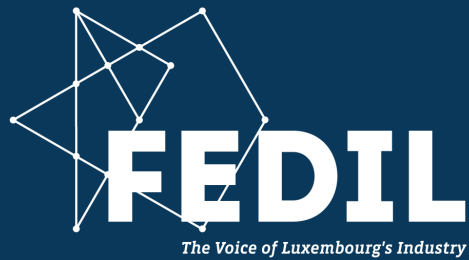




LUXEMBOURG'S INDUSTRY STRATEGY



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1. CONTEXT AND APPROACH

1.1. Why does Luxembourg need an Industry Strategy?

One might argue that Luxembourg's plans for the development and growth of its industrial sectors are covered well enough by the broader context of the country's economic development strategy. To explore this argument, it is worthwhile to discuss Luxembourg's current economic development approach briefly.

Luxembourg's current economic development plan is based on the study of the Third Industrial Revolution from 2013. In 2017, the study was taken as the foundation for defining six priority sectors described in Luxembourg's Smart Specialisation Strategy ¹. The six priority sectors are (1) Industry 4.0, (2) Ecotech (including energy, building, mobility), (3) Healthtech, (4) Logistics, (5) Space, and (6) ICT as a cross-cutting sector to the five previous ones. According to the economic development strategy, those six sectors strive towards a vision that builds an economy based on a growth model that qualifies as smart, data-driven and sustainable. This vision and the scope of the six priority sectors are described in several reference documents ² and should give useful guidance about how to direct Luxembourg's economic development efforts.

Experience shows, nevertheless, that some economic development projects still provoke fundamental discussions about whether they are in- or out-of-scope of the defined economic growth model. Arguments tend to emerge more frequently around industrial- than around service business-related projects, particularly when projects may present externalities. Those same discussions about the implementation of industrial projects regularly spur the polemic around the growth model referred to as "qualitative growth" but then fail to explain what this model means in practice for Luxembourg's economy.

Industrial development projects are, however, of essential importance for a resilient and diversified economic tissue. The industry is diversified in types of production and markets served and the companies' size. With large multinationals and local industries that have grown over the last decades, with SME's and start-ups, it represents a wide economic variety and contributes to economic resilience.

The peaks of the COVID-19 crises in spring 2020 demonstrated how risky it is when a country relies on minimalistic and narrow industrial manufacturing capabilities. While other European economies could repurpose parts of their manufacturing industry to produce the most scarce and vital goods, Luxembourg remained dependent on imports. This is also true if Luxembourg wishes to play an active role in the real economy's energy transition. Manufacturing capabilities will let Luxembourg benefit more from the EU's new green deal strategy as steel, aluminium, cement, glass and many other materials, technologies, and goods are necessary to reach carbon neutrality. Therefore, the high specialization in service businesses needs to be balanced by a broader range of manufacturing companies. The crises also showed that Luxembourg's industrial sector can be fragile and that it needs to be nurtured, actively developed and managed to thrive in the long term. This confirms the necessity of the EU's initiative of reshoring manufacturing companies back to Europe. This initiative from 2012 regained much traction during the COVID-19 crises and focused on healthcare companies. But reshoring is necessary across all sectors of the manufacturing industry.

Finally, it is common knowledge that the industrial sector has a catalytic effect on all research, development and innovation activities.

¹ Luxembourg Research and Innovation Smart Specialisation Strategy 2017, page 22 and following

² The third industrial revolution Lëtzebuerg; The data-driven innovation strategy for the development of a trusted and sustainable economy in Luxembourg, 2019; Luxembourg Research and Innovation Smart Specialisation Strategy, 2017

Luxembourg has committed total spending of 2.3% of GDP out of which the private sector should realize 1.7% for those activities.

The situation described above confirms that Luxembourg needs rather more than less industrial businesses and that a higher consensus is needed to decide how to develop the industrial sector. It also shows the need to clarify the definition of terms such as "qualitative growth" or "sustainable growth" and other elements that influence the country's growth plans. Luxembourg thus needs a strategy that helps to refine its vision about how it wishes to develop its industrial sectors in the future. Chapter ³ in the government's coalition plan 2018-2023 that describes the economy and competitiveness confirms the necessity for a coherent industrial strategy. It calls for a comprehensive approach to reconcile Luxembourg's ambitions in terms of prosperity, quality of life and environmental protection.

1.2. Method, scope and objective

The elaboration method of the present Industry Strategy does not adopt a classic SWOT-type or similar strategic analysis. It does not seek to identify new market opportunities that would best fit to Luxembourg's economy. Instead, the Industry Strategy sticks to Luxembourg's existing economic development vision about a smart, data-driven, and sustainable growth.

The added value of the present strategy exercise lies in refining and clarifying Luxembourg's overall economic development vision, specifically for the industrial sectors. It establishes an understanding of what "quantitative growth" and "sustainable or qualitative growth" mean for Luxembourg's economy and society. It provides the refinement

level to allow a factual discussion about whether industrial projects fit Luxembourg's growth model. The Industry Strategy shall enable rational, informed decisions about whether there is a fit even if projects present environmental or social externalities. Environmental externalities are, for example, CO₂ emissions or natural resource intensity, e.g., water use. Social externalities may be rising housing prices, congested traffic or similar.

Looking to encompass all sectors that may present such externalities, this paper adopts a broader scope of sectors than the classic industry view. Industry in this paper comprises all activities of Nace codes B to H, and J: (B) Mining and quarrying; (C) Manufacturing, (D) Electricity, gas, steam and air conditioning supply; (E) Water supply, sewerage, waste management and remediation activities; (F) Construction.; (H) Transportation and storage, and (J) Information and communication. Between 2010 and 2018, the sum of these seven sectors consistently contributed between 30%-35% of Luxembourg's annual gross value added and represented in 2018, around 40% of overall employment. Those numbers show that it is essential to sustain industrial sectors and to plan their future development within the broader context of Luxembourg's economic development efforts.

Therefore, the present Industry Strategy's objective is to develop a quantitative framework that assists in evaluating whether new industrial projects are compatible with Luxembourg's economic development vision. The framework intends to guide future industrial investment projects' decision-making and selection processes and improve the overall quality of the political discussion during this process. It aims to deliver a

³ Accord de coalition 2018-2023, pages 127

coherent and fact-based approach to find answers to how to design and direct the efforts that lead to industrial economic growth.

2. ESSENTIAL ELEMENTS OF LUXEMBOURG'S GROWTH MODEL

FEDIL observes that not all stakeholders in the discussions about Luxembourg's economy growth model seem to have the same understanding of key terms and concepts. To avoid confusions on this level, the present chapter aims to define the Industrial Federation's understanding of "sustainable growth", "quantitative and qualitative growth" and the concept of "decoupling".

2.1. Sustainable growth

We observe that sustainable growth is often used in an over-simplified way as a synonym for growth that cannot harm the climate or environment. However, it is incorrect to use the term sustainable growth only to characterize economic development with zero environmental externalities. According

to the United Nations' definition, sustainability is a term that encompasses a much broader concept. It is described as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."⁴

This concept materialized through its 17 sustainable development goals, recognizes among others the importance of well-functioning "industries, innovation and infrastructure", or "decent work and economic growth", "good health and well-being" or the elimination of "poverty" and a "quality education" for all. The fact that "climate action", as necessary as it is, represents only one out of 17 other goals, shows that sustainable development must be considered in a more holistic context (see Figure 1). It is a context which accepts that a sustainable economy relies on technological progress, economic growth, and also an efficient use of natural resources. Only a growing economy can create those decent jobs that lift people out of poverty. It is an economy that can finance an effective health and well-fare system, and that can offer quality education to all of its citizens.



Figure 1: United Nation's wholistic understanding of sustainability includes 16 other aspects besides climate action.

⁴ <https://www.un.org/sustainabledevelopment/>

The United Nation's understanding of sustainable development thus recognizes the need for strategies that build economic growth that can address a variety of social needs while at the same time tackling climate change and environmental protection.

By the standards of the United Nations, Luxembourg's growth model may be considered a sustainable one. In the 2019 UN sustainable development report ⁵, Luxembourg scores 74 out of 100 points, positioning itself as a good performer among other leading sustainable nations. Through an agile legal framework and by taking advantage of global markets, the country has developed one of the world's most performing economies. Along with this development, it continuously increased its environmental protection standards, often exceeding EU requirement. As a result of these efforts, it succeeded to develop a phenomenally high quality of life for its citizens, placing it among the highest average incomes countries in the OECD.

Luxembourg's industrial sector had to adapt continually to follow the pace of such a dynamic economic development. Today, Luxembourg's industry is among the most resource-efficient and productive in advanced economies. Otherwise, competing globally despite the local constraints of high wages and progressive environmental standards would not be possible.

2.2. Quantitative and qualitative growth

While this paper presumes that Luxembourg's economy must continue to grow in the future to create wealth for its citizens and to sustain the social welfare system, there is no doubt that we must reconsider economic development from a more sustainable-, people- and planet-centred perspective. However, proponents of sustainable growth tend to put an ecologically and socially

sustainable economy on the same level as one that can only grow qualitatively. They might exclude all sorts of quantitative growth or go as far as denying growth altogether.

However, scholars from different fields agree that growth is a vital characteristic of all living or dynamic systems. A society or economy that does not grow will degenerate and die sooner or later—a more nuanced understanding of how economic systems, e.g. sectors, mature seems to be necessary.

As industries evolve, they shift from an early phase that favours quantitative growth to a later mature stage of growing or transforming qualitatively. Qualitative growth, realized through or driven by productivity gains, requires a minimum set of existing production factors, coupled with experience, knowledge, and learning accumulated during an earlier quantitative growth period. The maturation of a sector that occurs through the accumulation of experience and expertise is necessary to empower qualitative growth through increased efficiency. In other words, in most sectors, quantitative growth precedes and enables later qualitative growth.

The Industrial Federation considers that both growth models, quantitative and qualitative, must be acceptable and work in equilibrium for economies to evolve.

2.3. Decoupling economic growth

Luxembourg's economic performance of the last few decades required an ever-increasing workforce. At the same time, the country's population is incapable of delivering much-needed personnel. Luxembourg's population is expanding almost seven times faster than the EU average ⁶. And still, it needs daily assistance of some 200,000 cross-border commuters to sustain

⁵ <https://dashboards.sdgindex.org/rankings>

⁶ Source Eurostat 2016: the fastest expansion in population was recorded in Luxembourg with an increase of 19.8 per 1000 persons, while EU average is at 3.0 per 1000

its economy's needs. Consequently, individual and public transport capacities are saturating, and housing prices are rising rapidly. The increasing demand for homes and mobility drives a booming construction sector that develops new housing, roads and other infrastructure projects. This, in turn, further consumes a surface area of the limited territory and intensifies energy and other natural resources consumption.

The mechanism described above includes characteristics of a vicious cycle. It is the mechanism of an economy that is majorly based on quantitative growth. In its quest to increase economic wealth, quantitative growth perpetually increases the quantity of its input factors. It requires an ever-larger labour force while consuming more and more of the territory's surface area yielding environmental and societal externalities.

The current growth model of Luxembourg may ultimately decrease the quality of life of its society. Figure 2 shows that Luxembourg's gross value-added growth (light-blue bars) between 2007 and 2017 requires steady domestic employment growth (red line). Economic growth is thus not decoupled from labour growth. Further, the labour productivity (blue line, representing value-added divided by personnel costs) is falling sharply over these ten years. It means that Luxembourg is losing international competitiveness.

The analysis of those elements shows that Luxembourg, due to the limited size of its territory, is confronted with the following fundamental challenge in search of industrial and non-industrial economic growth activities:

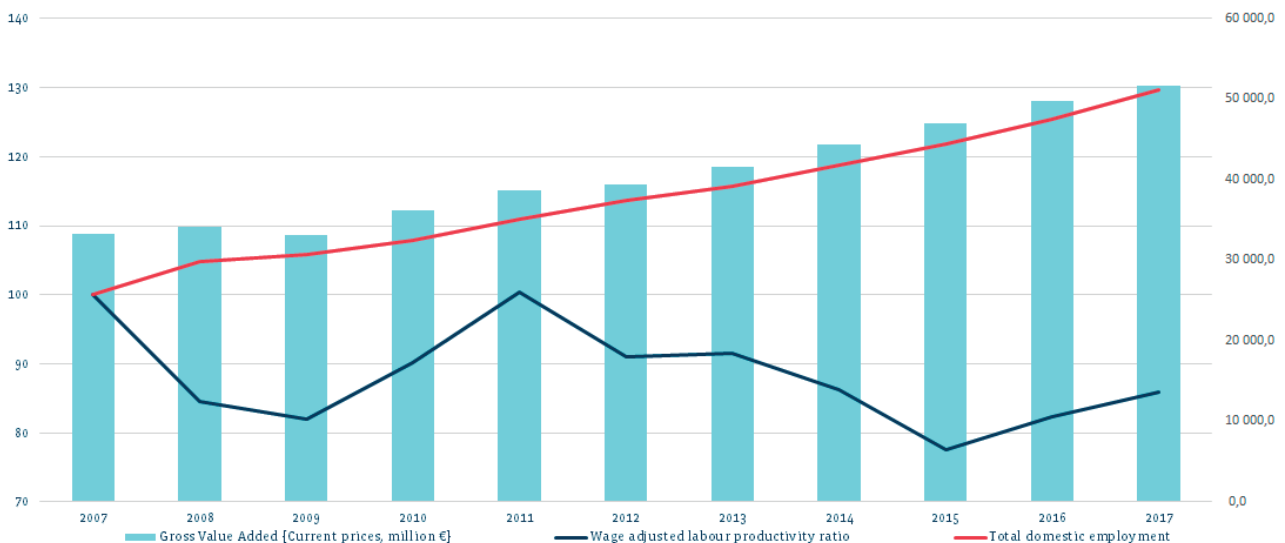


Figure 2: Luxembourg's gross value-added growth requires a steady increase in domestic employment, while wage adjusted labour productivity⁷ is falling (base 100 in 2007)

⁷ Source Eurostat 2020: wage-adjusted labour productivity is an indicator defined as the value added divided by personnel costs. This indicator is based on expenditure for labour input.

How can Luxembourg's economic growth activities be effectively decoupled from the simultaneous growth of human and other resources deployed on its territory?

This sustainability challenge is certainly not unique to Luxembourg. However, it is more pronounced and more rapidly perceived in Luxembourg due to its high-performing economy and its limited size of the territory.

The Industrial Federation acknowledges that Luxembourg's current growth model may endanger citizens' quality of life in the long term. FEDIL and its members are eager to support a model that succeeds in decoupling economic growth from resource intensity. The next chapters describe how industry contributes to decoupling and how a long-term sustainable growth model may look like.

3. HOW INDUSTRY CONTRIBUTES TO DECOUPLING

The industrial sector is well-positioned to decoupling the national economy and make it more resource efficient. Contrary to the general perception, value creation in the industry is highly resource-efficient and much less dependent on human resources than in most service sectors.

Unlike in the service sector, where most value-added equals the input of its labour, the industry's most significant share of value-added stems from its physical production output. The industry further designs its production processes to be scalable so that more output does not necessarily need more human resources. Scalability in most service sectors is, however, limited so that growth means higher labour intensity.

The industry can teach a lot to the service sector when it comes to improving resource intensity. It is good practice in manufacturing companies to define and work on recurring annual productivity objectives, energy efficiency objectives, and other resources and cost-saving targets. Over the decades, the industry developed sophisticated lean production- and quality management methods to eliminate losses and waste. Six Sigma is probably the best-known toolbox for efficiency and quality improvements. It is a data-driven methodology that includes Kaizen, 5S, Kanban or Just-in-time, to name only the most prominent ones.

Automatization and robotization are also more common in the industrial sector than in services. Both allow the industry to focus the deployment of human resources on high value-added tasks that machines cannot easily replace. In the future, digitalization, in combination with artificial intelligence, will further push the boundaries where machines can contribute to decoupling in the industry.

As a result, the industrial sector has been able to increase the value-added per employee over the years while at the same time decreasing environmental externalities (see Figure 3) and the use of energy. According to Eurostat, value-added per full-time employee in Luxembourg's manufacturing sector increased by 29% between 2012 and 2017. During the period 2017-2019, the 50 most energy-intensive Luxembourg companies achieve a total energy savings of 350 GWh. This represents an average improvement of 6,87%⁸ over three years and equals the amount of energy needed to supply all households of the city of Esch-Alzette with electricity for more than two years.

⁸ Source: Accord Volontaire FEDIL and myenergy

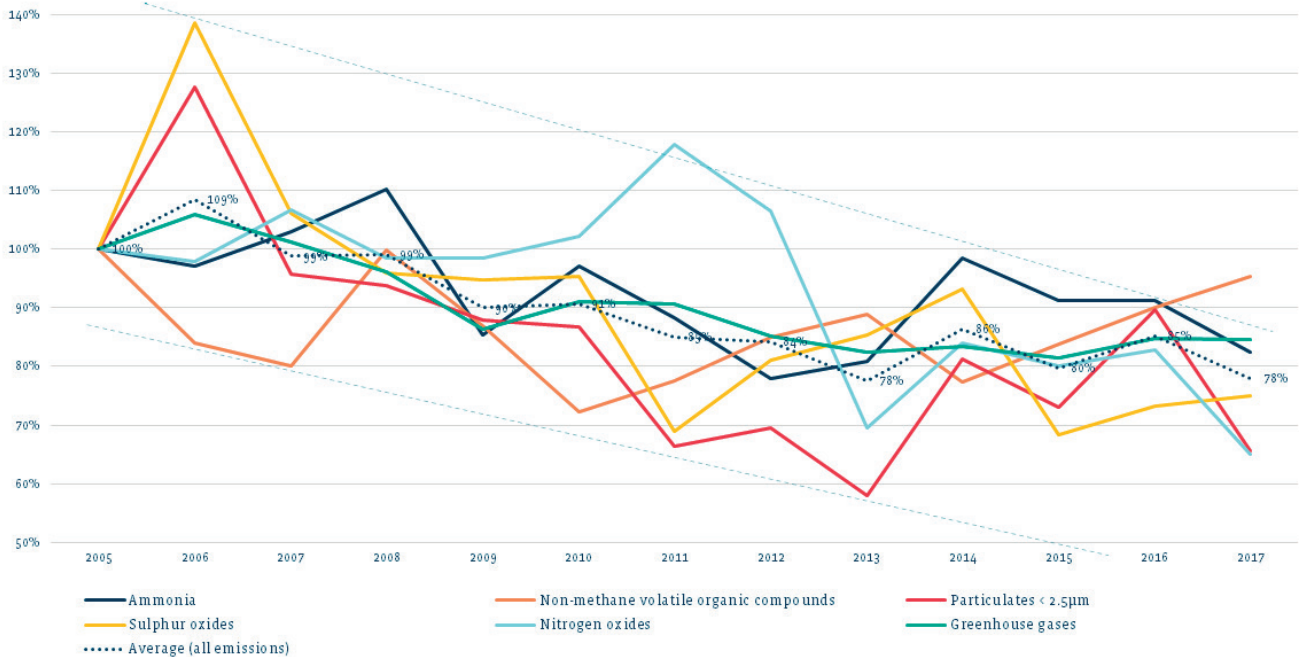


Figure 3: Air pollutants measured in Luxembourg's manufacturing industry are steadily decreasing⁹

The industry must be considered as a significant contributor to decoupling Luxembourg's economy from its need for resources. Believing that decoupling can be reached by decreasing industrial activity in Luxembourg is thus wrong. On the contrary, the industry shows excellent efficiency in human and other resources intensity. The industry further helps Luxembourg increase its diversification and resilience by making it less dependent on the services sectors.

4. STRATEGY THINKING BEYOND THE LINEAR GROWTH PARADIGM

4.1. Towards a circular industrial development model

Traditional business strategies focus on how to create linear growth. On the one hand, they typically look for ways to access new opportunities

and expand to untapped markets by a quantitative growth approach. On the other hand, they apply the qualitative growth approach to increase value by improving the existing, reducing costs, and resource intensity. Smart strategies for balancing both forms of growth are essential for businesses to evolve. Nevertheless, such linear growth strategies may not be suitable to address Luxembourg's sustainability challenge, which aims at decoupling growth from the use of human and other resources (refer to chapter 2.3).

Furthermore, as part of the sustainability challenge, business strategies must deal with climate change mitigation and environmental protection constraints. Those constraints may come in steadily increasing CO₂ taxes or prices, energy prices, or other obligations for compensation of using natural resources. Consequently, business strategies aiming to

⁹ Source: European Environment Agency

generate profits today need to think beyond the traditional linear growth paradigm.

Based on its understanding of growth and sustainability, as described in Chapter 2, this paper suggests a cyclical growth model to reach decoupling. The model attempts to describe a pathway towards the sustainable economic development of companies that interact in an ecosystem. The model does not represent an industry strategy; it describes how we must adapt the traditional scope of strategic planning towards a more holistic approach and beyond linear growth.

The model comprises three stages connected in a continuous cycle, see Figure 4:

1. The first stage describes the traditional way of industrial growth. Qualitative growth drives value creation in an early phase. Companies develop and expand their production assets along the growing demand on markets. Once markets become saturated, the shift towards qualitative growth occurs to continue the growth of value creation. The approach of this first stage corresponds to the traditional linear growth paradigm.

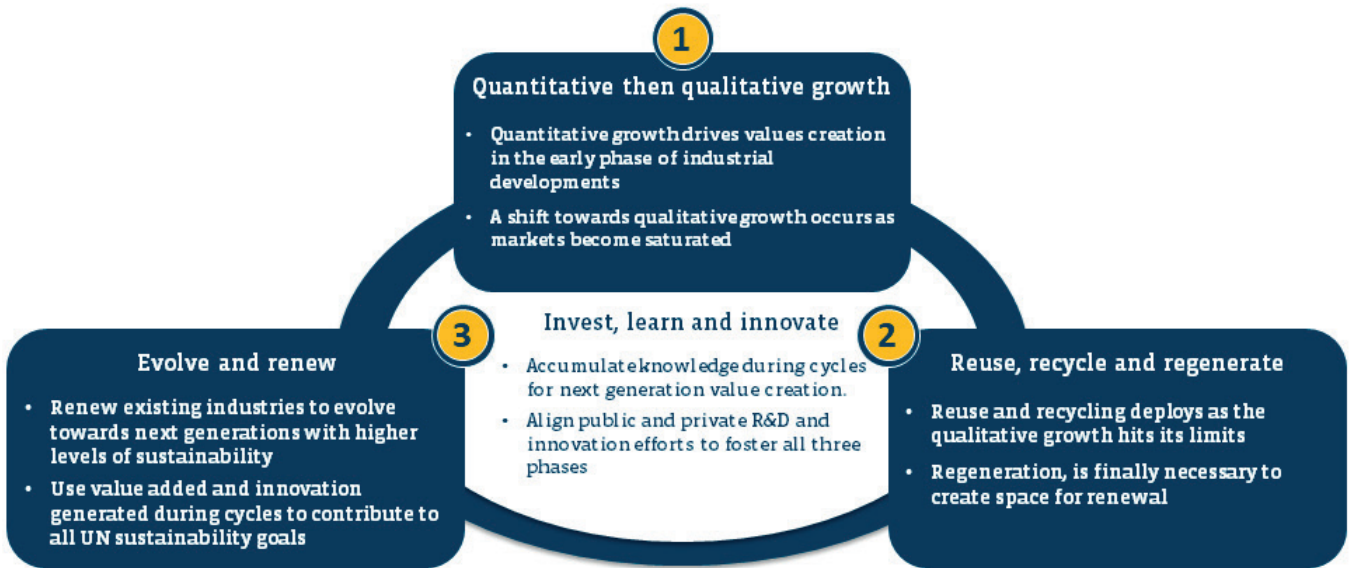


Figure 4: A sustainable growth model for industry

The shift from one growth model to the next makes value creation more resource-efficient but still not decoupled. It continues to rely on consuming yet new resources to fuel growth. For growth to decouple, it needs to acquire the ability to generate growth independently from consuming new resources. This is where stage two kicks-in (see 2).

The history of Luxembourg's steel industry is an excellent example to illustrate our model. Starting around the post-world-war-I area, quantitative and qualitative growth determine the local steel industry's expansion. In this period, which lasts until the 1980s, production capacities were steadily increased (quantitative growth) and modernized (qualitative growth). They peaked in the simultaneous operation of three blast furnaces known as furnaces A, B, and C at the Esch-Belval site between 1979 and 1987.

2. The second stage generates growth by reusing, recycling, and regenerating already used resources. Reuse and recycling shall replace the extraction and use of new resources and create an independent economic growth field. They comprise not only the reuse and recycling of material but also a shift towards using renewable energy. Reuse and recycling are a first step towards decoupling as they avoid the use of new resources.

However, at some point in time, reuse and recycling must be accompanied by a simultaneous regeneration of resources. The land occupied, water, air and other natural resources used during the quantitative growth periods must be regenerated to be used again. Along with Schumpeterian creative destruction, such regeneration also means disinvestment of

industrial assets or production factors to create new, modern, and more sustainable ways of value creation.

The stage of reuse, recycling and regeneration can also be illustrated by Luxembourg's steel industry. By the mid-1990's blast furnace C on the Belval site shut down, it is dismantled and sold for reuse in China. The land is later regenerated to develop the modern Belval site as we know it today. This site now hosts one of the world's most modern steel productions. Other parts of the former industrial site have been converted to the modern science city with the University of Luxembourg, the technology incubator and other service businesses. The creation of the science city is an excellent initiative; however, it is regrettable that terrain initially dedicated for industrial use has been converted for it.

3. The third stage aims to evolve and renew the existing growth approaches toward next-generation activities with a higher intrinsic sustainability level. Renewal can mean that production factors and value creation methods radically change within the same industry to satisfy a similar demand. It can also mean that demand changes altogether and that the underlying industry must adapt accordingly. In either way, once renewal is accomplished, businesses start over in stage one, seeking to grow again. Such renewal can emerge from within the sector or by newcomers, i.e. start-ups that disrupt the existing.

As for our example of Luxembourg's steel industry on the Belval site, the time for evolving is kicked-off already in the late 1970s by the first significant steel crises. The industry successively starts disinvestment from all

its blast furnace activities on the Belval site in the subsequent decade. At the same time, it completely renews steel production from melting iron ore in coal-fired blast furnaces to melting reused scrap metal in novel electric arc furnaces. The first such furnace starts production in 1996, bringing steel production to a next-generation level of sustainability.¹⁰

The last element of the model is not an explicit stage. It is, however, an ongoing prerequisite for the model to succeed: Investment, learning and innovation. All three are vital to run through the stages of our model. Considerable efforts in R&D and innovation are necessary to jump from one stage to the next. For each such jump, entrepreneurs are needed who are willing to invest and place their bets on innovation. Those risk-takers also expect a perspective for returns. Within the context of the climate crisis and policy actions towards carbon neutrality, such a perspective can only be rewarded if strategic planning widens its scope beyond the first stage to all three of them.

4.2. Key success factors of the circular industrial development model

Decoupling economic growth in Luxembourg means that the production factor-mix driving economic growth must change over time. The model described in the previous chapter shows how such change can be managed. However, the changes at each stage of the model are not trivial for companies; they require them to reinvent themselves every time. In their quest towards higher sustainability levels, they need supportive framework conditions and a government willing to partner for change. This chapter describes the framework conditions the industrial community regards as key factors for a successful industrial transition.

4.2.1. Accelerate administrative simplification

Administrative simplification is vital when it comes to supporting the industry to transform and renew. Authorization procedures must be developed to promote the industry's efforts towards a higher level of sustainability. For example, one could imagine waivers, priority treatment with accelerated procedures for projects related to decarbonization, energy efficiency, or waste reduction. Administrative simplification also needs to accelerate the allocation of available terrains for industrial development projects.

It would be worthwhile to benchmark Luxembourg's essential administrative procedures within the Greater Region and internationally to set clear, measurable objectives for improvement. FEDIL believes that Luxembourg as a small country that prides short communication channels and cooperation must have the ambition to count among the top performers in terms of administrative rapidity and simplification.

4.2.2. Support HR transformations and the development of talent

Companies that succeed in increasing human resource (HR) efficiencies and contributing to decoupling efforts need to be supported to realize the related changes. The government must be willing to engage in a positive dialogue with concerned companies and deploy all instruments to help flexibly release or reallocate human resources alternatively to promote the industry's sustainability efforts.

Supporting industrial renewal also means long term planning of education, talent development, and training to qualify people in required new fields of sustainable businesses. Complimentary international attraction programs can tackle short-term talent shortages.

¹⁰ Re-melting of recycled steel in electric arc furnaces is 75% less carbon-intensive than integrated steel making which relies on large volumes of extracted coal and iron ore.

4.2.3. Develop renewable energy

Access to competitively priced low-carbon energy represents a fundamental prerequisite to support the industry on their path towards more sustainability. It is safe to assume that significant decarbonization efforts will rely on industrial processes' electrification or their switch to low-carbon fuels such as hydrogen. Such low carbon energy must be accessible in abundance and affordable to develop competitive business activities. Electrification must be incentivized by an attractive and predictable electricity price policy.

Furthermore, digitalization, automatization, and IA deployment, which represent central milestones of the industry's roadmap towards decoupling, will massively drive demand for low-carbon electricity. Consequently, the whole economy's need for low-carbon power will increase. It will do so across a broad spectrum of industrial sectors, surpassing the ones identified today as electricity-intensive.

4.2.4. Promote investment, RDI and resilience

Businesses might be reticent to engage in renewal activities to reach higher levels of sustainability gradually. The reason for their reluctance is mostly due to the related business- and investment risks. Support and incentive mechanisms must be put in place to overcome this risk and accelerate corporate renewal and sustainability. Businesses must also rely on a well-performing public research, development, and innovation (RDI) system. The public RDI system's actors must be in an active dialogue with the industry to anticipate their challenges and develop the skills needed to support industrial transformation.

Public RDI actors further hold a significant key to unlock Luxembourg's potential for more economic resilience. They must, however, become leaner and more accessible to work with SMEs. The sanitary crisis demonstrated that economic resilience resides upon a healthy tissue of diversified industrial SMEs. Supporting innovation in those SMEs must thus receive closer attention from public research actors.

5. AN INDUSTRY STRATEGY FOR LUXEMBOURG

5.1. Strategic decision in four quadrants

An Industry Strategy that wishes further to decouple economic growth from the consumption of resources must ultimately focus on productivity in the relevant sectors. According to the motto "do more with less", productivity seeks to maximize output per unit of input. The implications for the design of an Industry Strategy that follows this motto are fundamental. Combined with our understanding of quantitative and qualitative growth (see Chapter 2), it must be guided by the following principle:

In its transformation towards a smart, data-driven and sustainable economy, Luxembourg's industry strategy must increase economic development while continuously improving its resource efficiency towards sustainable levels. While prioritizing productivity, it must focus on quantitative growth when developing new, inherently sustainable sectors. In contrast, qualitative growth must prevail to foster its Heritage sectors.

The desired economic development potential, on the one hand, and the required resource efficiency, on the other hand, represent the strategy's conflicting dimensions. They span a field of tension with four quadrants. Figure 5 describes the characteristics of the four categories of businesses, including some examples of specific sectors: the Heritage Industry, Next Generation Industries, Boosters and Enablers. For each of these business sectors, we suggest applying different

Norm Strategies. Norm Strategies describe distinct but standardized actions to promote the economic development of companies in that sector. Strategies depend on the development potential (vertical axes) and the sector's resource efficiency (horizontal axes). The rotating arrows in the Boosters and Enablers fields of the diagram symbolize their contribution in leveraging the Heritage industry. Both Boosters and Enablers play an essential role in transforming the Heritage

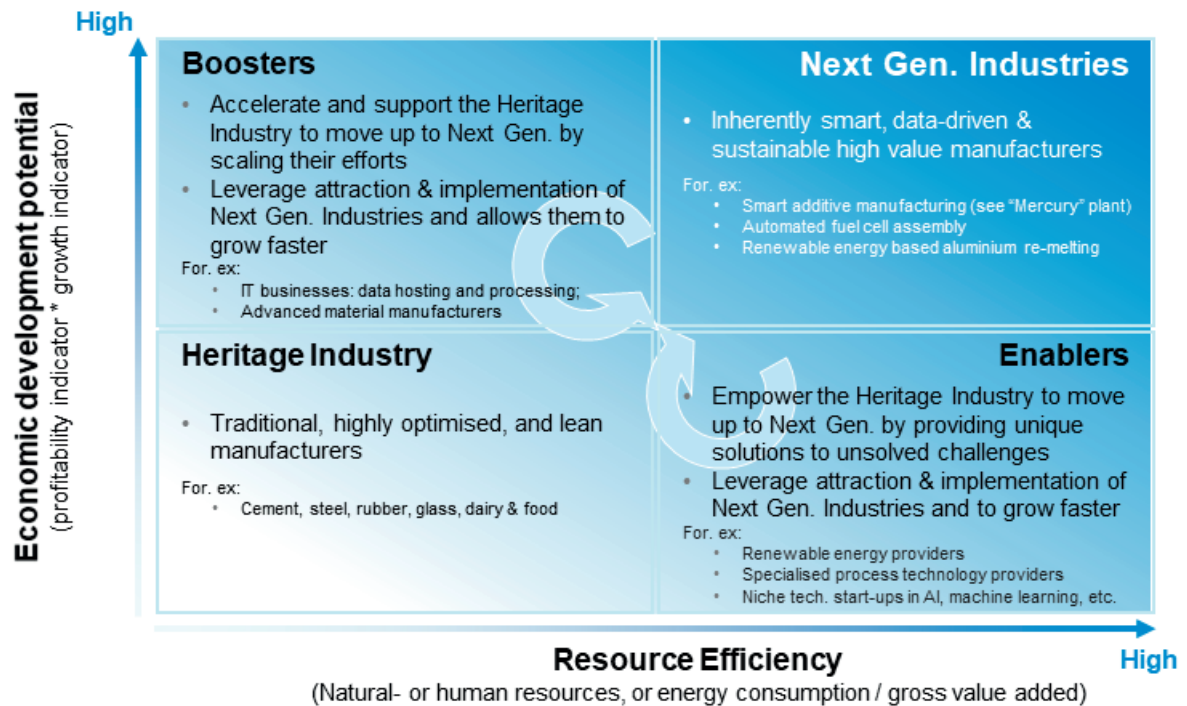


Figure 5: The Industry Strategy's decision making in four quadrants

Industry towards Next-Generation Industries, and to develop an ecosystem that attracts Next-Generation businesses from abroad directly.

The four quadrants' approach allows first to categorize, then assess and compare industrial development projects and manage them coherently according to a dedicated Norm Strategy. Such a coherent assessment of projects is beneficial for passively acquired projects, where foreign investors bring up a project they wish to realize in Luxembourg.

The assessment of industrial development projects in the diagram of Figure 5 can be done by quantifying businesses according to their economic development potential (vertical axes). It can be calculated by a composed indicator that multiplies a ratio for the concerned company's profitability ²¹ by a growth rate indicator ²². As for prospective projects, it is often difficult to predict those indicators; we suggest using statistical data of the concerned sectors for a first assessment.

The resource efficiency (horizontal axes) can be measured by quantifying natural ²³, human resources and/or the energy consumption divided by the expected gross value added ²⁴ of the projects in million Euros.

The Norm Strategies for each quadrant is described in the next chapter.

5.2. The four quadrants of the Industry Strategy

The following paragraphs describe the population of businesses in each quadrant in more detail, and it describes the Norm Strategies to adopt for them. Norm Strategies describe distinct but standardized actions to promote the industrial economic development for each of the quadrants' business

population. Figure 6 visualizes the suggested Norm Strategies per quadrants.

5.2.1. Heritage Industries: Safeguard & transform towards Next-Gen

Heritage Industries are the businesses in Luxembourg that created the post- World-War-II wealth for the country. They include the traditional manufacturing industries such as steel, cement, chemicals, rubber, plastic, glass, aluminium or the dairy- and food industry. Their highly optimized and lean processes enable them to operate successfully despite Luxembourg's high wages and tight environmental standards. Some of them even set environmental benchmarks in their industry across the EU. Nevertheless, those sectors are characterized by a relatively high resource intensity and moderate relative economic development potential. The businesses of these sectors are, however, essential for Luxembourg's economy. They represent the local industry's backbone, providing products and solutions for national consumption, generating a steady stream of fiscal returns, and providing direct and indirect jobs to many.

It seems important to note here that not all incumbent manufacturing businesses should be qualified as Heritage Industry. Luxembourg has an existing manufacturing base that demonstrates both resource efficiency and performance in terms of economic development. They may be in different stages and dynamic evolution towards Next-Gen Industries. This dynamic is illustrated in the diagram of Figure 6 by the two rotating arrows.

Furthermore, by their nature, businesses of all sorts, including those in the Heritage quadrant intrinsically strive towards higher resource efficiency. They are eager to eliminate losses and to

²¹ Profitability indicator = statistical gross operating surplus/turnover in % ; source Eurostat

²² Growth rate indicator = $(1 + \text{statistical sectoral CAGAR of production value 2012-2017})$ in % ; source Eurostat

²³ Natural resources are for example: land use in km²; water intake in million tonnes, etc.

²⁴ Gross value added = Sales - costs of raw material - cost of production - cost of outside service suppliers

move towards improving profitability and growth. Over the past decades, all the successful companies in Luxembourg have been continuously improving resource efficiency. Only by doing so, they stayed competitive despite the relatively high operating costs in our country. Today, digital transformation and other production technology upgrades may bear great opportunities for Heritage companies to improve resource efficiencies further.

efforts will support their move towards Next-Gen. Industries:

- **Productivity** growth in Heritage Sectors can be achieved by multiple options, such as through investment into new machinery, equipment or technology, product and process innovation or a highly-skilled workforce. Some of these options are supported already today by existing industrial policy initiatives ¹⁵.

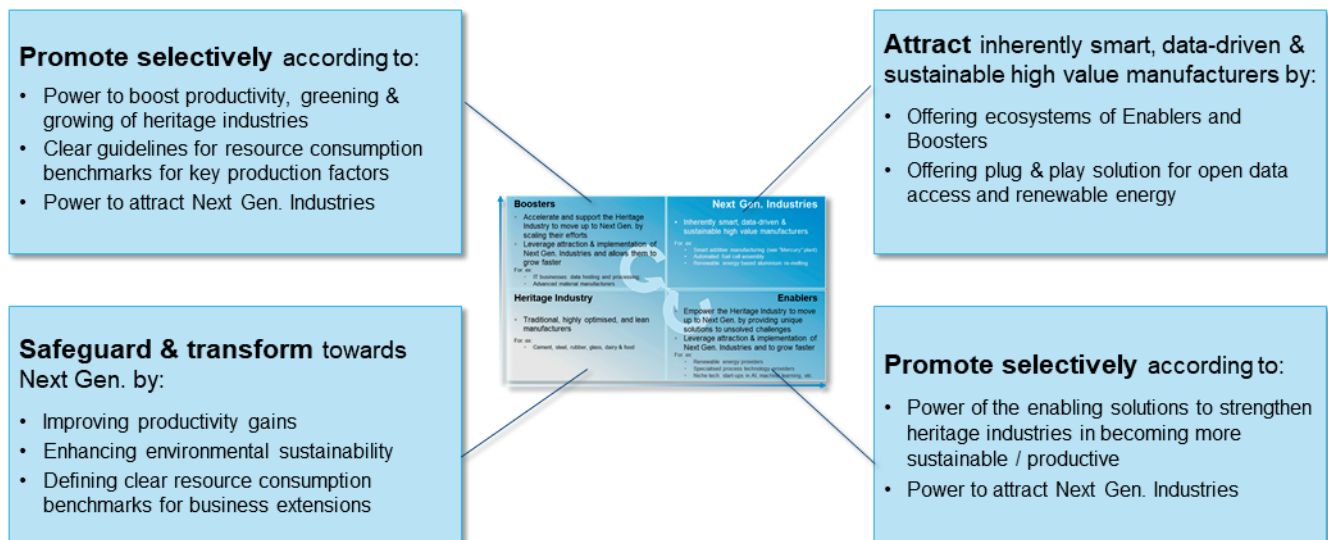


Figure 6: Coherent Norm Strategies for each of the quadrants of the matrix

The Norm Strategy's mission for the Heritage industry is precisely aiming to support them in catching those opportunities in their quest to move towards the upper right corner of Figure 6. It proposes to first safeguard their business by helping them to improve productivity and then to enhance their environmental sustainability. These

They are, however, not grouped and labelled as productivity growth policies. Relabelling, further refining, and regrouping them under the same goal of promoting productivity gains will undoubtedly improve their impact. They will better catch businesses' attention to the necessity of improving productivity gains.

¹⁵ For example: « Aide à l'investissement », RDI Law, Fit4Innovation, Skills Bridge »

Furthermore, being regrouped for the same purpose, these options will make it easier for entrepreneurs to take advantage of them actively. For such a productivity-promoting policy to succeed, it must include measures, such as de minimis subsidies, to reduce possible additional marginal costs for the entrepreneur. Such costs might occur when the constraint to grow via productivity improvements is more expensive than growing via alternative less costly but more resource-intensive alternatives.

Besides subsidies and/or tax credits designed to absorb additional marginal costs of growth, a Centre for Industrial Productivity is conceivable. The Center's missions shall be to educate the current industrial workforce in designing and running efficient production processes. It aims to inform about productivity aspects of Industry 4.0, digitalization, automatization, and robotization. Such a centre exists, for example at the Technical University of Darmstadt.

- **Business expansion:** For growth projects aiming at increasing production capacities, clear resource consumption benchmarks for the deployment of key production factors must be defined.

The industry strategy should manage capacity extension projects of existing companies in the same way as a greenfield implementation. Their assessment must be done by identifying their position within the four quadrants. This paper suggests in Chapter 8 a catalogue of quantitative production indicators for evaluating resource consumption benchmarks.

- The promotion of **sustainability** in Heritage Industries should be supported via a broader use of state aid for energy and environment ¹⁷. There is currently a tendency to focus this aid on large environmental and/or investment projects rather than to apply them on a broad scale.

The implementation of the Norm Strategy for the Heritage Sectors also needs to reflect on how Luxembourg can intensify the attraction of new talent. There is a need to boost a young, highly skilled workforce with scientific, technological, and engineering backgrounds. This workforce is vital to promote corporate productivity growth through process- and product innovation.

5.2.2. Next-Gen (Next-Generation) Sectors

In its long-term vision, these are the sectors that Luxembourg wishes to base its future economy upon. They are inherently sustainable, highly resource-efficient and are yet profitable with significant growth rates. Business decisions, operational processes and value creation in these sectors are smart. This means that they are based on data-intensive, technology-enabled and networking/platform-based solutions with high scalability.

The Norm Strategy to promote those sectors includes creating an attractive, easy to use ecosystem for such companies to implement in Luxembourg. It includes excellent information and communication infrastructure, such as high-speed internet, access to sets of open data for simulations, and competitively priced high-speed computing power. We might think about reliable access to cost-effective renewable energy, or infrastructures for low-carbon hydrogen sourcing, intelligent power grids, or power-to-gas systems. The nature of Next-Gen sectors' growth is quantitative as most of their substance has yet to be developed.

Luxembourg has already undertaken lots of efforts in providing the right ecosystem. And it is already focusing its sector-specific economic development efforts to attract the industries mentioned above. The playing field in this quadrant is, however, much broader in terms of target groups.

From the Industry Strategy perspective, we need to open the target sectors' scope toward attracting **High-Value Manufacturers**. High-Value Manufacturers are no traditional production companies. They cannot easily be associated with specific sectors as they generate value by a variety of activities. Their profiles are nevertheless similar regardless of their business, as they are carved to conduct a manufacturing activity in a high-cost country successfully.

Figure 7 synthesizes the most common business and technology characteristics of High-Value Manufacturers. A closer look at this profile's elements shows how those manufacturers succeed in working profitably in high-cost countries. Among others, they are generally keeping their resource intensities low.

High-Value Manufacturers that focus on small quantities, and design and engineering activities can be found in the high margin businesses of the energy-, mobility-, machinery-, computer- & electronics- or gaming and gambling software sectors. The British company Rolls-Royce is a very concrete example of such a High-Value Manufacturer. It supplies the global aviation market in the niche of jet engines. The company uses a hybrid business model to generate significant parts of its revenues by service contracts with a "power by the hour model". Its diversification into gas turbines for the world's energy markets is a competence-based diversification from its aero-turbines. The company has also adopted a technology-module based product-portfolio that allows its turbines to be mass customized¹⁸ according to airlines' requirements.

¹⁶ <http://www.prozesslernfabrik.de/>

¹⁷ *Loi du 15 décembre 2017 relative à un régime d'aides à la protection de l'environnement*

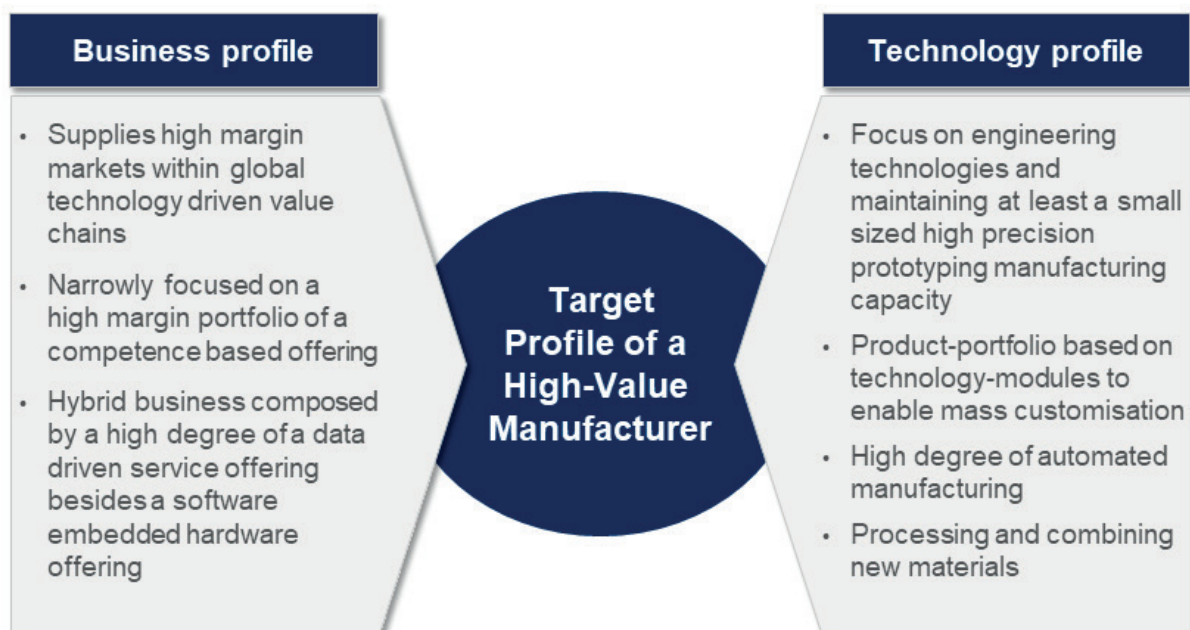


Figure 7: Profile of a High-Value Manufacturer, shaped to conduct a manufacturing activity in a high-cost country

The concept of High-Value Manufacturers in our Industry Strategy suggests redesigning Luxembourg's inward Foreign Direct Investment (FDI) activities. Its current sector-specific approach shows its limits, as High-Value Manufacturers are found in many different sectors. It might be worth reconsidering to broaden its sector-specific FDI target search towards a more profile-based identification approach.

5.2.3. Boosters

The population of businesses in this quadrant of the Industry Strategy is attractive due to their medium to high economic development potential. Their relatively high resource intensity, however, does not make them an easy pick. In the context of reaching a sustainable economy, many resource-intensive businesses of this quadrant would not seem attractive at first sight despite their good economic development potential. Nevertheless, we cannot deny promoting firms in this quadrant because many create the necessary foundations for Next-Gen businesses to implement and then scale and reach their full potential more rapidly. Due to their role of accelerating businesses to implement and grow faster, we call them "Boosters". They also have an essential part in accelerating Heritage industries to become more sustainable. For example, firms from the ICT sector, such as data hosting, data processing, or communication typically provide a scaling effect to Next-Gen. and the Heritage industries.

Boosters may also include companies from more traditional sectors, for example, from the

construction sector. They provide advanced construction materials and solutions for the whole building industry to become energy efficient and sustainable. Those examples show that resource-intensive business activities must be considered within the economic development strategy's broader context. They might reveal as Boosters to accelerate growth in Next-Gen sectors or help greening Heritage sectors.

For the effective economic development of Booster's, it is essential to make informed and objective decisions about their role in reaching Luxembourg's vision of a sustainable and growing economy (see Figure 6). This role can be assessed by comparing investment projects' upsides, i.e. their direct and indirect (boosting) economic development potential and the downsides, e.g. resource intensity. Chapter 8 suggests a catalogue of resource efficiency indicators and benchmarks to measure and compare Boosters' direct productivity. Their indirect productivity, i.e. their contribution to other sectors, must be analyzed case by case.

5.2.4. Enablers

Although their low resource intensity, sectors in this quadrant do not represent a primary target for the Industry Strategy due to equally low economic development potentials. Yet, we call them "Enablers" as they may play a pivotal role to help other sectors through their specific solutions. Those solutions might help Heritage sectors improve productivity, become greener, and transit towards higher sustainability levels.

¹⁸ Mass Customisation is the approach to delivering customised products in a way that is still cost efficient on a mass scale

Companies in this quadrant are, for example, specialized technology companies. Also, start-ups, focusing on niche market solutions for the energy transition, waste management or production processes, planning and optimization.

The Norm Strategy for Enablers is a selective approach. It depends according to the general need of the Heritage sectors for specific solutions, see Figure 6.

6. INDUSTRY STRATEGY FORMULATION PROCESS

The industrial community's vision of a proper Industry Strategy aiming at coherently moving Luxembourg's industry towards a more sustainable, decoupled future relies on the interplay of the two instruments presented in the previous chapters: The decision matrix and the sustainable growth model (see Figure 8).

For a given type of industry, as assessed by the decision matrix, its related norm strategy must be considered within the context of that company's maturity according to the life cycle model. Also, a given population of companies per stage in the life cycle model influences how to prioritize the development and attraction of the different types of businesses in the decision matrix. The combined use of both tools offers many strategic options but at the same time reveals many unknowns and opens lots of options. The related complexity is not trivial and risks to get out of hand rapidly.

We thus suggest sticking to a strategy formulation process that allows to systematically work through all options and variations while progressively eliminating unknowns along the way. The result of the process should be a clear and verifiable vision of how Luxembourg's industry may be developed in the future. Figure 9 depicts the four-stage process including the actions and deliverables for each of the stages.

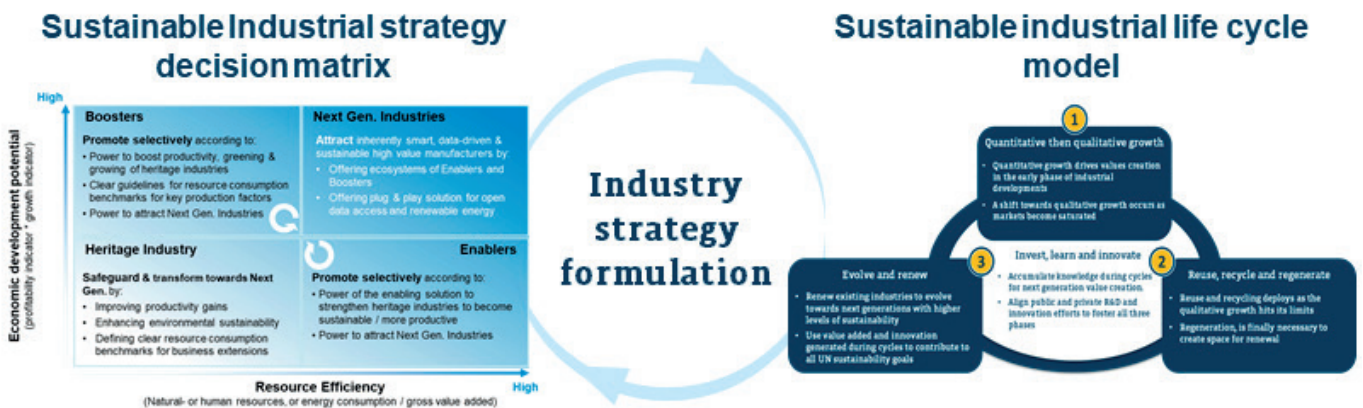


Figure 8: Strategy formulation is an interplay between two instruments

1. Assess the Heritage sector's needs

The first stage aims at assessing the current situation of the local Heritage sector. Both tools, the decision matrix and the life cycle model help, find out more about the sector's population. They allow diagnosing the population's resource intensity, growth potential, and in what stages of the life cycle model its companies are located. In parallel to the current situation diagnosis, a discussion can be started about their future opportunities, plans, and the requirement needed to move towards a higher level of sustainability.

The three deliverables of this stage provide a transparent vision about the Heritage industry's current state. Above all, it unveils what ecosystem in terms of cross-sectoral Boosters and Enablers it requires, growth barriers it encounters, and what support measures it expects to overcome them. Those deliverables give industry policy invaluable information about how to prioritize its efforts in terms of industrial development.

Currently, such cross-sectoral Boosters and Enablers may be, for example, companies with competencies to reduce carbon emissions across a variety of manufacturing processes of energy-intensive industries. The attraction of such businesses would not only help the local Heritage industry to growth. Luxembourg could also position itself as a host location for such Boosters and Enablers to access the entire European Heritage industry's market while having its local pilot partner from the industry and public R&D actors right at its doorstep.

2. Identify Next Gen target sectors

The second stage aims to pinpoint potential Next-Gen companies to attract to Luxembourg. As described in chapter 5.2.2, this paper advocates to populate the Next Gen industry with High-Value Manufacturers. It means that efforts should focus on attracting companies aspiring to become High Value Manufacturers as accomplished, and well-established High-Value Manufacturers might not be interested in moving to Luxembourg.

A benchmarking analysis along the decision matrix' axes – resource intensity and economic development potential – might be useful for the detection of aspiring High-Value Manufacturers. It can reveal companies' aspirations compared to best-in-class businesses. The lifecycle analysis might also reveal when a company might want to jump to the next stage of its life cycle. The decision for such a jump might be dependent upon external competencies that the company can rely on and find in a well-developed business ecosystem. Luxembourg should develop such an ecosystem of Boosters and Enablers that serves aspiring High-Value Manufacturers to realize their evolution in a cost-competitive manner. Such an ecosystem would represent a great unique selling argument to attract the next generation's sustainable businesses to Luxembourg.

The two deliverables of the second stage yield, on the one hand, a long list of FDI attraction targets in the form of aspiring High-Value Manufacturers and on the other hand, the requirements according to which an ecosystem of Boosters and Enablers needs to be developed.

3. Define Ecosystem and Next-Gen Targets

The third stage of the strategy formulation process builds upon the deliverables of the first two. Knowing the requirements for an ecosystem that supports both the Heritage Industry and aspiring High-Value Manufacturers, this stage can now define the shape of the most efficient set of Boosters and Enablers to develop. This set of companies forms

the ecosystem to build in Luxembourg. The efficiency of the ecosystem in this context can be quantified by the ratio of the business value a specific ecosystem design supports divided by the efforts to establish that same ecosystem over time. Enabler and Booster companies with broad cross-sectoral competencies and technologies seem to be the most attractive

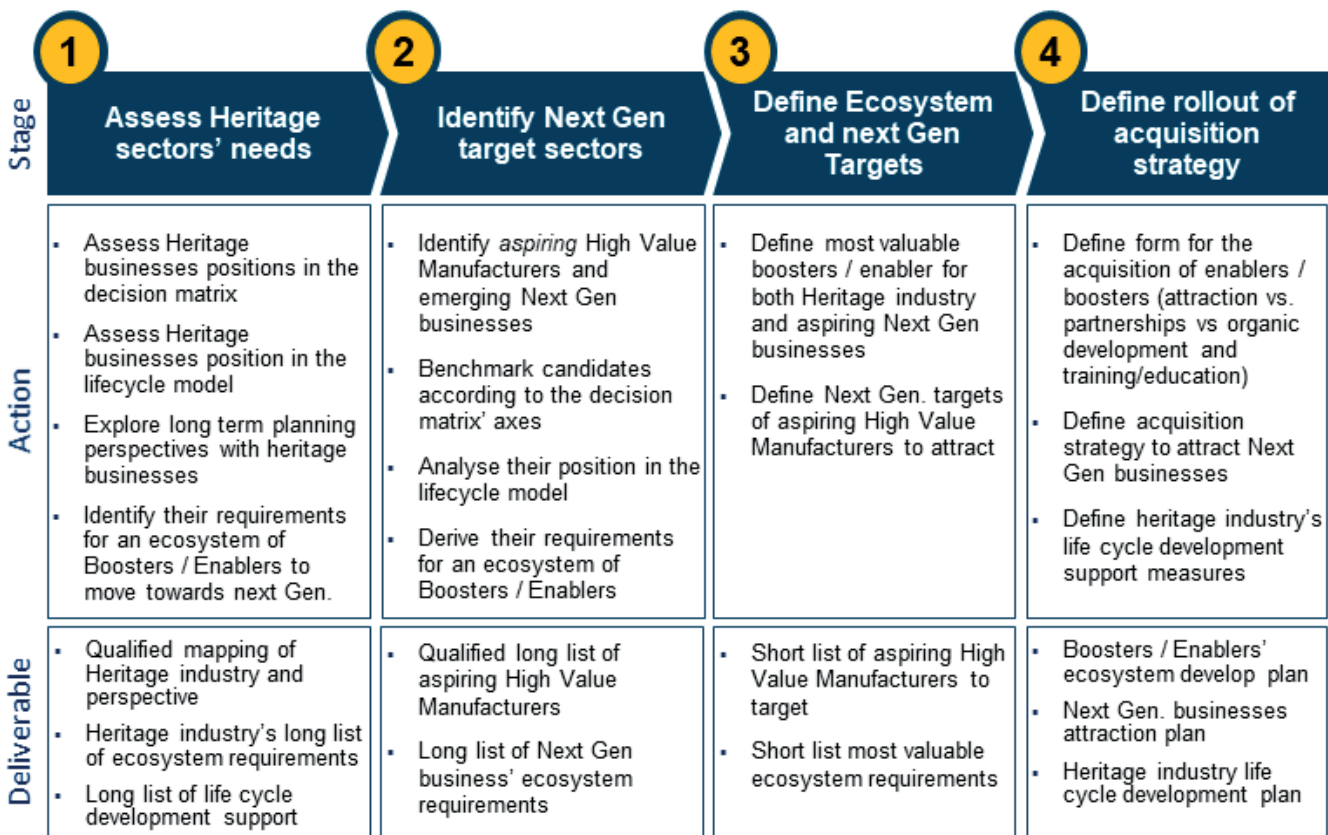


Figure 9: Industry strategy formulation process

choice. They can deploy their assets to make a large number of companies more sustainable. Also, reflections about developing the ecosystem must include a role for Luxembourg's Greater Region; not all competencies may be needed in direct proximity.

It seems important to note that the ecosystem's design should prioritize the support of the existing Heritage to transform over attracting new businesses. Experience shows that it is difficult and often more costly to attract new businesses successfully than to preserve and gradually upgrade the existing ones.

Once the ecosystem's design is defined, the long list of Next-Gen businesses from the previous stage can be trimmed to fit that specific ecosystem. Thus, this stage's deliverables are the shortlists of target companies both to develop the ecosystems (Boosters and Enablers) and the Next-Gen sector.

4. Define rollout of acquisition strategy

The rollout of the acquisition strategy consists of developing hands-on plans, to implementing the industry strategy on the ground. It includes the discussion under which form the ecosystem's competencies should be developed. For example, competencies can be acquired for the local ecosystem by attracting Booster or Enabler companies to relocate physically to Luxembourg. This approach might be sensible for competencies that can be deployed across many different sectors. However, a relocation might not be necessary for particular competencies that only find isolated use. They may be available in Luxembourg's greater region, or an international partnership or joint-venture followed by technology and

competence transfer could be the solution. For most essential but non-time-critical competencies, in turn, it might be justified to develop them in Luxembourg by adapting the middle- and higher education curriculums to grow them organically over time.

Rollout activities also include adapting Luxembourg's inward FDI efforts to attract future High-Value Manufacturers. The current sectoral focus might need to be reviewed and updated. Finally, other accompanying support measures must be developed and put in place to help the Heritage industry to transform more rapidly. Such measures might include incentive programmes, subsidies, or specific training.

This last stage's deliverables are three plans: The Boosters' and Enablers' ecosystem develop plan, the Next Gen. businesses attraction plan, and the Heritage industry's life cycle development plan.

7. WIDENING THE SCOPE OF THE CURRENT SECTORAL APPROACH

According to the four quadrants' concept, managing the industry strategy means to widen the traditional approach's scope that identifies companies according to their sectoral market adherence. The new approach describes Enablers, Boosters and Next-Gen Industries independently from their sectoral business activities. Some of the current six priority sectors, such as Space or ICT, perfectly correspond to the new approach. However, we risk eliminating or overlooking implementation projects that belong to other sectors, not labelled as a priority. Identifying projects without explicitly referring to their sectoral adherence, but according to their resource

efficiency and economic development, potential seem sensible. This approach seems to make much sense when considering the conversion of many traditional business activities due to rapid technological change. Change that has been dramatically accelerated in the last decade by the digital transformation.

Digital technologies cut across all sectors and business activities. They change the way how companies operate. Formerly sharp and static sectoral boundaries become increasingly fluid, allowing companies to access new markets and segments. The clear distinction between partners and rivals also shifts towards a situation where the same companies fiercely compete in one area while cooperating in another.

One of the most prominent industrial companies to illustrate this situation is the Tesla Motor company. Embracing digital technologies and fast technological change in general, this company is about to revolutionize one of the most traditional Heritage sectors, the automotive. While a traditional sectoral approach would not focus on Tesla Motors as it is part of a relatively slow-moving sector, the new approach would instantly identify its potential due to the increased efficiencies and growth potential.

Tesla Motors also is an excellent example of how fluid sectoral boundaries have become: With its electric vehicles, Tesla competes with traditional car manufacturers such as Honda, BMW or Volkswagen. However, it is less evident that it also competes indirectly with platform companies from the ICT industry, offering ride-sharing solutions such as Uber or the French BlaBla car. Another Tesla competitor in the ICT world is Google. Tesla's autonomous vehicle functions compete with Google's AI²⁰ software developments

to provide self-driving cars. At the same time, Tesla is also Google's partner as its vehicles' navigation system is based on Google Maps. Moreover, with its Powerwall products that repurpose used vehicle batteries for home use, Tesla competes in the home energy industry with companies such as Siemens or Honeywell and utility companies from the energy sectors such as RWE or Enovos. In a traditional sectoral approach, we would struggle to decide whether to identify Tesla as an automotive-, ICT-, home-energy- or utility sector company.

One might argue, on the one hand, that Tesla is an extreme case of digitalization. Its speed of technological progress and innovation could hardly be considered transferrable to other sectors. On the other hand, if we promote the digital transformation and if we wish that it revives Europe's industry, we must accept that our conception of the most traditional sectors might become increasingly blurred over time when successful. The implication for Luxembourg's economic development policy is evident. Besides the traditional sectoral approach, we must adopt a broader view when looking for the right businesses to support Luxembourg's economic future. FDI attraction strategies and company evaluations directed strictly according to the current sectoral approach would risk missing future acquisition opportunities.

8. MINIMUM PRODUCTIVITY BENCHMARKS

The basic idea behind setting guidelines for minimum productivity indicators on key production factors is to guarantee a minimum level of return per production factor. This is particularly important for production factors whose resource consumption needs to be limited. According to the discussion in chapter 2.3, some of

²⁰ Artificial Intelligence

the most critical production factors to limit are the required surface area for an industrial project, the workforce deployed in Luxembourg, the consumed energy and the emissions emitted for operations.

8.1. Resource intensity productivity indicators and benchmarks

Implementing minimum resource intensity benchmarks for key production factors in case of business expansions and industrial FDI attraction

The indicators in Table 1 do not intend to substitute current authorization procedures, including environmental authorization procedures. They aim to guide business development initiatives towards projects by quantifying decision-making in the Industry Strategy context. Once a project qualifies according to the above indicators, it must still run through the established authorization procedures. At the same time, environmental and other permitting schemes must not become an instrument for industrial policy decision making

	Indicators	Metrics	Benchmarks	Explanation
1	Gross value added* / employee	{k€}	72.1**	an indicator of labour productivity
2	Gross value added* / utilised surface area	{k€/ha}		an indicator for surface area productivity
3	Gross value added* / consumed energy	{k€/kwh}		an indicator for energy efficiency
4	Gross value added* / Co2 equivalent emissions	{k€/t}		an indicator for environmental efficiency
5	Gross operating surplus / turnover	{%}	8.6**	an indicator for profitability

* Gross value added = Sales - costs of raw materials - cost of production - cost of outside service suppliers

** Luxembourg's manufacturing industry's average performance across all sectors in 2015, source Eurostat

Table 1: Possible productivity indicators for key production factors

can be achieved via a set of productivity indicators. Indicators that define minimum productivity thresholds and applicable across all sectors will naturally guide business development efforts towards activities with inherently higher levels of productivity on those factors. Table 1 suggests a set of indicators with corresponding metrics and some benchmarks that can be used as minimum thresholds. Beside the four production factors of Table 1, we also suggest an overall performance indicator for business profitability, see indicator 5.

and implementation. In other words, permitting schemes should focus on the factual application of environmental legislation without taking stakes in industrial policy.

The statistical benchmark values for the indicators 2-4 in Table 1 are currently not publicly available. They need to be determined using historical empirical data. The proposal to use a statistical average as a threshold for indicators 1 and 5 reflects the ambition to attract industrial investment projects that will at least improve the

average performance of the existing local industry. Alternatively, for a given sector, benchmark values can be set by the leading companies of that sector which use the best available technologies in terms of resource efficiency and environmental sustainability.

This paper now suggests applying the benchmark indicators 1 and 5 from Table 1 to average performances of manufacturing sectors across

Europe to make the case. According to our understanding of sustainable growth, *all sectors with a high indicator of labour productivity and profitability are potentially interesting for business in Luxembourg.* Figure 10 shows that five out of seven sectors on the left side of Luxembourg's average (see the yellow bar in Figure 10) qualify. Those five sectors both exceed Luxembourg's average labour productivity and profitability.

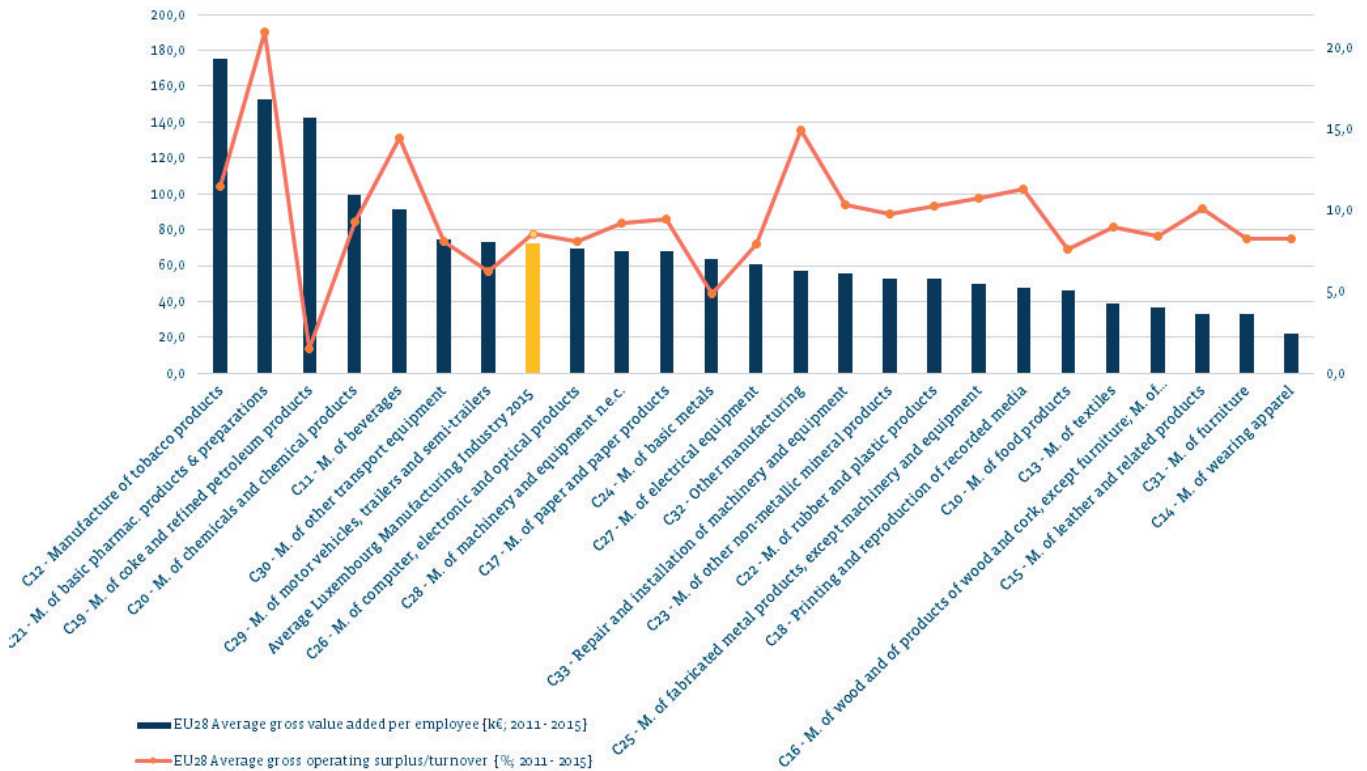


Figure 10: Average performance across the EU 28 manufacturing sectors versus Luxembourg's overall manufacturing sector

The comparative analysis shown in Figure 10, relies on statistical data from Eurostat. For some of the indicators suggested in Table 1 (e.g. indicators 2 - 4) statistical comparison data might be hard to find. Nevertheless, the indicators can be used to compare competing investment projects with each other. For such an evaluation, the project's business plan can be evaluated against past project data and average sectoral statistical data.

Assessing investment projects only by productivity indicators might fall short of understanding their broader impact. We thus suggest also to analyze how a project can influence the economic and social ecosystem that is already in place. Business projects that might not be able to meet all productivity-based indicators

may, nevertheless, have an excellent benefit for the existing ecosystem. A new industrial implementation might, for example, bring new business opportunities for established suppliers or service companies or strengthen the reputation and thus the attractiveness for further business implementations in a given sector. Table 2 suggests a set of indicators that assess the impact of a new investment onto the existing economic and social ecosystem.

Table 2 includes quantitative (6-10) and qualitative (11-13) indicators making a direct and purely objective comparison of projects challenging. Together with the indicators of Table 1, it provides a robust framework to guide active industrial foreign direct investment (FDI) attraction efforts.

	Ecosystem Impact	Metrics	Explanation
6	Total number of job creations	number	an indicator for the job market, and an implications for housing & mobility needs
6a	out of which number of high value added job creations	number	
7	Total wages and salaries	{Million€}	an indicator for fiscal revenues together with 7a
7a	out of which above minimal wage	{Million€}	
8	Initial total investment	{Million€}	an indicator for potential revenues for existing businesses
8a	out of which in land	{Million€}	
8b	out of which in existing buildings and structures	{Million€}	
8c	out of which in construction and alteration of buildings	{Million€}	
8d	out of which in manufacturing and equipment	{Million€}	
9	Investment rate (Investment/value added at factors cost)	{%}	an indicator for recurring revenues for existing busi.
10	R&D expenditure rate (Investment/value added at factors cost)	{%}	an indicator for R&D intensity
11	Potential to enhance the competitiveness in the sector	low/middle/high	
12	Potential to drive salary increase in the sector	low/middle/high	
13	Potential to enhance sector's economic attractiveness for futher F	low/middle/high	

Table 2: Indicators assessing the impact of an industrial investment on the existing ecosystem

9. IMPLEMENTATION OF THE INDUSTRY STRATEGY

The Industry Strategy holds two principal instruments to direct its coherent implementation: (1) Foreign direct investment (FDI) attraction activities and (2) the attribution of land necessary for the development of industrial projects. While the first allows to actively manage the transformation of Luxembourg's industrial landscape by attracting foreign industrial investments according to the strategy; the second enables it to implement a selective decision process according to its scope. In the interest of all stakeholders, and Luxembourg's reputation among the international investors' community, final decisions about whether to accept a project must be communicated in the early stages of a project and with clear, and detailed feedback to investors.

The decision making about whether to accept or refuse industrial processes must be coherent and understandable for investors. It must refrain from including political, party-specific ideological elements or falling back to permitting schemes that would seem arbitrary and designed to fit its author's goodwill or pre-determined conviction.

On the ground, the implementation of an Industry Strategy that contributes to transforming Luxembourg into a smart, data-driven and sustainable economy must focus on the following four policy actions:

1. Encourage and incentivize Heritage sectors' efforts to continuously increase productivity and resource efficiency.

The digital transformation via Industry 4.0, robotization and automatization offers a significant lever to increasing productivity in these sectors. Policy initiatives that help to accelerate a broad adoption of such solutions include a high-performance Digital Innovation Hub (DIH), dedicated training, and easy access to the local academic computing power and its related expertise.

Resource efficiency and sustainability in terms of energy consumption can be promoted by a policy that incentivizes corporate investments into energy-efficient and low carbon production equipment. Such incentives can be given by allowing fiscal deductions of those investments from CO₂- and other environmental levies. This route can be built by the extension of current energy efficiency voluntary agreements between the government and the (Heritage) industry. Extensions can be made both in terms of admitting more companies to the contract and accepting as climate efforts the industry's contributions to increasing renewable energy and reducing CO₂ emissions.

Access to competitively priced renewable-, low carbon electricity and alternative fuels such as hydrogen can further represent a substantial competitive advantage for the Heritage industry. They will enable the Heritage sectors to dramatically reduce their environmental impact and benefit from a more cost-effective operation as they can shed related national and EU levels ecological levies such as CO₂ taxes and ETS emission rights.

Moreover, it is safe to assume that significant decarbonization efforts will rely on industrial processes' electrification or their switch to low-carbon fuels. Demand for such low-carbon electricity or clean fuels is expected to surge in the future as digitalization is increasing across all business sectors, and the transport and mobility sectors are looking for renewable energy solutions. Consequently, the whole economy's need for low-carbon energy will increase, and it will do so across a broad spectrum of sectors, surpassing the ones identified today as electricity-intensive. As such, the ability to offer low carbon, competitively priced electric power and alternative fuels will become a factor for Luxembourg's economic attractiveness in the future. Public policy and related investments to secure those clean energy sources are, thus, a must to support the Heritage industry to transform and attract companies from the Next-Gen sectors.

2. Promote innovation in Heritage sectors to develop towards high-value manufacturing.

Develop a Digital Transformation Industry Action Plan with representatives from the industry to accelerate the penetration rate of digital transformation initiatives. This action plan must promote the broad deployment of Industry 4.0 technologies with a particular focus on:

- a) Diversifying traditional manufacturers into new growth or higher margin niche markets of high-value manufacturing;
- b) Increasing data-driven industrial excellence and productivity to maintain profits in shrinking markets;
- c) Developing data-driven business models by enhancing hardware products through IT embedded capabilities.

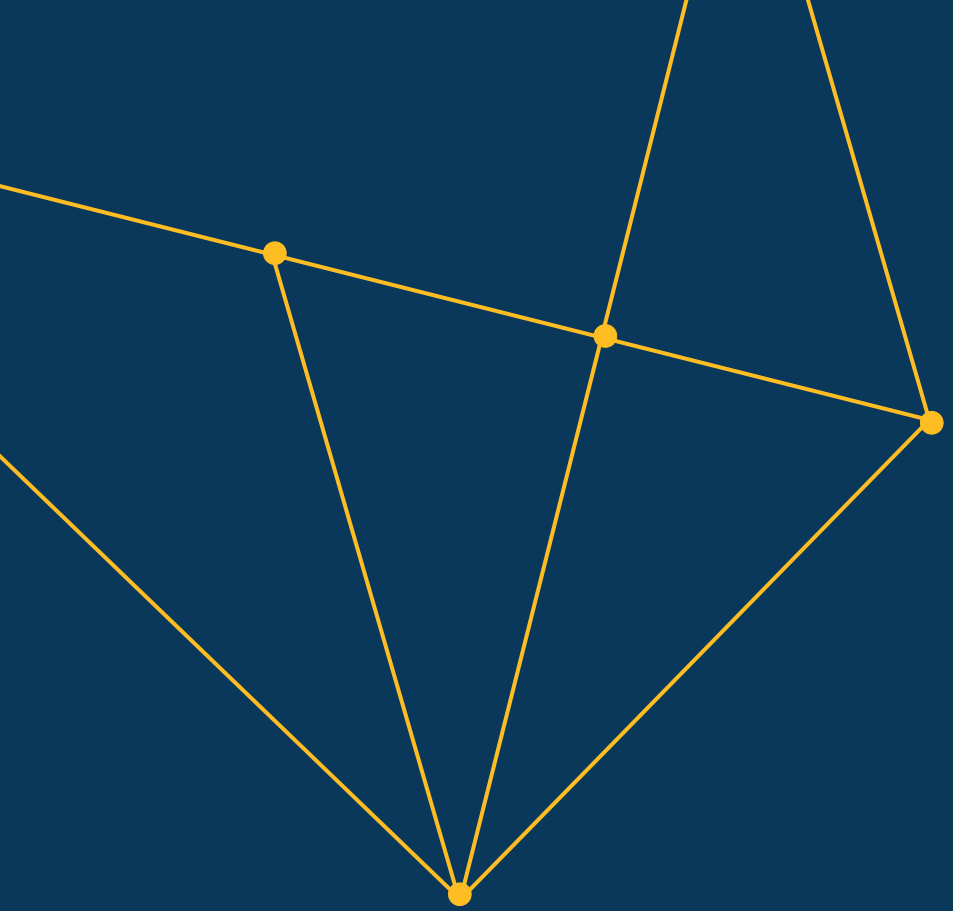
3. Push the creation of start-up companies native to the Next-Gen, Booster and Enabler sectors.

Establish an industry park that fosters the creation of Next-Gen start-ups by offering proximity to academia and the established Heritage sectors. Create a non-sector specific start-up attraction programme that attracts companies providing solutions for Heritage sectors to transform. In other words, needed are attraction programs to acquire Boosters or Enablers. Such a program can be designed as a problem-solving quest to find solutions for the Heritage sector's transformation challenges. The winning companies are awarded the markets of the Heritage sectors as well as a standard package to implement operations in Luxembourg.

4. Focus foreign direct investment attraction activities on developing an ecosystem that is favourable to Next-Gen sector companies.

Besides directly targeting Next-Gen companies' attraction, put a stronger focus on foreign direct investment attraction that helps to establish a robust ecosystem of Boosters and Enablers. Such an ecosystem will favour the direct attraction efforts of Next-Gen grown-up companies. At the same time, it will accelerate the transition of the Heritage sectors.

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