



ELLEN MACARTHUR  
FOUNDATION

# **DELIVERING THE CIRCULAR ECONOMY A TOOLKIT FOR POLICYMAKERS**

## **SELECTION OF KEY EXHIBITS**



## **DISCLAIMER**

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This document contains key exhibits from the report *Delivering the circular economy: a toolkit for policymakers*.

The report has been produced by a team from the Ellen MacArthur Foundation, which takes full responsibility for the report's contents and conclusions. While the key contributors and contributors listed in the acknowledgements provided significant input to the development of this report, their participation does not necessarily equate to endorsement of the report's contents or conclusions. The McKinsey Center for Business and Environment provided analytical support. NERA Economic Consulting provided support for the macroeconomic and policy analysis for Parts 2 and 3 of the report.

The report describes a methodology for circular economy policymaking. It also explores a range of policy options that Denmark - the country of the report's pilot study - could choose to pursue. The report does not recommend any specific policy intervention to Denmark or to any other country.

## **PROJECT FUNDER**

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**CIRCULAR  
ECONOMY AND  
TOOLKIT  
METHODOLOGY**

# Circular economy - an industrial system that is restorative and regenerative by design

## PRINCIPLE 1

**Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows**  
**ReSOLVE levers: regenerate, virtualise, exchange**



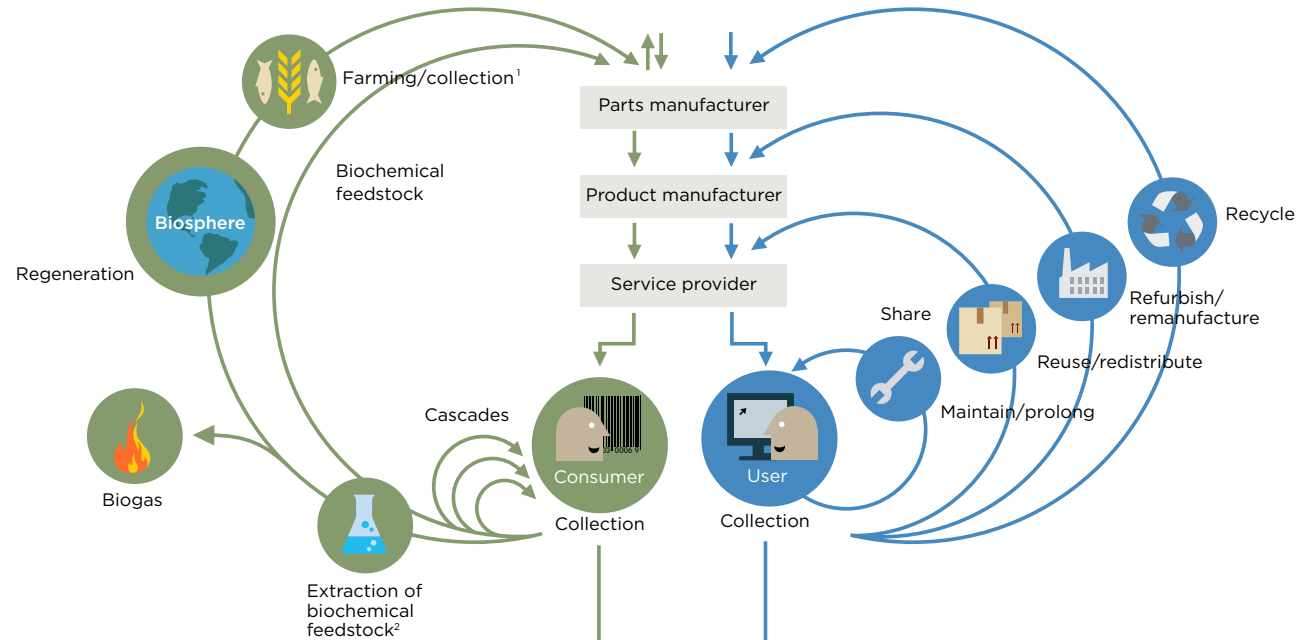
Regenerate Substitute materials Virtualise Restore

Renewables flow management

Stock management

## PRINCIPLE 2

**Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles**  
**ReSOLVE levers: regenerate, share, optimise, loop**



## PRINCIPLE 3

**Foster system effectiveness by revealing and designing out negative externalities**  
**All ReSOLVE levers**

MINIMISE SYSTEMIC LEAKAGE AND NEGATIVE EXTERNALITIES

1 Hunting and fishing

2 Can take both post-harvest and post-consumer waste as an input

SOURCE: Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: A Circular Economy Vision for a Competitive Europe* (2015).

Drawing from Braungart & McDonough, *Cradle to Cradle* (C2C).

## The ReSOLVE framework: six action areas for businesses and countries wanting to move towards the circular economy

### REGENERATE



- **Shift to renewable energy and materials**
- **Reclaim, retain, and restore health of ecosystems**
- **Return recovered biological resources to the biosphere**

### SHARE



- **Share assets (e.g. cars, rooms, appliances)**
- **Reuse/secondhand**
- **Prolong life through maintenance, design for durability, upgradability, etc.**

### OPTIMISE



- **Increase performance/efficiency of product**
- **Remove waste in production and supply chain**
- **Leverage big data, automation, remote sensing and steering**

### LOOP



- **Remanufacture products or components**
- **Recycle materials**
- **Digest anaerobically**
- **Extract biochemicals from organic waste**

### VIRTUALISE



- **Dematerialise directly (e.g. books, CDs, DVDs, travel)**
- **Dematerialise indirectly (e.g. online shopping)**

### EXCHANGE



- **Replace old with advanced non-renewable materials**
- **Apply new technologies (e.g. 3D printing)**
- **Choose new product/service (e.g. multimodal transport)**

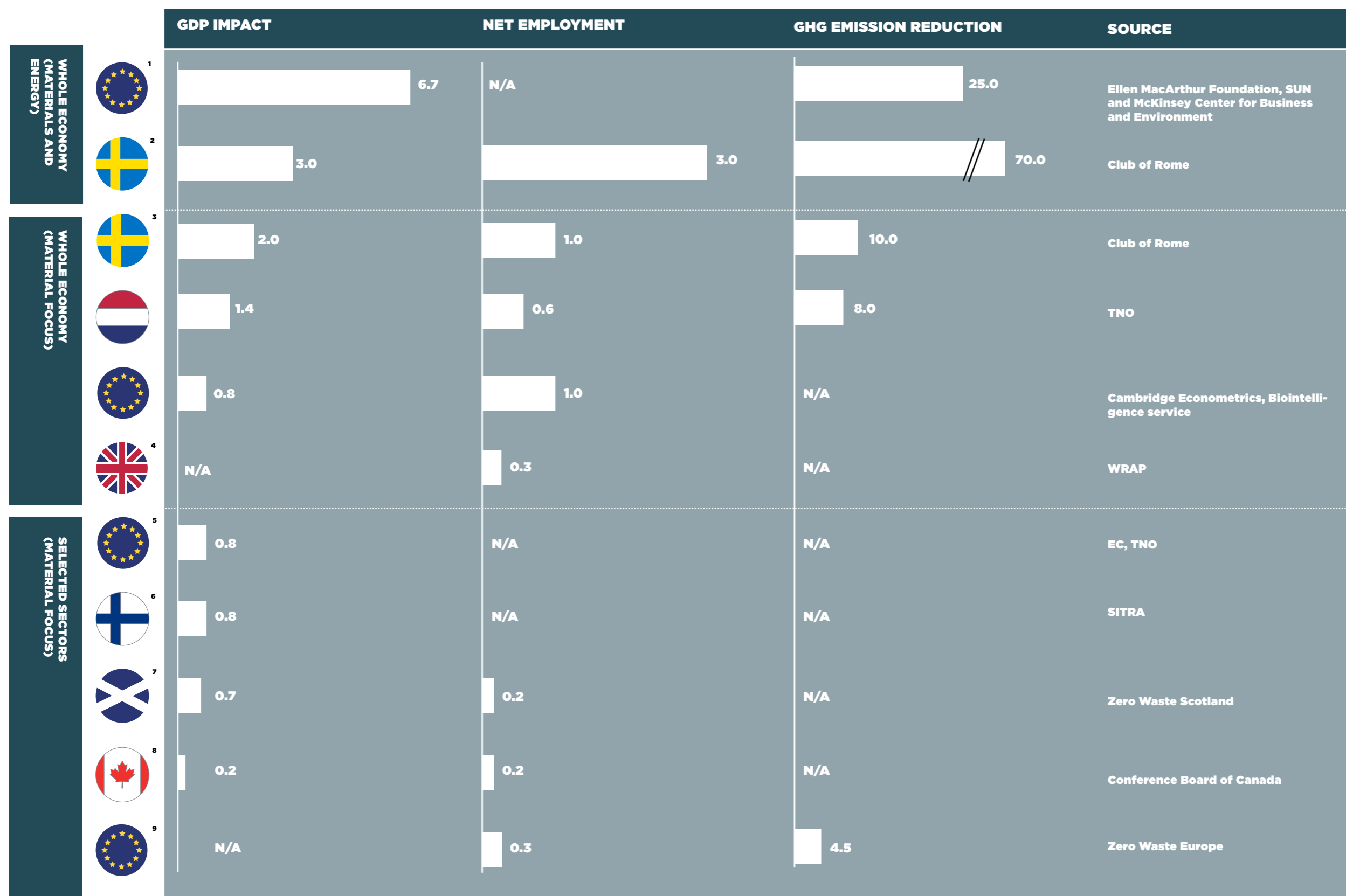
SOURCE: Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: A Circular Economy Vision for a Competitive Europe* (2015). Based on S. Heck, M. Rogers, P. Carroll, *Resource Revolution* (2015).

## Indicative prioritisation of ReSOLVE action areas for 20 sectors in Europe

	REGENERATE					
	High	Middle	Low	High	Middle	Low
<b>ECONOMIC ACTIVITIES</b>						
Information & communication services, media and telecommunications	Middle	Low	High	Middle	High	Middle
Scientific R&D, other professional, scientific & technical activities	Middle	Low	Low	Middle	High	Middle
Education	Middle	Low	Low	Middle	High	Middle
Human health and social work activities	Middle	Low	Low	Middle	High	Middle
Administrative & support services	Middle	Low	Low	Middle	High	Middle
Arts, entertainment and recreation	Middle	Low	Low	Middle	High	Middle
Financial and insurance activities	Middle	Low	Low	Middle	High	Middle
Legal & accounting head offices, consulting, architecture & engineering, TIC	Middle	Low	Low	Middle	High	Middle
Distributive trades (incl. wholesale and retail trade)	High	High	Low	Low	High	Low
Manufacture of wood and paper products, and printing	High	High	Low	Middle	High	Middle
Public administration and defence; compulsory social security	Middle	High	Low	Low	High	Low
Real estate activities	Middle	High	Low	Middle	Low	Middle
Manufacturing of textiles, apparel, leather and related products	High	High	Low	Middle	Low	Low
Construction	Middle	High	High	High	Low	Low
Manufacturing of transport equipment	Middle	High	Low	High	High	Low
Manufacturing of furniture	High	High	Low	Low	Middle	Middle
Water supply, waste & remediation	High	Low	Low	Middle	Middle	Low
Manufacturing of elec. equipment, computer, electronic and optical products	Middle	Low	Low	High	Low	Low
Manufacturing of machinery and equipment	Middle	Low	Low	High	Low	Low
Manufacturing of rubber, plastics, basic and fabricated metal products	Low	Low	Low	High	Middle	High
Transportation and storage	Middle	Low	Low	High	Middle	High
Agriculture, forestry and fishing	High	Middle	Low	Middle	Middle	High
Manufacturing of food, beverages and tobacco products	High	Middle	Low	High	Middle	High
Mining and quarrying	Middle	Middle	Low	High	Middle	High
Electricity, gas, steam and air-conditioning supply	High	Middle	Low	Low	High	High
Manufacturing of coke, refined petroleum, chemicals products	Middle	Middle	Low	Low	Middle	High
Manufacturing of pharmaceuticals, medicinal chemical, botanical products	Low	Middle	High	Low	Middle	Low
Accommodation and food service activities	Low	High	High	Low	Low	Middle

SOURCE: Adapted from Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: A Circular Economy Vision for a Competitive Europe* (2015).

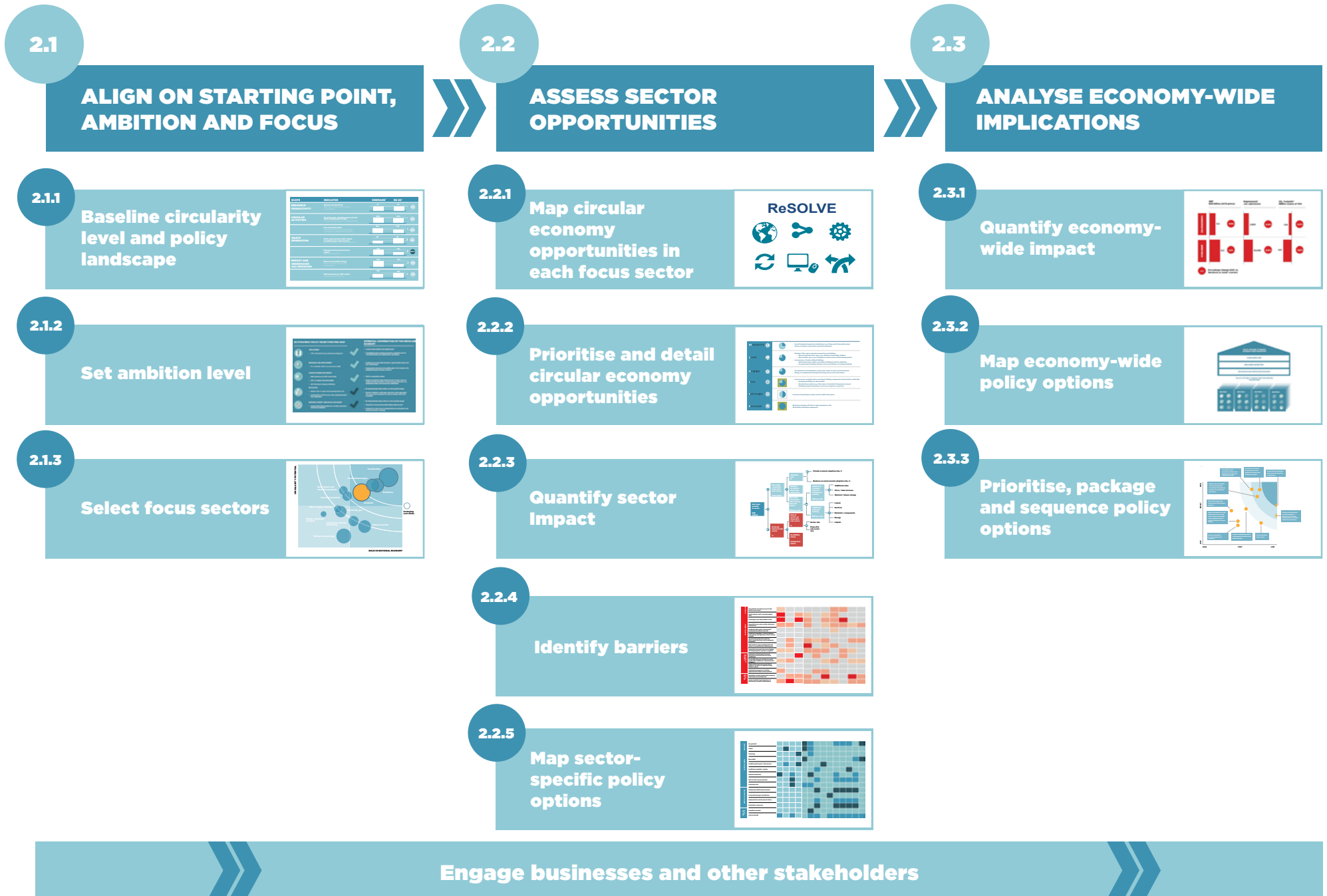
# Estimated potential contribution of the circular economy to economic growth, job creation and reduction of greenhouse gas emissions



1 2030 scenario.  
 2 Full scenario; GDP impact equal to trade balance effect.  
 3 'Material efficiency scenario'; GDP impact equal to trade balance effect.  
 4 Net job creation from increased reuse, remanufacturing, recycling, bio-refining and servitisation.  
 5 Built environment.  
 6 Forestry, pulp and paper, machinery, equipment and electronics, built environment, food waste, P2P sharing.  
 7 Remanufacturing industry.  
 8 Ontario; Waste management and recycling industry.  
 9 Waste management and recycling industry; compiled from several reports, see [http://ec.europa.eu/environment/circular-economy/index\\_en.htm](http://ec.europa.eu/environment/circular-economy/index_en.htm), [http://ec.europa.eu/smart-regulation/impact/planned\\_ia/docs/2014\\_env\\_005\\_waste\\_review\\_en.pdf](http://ec.europa.eu/smart-regulation/impact/planned_ia/docs/2014_env_005_waste_review_en.pdf)

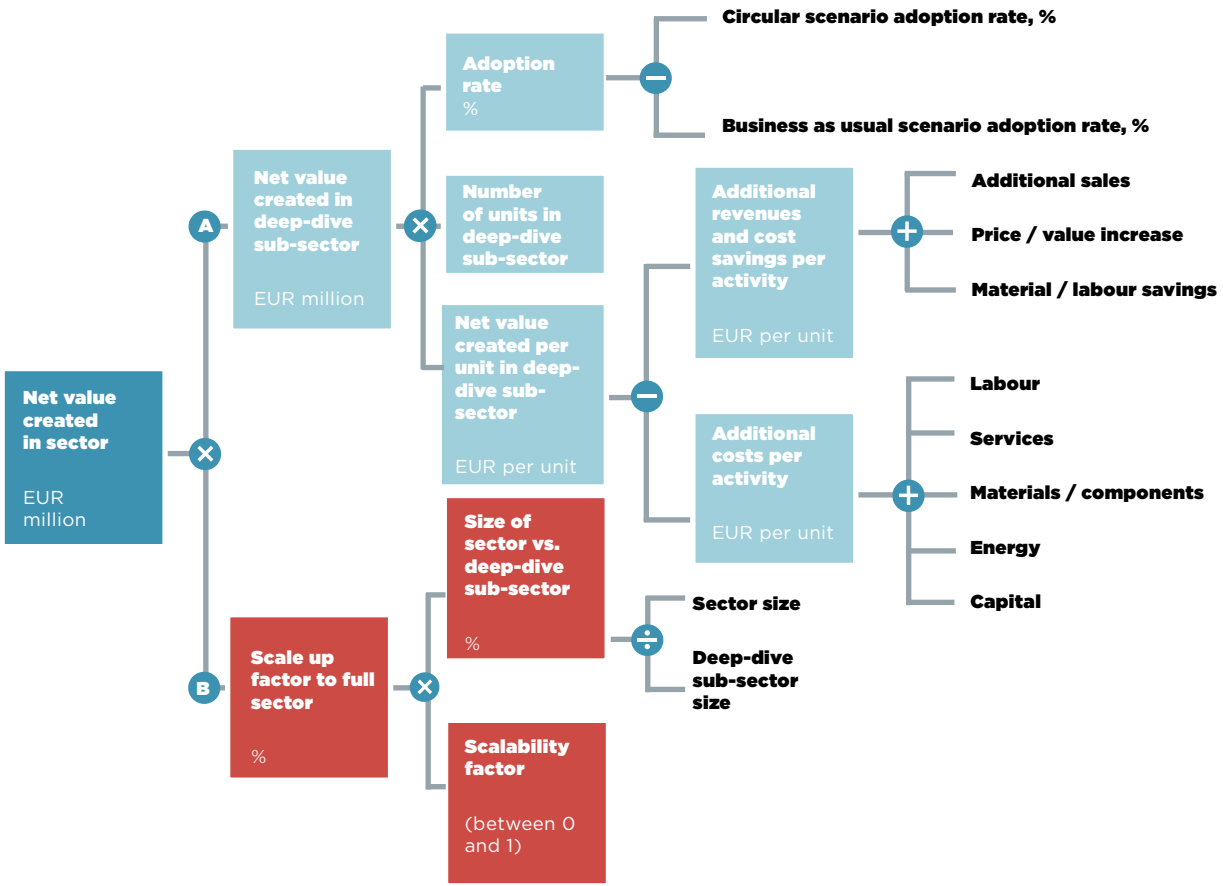
SOURCE: NL: TNO, Opportunities for a circular economy in the Netherlands (2013); EU (1): Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, Growth Within: A Circular Economy Vision for a Competitive Europe (2015); EU (2): Cambridge Econometrics / Biointelligence Service / EC, Study on modelling of the economic and environmental impacts of raw material consumption (2014); SWE: Club of Rome, The circular economy and benefits for Society (2015); UK: WRAP, Employment and the circular economy: job creation in a more resource efficient Britain (2014); FIN: SITRA, Assessing circular economy potential for Finland (2014); EU, built environment: TNO / EC, Assessment of scenarios and options towards a resource efficient Europe: an analysis for the European built environment (2013); SCO: Zero Waste Scotland, Circular economy evidence building programme: Remanufacturing study (2015); EU, waste management: Zero Waste Europe, EU circular economy package: Questioning the reasons for withdrawal (2015); CAN: Conference Board of Canada, Opportunities for Ontario's Waste: Economic Impacts of Waste Diversion in North America (2014)

## Step-by-step methodology











# Schematic overview of sector-specific impact quantification

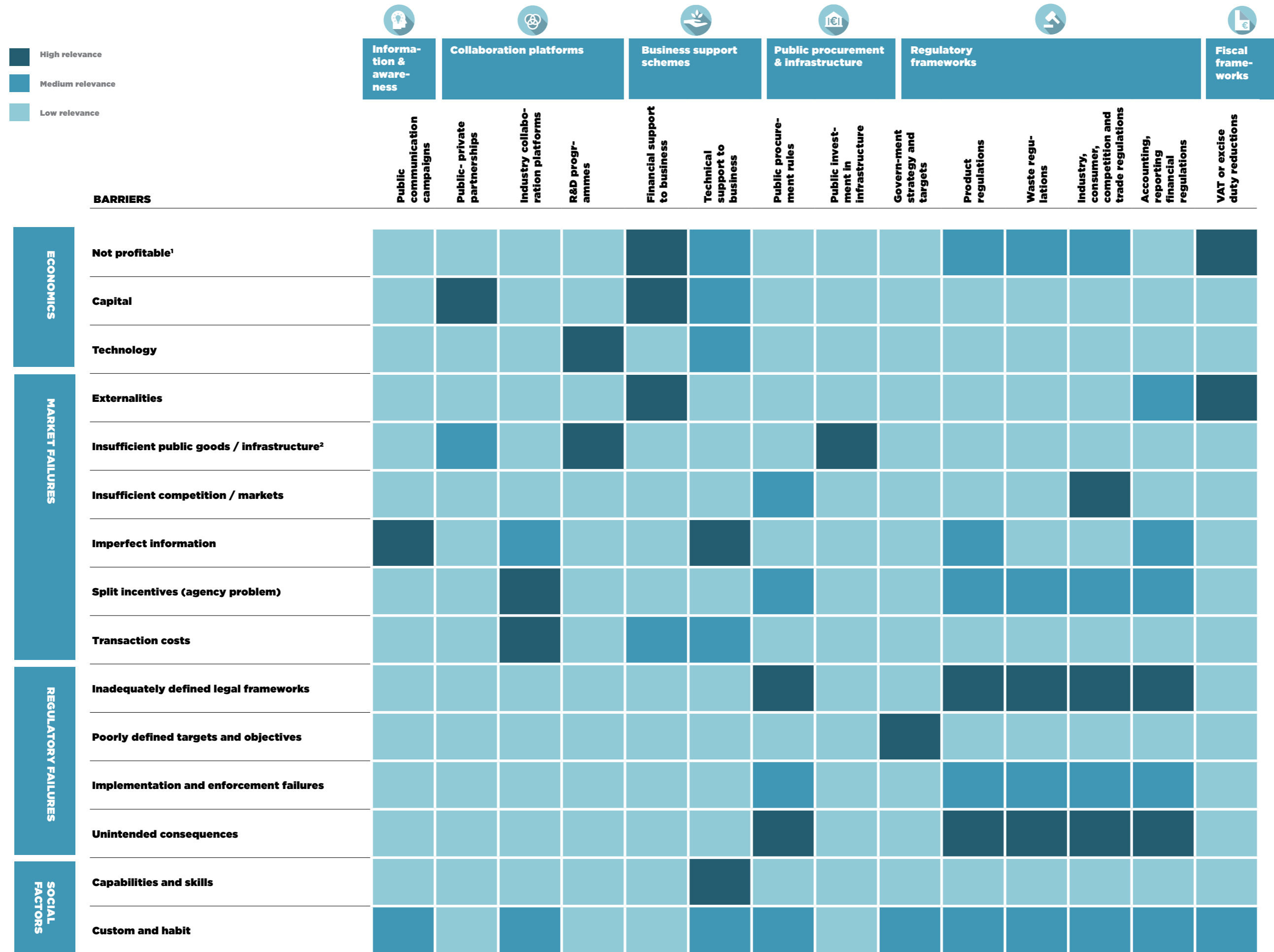


SOURCE: Ellen MacArthur Foundation

## Six policy intervention types with examples

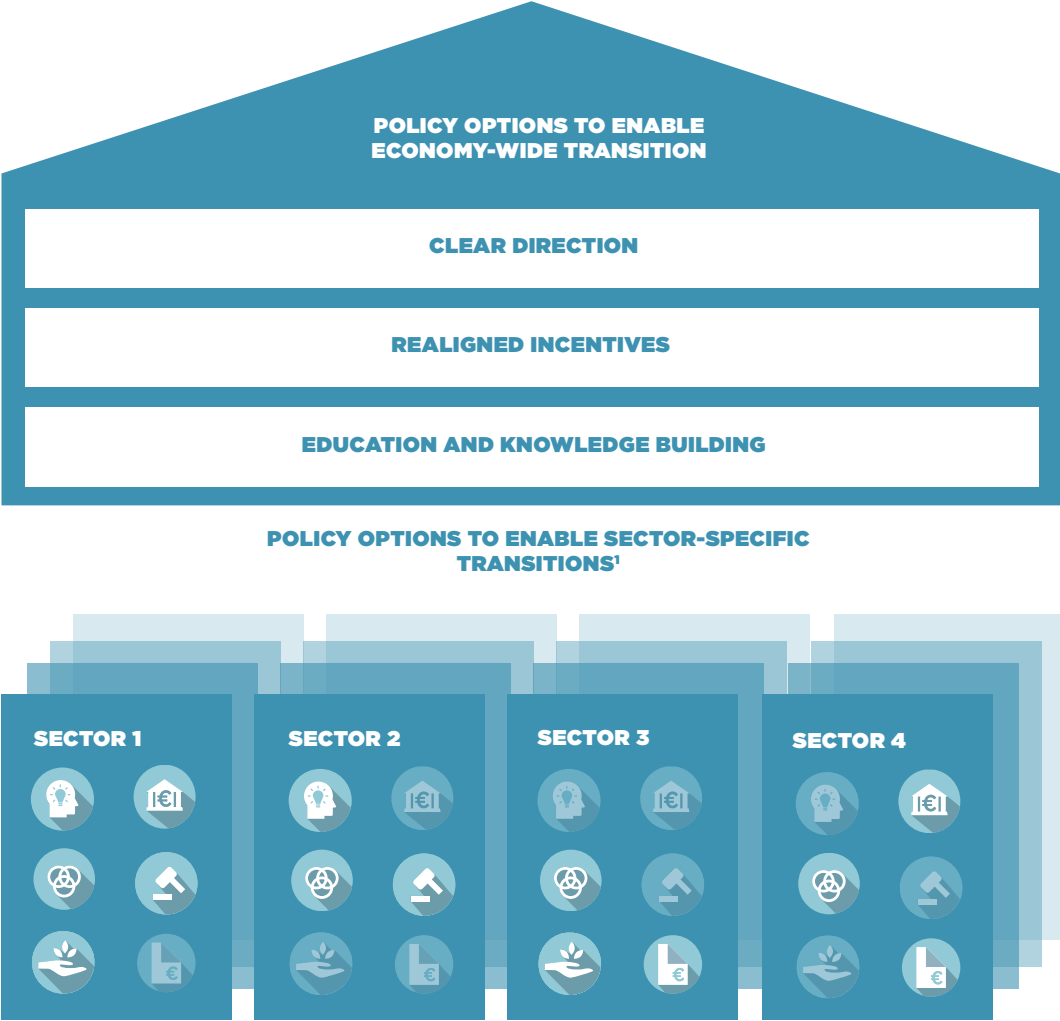
	<b>POLICY INTERVENTION TYPES</b>	<b>EXAMPLES</b>
	<b>EDUCATION, INFORMATION &amp; AWARENESS</b>	Integration of circular economy/systems thinking into school and university curricula
		Public communication and information campaigns
	<b>COLLABORATION PLATFORMS</b>	Public-private partnerships with businesses at national, regional and city level
		Encouragement of voluntary industry collaboration platforms, encouraging value-chain and cross-sectoral initiatives and information sharing
		R&D programmes in the fields of, for example, material sciences and biosystems
	<b>BUSINESS SUPPORT SCHEMES</b>	Financial support to business, for example direct subsidies, provision of capital, financial guarantees
		Technical support, advisory, training and demonstration of best practices to business
	<b>PUBLIC PROCUREMENT &amp; INFRASTRUCTURE</b>	Public procurement
		Public investment in infrastructure
	<b>REGULATORY FRAMEWORKS</b>	Government (sector) strategy and associated targets on resource productivity and circular economy
		Product regulations, including design, extended warranties and product passports
		Waste regulations, including collection and treatment standards and targets, the definition of waste, extended producer responsibility and take-back systems
		Industry, consumer, competition and trade regulations, for example on food safety
		Accounting, reporting and financial regulations including accounting for natural capital and resources, and the fiduciary duty of investors and managers
	<b>FISCAL FRAMEWORKS</b>	VAT or excise duty reductions for circular products and services
		Tax shift from labour to resources

# Mapping policy interventions to barriers



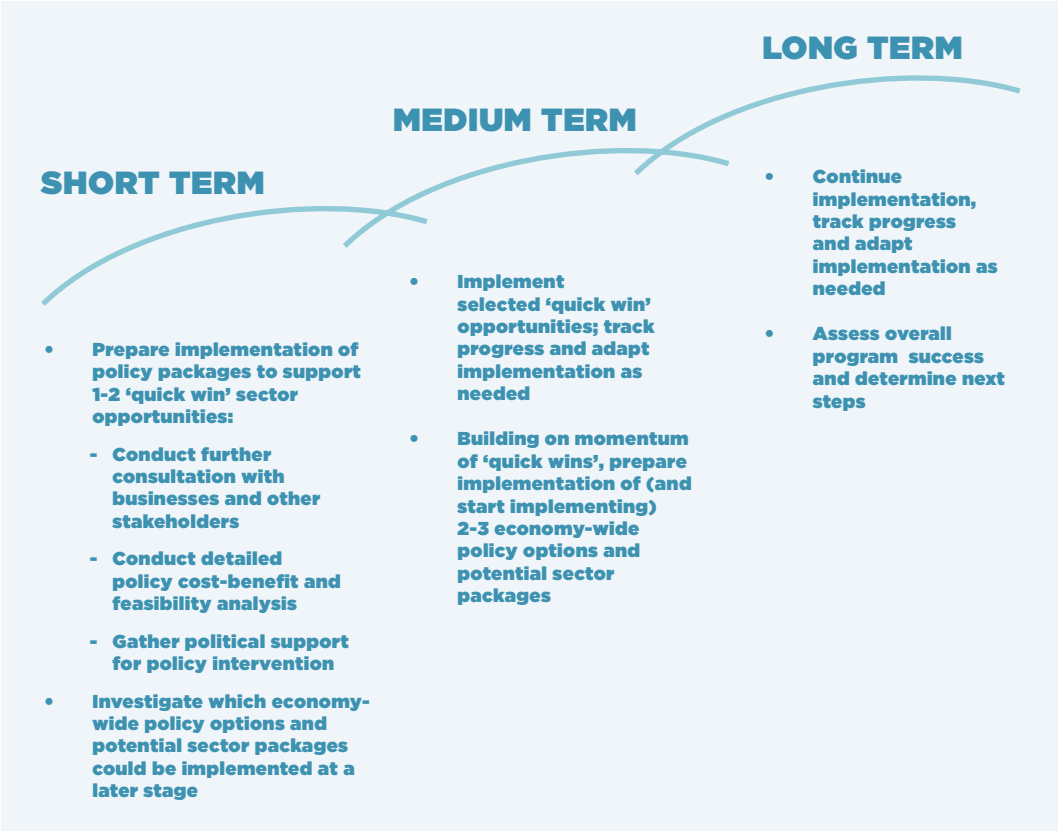
<sup>1</sup> At market prices excluding the full pricing of externalities such as greenhouse gas emissions, ecosystem degradation and resource depletion  
<sup>2</sup> Infrastructure defined as fundamental physical and organizational structures and facilities, such as transportation, communication, water and energy supplies and waste treatment

# How economy-wide circular economy policy might complement sector-specific policy



<sup>1</sup> One policy package per circular economy opportunity. For definitions of policy types, see Figure 7. SOURCE: Ellen MacArthur Foundation. Adapted from Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment, *Growth Within: A Circular Economy Vision for a Competitive Europe* (2015).

# Example roadmap for packaging and implementing policy options

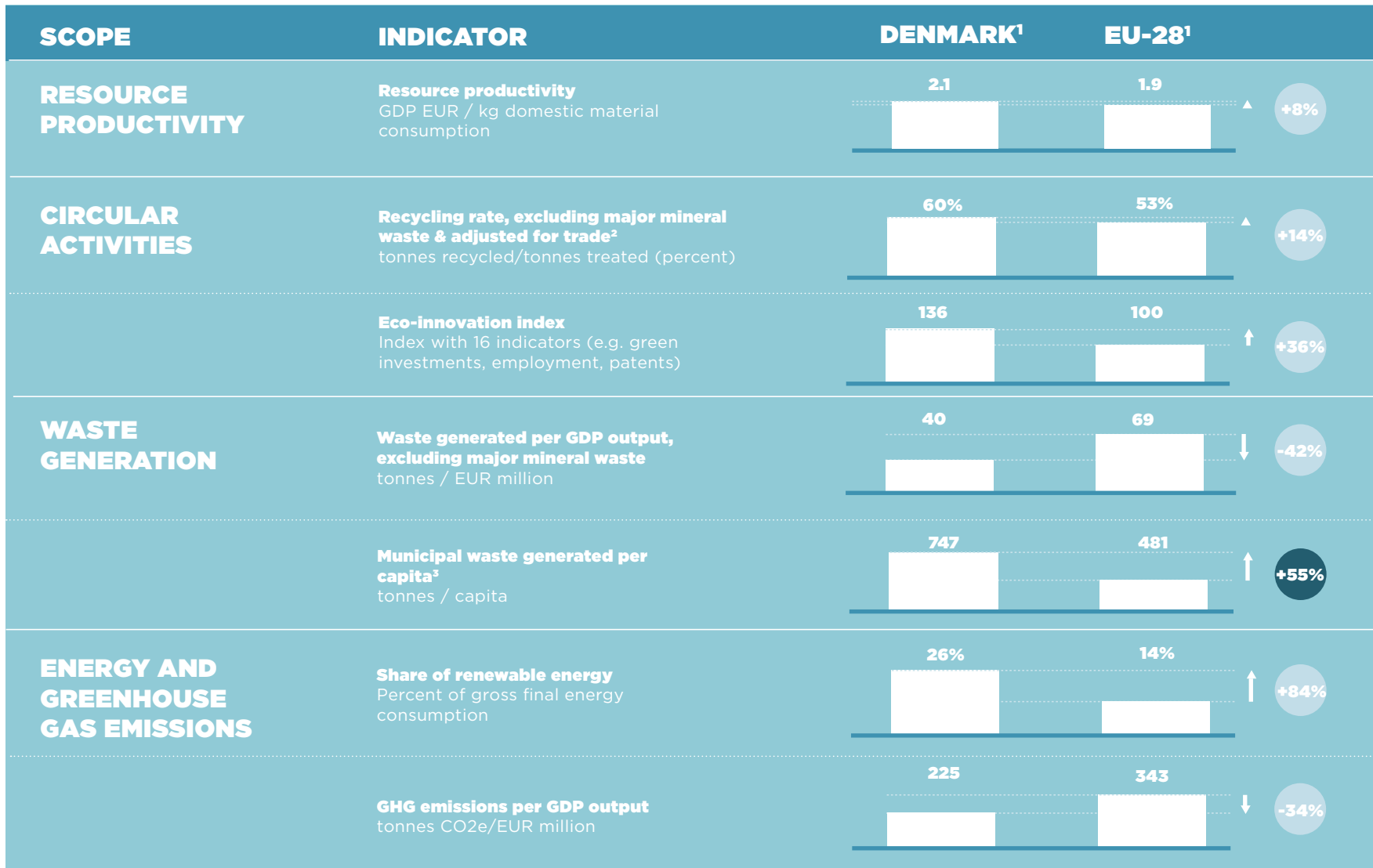




**CASE STUDY**  
**DENMARK**



# Circularity baselining in the Denmark pilot



<sup>1</sup> 2012 values if not stated otherwise

<sup>2</sup> Recycling of domestically generated waste (incl. exported waste, excl. imported waste)

<sup>3</sup> 2013 data

SOURCE: Resource Efficiency Scoreboard 2014 Highlights, European commission (2014); Eurostat; Statistics Denmark, Danish EPA



## Policy landscape in the Denmark pilot



### EDUCATION, INFORMATION & AWARENESS

- Consumer information campaigns, e.g. 'Use more, waste less' and 'Stop Wasting Food'

- Systems thinking integrated in curricula
- Further pilot projects to demonstrate circular economy potential to businesses



### COLLABORATION PLATFORMS

- Green Industrial Symbiosis programme
- Four new partnerships (food, textile, construction and packaging) as part of the Danish Waste Prevention Strategy
- Rethink Resources, an innovation centre to support resource efficiency in companies
- 'Genbyg Skive' pilot project to re-use building materials to create business opportunities and reduce waste

-



### BUSINESS SUPPORT SCHEMES

- Fund for Green Business Development (EUR 27m 2013–2018) to support innovation and new business models
- Maabjerg Energy Concept (MEC) bio-refinery part funded by Innovation Fund Denmark (EUR 40m)

- Dutch 'Green Deal' inspired programme to provide on-demand support to companies in implementing circular economy opportunities



### PUBLIC PROCUREMENT & INFRASTRUCTURE

- Government Strategy on Intelligent Public Procurement contains initiatives to support circular procurement practices
- Strategy on waste prevention also contains an initiative to develop guidelines for circular public procurement

- Guidelines on the circularity of materials and products integrated into public procurement policy



### REGULATORY FRAMEWORKS

- Ambitious energy efficiency and GHG emissions targets, e.g. 40% GHG reduction by 2020 vs. 20% at EU level,
- Ambitious targets for recycling/incineration/landfill, updated every 6 years, e.g. recycle 50% of household waste by 2022
- Taskforce for increased resource efficiency to review existing regulations affecting circular economy practices

- New metrics introduced to measure economic performance, e.g. complements to GDP such as natural capital
- Engagement at EU level to adapt existing or introduce new regulations relevant to the circular economy, e.g. product policy



### FISCAL FRAMEWORKS

- Taxes on extraction and import of raw materials, vehicle registration and water supply
- High and incrementally increased taxes on incineration / landfill to promote recycling and waste prevention
- Highest energy taxes in Europe (70% above EU27) and CO2 taxes
- Tax cuts designed to promote use of low-carbon energy

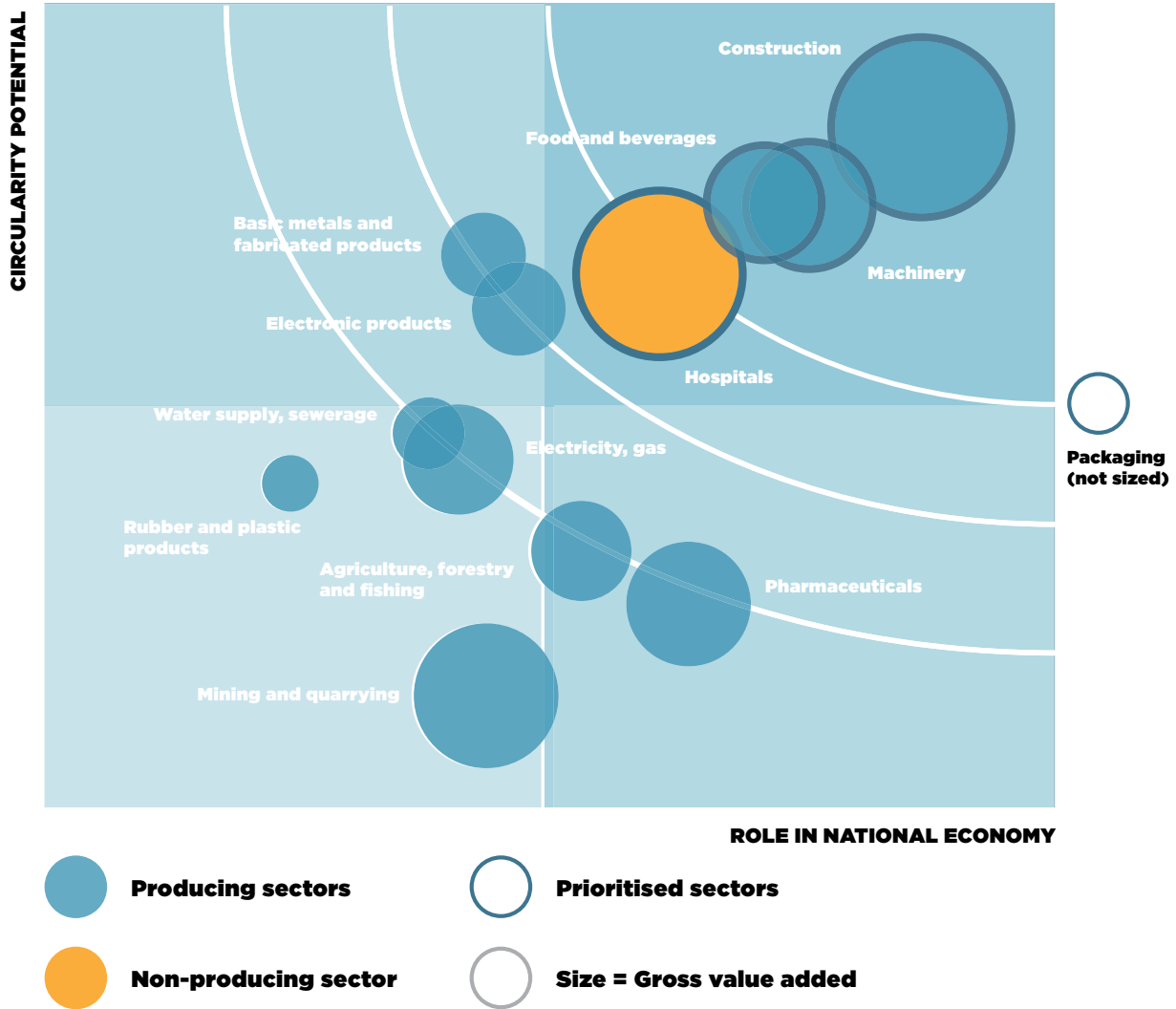
- Investigation into effects of tax shift from labour to resources

SOURCE: European Commission, Tax reforms in EU Member States 2013; IEA, Energy Policies of Denmark: 2011 review; Nordic Council of Ministers, The use of economic instruments in Nordic environmental policy 2010-2013; Danish legislative council, Waste management policy in Denmark, 2014; The Ex'Tax project, New era. New plan. Fiscal reforms for an inclusive, circular economy, 2014.





## Results of sector prioritisation in Denmark pilot



NOTE: Only producing sectors (24% of national GVA) and hospitals (3.5% of national GVA) considered  
 SOURCE: Statistics Denmark (2011 data); Danish Business Authority; Danish Environmental Protection Agency; Ellen MacArthur Foundation

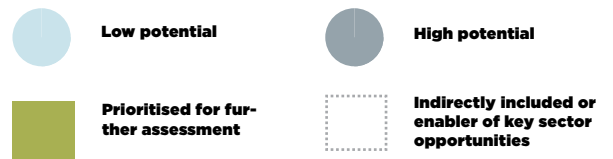


## Short-term and long-term scenarios used in the Denmark pilot










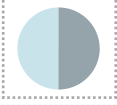

























	<b>Short-term (2020)</b>	<b>Long-term (2035)</b>
<b>BUSINESS &amp; CONSUMER BEHAVIOUR</b>	<ul style="list-style-type: none"> <li>Increased acceptance of performance based business models in businesses and the public sector, but still for niche product categories (e.g. -10% of imaging / radiation equipment in hospitals, -10% of machinery products)</li> <li>Households are comfortable using new separation systems introduced by municipalities as part of the “Denmark Without Waste” strategy (e.g. increase in collection rate of household plastic packaging waste by 15 percentage points)</li> <li>Significant remaining margins for improvement in waste reduction</li> <li>Rapidly increasing interest in sharing business models (e.g. shared residential and office space)</li> </ul>	<ul style="list-style-type: none"> <li>Broad acceptance of access over ownership business models in businesses and public sector (e.g. -30% of a broad range of products in hospitals, -30-70% of machinery products)</li> <li>Fully optimised waste collection and separation infrastructure provided by municipalities and waste managers (collection of 70-80% of plastics for recycling)</li> <li>Avoidable food waste reduction approaching theoretical limits due to improved knowledge and use of best practices among consumers, businesses and public institutions (e.g. hospitals)</li> <li>Sharing has become the new norm for traditionally underutilised assets (buildings, cars, and durables)</li> </ul>
<b>TECHNOLOGY</b>	<ul style="list-style-type: none"> <li>Key circular economy technologies (e.g. cascading bio-refineries, bio-based alternatives to plastics, 3D printing and design for disassembly in construction, remanufacturing techniques), existing today at late R&amp;D or early commercial stage, have been successfully piloted</li> </ul>	<ul style="list-style-type: none"> <li>Key circular economy technologies existing today at R&amp;D or early commercial stage have reached maturity due to accelerated innovation</li> <li>Increasing remanufacturing of machinery components for use in “as new” products enabled by increasing importance of software for performance</li> </ul>

Source: Expert interviews; DBA; Danish EPA; Ellen MacArthur Foundation.

# Qualitative opportunity prioritisation of focus sectors in the Denmark pilot



## QUALITATIVE ASSESSMENT OF POTENTIAL IN DENMARK PILOT<sup>1</sup>

	FOOD & BEV.	CONSTRUCTION	MACHINERY	PACKAGING	HOSPITALS
REGENERATE 					
SHARE 					
OPTIMISE 					
LOOP 					
VIRTUALISE 					
EXCHANGE 					

<sup>1</sup> Assessment based on focus subsector, product category or material stream in each sector. Food & beverage: Waste/by-products from pork / dairy processing, residual biomass from agriculture, organic waste from households, retail & hospitality. Construction: New buildings. Machinery: Manufacturing of pumps and wind turbines. Packaging: Plastic packaging. Hospitals: Purchasing of goods. SOURCE: Ellen MacArthur Foundation



## Ten circular economy opportunities in five focus sectors



### FOOD AND BEVERAGE

1

Value capture in cascading bio-refineries

2

Reduction of avoidable food waste



### CONSTRUCTION AND REAL ESTATE

3

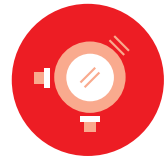
Industrialised production and 3D printing of building modules

4

Reuse and high-value recycling of components and materials

5

Sharing and multi-purposing of buildings



### MACHINERY

6

Remanufacturing and new business models



### PLASTIC PACKAGING

7

Increased recycling of plastic packaging

8

Bio-based packaging where beneficial



### HOSPITALS

9

Performance models in procurement

10

Waste reduction and recycling

SOURCE: Ellen MacArthur Foundation



# Illustrative status of circular economy in Denmark today and potential by 2035

2015 2035

## LINEAR ECONOMY

- Linear flows (landfill, incineration)
- Efficiency; waste avoidance
- Non-renewable energy

## TRANSITION ECONOMY

- Low-value circular flows (e.g. recycling, AD)
- Mix of renewable and non-renewable energy

## CIRCULAR ECONOMY

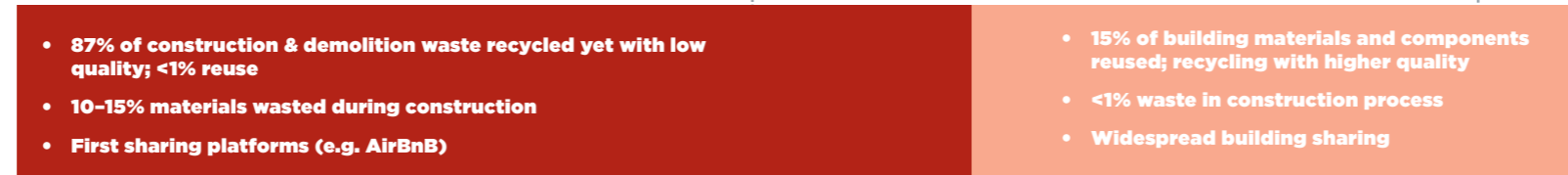
- High-value circular flows (e.g. reuse, reman, cascaded value extraction for organics)
- Circular business models (e.g. sharing, leasing)
- Renewable energy



### FOOD AND BEVERAGE



### BUILT ENVIRONMENT



### MACHINERY



### PLASTIC PACKAGING



### HOSPITALS



### ENERGY (NOT FOCUS IN PILOT)



### DENMARK (BASED ON SECTORS ABOVE)

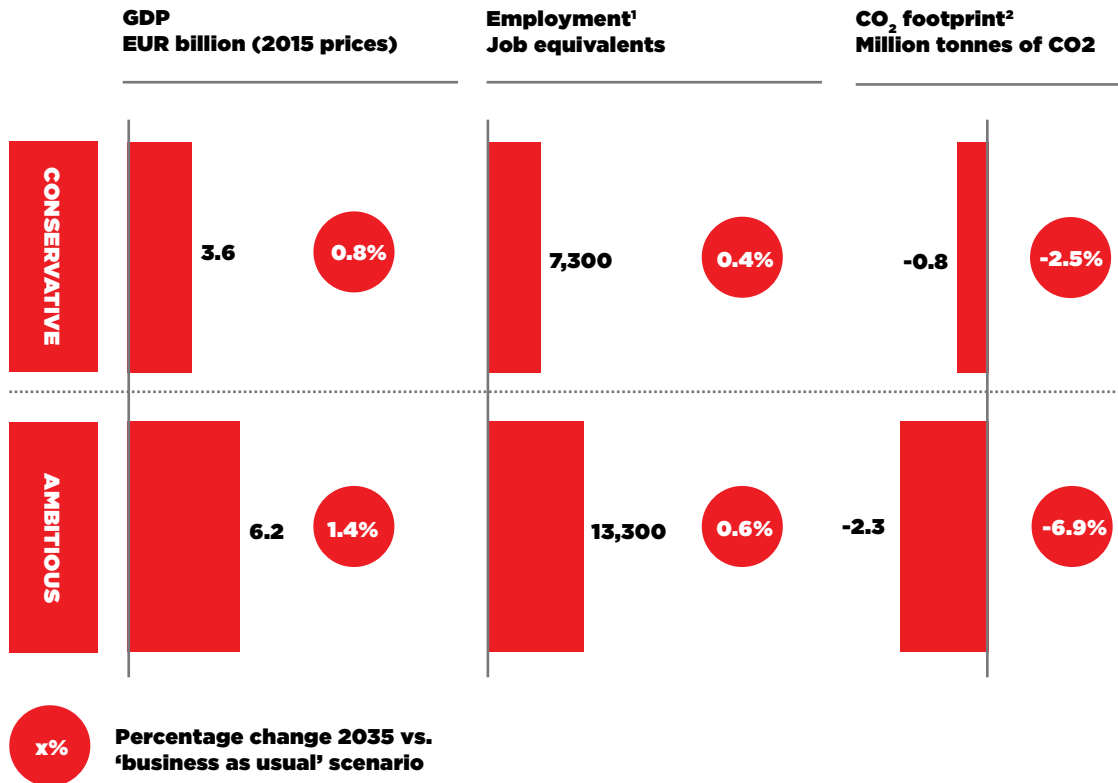


SOURCE: Statistics Denmark; Eurostat; Danish Climate Policy Plan; expert interviews; Ellen MacArthur Foundation



## Estimated potential impact of further transitioning to the circular economy in Denmark

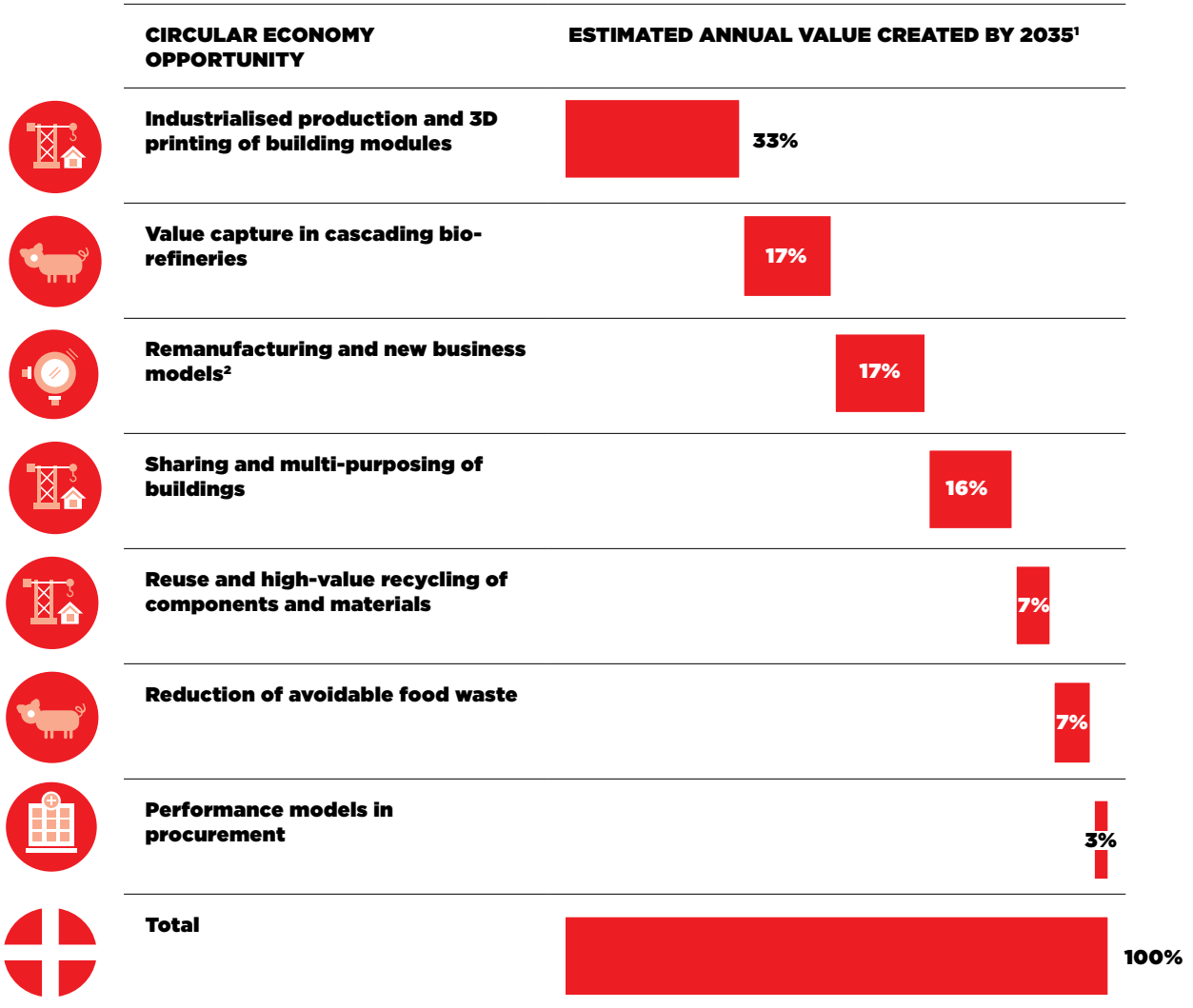
Economy-wide impact by 2035. Absolute and percentage change relative to the 'business as usual' scenario.



1 Employment impact modelled through conversion of labour bill to job equivalents via a wage curve approach (elasticity = 0.2). Percentage change is vs. 2013 total full-time employment (Source: Statistics Denmark)  
 2 Change in Global CO<sub>2</sub> emissions vs. Denmark baseline 2035 emissions; other GHG emissions are not included.  
 SOURCE: Ellen MacArthur Foundation; NERA Economic Consulting



## Breakdown of potential economic impact by quantified opportunity



<sup>1</sup> Average between conservative and ambitious scenario. This sector-specific impact does not include indirect effects, e.g. on supply chains, that are captured in the economy-wide CGE modelling.

<sup>2</sup> Including scaling from machinery sector (including pumps, wind turbines and other machinery products) to adjacent manufacturing sectors (electronic products, basic metals and fabricated products, other manufacturing, mining and quarrying)

SOURCE: Ellen MacArthur Foundation



# Barrier matrix for the ten prioritised opportunities in Denmark

## CIRCULAR ECONOMY OPPORTUNITIES

- Critical barrier ('make or break')
- Very important barrier (to scale-up / acceleration of lever)
- Important barrier (to scale-up / acceleration of lever)
- Limited or no barrier



**Value capture in cascading bio-refineries**



**Reduction of avoidable food waste**



**Industrialised production and 3D printing of building modules**



**Reuse and high value recycling of components and materials**



**Sharing and multi-purposing of buildings**



**Remanufacturing and new business models**



**Increased recycling of plastic packaging**



**Bio-based packaging where beneficial**



**Performance models in procurement**



**Waste reduction and recycling in hospitals**

**BARRIERS**

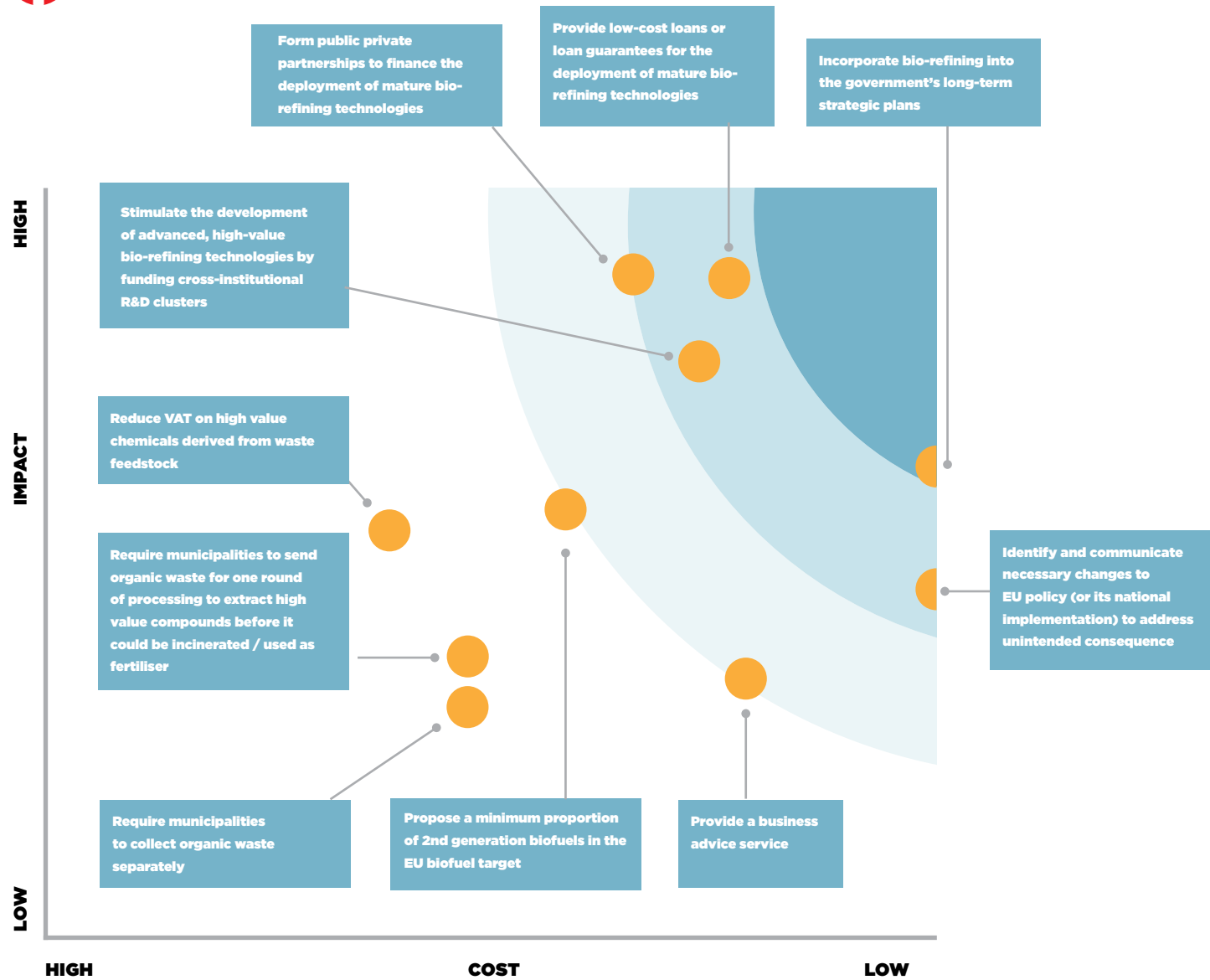
	Value capture in cascading bio-refineries	Reduction of avoidable food waste	Industrialised production and 3D printing of building modules	Reuse and high value recycling of components and materials	Sharing and multi-purposing of buildings	Remanufacturing and new business models	Increased recycling of plastic packaging	Bio-based packaging where beneficial	Performance models in procurement	Waste reduction and recycling in hospitals
<b>ECONOMICS</b>	Not profitable for businesses' even if other barriers are overcome	Lightorange	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Orange	Orange	Lightgrey	Lightgrey
	Capital intensive and/or uncertain payback times	Critical	Lightgrey	Orange	Lightorange	Lightgrey	Lightorange	Orange	Lightgrey	Lightgrey
	Technology not yet fully available at scale	Critical	Lightgrey	Critical	Orange	Lightgrey	Orange	Orange	Critical	Lightgrey
<b>MARKET FAILURES</b>	Externalities (true costs) not fully reflected in market prices	Orange	Orange	Lightgrey	Orange	Lightorange	Orange	Orange	Lightorange	Orange
	Insufficient public goods / infrastructure <sup>2</sup> provided by the market or the state	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightorange	Lightgrey	Lightgrey	Lightgrey
	Insufficient competition / markets leading to lower quantity and higher prices than is socially desirable	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey
	Imperfect information that negatively affects market decisions, such as asymmetric information	Lightgrey	Orange	Lightgrey	Orange	Lightorange	Orange	Lightgrey	Lightgrey	Orange
	Split incentives (agency problem) when two parties to a transaction have different goals	Lightgrey	Orange	Lightgrey	Critical	Lightgrey	Lightorange	Orange	Lightgrey	Lightgrey
	Transaction costs such as the costs of finding and bargaining with customers or suppliers	Lightorange	Lightorange	Lightgrey	Orange	Orange	Orange	Lightgrey	Orange	Lightorange
	Inadequately defined legal frameworks that govern areas such as the use of new technologies	Lightgrey	Lightgrey	Critical	Lightgrey	Orange	Lightgrey	Lightgrey	Orange	Lightgrey
<b>REGULATORY FAILURES</b>	Poorly defined targets and objectives which provide either insufficient or skewed direction to industry	Lightorange	Orange	Lightgrey	Lightgrey	Lightorange	Orange	Lightgrey	Lightorange	Lightorange
	Implementation and enforcement failures leading to the effects of regulations being diluted or altered	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey	Lightgrey
	Unintended consequences of existing regulations that hamper circular practices	Orange	Lightgrey	Lightgrey	Lightgrey	Orange	Orange	Lightgrey	Lightgrey	Lightgrey
	Capabilities and skills lacking either in-house or in the market at reasonable cost	Lightgrey	Orange	Orange	Orange	Lightgrey	Critical	Lightgrey	Lightgrey	Critical
<b>SOCIAL FACTORS</b>	Custom and habit: ingrained patterns of behaviour by consumers and businesses	Orange	Critical	Orange	Orange	Lightorange	Lightorange	Lightgrey	Orange	Orange

<sup>1</sup> At market prices excluding the full pricing of externalities such as greenhouse gas emissions, ecosystem degradation and resource depletion  
<sup>2</sup> Infrastructure defined as fundamental physical and organisational structures and facilities, such as transportation, communication, water and energy supplies and waste treatment





## Prioritisation of policy options – ‘Value capture in cascading bio-refineries’



SOURCE: Ellen MacArthur Foundation; NERA Economic Consulting