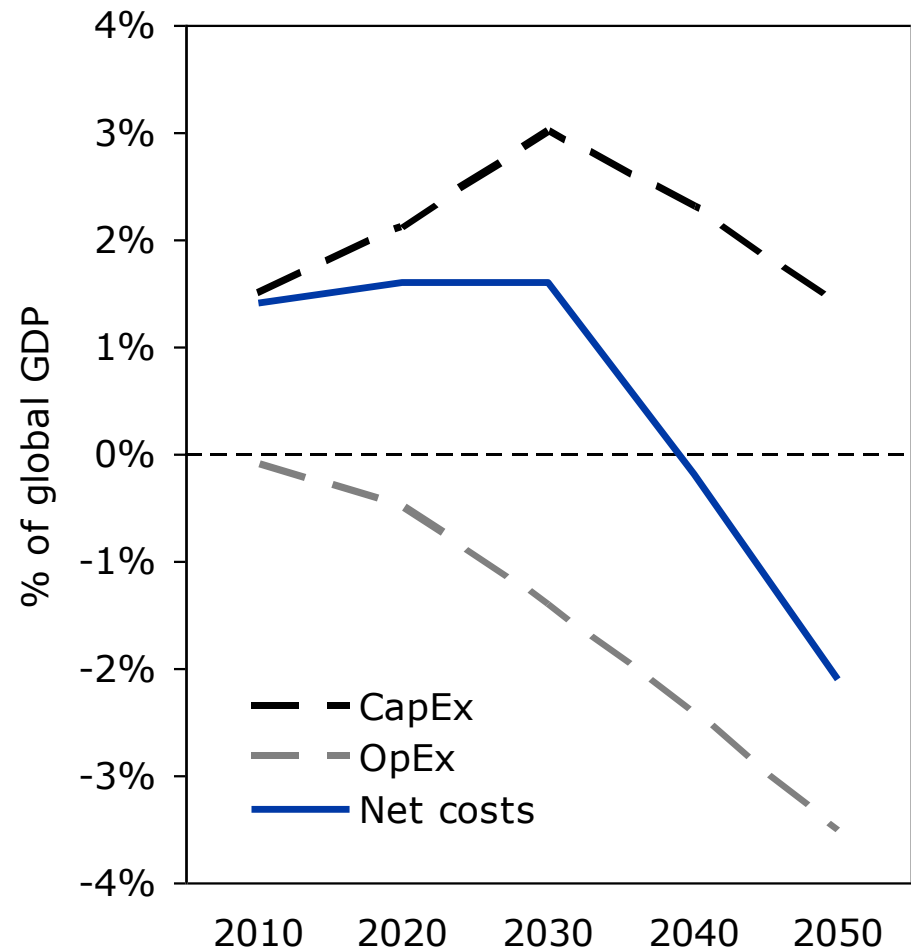
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3. Residues coming from transport fuel processing are used in routes separate from but similar to the residue routes

95% renewable energy worldwide by 2050 is possible

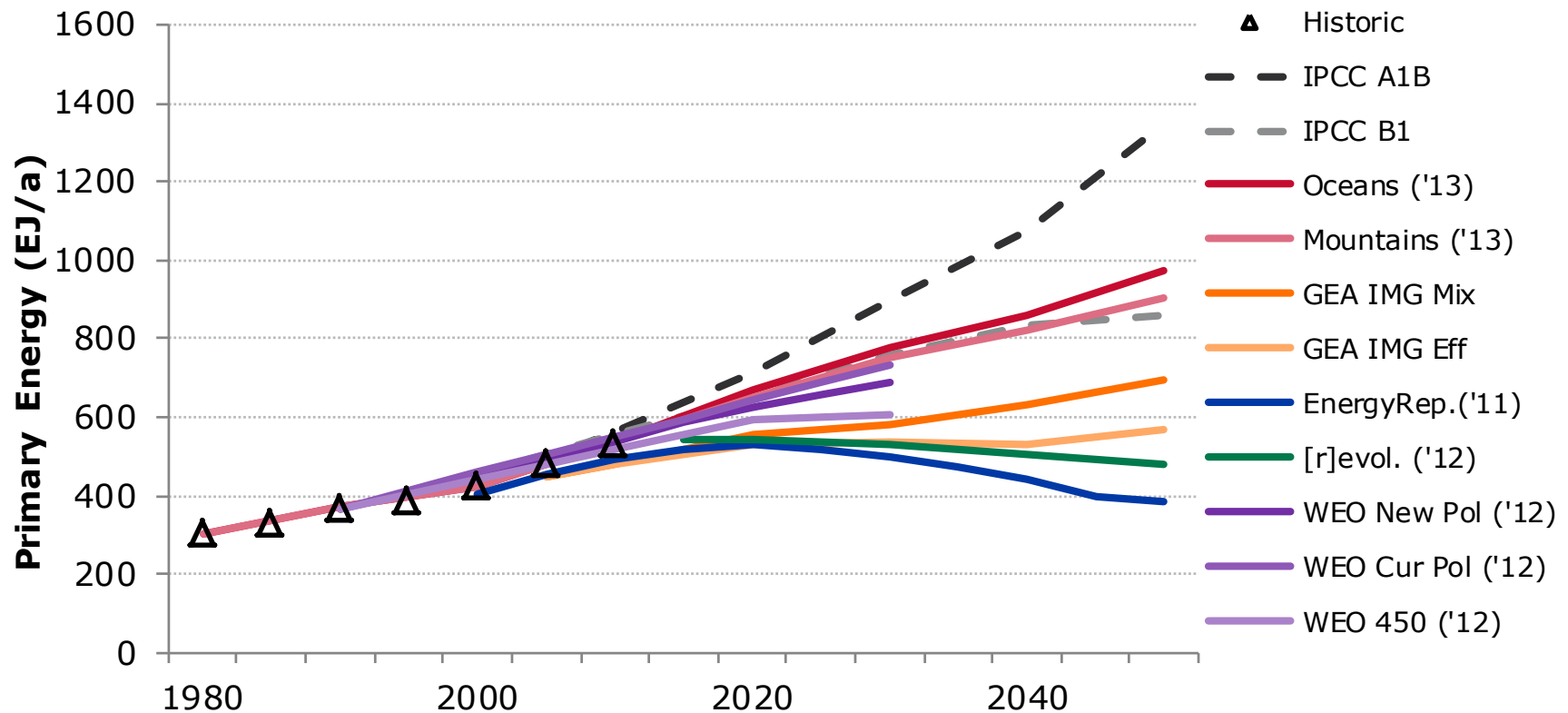


Global net costs will peak below 2% of GDP, and will turn to net savings after 2035

- > Net annual costs <2% before 2030
- > Net annual savings >2% by 2050
- > CapEx peaks at ~3% in 2030,
- > Savings increase steadily to ~3.5% in 2050
- > Barriers:
 - Short-term planning
 - Initial investments are still large

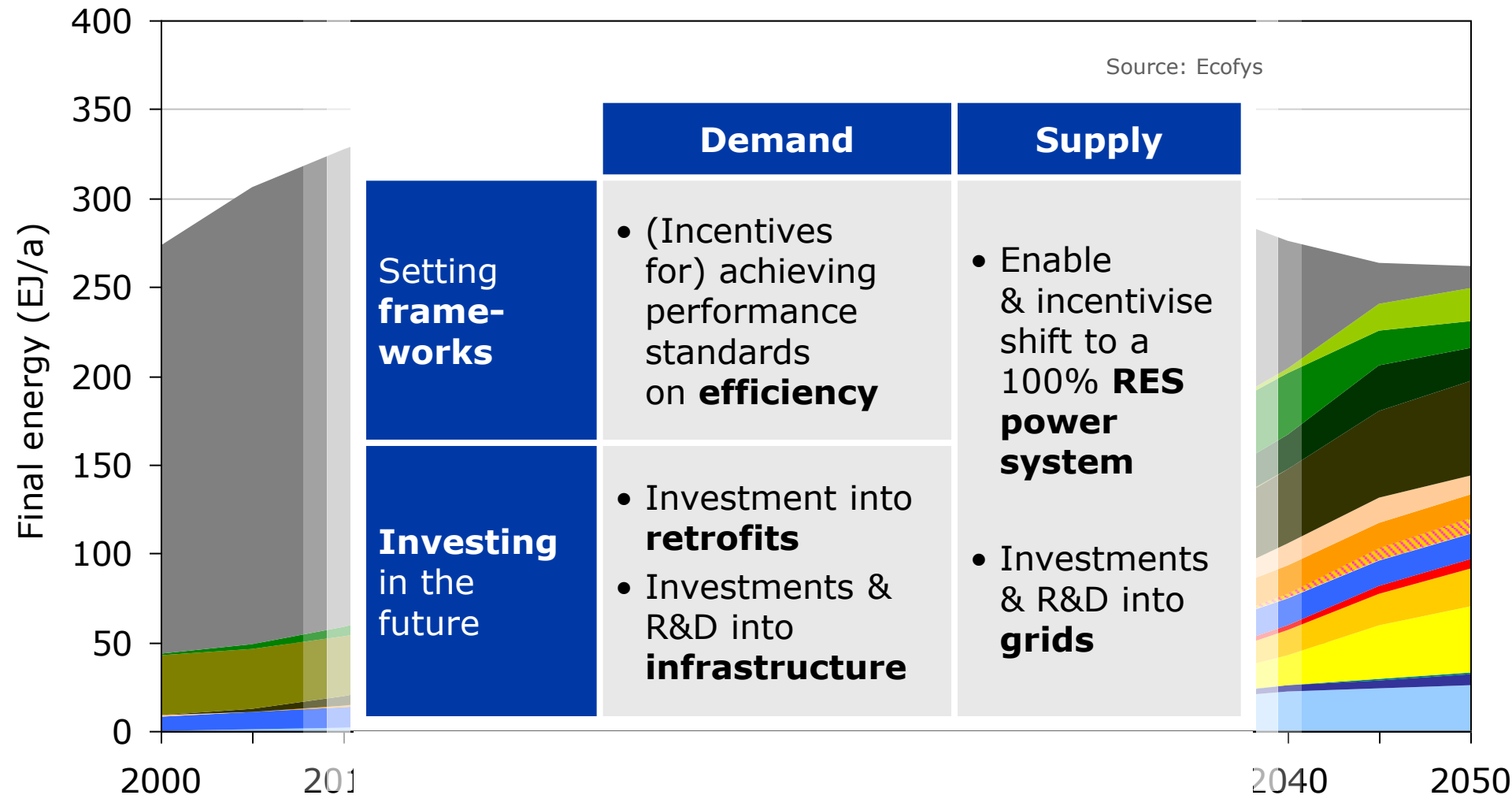


The Energy Report is amongst the most ambitious visions today



No other major scenario foresees a larger reduction in energy demand over the next 40 years

The Energy Scenario requires strong actions from all stakeholders to be realised



Action points to reach a fully sustainable global energy system



- **Electrify to shift demand to the most abundant renewable energy sources**



- **Scale up renewable power options**



- **Make initial investments to reap net savings by 2040**

- **Maximise energy efficiency to stabilise and reduce demand**



- **Prepare electricity grids for high supply-driven share**



- **Supply residual fuel and heat demand with sustainable bio-energy**



- **Action by all stakeholders is required now to change direction**



Downloads available online:

Full report:

**www.panda.org/energyreport or
www.ecofys.com/energyreport**

**Summaries, presentations,
translations (full Spanish, Chinese version, partial French version):**

www.ecofys.com/energyreport