



**Building evidence to support
vocational excellence for the digital
and green transitions**

**The Role of Centres of Vocational
Excellence in the Green Transition**





PREFACE

The study “The role of Centres of Vocational Excellence in the Green Transition” has been funded by the European Union and produced by the European Training Foundation (ETF).

This report presents five case studies of Centres of Vocational Excellence and their approaches to green transition. The case studies were carried out in Denmark, Morocco, Australia, USA and Singapore.

The study project was coordinated by Stefan Thomas (ETF). The research design was led by Andreas Bjerre Lunkeit (DTI), Martin Eggert Hansen (DTI) and Stefan Thomas (ETF). The research was undertaken in the period from October 2022 to August 2023 by a team of researchers working at the Danish Technological Institute (DTI). The report was written by Andreas Bjerre Lunkeit, Emil Højbjerg Thomsen, Karsten Frøhlich Hougaard and Martin Eggert Hansen (all DTI).

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INTRODUCTION

The green transition has become a ubiquitous term. It is the title of a global policy vision for sustainable growth and an economy that does not rely on fossil fuels and overconsumption of natural resources. The greening of the economy and society is taking place with enormous momentum. Vocational schools and centres are also affected. On the one hand, they have to respond to this dynamic with adapted or new offers for education and training. On the other hand, they are coming under pressure to become greener themselves, for example by using renewable energy, energy-efficient buildings or introducing advanced recycling systems.

What does the green transition mean for Vocational Education and Training (VET)? This report presents examples from Australia, Europe and Africa of how Centres of Vocational Excellence (CoVEs)

manage the green transition and what lessons they have learned to date. The five CoVEs are:

- **The Green Tech Academy** at the **Olathe West High School, Kansas, USA**. The Green Tech Academy (GTA) is a specific VET programme integrated into high school. The GTA programme provides students with knowledge and skills in two specific areas of study, notably renewable energy sources and agriculture, with a focus on environmental sustainability. The GTA programme is particularly notable for providing students with both technical and transversal skills that are relevant to the green transition.
- **TAFE Queensland, Robina Campus, Australia**. The campus has been designed to be an important national institution in terms of the integration

of environmental as well as social sustainability into VET in Australia. The Robina Campus, which has been operational since July 2022, has made a strategic effort to embed sustainability in all aspects of campus operation, including campus design, course curriculum, and student life.

- **The Temasek Polytechnic, Singapore**. Temasek Polytechnic (TP) in Singapore offers 36 diploma courses at EQF level 5 across six schools. TP has integrated sustainability into education programme content and students' projects and therefore TP may be an inspiration to other vocational education providers.
- **The Training Institute for Renewable Energy and Energy Efficiency** (*Institut de Formation aux Métiers des Energies Renouvelables et de l'Efficacité Énergétique, IFMERE*), **Tangier, Morocco**. IFMERE is an important VET institution in Morocco when it comes to providing students with green and transversal skills relevant to the green transition. The IFMERE produces highly skilled technicians for the energy sector – mainly wind and solar power, and energy efficiency.
- **The Green Academy, Denmark**. A VET institution focusing on education and training in agriculture and horticulture. The school offers a wide range of education and training programmes in green areas such as landscaping, gardening, floristry, forestry, agriculture, agricultural machinery operation and animal care.

The case studies show that the green transition requires a whole-institution approach, including the development of an implementation strategy, the

'greening' of curriculum content and the learning environment, the 'greening' of campuses, the development of faculty skills, and collaboration with industry, research institutions and many other external stakeholders.

Taken together, the case studies represent very different VET systems and show that VET institutions can take many different paths towards a green transition. We hope that this report and the examples will inspire VET institutions and policymakers worldwide.

The report is part of the project 'Building Evidence to Support Vocational Excellence for the Digital and Green Transitions', implemented by the European Training Foundation (ETF). The study was conducted between May 2022 and January 2023 by the Danish Technological Institute (DTI).

The report contains the following main sections:

- 'Conceptual clarification', which introduces the reader to key concepts and issues. For example, what do we understand by centres of vocational excellence? What is the 'twin transition' (the green transition and the digital transition together)? How do we understand the 'greening' of society and the economy? How do we define green skills? How do we understand the whole-institution approach?
- 'Methodology', which describes how the cases were selected and how data collection and site visits were planned and carried out in collaboration with each institution.
- 'Summary', which sets out the main findings and cross-cutting conclusions based on the case studies.

- Section 'Cases I to IV', which presents the individual cases, each of which is 20–35 pages long.
- 'Appendix', which contains a glossary of the abbreviations and terms used in the report.

CONCEPTUAL CLARIFICATION

Centres of Vocational Excellence (CoVEs) are VET providers, groups of VET providers or organisations coordinating VET providers that collaborate with economic, educational, social and political partners and help to create local 'skills ecosystems' with the aim of providing high quality VET skills and contributing to regional development planning and growth. Their excellence can be described in terms of the extended scope of their activities; the high quality of their performance and their capacity to respond and develop to meet the needs of their stakeholders. They usually play a leading role in the VET system, acting as a model, coordinator or pathfinder for other VET providers.

The above definition of CoVEs is based on the EU Commission's description of '*Centres of Vocational Excellence'.¹

- The mapping study 'Mapping Centres of Vocational Excellence'² has identified the following key factors in the success of CoVEs:¹ Learner-centred approach: The concept of vocational excellence involves a holistic learner-centred approach. CoVEs promote experiential, inquiry-based, experimental and playful learning in the classroom by allowing students to bring their

own knowledge, experiences, and ideas to the process of acquiring new information and developing new insights.

- Strong and collaborative relationships with stakeholders: CoVEs have developed networks and collaborative relationships with industry associations, higher education and research institutions, employers, development agencies, and other public authorities with a common interest in specific sectors or industrial ecosystems.
- Strong link to regional development, innovation, and smart specialisation strategies: CoVEs systematically anticipate regional priorities and sectoral skills needs, in addition to national priorities. By working closely with companies on applied research projects, creating knowledge and innovation hubs, and supporting the entrepreneurial initiatives of their learners, CoVEs stimulate local business development.
- Responding to technological developments and skills needs: CoVEs have developed agile and flexible organisations that respond to evolving technological developments and new skill needs. Curriculum development and skills provision continuously involve industry associations, research institutions, and other external stakeholders. CoVEs enable their learners to acquire both vocational and key competences through education that builds innovative partnerships with the world of work.
- International collaborative networks: CoVEs have developed international collaborative networks with other CoVEs in different countries. The European

Training Foundation (ETF) has established the ETF Network for Excellence (ENE) to develop an international network of CoVEs. The ENE brings together hundreds of organizations and CoVEs from the EU neighbourhood, Central Asia, Africa and the EU.

Becoming a CoVE is a process of becoming mature. The characteristics of a CoVE do not make up a definitive checklist, but rather a process of maturing. Therefore, based on the mapping study, a model of maturity with three stages has been developed. In the first stage, the CoVE begins to improve on its VET routine activities, with close links to the labour market. For example, curricula and programmes are closely aligned with the needs of the labour market. In the second stage, the CoVE improves strategic development by playing a more active role in skills anticipation mechanisms to ensure a close match between VET and labour market needs. In the third, mature stage, the CoVE achieves excellence by co-creating local skills ecosystems, local innovation, and regional development.

What is the green transition?

The green transition is a shift to an economically sustainable growth model that does not rely on fossil fuels and promotes the circular economy and biodiversity. The green transition is a global political agenda addressed by governments and international organisations. United Nations has launched the Global Green New Deal (GND), which calls for public policy to address climate change along with achieving other social aims like job creation, economic growth and reducing

economic inequality.² Similarly, the the European Green Deal aims to transform the EU into a modern, resource-efficient, and competitive economy, with zero net greenhouse gas emissions by 2050 and leaving no person or place behind. The European Commission has adopted proposals to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. The EGD also aims to achieve clean air, water, soil, and biodiversity, energy-efficient buildings, healthy and affordable food, improved public transport, clean energy and technological innovation, durable products, and future-proof jobs and skills training.

What is the 'twin transition' – the term that denotes the green transition and the digital transition?

Society and the economy are undergoing two simultaneous transitions – the green and digital transitions. They refer to the simultaneous development of a shift in production and consumption patterns that use natural resources more sustainably, while at the same time using digital technologies to improve energy and production efficiency and reduce waste. This transition reflects both growth awareness of the impact of human activities on the environment and the expansion of renewable energy sources and digital technologies. The twin transition can enable a more sustainable and efficient future, where economic growth goes hand in hand with environmental protection.

The cases in this report focus on the green transition, which will be described below.

² United Nations, Global New Green Deal: <https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=670&menu=1515>.

Impact of the green transition on job content and skills needs.

The green transition and the growth of the green economy are expected to create new opportunities for green skills and jobs. The International Labour Organisation (ILO) estimates that the global transition to a green economy could create up to 24 million new jobs by 2030 (ILO, 2018). At the European level, the European Commission estimates, that under the right conditions, the implementation of the European Green Deal could create about 1 million additional jobs in the EU by 2030 (European Commission, 2019).³ The transition to a green economy creates an increasing demand for people with skills and knowledge for the green transition.

How to define green skills? The GreenComp framework (European Sustainability Competence Framework) identifies and promotes more transversal competences needed by all citizens to live and work in a greener society. The green transition requires individuals with a variety of skills, including proficiency in digital technologies, an understanding of technical and social aspects of sustainability, and an entrepreneurial spirit to identify new opportunities in the green economy. Effective communication and negotiation skills are also crucial for building partnerships and engaging with stakeholders.

The European Skills, Competences, Qualifications and Occupations (ESCO) taxonomy of green skills has a labour market focus. It identifies 381 skills, 185 knowledge concepts, and 5 transversal skills in ESCO that are

considered crucial for a successful and equitable green transition of the labour market. The taxonomy serves as a valuable reference point for the development of green training programmes in VET. Firstly, the ESCO portal allows access to the taxonomy for a closer examination of green skills and knowledge concepts, such as the sectors and occupations to which they are linked. The taxonomy also defines which skills and knowledge concepts are essential for the greening a specific occupation and identifies skills for the green transition that can be applied across different occupations. Finally, the taxonomy categorises green skills and knowledge concepts based on educational standards such as the International Standard Classification of Education (ISCED-F). With this information, VET providers can identify and define skills to be integrated into their curricula and training programmes to support the green transition.⁴

As indicated above, green skills are a very broad range of technical, manual, and theoretical skills as well as transversal, personal competences and attitudes. While technical and manual skills are needed for the green transition, it is also considered important that STEAM (Science, Technology, Engineering, Arts and Mathematics) competences are strengthened at all levels. It is also important that education and training promote awareness of the relationship between nature and human society and activities, as well as attitudes

⁴ The ESCO presentation is based on the description in this report, page 11: 'GRETA – Greening Responses to Excellence through Thematic Actions'. [Online] Available at: https://www.etf.europa.eu/sites/default/files/2023-05/GRETA_Greening%20of%20VET.pdf.

³ European Commission, 2019. The Possible Implications of the Green Transition for the EU Labour Market.

that emphasise social growth and well-being for all (i.e. a nature-centred vision of the world as opposed to an anthropocentric one, sometimes also referred to as biosphere values).

However, there is a perceived shortage of relevant skills for the green transition at global level, not least in Europe. The publication 'The Green Employment and Skills Transformation' focuses on the impact of the green transition on employment and skills in the European Union (EU). The report analyses how the transition to a green economy is affecting the labour market and the skills required for different green jobs. The report highlights the disparities in the availability of green jobs and skills for the green transition as a major challenge (Cedefop, 2021)⁵. This disparity is confirmed by UNESCO-UNEVOC, which examined the climate change action plans of 57 countries in relation to skills development.⁶

Developing green skills and jobs requires overcoming several challenges such as creating awareness, providing education, and training, and implementing a greening process for qualifications. This is both a challenge and an opportunity for VET, where the development of green skills is crucial for meeting the needs of the evolving labour market.

What do we understand by the whole-institution approach to the green transition?

As mentioned above, the green transition is a challenge for VET that

⁵ <https://www.cedefop.europa.eu/en/publications/4206>.

⁶ UNESCO-UNEVOC, 2021. *Skills development and climate change action plans - Enhancing TVET's contribution*. [Online] Available at: https://unevoc.unesco.org/pub/skills_development_and_climate_change_action_plans.pdf.

requires a whole-institution approach. An institution-wide approach to the green transition is organised in a process that involves all stakeholders – the institution's management, teachers, learners, and administration – to jointly develop a vision and plan to implement the green transition across the whole institution. However, the study indicates that many relevant initiatives and actions can be successfully launched without being part of an overall strategy. The key elements of the whole-institution approach are:

'Greening' the curricula and training programmes is essential to provide new green skills for the labour market and change values and mindsets. The cases in this report show that greening the curricula can also include the integration of sustainability goals in non-green programmes or the introduction of new green programmes.

Campus greening. Sustainability is not just subjects or a set of skills to be learned, but a way of life. The whole-institution approach may also include objectives to promote an integrated campus management with a view to strengthening operational sustainability mechanisms. The cases in this report provide numerous examples of how Centres of Vocational Excellence (CoVEs) have waste recycling and other sustainability initiatives.

Teachers and teacher training. Teachers play a crucial role as they are responsible for the education of students. The whole-institution approach emphasises the importance of professional development and training to ensure that teachers have the necessary skills and knowledge to deliver high quality green education. The cases in this report show that teachers are important role models for learners

by telling stories of how sustainability can be integrated into key tasks of the profession. For example: How to be a sustainable mechanic? How to be a sustainable hairdresser?

Involving stakeholders. The whole-institution approach recognises the importance of partnerships between VET providers and a wide range of stakeholders in supporting the green transition, including parents, government officials, knowledge institutions and, last but not least, businesses. Each of these stakeholders brings unique perspectives and resources that can contribute to the success of the green transition. The alignment of skills provision with regional and national green policies is also included in this dimension. Cases in this report show that national policies and strategic sustainability plans play as inputs to greening of programmes.

Strategies. A systematic approach to VET greening requires that the management develop appropriate greening strategies. VET providers can develop such strategies by setting priorities, objectives and timelines, e.g. for greening their campus or addressing the four dimensions of greening outlined above, while other VET providers may choose a holistic approach to greening.

The whole-institution approach guides educational institutions on how to best organise the green transition. In the cases described in this study, we have used the whole-institution approach as a framework that enables an analysis of the involvement of the whole institution and its external stakeholders in the green transition.

This will be explained in the next section, where we discuss methodology.

METHODOLOGY

The cases in this report are based on a qualitative research design, with most of the data presented being collected through group interviews conducted during visits to the respective organisations.

The study of the Centres of Vocational Excellence (CoVEs) and the green transition has been carried out in the following main steps:

1. Identifying and selecting CoVEs;
2. Preparing and conducting 3-day visits and interviews at each institution
3. Developing the case studies (approx. 30 pages each)
4. Conducting transversal analysis and drafting the case study report.

Identifying and selecting CoVEs

The CoVEs were selected for the study based on several sources, such as mapping studies/platforms, ongoing projects, and contact networks of the Danish Technological Institute (DTI) and the European Training Foundation (ETF). Some of the web pages used are:

- 'Mapping of Centres of Vocational Excellence (CoVEs)'; ET 2020 Working Group on Vocational Education and Training (VET) (2019). [Link](#)
- 'Community of Practice Centres of Vocational Excellence', CopCoves 2021. In this community project, leaders of Erasmus Centres share their experience of implementing the Centres of Vocational Excellence. [Link](#)
- The CVETNET. A European project co-financed by the Erasmus+ Programme, which aims to build the capacity of CVET providers' networks and their members to support SMEs' adaption to digital transformation. [Link](#)

Based on the initial mapping, a diverse sample of CoVEs was selected to best represent different continents and countries.

Preparing and conducting 3-day visits and interviews at each institution

To ensure informed missions and interviews, DTI collected as much case documentation as possible from each CoVE prior to the 3-day mission, and more specifically website information on the content of learning programmes, statistics, and financial information. Each CoVE appointed a 'liaison officer' to handle correspondences with the DTI. The interviews during the visit were arranged in advance by allowing each CoVE to plan the time and location of the interviews by completing a timetable for the DTI.

All CoVEs were visited by one DTI consultant, each mission lasting 3 days. During the mission, interviews and focus groups were conducted with the management of the CoVE, teachers and trainers, students, external partners and other relevant stakeholders.

The Green Transition is a comprehensive process involving the whole institution and its external partners. The aim of the case studies is to analyse how VET institutions manage the Green Transition, what strategies are used, how the process is organised, and how it involves the management, teachers, learners, and collaboration with external stakeholders. The four groups interviewed were representatives of the management, teachers, students and external stakeholders. All interviews were semi-structured, meaning they followed a loose

interview guide with room for digression. These are some of the main research questions asked:

Management

- Are national strategies/policy initiatives used by the CoVE as a guiding reference for its own green transition?
- What is the CoVE's understanding of the green transition?
- What resources (financial, human, competences/know-how, equipment, etc.) are allocated to the Green Transition?

Green learning content and programmes for green occupations

- How is the green transition of the economy and society reflected in green learning content and programmes for green occupations?
- How does the management 'translate' the green transition of the economy and society into new skills and programmes?

External stakeholders and partnerships

- How does collaboration with external partners contribute to the green transition of the CoVE?
- What external partners are involved in the green transition of the CoVE?
- What strategies are used to cooperate and collaborate with external partners?

Pedagogical approach

- What pedagogical approach is used to support the development of learners' green knowledge and skills?
- How are learners involved in the green transition of the CoVE and other stakeholders?
- What tools are used to create a green learning environment?

- How are teachers and trainers involved in the green transition of the CoVE and other stakeholders, and what is their role in relation to learners?
- How are teachers' skills and competences updated to support the green transition of the CoVE?

Development of case studies

The case studies were drafted by the DTI based on data from the conducted interviews. The interview data was supplemented by the consultants' desk research and information provided by each of the organisations interviewed,

such as strategic documents. Case reports also drew on other relevant reports on the themes, such as government papers and Cedefop reports on vocational education and training.

Transversal analysis and reporting of case studies

Based on the case studies, a transversal analysis was carried out to identify common patterns and differences across the cases. The summary below sets out the main results of the transversal analysis.

KEY FINDINGS

The five CoVEs represent different countries, VET systems and areas of educational activity. Each CoVE has its own contextual background and has chosen its own path of green transition according to the skills needs of the economy and society. However, five cases are not a sound basis for generalisations. Instead, the five cases should be seen as inspiring examples of how CoVEs have managed the green transition and what lessons they have learned.

The five case studies represent a very rich pool of practices, tools, and strategies from which we could draw an infinite number of lessons and examples across the cases. We therefore summarise the main findings below, grouped under the main themes of the study. The findings are presented in italics, followed by case examples that support each finding.

MANAGEMENT OF THE GREEN TRANSITION

The governance of the green transition is driven forward by national policies and strategies, which are translated into green objectives and actions at the institutional level by the management. At the institutional level, national policies and strategies are used as a guiding reference for the development of green programmes and skills that address green skills needs. National strategies and green policies are an important driver for the development of green skills needs in the economy, as businesses are encouraged or required to adopt sustainable practices. The cases show that there has been a growing political focus on green policies and the climate agenda over the last two decades, including policy initiatives to green VET skills provision.

In the Danish case, for example, the strategic direction of the **Green Academy Denmark** influenced by national and regional strategies that increasingly focus on climate action and the green transition. The Green Academy Denmark sees the national strategy Smart Specialisation Strategy (Danish Board of Business Development, 2019) as an important driver, which has increased the need for green skills in the field of landscaping and gardening. Private companies, including small and medium-sized enterprises, are increasingly required to measure their carbon footprint. This has led to an increased demand for further education and training in biodiversity and sustainability for adult employees of Danish and foreign companies. In recent years, the demand for this type of course has increased as industry has become more interested in the green transition and has seen economic incentives to work sustainably.

Similarly, in the case of **Singapore**, the **Temasek Polytechnic (TP)** sees the government's Green Plan 2030 as a key guiding strategy for TP's contribution to a greener economy and the green transition of the institution and its activities. For example, the management explains that one of the pillars of the Green Plan is renewable energy. Consequently, TP has installed a solar system on the roof of the institution and has undergone an energy audit of the building's energy consumption. In addition, the integration of sustainability into learning and student project work is guided by the Ministry of Education (MOE), which enhances the curriculum and skills training to prepare students for the green economy. The MOE has launched the Integrative Built Environment Centre (IBEC), which is

part of the TP, as part of the initiative 'Laboratories to Enhance National Sustainability Efforts initiative'. At the institutional level, the TP has aligned its curricula with the MOE's strategies, and Singapore Skills Future (SSG), a statutory board under the MOE, drives, coordinates and assists in their implementation.

Although the sustainability and climate change agenda is growing in political prominence, the political priority given to sustainability at the national level fluctuates, reflecting the fact that governments come and go and that politics is inherently unstable.

In the **US**, recent US administrations have taken various positions on addressing the impacts of climate change and transitioning to a green economy. Under President Obama, the US was among the 196 State Parties that adopted the Paris Agreement at COP21 in December 2015. However, the US administration under President Trump (2017–2021) chose to withdraw from the Paris Agreement a few months after Trump took office, arguing that the Agreement contained terms that placed an unfair and unacceptable burden on US businesses, workers, and taxpayers. More generally, the Trump administration took a range of measures to roll back the environmental regulations implemented by previous US administrations, including policies aiming to cut GHG emissions (Pitt, et al., 2020; Daley, 2020). In the absence of federal leadership on climate change mitigation, US states and regions have developed and adopted their own environmental policies seeking to reduce GHG emissions, for example, by promoting renewable energy, energy-efficient buildings and more sustainable transport systems (Ricketts, et al., 2020).

Similarly, in **Australia**, national policy on climate change has fluctuated over the past few decades. However, since 2018 the government has explicitly sought ways to enhance green policies. A 2018 report published by the International Labour Organization (ILO) pointed out that, after the more progressive period described above, there was a lack of green skills policies at the national level. In fact, the report found that there were no major developments in this policy area between 2012 and 2018 (Curtis, et al., 2018). Since then, the Liberal government under Prime Minister Morrison (2019–2022) has introduced a range of initiatives focusing on improving skills and training. While none of these had an overarching focus on sustainability, some focused on skills development for sectors in the green economy that were expected to play a growing role in the national economy.

In **Morocco**, the National Energy Strategy (NES) is one of the most ambitious and comprehensive renewable energy strategies in the Middle East and North Africa (MENA) region. Based on the Paris Agreement, Morocco aims to reduce its greenhouse gas emissions by 42% by 2030 (Alhamwi, 2015). To meet this target, Morocco plans to reduce energy consumption by 15% by 2030 and reach 52% of installed electricity capacity from renewable sources by 2030 (20% wind, 20% solar, and 12% hydro). The Training Institutes for Renewable Energy and Energy Efficiency (IFMEREE) are directly rooted in the strategy. As part of the implementation plan for the NES, the decision was made to set up three training institutes in the cities of Oujda, Tangier, and Ouarzazate as a public-private partnership. The IFMEREE is a pioneering VET provider in terms of skills for the green transition. For initial

education and training, the IFMEREE offers four different VET programmes in photovoltaic systems, wind systems, photovoltaic systems installation, and energy efficiency. Each programme lasts for 2 years, including on-the-job training for a total of 4 months.

Addressing skills needs of the green transition at the regional/local level, the CoVE is part of an extended 'skills-eco system', where skills provision is based on a collaborative partnership with the industry, trade associations, governmental institutions, and research institutions. Some theories argue that once skills are available, then the economy will grow. The cases of the CoVEs show that, on the contrary, under the extended ecosystem concept, it is the economic growth and industry developments that drive the demand for skills, and the VET institution can be an active partner in supporting this development process. Government action plans for expected industry developments at the sectoral or regional/local level are used as a guiding reference by VET in partnership with the eco-system.

In the case of **Singapore**, the **Temasek Polytechnic's** delivery of skills that meet the needs of the labour market and businesses is based on close collaboration between government institutions, employers, industry associations and trade unions, forming an 'eco-skills system'. In 2016, Industry Transformation Roadmaps (ITMs) were developed for 23 industries to address issues in each industry and deepen partnerships between government, companies, industries, trade associations, and chambers. Each ITM comprises a plan for growth and competitiveness, supported

by four pillars — productivity, jobs and skills, innovation, and trade and internationalisation. The collaboration takes place through an elaborate network of committees and is guided by an ITM for each industry. Through its various economic and workforce agencies, the government actively involves the private sector in transforming and restructuring the industry and training institutions are a key component of this effort.

Similarly, in the US case, the strategic direction of the **Green Tech Academy** at **Olathe West High School, Kansas**, is guided by the state plan for VET, which refers to 16 career clusters and 37 career pathways approved by the State of Kansas and the regional climate action plan for Kansas City and the region. The clusters identified in the state plan make VET institutions part of an ‘eco-skills system’, as the plan refers to comprehensive local needs assessments to align VET programmes with local skills needs in the different state counties or education districts. It emphasises that the content of secondary and post-secondary programmes, and the evaluation of their effectiveness, should be based on these assessments. The regional climate action plan sets out a non-binding framework for local action towards ‘a prosperous green economy and a healthy natural environment’. It is structured around a series of targets in eight areas, including transport, energy generation, and finance and innovation. In the latter area, the Plan defines the goal to be achieved as follows: ‘*Leverage green economy through job training and the innovation ecosystem to accelerate climate action*’. Some of the partners listed as enablers for the achievement of this goal are workforce development programmes, trade organisations and

VET providers. The Climate Action Plan also specifically highlights the renewable energy sector in this context as ‘*one of the largest employers in a previously oil-and-gas driven economy*’.

The management of the CoVEs ‘*translates*’ the national/regional strategies into green goals and action plans for their achievement. Across the cases, the management tends to adopt a flexible, procedural approach, with industry relevance being the key criterion guiding the provision of skills. However, the CoVEs differ in the extent to which they establish an overall systematic strategy with precise objectives and targets.

Some CoVEs prefer a ‘simple’, flexible approach where industry relevance is the key criterion for skills provision, allowing for disruptive innovation. These CoVEs avoid developing elaborate long-term strategies with many detailed objectives. The rationale for this approach is that green technologies, practices and the skills needs of businesses are continuously evolving. Setting exact precise targets for the future direction of the green transition poses a risk of the targets becoming obsolete.

The **Green Academy Denmark** provides an example of this approach. As described by the management, the institution’s approach to handling the green transition at the Green Academy Denmark ‘is not set in stone’. The school’s management believes that the green transition requires innovative solutions that can be difficult to capture in a written strategy. The green transition is diffuse, and the best solutions have not necessarily been found yet, according to the Green Academy Denmark. This approach means that some initiatives have failed over the

years — a logical consequence of trying out new things with this approach. However, when they fail, they do so quickly and the institution can move on without investing a lot of resources. In general, the Green Academy Denmark’s experience with this approach has been successful. Therefore, the management shows a great deal of trust in teachers when they want to pursue or test new approaches or participate in new projects.

Similarly, the **Green Tech Academy** in the USA has adopted a flexible approach that is not guided by an overall strategy and has a simple organisational structure at the institutional level. The Olathe Public Schools Strategic Plan for the period 2021–2026 does not set specific greening targets. It defines the ideal Olathe Public Schools graduate in terms of what cognitive, personal, and interpersonal skills they will have acquired as part of their schooling. However, the management of Olathe West High School has developed more specific greening goals (in the form of SMART Goals) for Green Tech Academy students to achieve over the next few years. As to organisational structure, there is no unit or position within the school management that is dedicated solely to the development and implementation of greening initiatives at the Olathe West High School. As a result, such initiatives must be coordinated by the management team. While there is no ‘greening officer’ or ‘sustainability manager’ within the leadership team at the Olathe West High School, greening initiatives are driven primarily by the Assistant Principal in charge of the Green Tech Academy programme.

In contrast, other CoVEs establish, adopt, and elaborate strategies with

comprehensive lists of objectives and action plans for their objectives, along with evaluation systems to follow up on the progress in their implementation. In addition, organisational units are established with the responsibility of managing sustainability implementation.

The case of **Robina Campus** in Australia provides an example of this approach. As a framework for this process, the management of TAFE Queensland on the Gold Coast has chosen eight priority goals to focus on from the United Nations Sustainability Goals (SDGs). As described in the case study, clear strategies and approaches have been put in place at the Robina Campus for integrating sustainability into all available training programmes and promoting sustainability on campus.

In the plan, the TAFE Queensland outlines its sustainability goals and describes the strategies and actions to be implemented in order to reach these goals. The United Nations Sustainable Development Goals (SDGs) are a central element of the action plan, which emphasises that VET has a key role to play in achieving them. Throughout the four-year plan, the TAFE Queensland remains committed to supporting sustainability by focusing on eight areas aligned with ten of the seventeen UN SDGs. The unit responsible for the implementation of sustainability is the SES Committee which works towards the implementation of TAFE Queensland’s Social and Environmental Sustainability Action Plan. The Action Plan is followed up with updates on ongoing projects that support the plan and the SES Committee engages staff, students, and the community by promoting awareness of the Sustainable Development Goals.

The CoVEs responding to the green transition through curriculum changes do so with a high degree of external stakeholder involvement, with consultation built into the organisation of the VET system at both national and local level. As a result, VET institutions have a responsive organisation that adapts easily to labour market needs and policy priorities.

In **Denmark**, for example, the national VET system is characterised by a high level of stakeholder involvement. This includes social partners, vocational schools, teachers, and students who are involved in the development of VET. These stakeholders play an important role in advising the Ministry of Children and Education on policy, programme structure, etc. Different stakeholders at local level are also involved in the curriculum development that fits local labour market needs. Danish VET providers work closely with businesses and organisations to support the green transition. In the area of green technologies, many vocational schools have established partnerships with companies and organisations working on renewable energy projects that provide students with valuable hands-on experience, helping to ensure that the workforce has the skills needed to support the transition to a green economy.

In **Australia**, the private sector and industry also play a key role in the development of the VET system, collaborating with the government and VET institutions to ensure that collaboration drives economy-wide improvements of productivity and competitiveness. To support of this objective, industry representative bodies, such as the Australian Industry and Skills Committee (AISC), provide

advice on how to ensure that the VET system is responsive to national skill needs. In addition, a range of Service Skills Organisations have also been established. These independent, professional service organisations collaborate with Australia's eleven government-funded Industry Skills Councils to review and develop training packages to address skills demand in specific sectors.

In **Singapore**, the **Temasek Polytechnic** has a responsive organisation with corporate-level management overseen by the Board of Governors, which represents government agencies/ministries, industry/sectoral organisations, experts/researchers, government bodies and other stakeholders. In addition, numerous committees are established at the corporate and school level (School Advisory Committees). These represent relevant government institutions and industry associations and companies related to the field. The large number of committees reflect the fact that TP's management continuously works in close cooperation with industry partners and other external stakeholders in order to ensure the industry-relevance of TP's skills provision. Overall, management describes the green transition as a collective effort multi-stakeholder effort involving industry, government management and staff.

The green transition is not just a subject to be learned, but a way of life. The management of CoVEs is moving forward by 'greening' the campus, buildings, daily life and educational facilities, transforming them into a green learning space. This contributes to a 'culture of sustainability'. All the CoVEs have adopted systematic

action plans for the greening of their campuses, with regular assessments to monitor progress. Accreditations are used to document the green transition and its progress. The greening of the campus is seen by the management, staff and students as important in reinforcing environmental awareness and sustainability values. It creates a culture of sustainability. The greening of campus and daily functions make sustainable practices more concrete and present for everyone. This provides informal learning about environmental issues as the campus and buildings become a 'living laboratory' of sustainability. The culture of sustainability implies that teachers and trainers are expected to act as role models who reflect on their own behaviour, continuously supporting students in developing a sustainability mindset. This creates a 'trickle-down effect', where students in workplaces inspire others to reflect on and adopt more sustainable practices.

The **Green Academy Denmark** is in the process of greening its buildings and facilities. For instance, it is working to convert most of its machinery from fossil fuels to electricity-powered alternatives. This not only contributes to the greening of the school, but also provides students with the opportunity to experience the latest technology in the field, which both motivates them and supports them in acquiring green skills. Another example is the school's new boarding home. It has solar panels on its roof, which is also partially covered with vegetation (stonecrops and mosses) and has state-of-the-art local rainwater harvesting throughout the area. Next in line is a new sports centre which will also be built with sustainable materials and will have a green roof.

In the **US**, the **Green Tech Academy** has also 'greened' the campus by designing the school building to be as energy efficient as possible. With large rectangular windows on all sides of the building, it also has a large skylight window above its atrium, which also houses the library. To reduce energy consumption, the interior of the building receives a lot of natural light. In addition, sensors and a building monitoring system ensure that lighting is automatically dimmed or switched off, depending on whether relevant areas are in use or not. Outside on the south side of the building, there are two solar panel arrays, each consisting of 52 solar panels. The solar panel system has an output of up to 1 350 kWh (at peak performance) and is used to power parts of the main building, including the wing that houses the Green Tech Academy programmes, resulting in a net-zero carbon footprint. During the summer break, excess energy from the solar panels is fed back into the public grid.

Similarly, at the **Robina campus** in **Australia**, the culture is clearly shaped by the fact that the campus is intended to be a flagship for TAFE Queensland's commitment to sustainability; it is also shaped by strong leadership. Designed with sustainability in mind, the Robina Campus building incorporates a number of specific features to support of energy efficiency and carbon footprint reduction. There are 250 solar panels on the roof of the building, which, depending on weather conditions and electricity usage in the building, can generate around a third of the energy needed to power the building. In addition to the solar panels, the campus also has a rain-fed irrigation system. The building also has sensor-controlled lighting – mainly using energy-saving LEDs – and features solar glass,

which is specially coated to reduce the amount of heat entering the building.

In the case of **Singapore**, the **Temasek Polytechnic** has launched several initiatives to develop a green campus: (1) rainwater harvesting in 2012, which made the TP the first educational institution to implement a rainwater collection system used to irrigate its entire campus; (2) solar energy harvesting by installing solar panels on the roof to facilitate further research on photovoltaic technology and supplement electricity supply; and (3) green roofs and walls. TP's building has green plantations on the roof and walls. The green roof and walls embody the spirit of TP's continuous effort to be eco-friendly and sustainable. They also serve as reminders to the student population of the need to be sensitive to their environment to encourage its protection and preservation.

SUSTAINABILITY IN CONTENT AND PROGRAMMES

The CoVEs integrate sustainability and green content into most of their educational programmes, and this integration includes both 'non-green programmes' and 'inherently' green programmes. 'Non-green educational programmes' do not have explicit green objectives or concern green technologies. Integrating green content into such programmes means that vocational practices and problem solving must take environmental considerations into account to optimise the use of resources and environmental impact. In contrast, 'inherently green programmes' which, by title and content alike,

explicitly address green objectives and technologies, usually prepare students for work in a green occupations or jobs.

The five case studies provide a fine spectrum of centres: the Green Academies in Denmark and Kansas, and IFMERE in Morocco offer explicitly green programmes, while the Robina Campus in Australia does not offer any truly green programmes. Instead, the focuses on embedding sustainability in non-green programmes. The Temasek Polytechnic offers both non-green and green programmes. In some VET systems, for example in Denmark, national legislation requires the integration of green content into educational programmes.

In line with the Sustainability Plan, the management of the **Robina Campus** is working towards integrating sustainability into the overall curriculum and student life on campus. In terms of formal education, efforts have been made to link every single course unit in all educational programmes to the sustainability focus areas outlined in the plan. At the same time, campus design and sustainable initiatives promote knowledge and values that support climate responsibility and socially just practices. The 'embedding' of sustainability within training programmes is achieved by linking knowledge and skills to environmental sustainability to show VET students how practices in relevant industry sectors can be made 'greener' by using resources more efficiently and implementing waste management systems. For example, hairdressing and beauty therapy students are being taught about the chemical content of beauty products so that they can identify which products are more biodegradable than others. These students also learn how to use resources

efficiently, for example by optimising the number of beauty products used in a treatment and limiting the use of water, detergents and electricity when sanitising equipment.

In the **US**, the **Green Academy** provides genuine green programmes. In learning about the economic, environmental, and social impacts of energy production and consumption, students learn to understand the positive and negative aspects and impacts of both renewable and non-renewable energy. They will also be taught how the technologies for producing energy from biomass, solar, wind, water and waste work and how they have been developed. In the context of energy use in transport, students learn to analyse the similarities and differences between different types of engines, including compression ignition, electric, gas and rocket engines.

The IFMERE in Morocco offers green programmes that are related to sustainable energy and energy efficiency. Here are some examples:

The Solar Energy Programme. Solar energy technicians specialise in solar energy systems with a versatile profile that implements photovoltaic and low-temperature thermal solar systems (solar heating). The technicians assess the feasibility of such installations on the customer's premises and the equipment to be provided.

The Wind Energy Programme. Wind turbine technicians specialise in the operation and maintenance of wind turbines (from a 100 KW turbine to a multi-MW array). The technicians are required to intervene at all stages of the construction of a wind farm. They can be

employed as technicians by the company that builds and installs the wind system or as technicians for the paying client.

The Energy Efficiency Programme. The technicians who specialise in energy efficiency are specialists in active and passive energy efficiency techniques. They have the competences to make design drawings, perform calculations and help draw up specifications.

The **Green Academy in Denmark** is working on integrating sustainability and green aspects, such as biodiversity and carbon footprint reduction, into all its existing programmes. In addition, the integration of green content into educational programmes is required by national legislation. The learning objectives of each subject are affected by the green transition in the sense that the greening perspective is an extra layer that must now be integrated into all school programmes. For example, when students are doing construction work, they need to learn to be aware of what kind of raw materials they are using, whether a permeable coating should be part of it to repel rainwater, etc.

An example of the integration of sustainability into the Landscape Gardening programme comes from the Green Academy's participation in the European Platform for Urban Greening (the EPLUG partnership). The EPLUG partnership aims to intensify the collaboration within the knowledge triangle (VET – Research & Development – Business) Here, it was necessary to start thinking in terms of biodiversity and sustainability in the construction of parks and gardens in the city, as opposed to the classic tradition of focusing primarily on creating something purely exotic or aesthetic.

Green technologies and solutions to sustainability problems are constantly evolving. Sustainability issues are open-ended problems with no definitive solutions. Tomorrow's solutions to sustainability problems are not known today. Consequently, the development of green skills is not based on fixed curricula and textbooks. Instead, green skills development places a high priority on problem-based learning. This means assignments and projects are presented as open-ended problems, and students develop independent and critical thinking skills by reflecting on the advantages and disadvantages of given technologies and solutions.

The involvement of industry/business representatives in student projects/ assignments can help students to develop critical, independent and creative thinking skills. It is seen as beneficial for students to learn to go beyond the curriculum and develop independent thinking by trying out their own ideas. Green knowledge may not be pre-determined, but rather developed by the students on their own.

In the **US**, the **Green Tech Academy** believes that it is important for students to develop independent, critical thinking when solving problems. They stress the importance of meaningful, critical conversations between teachers and students – as well as among students – to help the students evaluate the possible outcomes and implications of proposed solutions proposed to a given problem. The aim of the approach is to get students to identify and ask important questions, which includes a strong encouragement to GTA teachers to also question what they may be teaching.

In addition, teachers encourage students to pursue their personal interests in a relevant problem in a way that goes beyond the original framework for an assignment that is foreseen or given by the teachers. This is best illustrated by the example of a student specialising in sustainable agriculture. She was originally assigned the task to investigate whether hydroponic systems are more sustainable than traditional forms of farming and to summarise the advantages and disadvantages of using hydroponic systems to grow food. Hydroponics is the technique of growing plants using a water-based nutrient solution rather than soil. While working on the task, the student learned that these systems can be expensive and wanted to find a way to produce them at a lower cost. With the help of her teacher, she used 3D design software and 3D printers to successfully produce first a small and then a larger prototype of a hydroponic system.

In **Singapore**, the **Temasek Polytechnic** (TP) emphasises that when students work on architectural and building management assignments, they must consider the environmental advantages and disadvantages of given solutions to optimise energy use. When students work on architectural building design, they use digital tools to design, document, visualise and deliver architectural, engineering and construction projects. As part of problem-solving, the students perform an integrated energy analysis, enabling them to simulate and improve the energy performance of buildings. The TP finds it important that students develop green skills based on hands-on, experimental and self-directed learning,

and this is very well reflected in the students' work on their own engineering projects. When developing their technical equipment for experiments, they collect what they need in large 'spare part libraries' where technical spare parts and tools are stored in alphabetical order. The students also have access to workshops where they can work independently and in collaboration with other students.

Similarly, at the **Green Academy** in **Denmark** the learning outcomes of the programmes state that students must be able to reflect on environmental issues. For example, the learning outcomes of the course 'Plant & Animal Science' emphasize the ability of students to differentiate between the nutritional needs of animals at different stages of growth and production systems, and the ability to investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture.

The integration of green content into educational programmes is done in close collaboration with industry partners to ensure industry relevance of the skills provision. Collaboration with industry partners at the institutional level is formalised in regular boards and committees that develop syllabi and curricula in detail. Research institutions may also be involved in updating content on green technologies and practices. Collaboration between educational institutions and industry partners has the following mutual benefits: the VET institution receives expert advice to ensure that the content is up to date, while the industry ensures the future provision of industry-relevant skills, including through continuing education and training for adult employees.

In the **US**, the **Green Tech Academy** has its own advisory group comprising 15 members who represent different companies, including the architectural firm Hoefler Welker, Kiewit Engineering Group, and Corteva Agriscience. The management and GTA teachers have formal meetings with the advisory board twice a year, with more frequent informal contact by telephone or email. Board members can be described as quite active. As well as advising on curriculum development, they also support the academy in more direct ways. In addition to sponsoring equipment or field trips, stakeholders also actively contribute to student education.

In **Singapore**, at the **Temasek Polytechnic**, the process of developing a new programme typically involves the top management department of TP for Specialist Diploma Programme Development and the management at the school level (e.g., School of Engineering), which will be involved as the provider of the diploma programme. The TP management and industry representatives then form a technical committee where they develop proposals for a syllabus of the basic content of the programme. The draft proposals are discussed with the Skills Agency and the Ministry of Education. The formulation of green skills/ competences for a programme, such as TP's Integrated Facility Management programme, takes place in a technical committee with representatives from the Singapore International Facility Management Association (SIFMA), SIFMA-certified companies and the TP. As an industry partner, SIFMA is in touch with a wide range of certified companies, ensuring that the

programme is based on a deep and up-to-date understanding of companies' use of technology and their needs. The school presents its draft curriculum based on the Skills Future Agency's framework, asking: 'Is this what industry wants?' Then, the programme content is negotiated with SIFMA and businesses in a process that typically involves 5 or 6 technical committee meetings. During the meetings, the curriculum is progressively refined and is then circulated for comments to trade associations and certified companies.

Similarly, at the **Robina Campus** in Australia, the management of TAFE Queensland meets regularly with industry sector panels to discuss the content of training programmes with industry partners. However, there has been little input from industry in terms of integrating sustainability into the curriculum for the training programmes offered at the Robina Campus. Instead, the 'greening of the curriculum' is driven primarily by the strategic sustainability goals of both TAFE Queensland and the Robina Campus management.

EXTERNAL STAKEHOLDERS

CoVEs organisations are part of VET systems with built-in responsiveness to development trends and industry needs at the national, regional and local levels. The involvement of external stakeholders from industry and business in curriculum development at the institutional level is formalised through committees and boards. Cooperation between education and the private sector is mutually beneficial. However, the collaboration between education and private businesses can be challenging due to different cultures. The pace of change in the world of

educational can be slower than the pace of change in private enterprises because educational institutions need time to implement curriculum changes and admission requirements. As a result, VET institutions find that they need to adapt to the workflows and pace of industry in order to establish fruitful cooperation. In continuing education and training, VET institutions must be flexible and able to deliver materials and courses quickly.

The **Green Academy Denmark** has a long and strong tradition of close cooperation with industry partners, and the cooperation among Danish partners has been structured within the framework of the European Platform for Urban Greening (EPLUG).

Teachers at the Green Academy Denmark have often met with professionals from companies involved in EPLUG, when developing new teaching resources. One of the companies, OKNygaard, has provided information about the needs of the industry. Working with industry partners in this way has also given the teachers at the Green Academy Denmark the opportunity to learn about the latest technologies used in the sector.

In the **US**, the **Green Tech Academy** is very responsive to the development and skills needs of the relevant industries when it comes to selecting educational content and defining the learning outcomes of the courses offered within the programme. The GTA programme has its own advisory group comprising 15 members who represent different companies, including Hoefer Welker Architects, Kiewit Engineering Group, and Corteva Agriscience.

In **Denmark**, the VET institutions have a degree of autonomy, but

they must always ensure that the content of the training programmes is in line with the training agreements and learning objectives set by the educational committee for each area of training. These committees consist of representatives of employers' and employees' associations. In order to ensure that the subjects taught at the Green Academy Denmark are relevant to the industry, the school is active in establishing an active network of external business partners who wish to support the green transition.

CoVEs enhance their development and spread excellence by seeking inspiration abroad. The search for new technologies and ideas requires an innovative, global mindset, where the VET institution looks beyond the local business community. Students are also encouraged to develop a global mindset and seek inspiration abroad through internships and project work.

The **Green Academy Denmark** is largely a place that seeks and disseminates inspiration from other countries. The school is always on the lookout for new knowledge and inspiration on how to handle different aspects of the green transition. The Green Academy Denmark has indeed found inspiration in other countries on how to teach green transition, and new innovative ideas and ways to address the green transition often come from participation in international projects. The Green Academy Denmark also encourages its students to explore new knowledge by studying abroad for a period. Similarly, students can bring back new ideas from around the world that can make a difference at the school.

In **Singapore**, the **Temasek Polytechnic's** excellence in solar

energy systems and other sustainable building technologies is widely shared at national and international level. On the national level, primary schools and other upper secondary schools are invited to visit and experience its solar energy supply system and other projects. Internationally, the TP 'exports' its know-how and undertakes many projects with developing countries. In partnership with industry, the TP has carried out numerous sustainable projects in developing countries.

PEDAGOGICAL APPROACH

The CoVEs have a strong focus on developing skills based on practical, hands-on experience and where students are encouraged to develop their own insights based on experimentation and creative thinking. Some of the CoVEs motivate students by having them develop projects and initiatives to be used by real clients. Sustainability and green content are not only taught as theoretical subjects but must be practically related to the given vocational field of learning. For example, how can a hairdresser make her business greener and more sustainable? How can the facility manager inspect a building's services in a sustainable way?

The pedagogical approach at the **IFMERE, Morocco**, can be described as a learner-centred, facilitated approach to learning with a focus on practical skills. Each module begins with the teacher explaining the learning objectives for the specific module to ensure that the students understand the purpose and the expected learning outcomes of the module. Learning sessions are often designed as a combination of theoretical introduction and practical exercises. However, there

is a high degree of pedagogical freedom and teaching can also be designed as a project-based course or include visits to companies or similar.

The pedagogical approach at the **Robina Campus** is strongly characterised by the provision practical training to students. Thanks to the training facilities available at the campus, VET students are being taught in professional settings. Early Childhood Education students and Care students, for example, are prepared for their future work in nurseries in a room equipped with toys and furniture designed for children. In other courses, students are given the opportunity to gain relevant work experience on campus. Sport and Recreation students, for example, can work in the campus gym, which is open to the public. Here, they practise developing personalised training plans for clients and instruct them in the proper use of the fitness equipment. Hospitality Management students develop their skills by serving food and soft drinks in the campus café, bar and restaurant on campus, some of which are student-run. Similarly, Beauty and Hairdressing students learn in a beauty salon setting, where part of their training involves the provision of beauty services and haircuts to private customers.

The **Danish VET system** has a strong focus on providing students with the practical skills they need to succeed in the workplace. The emphasis on practical training is seen as one of the reasons why the Danish economy has a high employment rate and a low youth unemployment rate. VET also plays a key role in meeting the skills needs of Danish businesses, helping to ensure that the country has a highly skilled and adaptable workforce. For example, the municipality

of Aarhus has made part of the waterfront in Aarhus available to the Green Academy Denmark for student projects. It is a great motivation for students to have the opportunity to exhibit their work in public. This gives them the opportunity to showcase their work to friends, family and the general public. For example, the site was used to build and learn about insect hotels in 2021.

Digital learning spaces and collaborative, multidisciplinary learning are important pedagogical elements of students' work with green projects and assignments. Collaborative and multidisciplinary learning is an important approach to green skills as it encourages students to see different perspectives on environmental problems.

The digitally enabled learning spaces are inclusive and allow for blended learning and interaction between students in group work, with the teacher playing a consultative role. Videoconferencing in learning spaces enables visual demonstrations of work processes and the participation of remote students. In addition, students are aware that digital learning spaces mean 'paperless' learning, which is good for the environment.

At the **Robina campus**, audio-visual technology is used to create learning environments that are more inclusive and offer different ways for students to participate in education and training. The so-called Technology Enabled Active Learning (TEAL) rooms not only help to minimise the use of paper on campus but more importantly allow for different forms of interaction and blended learning between students. For example, the campus has several collaborative spaces where students who are physically present can engage in group work with

other students who are participating remotely. A number of training spaces, including the training kitchen and hair and beauty salons, have rotating cameras set up to capture the different work areas. Cameras are used to film close-ups of instructors demonstrating how to do a particular task. In cookery, this may be filleting a fish or decorating a cake with icing. In the hairdressing salon, students might be shown how to use a curling iron or how to use a specific haircutting technique. The cameras in the training spaces may capture these demonstrations from different angles for two purposes. On the one hand, the filmed content is displayed simultaneously on several screens in the training space, allowing all students to follow relevant demonstrations, including those who may not be able to see directly what the instructor is showing because their view is blocked by other students or equipment.

In **Singapore**, at the **Temasek Polytechnic**, multidisciplinary learning is increasingly being used in relation to the development of green skills as it helps students understand different perspectives of various problems to be solved. For example, the students are given an assignment on 'urban farming'. Students from the School of Applied Science will grow plants under specific conditions, while students from the School of Engineering will work on developing the part of the building where the plant will grow. The students work together on how to use sensor technology and other digital tools to monitor and optimise the urban farming process. The digital tools in the institution's Learning Management System (LMS) support collaborative group learning. When students work collaboratively via the LMS, they use

a channel, which is only accessible to the students in the group. The channel allows students to exchange messages and files with each other. The collaborative work of the LMS is supported by a built-in videoconferencing tool that enables real-time online engagement, real-time chat, and audio and videoconferencing.

Sustainability also takes place through informal learning, where students participate in sustainable practices in their daily learning environment. Informal learning is unstructured and takes place away from traditional, formal learning settings such as a classroom. It does not have clear goals or objectives, as it is often unplanned and self-directed by the learner. In addition, teachers are important role models of the culture of sustainability and can contribute to highlighting green values through 'storytelling'.

On the **Robina Campus** in **Australia**, a lot of informal learning about sustainability takes place. In general, it can be said that many individual initiatives across the campus have contributed to the strategic objectives of the Robin campus Sustainability Plan to 'build a culture of sustainability'. The café, bar, and restaurant offer locally or regionally produced food and drinks, while public displays inform students and staff about the energy and resource efficiency of the campus. Some of the walls on the campus building have been decorated with messages about the importance of environmental sustainability and the UN SDGs, while some of the carpets and meeting room tables in the building are made from recycled materials. These examples demonstrate a holistic approach to the integration of sustainability at

the Robina campus and are expected to inform students' awareness and learning.

In addition, teachers contribute 'sustainability stories' from their industry experience, which serves an important purpose. Teachers regularly share their industry experience with students in the form of a story to make practical examples more tangible and concrete. After they return from placements, students often share with their teachers that they have been able to see the examples shared in the classroom. This way, students can create links to what they have been learning.

In **Singapore**, at the **Temasek Polytechnic**, a key pedagogical element of the of the Integrative Built Environment Centre (IBEC). IBEC is assembling various systems and machinery commonly found in the buildings to give students hands-on experience of sustainable building operations. These include a chiller plant, lift and escalator installations, security processes using artificial intelligence and an electric vehicle laboratory. For example, the IBEC has opened one of its escalators for educational purposes, offering a course to qualify as a Building and Construction Authority (BCA) accredited lift and escalator inspector. Similarly, the institution's rooftop solar panels are monitored from a large control room that doubles as a laboratory where students can use digital sensor data for projects. In this way, students experience the assessment of the environmental performance criteria of

many facilities and functions on campus in their learning environment.

Teacher training and upskilling to support the green transition is important. The CoVEs have systematic processes in place to ensure that teachers develop insight into sustainability and how to integrate green content into the curriculum. Peer observation and feedback processes are also used to support the development of each teacher's skills. CoVEs involve industry and businesses in upskilling teachers to ensure that their skills are up to date.

In the **US**, at the **Green Tech Academy**, teachers describe how their professional development is supported by regular contact with industry stakeholders. They find it helpful to gain knowledge and expertise stemming from specific professional experiences, while having the freedom to integrate this into their teaching as they see fit. For example, meeting industry stakeholders at conferences allows them to approach them and get answers to specific questions they may have in relation to the subject they are teaching.

In **Australia**, the **Robina campus** has a systematic approach to developing the sustainability skills of all employees. All 13 members of the Senior Leadership Team have completed the Essentials for Business course from Cambridge University (UK). The course is designed to help participants develop a common understanding of sustainability and how it can be promoted within organisations.

The course, which takes around 8 hours to complete, is focused on broader sustainability objectives around social, environmental and economic factors. In addition, management at the TAFE Queensland in the Gold Coast region has developed a 4-hour sustainability orientation programme that further explores the seventeen UN SDGs. All staff at the Robina campus are required to complete this online course before starting work at the campus. In addition, professional development is facilitated through a peer observation and feedback process implemented by Education Team Leaders.

In **Denmark**, the **Green Academy** believes that input from industry partners such as OKNygaard is an important factor in upskilling teachers. According to the teachers at the Green Academy Denmark, a teacher is employed in vocational education and training, his/her knowledge can quickly become outdated, as didactics and pedagogy take up a lot of time in preparing classes and materials, and subject knowledge can therefore deteriorate. However, it is very important to have up-to-date knowledge, especially when it comes to facilitating the green transition. Close collaboration and input on current industry trends is a great way to keep teachers' knowledge up-to-date.

In the **US**, the **Green Tech Academy** stresses the importance of continuing to work with industry partners to keep up with developments and needs. They believe that GTA teachers need to be lifelong learners and attend industry events, as developments in industry outpace the development of relevant

teacher training textbooks. In general, the management of the high school and the academy programme are willing to find funding for industry-based training for GTA teachers if the teachers believe that this will improve the quality of the skills taught through the programme. At the same time, the principal of the Olathe West High School highlights the existing collaboration with Kansas State University and its College of Agriculture to provide opportunities for teacher training in sustainable agriculture.

In **Singapore**, at the **Temasek Polytechnic**, sees private sector involvement as in developing teachers' green teaching skills. To help them keep up with ever-changing industry practices, the school's teachers can upgrade their skills through industry and workplace placements or postgraduate courses. Management estimates that, on average, 10% of teaching staff are involved in industry placements for continuous professional development (CPD). The school encourages 10% of the staff to undertake industry attachment and 90% of staff to attend webinars, training events, conferences and exchange sessions, and publish papers, participate in projects, be guest speakers, and more to further their continuous professional development. The TP is very flexible about the length and form of industry placements, with arrangements ranging from part-time (8 hours per week) to year-long placements. The organisational unit responsible for the professional development of teachers at TP is the TP Staff Capability Development Department, which has a system and processes for CPD on the intranet.

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CASE I

GREEN ACADEMY DENMARK



1. INTRODUCTION

This introductory chapter contains several sections with background information relevant to the case study at hand. First, the Green Academy Denmark is briefly introduced. Other sections outline the Danish vocational education and training (VET) system and describe the national policies relevant to the greening of the system.

1.1 GREEN ACADEMY DENMARK

The Green Academy Denmark ('Jordbrugets Uddannelsescenter Aarhus' in Danish) is a VET institution focusing on providing education and training in agriculture and horticulture. The school offers a wide range of education and training programmes within the green sector, such as landscaping, gardening, floriculture, forestry, agriculture, the operation of agricultural machinery and animal care. The institution offers a range of

programmes and courses that provide students with the skills and knowledge they need to work in these fields, from basic training in agricultural techniques to advanced studies in specialised areas such as plant breeding and soil science.

The programmes and courses offered at the Green Academy Denmark are placed at national qualification levels 3 and 4, which correspond to EQF levels 3 and 4.⁷

The Green Academy Denmark is located near the city of Aarhus, in central Denmark. The school is divided into two campuses, the main campus housing the Horticulture and Landscaping programmes and the second campus housing the Agriculture programmes. The school also has a boarding house for national and international students.

⁷ Ministry of Higher Education and Science. *Types of Qualifications*.

FIGURE 1. THE MAIN CAMPUS AT THE GREEN ACADEMY DENMARK



'Jordbrugets Uddannelsescenter Aarhus' in Danish, image: Green Academy Denmark

In addition to its educational programmes, the Green Academy Denmark also conducts research in the field of landscaping. The institution's research focuses on the development of sustainable and environmentally friendly practices and technologies for agriculture and horticulture, with a particular emphasis on organic farming and the use of renewable energy.

Overall, the Green Academy Denmark is an important educational institution in terms of providing knowledge and skills in landscaping within the Danish VET system. Through its educational programmes, research, and partnerships with enterprises and organisations, the Green Academy Denmark contributes to the sustainable development of the Danish horticultural and agricultural sector.

1.2 THE DANISH VET SYSTEM – A BRIEF DESCRIPTION

In the period 2011–2021, the share of young people under the age of 25 who completed an initial vocational education and training programme in Denmark decreased by 15 percentage points (Statistics Denmark, 2022)⁸. At the same time, the share of young people who have completed general and upper secondary education programmes, which provide access to higher education, has increased steadily over the same period.

As a result, the role of VET in workforce development is high on the political agenda in Denmark, and the newly appointed Danish government has

⁸ from a share of 38% of young people under the age of 25 years in 2011 to 23% in 2021.

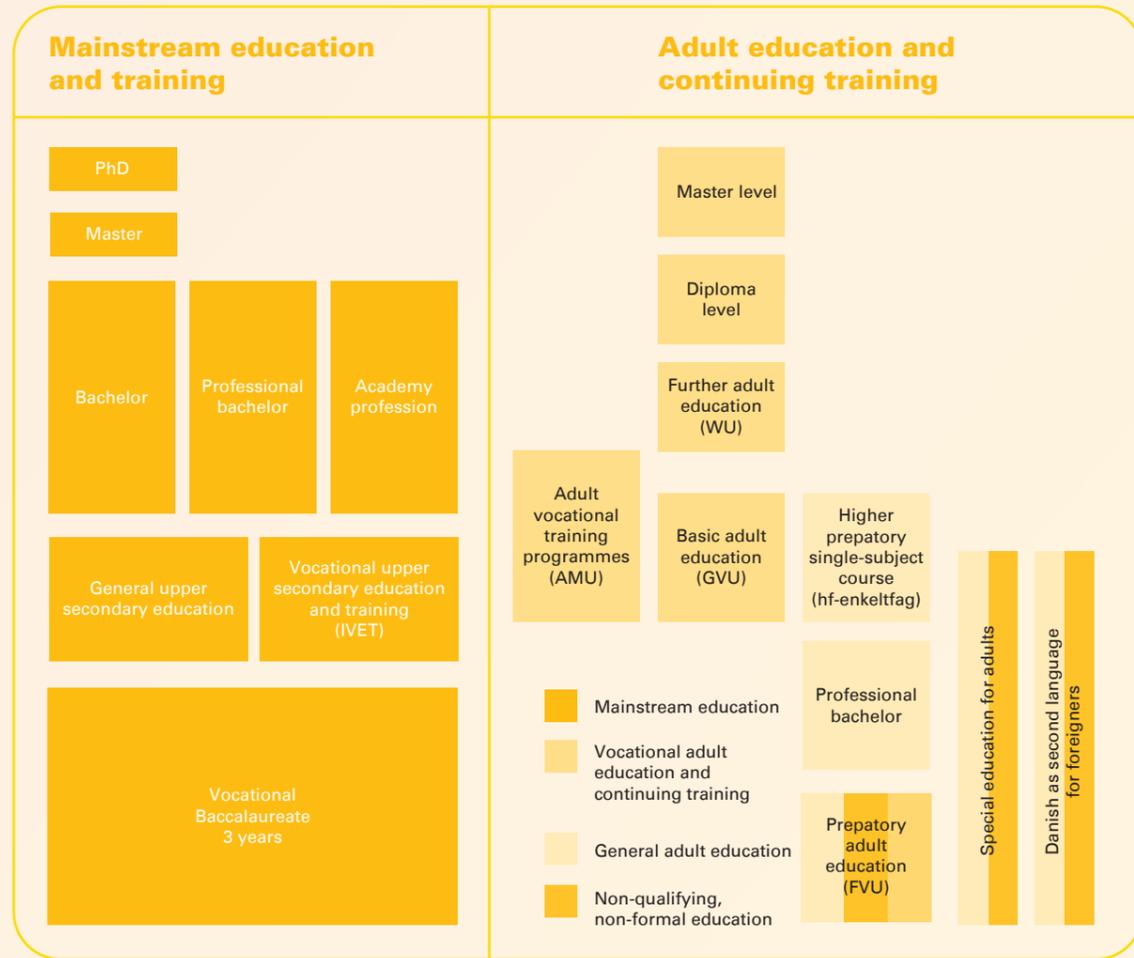
stated in its government platform that it intends to strengthen the national VET system and encourage more people to apply for VET programmes (The Danish Government, 2022).

This strategic goal is prioritised across the political spectrum, as there is broad agreement that the successful transition to a green economy will require a significant number of workers with a vocational education background. The Danish government has set ambitious targets for reducing greenhouse gas emissions and increasing the use of renewable energy, and the vocational education and training system is helping to prepare the next generation of workers to support this transition.

In addition to offering specialised programmes, many vocational schools in Denmark are taking a holistic approach to sustainability, integrating sustainability and renewable energy principles into their existing programmes and curricula. For example, some schools use renewable energy sources to power their facilities and teach students about sustainable practices in their workshops and laboratories.

As shown in Figure 2 above, the overall education and training system in Denmark comprises two parallel tracks: 1) the general education system and 2) the adult general and vocational education and continuing training system. Initial vocational education and training takes place at upper secondary level within general education. Students who have completed an eligible initial VET programme can continue on to higher education by taking a vocational bachelor's degree course (as long as they meet additional entry requirements, such as having completed upper secondary education or holding

FIGURE 2. STRUCTURE OF THE DANISH EDUCATION SYSTEM



Cedefop, 2012

a comparable qualification). In adult education and continuing training, VET takes place at all levels of education (Cedefop, 2012; Ministry of Higher Education and Science, 2022).

In Denmark, initial VET programmes generally consist of a basic or foundation course with a duration of approximately 1 school year, which is usually college-based, followed by the main programme. The duration of the main programme varies between 1 and 5 years. During

this part of the education, students are mainly in apprenticeships, but also have regular short periods of schooling.⁹

According to Cedefop, the Danish VET system has a number of distinctive features. First and foremost, public funding is central to Danish VET, with educational institutions receiving

⁹ UddannelsesGuiden, 2022. *Erhvervsuddannelsernes opbygning*.

performance-based block grants. The block grants are based, among other things, on the number of students enrolled at an institution and the number of students who graduate in a given year.¹⁰

In addition to funding, VET institutions are also subject to standards for vocational schools and programmes set by the Ministry of Children and Education. This means that the VET system is centralised in terms of providing nationally recognised qualifications. However, schools are to some extent pedagogically decentralised in terms of adapting VET to local needs and demands.

The Danish VET system is a dual education system that combines work-based training with theoretical instruction. The theoretical part is provided by the schools and the on-the-job training is provided by employers in the form of apprenticeships. Apprenticeships are based on a contract, or training agreement, between an apprentice and a company, with two-thirds of the programme generally taking place in the company.

The national VET system is also characterised by a high level of stakeholder involvement. This includes both social partners, vocational schools, teachers, and students who are involved

in the development of VET. These stakeholder groups play an important role in advising the Ministry of Children and Education on policy, programme structure, etc.¹¹ Various stakeholders are also involved at local level in the development of curricula that meet the needs of the local labour market.

The Danish VET system has a strong focus on providing students with the practical skills they need to succeed in the world of work. This emphasis on practical training is one of the reasons the Danish economy has a high employment rate and a low youth unemployment rate. VET also plays a key role in meeting the skills needs of Danish businesses, helping to ensure that the country has a highly skilled and adaptable workforce.

Finally, Danish VET providers also work closely with companies and organisations to support the green transition. Many vocational schools have partnerships with companies and organisations that are working on renewable energy projects, providing students with valuable practical experience, and helping to ensure that the workforce has the skills needed to support the transition to a green economy.

¹⁰ Cedefop, 2019. *Vocational Education and Training in Europe (Denmark)*.

¹¹ Cedefop. *Vocational Education and Training in Europe (Denmark)*.

2. MANAGEMENT AND ORGANISATION OF THE GREEN ACADEMY DENMARK

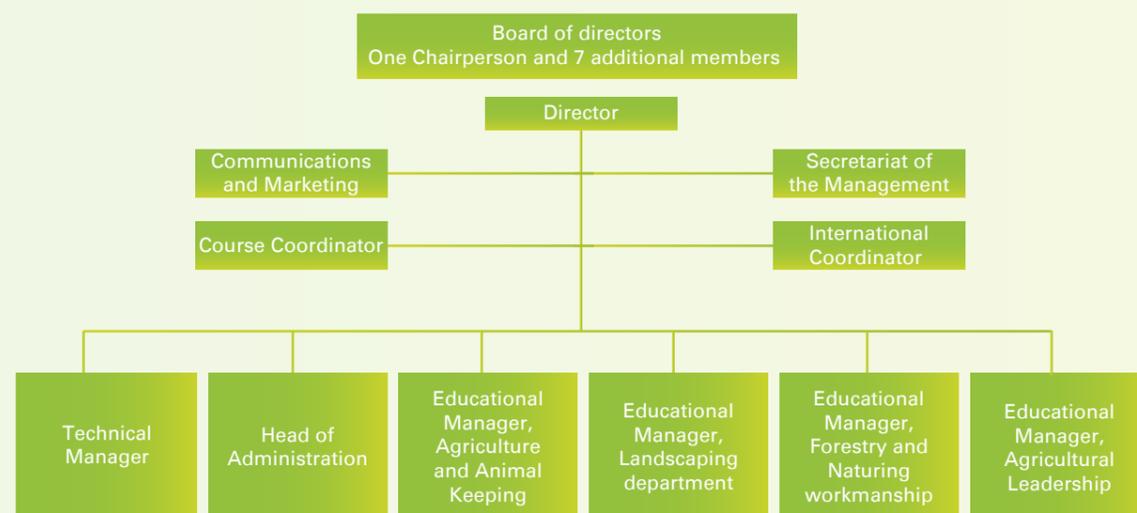
The Green Academy Denmark is funded by the Danish Ministry of Education and is recognised as a Centre of Vocational Excellence (CoVE) in landscaping. The institution is managed by a board consisting primarily of representatives of the relevant employer and employee associations.

The organisation of the institution is shown in the diagram below. The Director has overall responsibility for the day-to-day running of the institution, and under him – in addition to a number of staff functions, a technical manager responsible for building management and an administrative manager – there

are four educational managers with pedagogical responsibility for the various educational fields offered by the Green Academy Denmark.

From the Green Academy Denmark’s point of view, the green transition has become the main topic of the public debate in recent years. This has also had a strong impact on the Green Academy Denmark, as a provider of skilled workers who can actively participate in the transformation of society towards greater sustainability. In the last 3 years, the green transition has also become highly relevant to the gardening and landscaping sector.

FIGURE 3. ORGANISATIONAL CHART



A key driver that has increased the need for green skills in the field of landscaping and gardening is the fact that private companies, including small and medium-sized enterprises, are increasingly required to measure their carbon footprint.

In addition to other drivers of the demand for green skills, the Green Academy Denmark is also affected by changing climate conditions in the horticulture and agriculture sectors. For example, seasonal work, which used to be an important part of the sector, has almost disappeared. This is due to shorter winters in Denmark, which are generally considered to be the result of climate change.

The Green Academy Denmark has therefore had to integrate the green transition into the management and organisation of the school.

2.1 FRAMEWORK CONDITIONS AND STRATEGIC APPROACH OF THE GREEN ACADEMY DENMARK

The Green Academy Denmark does not have a written strategy or action plan for the green transition of the institution. However, goals related to the green transition are to some extent included in the overall strategy of the institution, and the school expects that the focus on the green transition of the institution will increase in the coming years.

The school’s strategic direction is influenced to some extent by national

and regional strategies. These strategies are increasingly focused on climate action and the green transition.

Among the strategies that have influenced and inspired the Green Academy Denmark is the Smart Specialisation Strategy of the Municipality of Aarhus (Aarhus Municipality, n.d.), which is rooted in the national Smart Specialisation Strategy (Danish Board of Business Development, 2019). The municipal strategy highlights, among other things, the region’s potential in climate and environmental technology and sustainable food, both of which are relevant to the Green Academy Denmark.

Most important for the strategic direction of the Green Academy Denmark, however, are the new regulations on climate action, such as regulations on rainwater infiltration and the greening of urban spaces. These are driving the competence needs of the students at the Academy.

The framework for the Green Academy Denmark is set by the Ministry of Children and Education. The school therefore follows the directions given by the Ministry, but in the case of the green transition, Denmark often uses its freedom to launch green initiatives that are even more ambitious than requested by the ministerial guidelines.

As regards the green transition, Green Academy Denmark has adopted an innovative leadership approach, a ‘fail-fast culture’, which it to be introduced in the next section.

FIGURE 5. GREEN WALL AT THE GREEN ACADEMY DENMARK



Image: DTI

2.2 AN INNOVATIVE LEADERSHIP APPROACH – CULTIVATING A FAIL-FAST CULTURE

The Green Academy Denmark's approach to the green transition is not set in stone. The management of the school believes that the green transition requires innovative solutions, which can be difficult to capture in a written strategy. According to the Green Academy Denmark, the green transition is diffuse and the best solutions have not necessarily been found yet.

Therefore, the management of the Green Academy Denmark puts a lot of effort in creating and nurturing a culture among teachers that encourages them to be

open and curious about new inputs and to actively participate in the development and testing of new initiatives and wild ideas.

This entrepreneurial approach is inspired by the Lean Start-up management concept. This is a management approach that focuses on creating an efficient process to bring relevant products to market faster and with more value for the end user. This approach favours experimentation instead of elaborate planning, and iterative design over traditional 'big design upfront' development.¹² This means that the approach involves a process of iterative experimentation, where ideas are quickly

¹² Harvard Business Review, 2013. [Why the Lean Start-Up Changes Everything](#).

tested and evaluated to reduce the risk of spending a lot of resources on something that does not ultimately work.

The approach also emphasises the use of feedback to improve the product quickly. This is also very important for the Green Academy Denmark. Therefore, initiatives and ideas must be based on the needs and feedback from the companies for which they educate and train the students. It is crucial that teachers do not limit themselves to teaching what they are used to or what suits their own interests. Instead, they must focus on the needs of industry and society.

Teachers in the Danish VET system have a degree of autonomy in developing curricula and teaching materials, but they must always ensure that the content of the educational programmes is in line with the educational agreements and learning objectives set by the educational committee for each area of vocational education.¹³ These committees consist of representatives of employer and employee organisations.

This approach means that if initiatives fail, they fail quickly, and the school can move on without investing a lot of resources. And most often, the Green Academy Denmark finds that this approach is successful. As a result, the management shows a great deal of trust in teachers when they want to pursue or try out new approaches or participate in new projects.

In general, this approach has been welcomed by the teachers who find it very motivating that they are encouraged to pursue their ideas and interests.

¹³ Retsinformation, 2022. [Law of Vocational Education and Training](#).

However, the Green Academy Denmark notes that not all teachers necessarily find this approach rewarding. It is therefore necessary to have realistic expectations of staff.

The Green Academy Denmark believes that one of the most important factors in its success with greening education programmes is the courage to look for and try out new solutions even without a fully elaborated plan or strategy.

2.3 FINDING INSPIRATION AND DISSEMINATING EXCELLENCE

The Green Academy Denmark looks for inspiration from other countries. The school is always on the lookout for new knowledge and inspiration on how to deal with different aspects of the green transition.

The Green Academy Denmark has found that it is particularly important to be curious and to look for new inspiration abroad when it comes to the green transition, as it requires new, innovative solutions.

An example of how the Green Academy Denmark has found new inspiration on teaching the Green Transition comes from the Netherlands. Based on the participation of a teacher from the Green Academy Denmark in a project, the school has started work on 3D visualisation of the school's approximately 250 different plants. The 3D visualisation of the plants will make it possible to teach using virtual reality glasses. This will enable students to learn about plants and the different stages in their development during the seasons.

The plan is to create a virtual library of all plants that the students on the Landscape Gardening programme will need to know at different stages of the year.

In addition, the Green Academy also prides itself on disseminating good practice and good ideas among other VET providers.

A prime example is a Hungarian school that has found great inspiration in the Green Academy Denmark over the last 7 years. The Hungarian school has sent teachers to Denmark to learn from the Green Academy Denmark and to develop a new structure for their training in landscaping gardening that is

strongly inspired by the organisation of horticultural education and training at the Green Academy Denmark.

In this case, and in general, the Green Academy Denmark has a very open and cooperative approach and shares as much teaching material and other learning aids with other VET providers as needed. As a school with a high level of expert knowledge, the Green Academy Denmark is committed to sharing this knowledge with schools that are less advanced in their development of education and training.

The Green Academy Denmark also strongly encourages its students to

explore new knowledge by studying abroad for a period of time. For the teachers at the school, new innovative ideas and ways of tackling the green transition often come from participating in international projects. Similarly, students can bring back new ideas from around the world that can make a difference at the school.

The picture below shows a selection of students currently studying abroad displayed to inspire others. The map has QR codes that link to short videos on YouTube about each student and the place they are visiting. Every year, the school sends around 100 students around the world for both short- and long-term mobilities (from 2 weeks to 12 months).

FIGURE 4. ONE OF THE SIX GREENHOUSES AT THE GREEN ACADEMY DENMARK



Image: DTI

FIGURE 6. WORLD MAP SHOWING THE LOCATION OF STUDENTS CURRENTLY STUDYING ABROAD, DISPLAYED TO ENCOURAGE OTHER STUDENTS TO PURSUE NEW KNOWLEDGE AND EXPERIENCES ABROAD, INCLUDING NEW SOLUTIONS FOR THE GREEN TRANSITION



Image: DTI

2.4 BENEFITS OF PARTICIPATING IN THE EUROPEAN PLATFORM FOR URBAN GREENING

The Green Academy Denmark is part of the European Platform for Urban Greening (EPLUG) project.¹⁴ Its purpose is to increase the knowledge and skills needed to address climate adaptation, biodiversity and well-being in the urban green environment and to broaden the expertise of professionals in landscaping and related fields in Europe. It therefore aims to intensify the collaboration within the knowledge triangle (vocational education and training, research & development, and business) in order to facilitate the development of high-quality curricula and qualifications focused on the skills needs and societal challenges in urban landscaping.

The project involves six Centres of Vocational Excellence (CoVEs) connected by a platform. The platform functions as a knowledge hub for urban greening, where the project partners can share their experience with new trends and aspects of urban greening, such as vertical gardening.

The Green Academy is part of the 'Team Denmark CoVE', which is represented on the platform and also includes Denmark's largest landscaping company, OKNygaard, and the City of Aarhus (see Figure 7 below). The CoVE can be described as a regional skills ecosystem focused on addressing climate change, biodiversity and human well-being in urban areas. It is the first of its kind in Denmark.

¹⁴ Link to the project's website: [European Platform for Urban Greening](https://www.eplug.eu/).

One of the key activities of the partners in the CoVE was the joint development of a 2-day course on biodiversity. The aim of the activity was to promote the exchange of perspectives and knowledge between the Green Academy Denmark and landscaping professionals in order to train them in the management and maintenance of green spaces in line with the protection and enhancement of biodiversity.

The Green Academy Denmark has a long and strong tradition of close cooperation with industry partners, and the format established between the Danish partners within the EPLUG project is new and has further strengthened existing ties. For the teachers at the school, for example, the partnership with OKNygaard has led to collaboration on very concrete activities. This meant developing curricula together rather than just networking with representatives from an industry partner.

Teachers from the Green Academy Denmark have often met with specialists from OKNygaard in connection with the development of new teaching and learning materials. OKNygaard provided very concrete information about the needs of the industry, and the Green Academy Denmark prepared resources and tested them on adult employees from the company in pilot projects. The learning materials were then adapted according to the feedback received.

This co-operation with OKNygaard also gave the Green Academy Denmark's teachers the opportunity to see and learn about the latest technologies used in the sector.

FIGURE 7. PROJECT OVERVIEW OF THE ESTABLISHMENT OF A DANISH CENTRE OF VOCATIONAL EXCELLENCE OF WHICH THE GREEN ACADEMY DENMARK IS PART

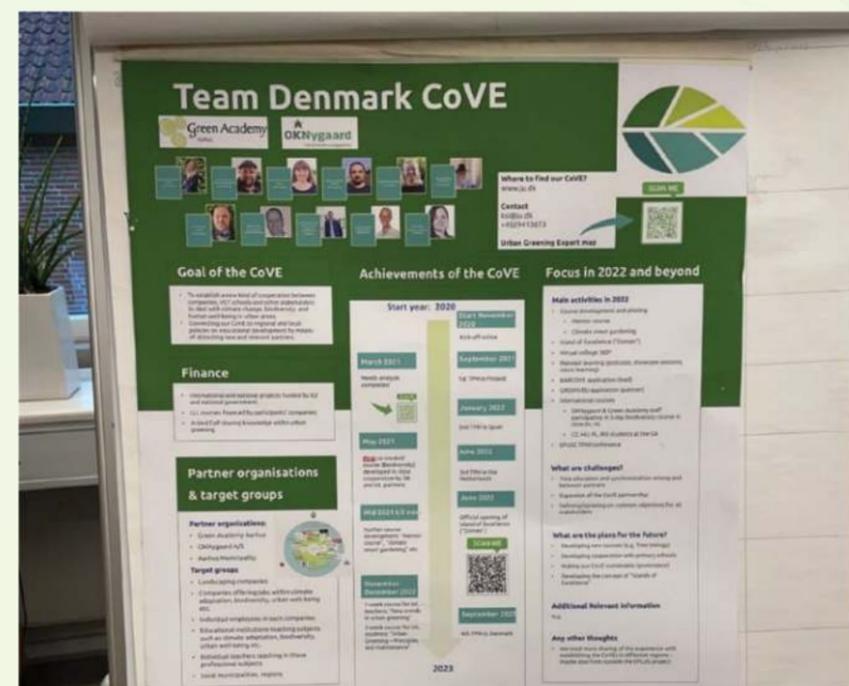


Image: DTI

It is important to note that the pace of the educational world can be quite different from that of a private company. In order to establish a fruitful collaboration, the Green Academy Denmark had to adapt to the workflows and pace of the industry. The teachers explain that it has put a positive pressure on themselves and the school's management to deliver materials and courses faster than usual.

In addition, the collaboration has taken some time to get used to, as it brought about a change in the role of teachers at the Green Academy Denmark. Working for a public educational institution, teachers are used to providing employees for the industry. In this project, however, the deliverables were produced in tandem. This meant that the teachers had to get used to

asking the companies to deliver as well. It was therefore important to clearly articulate the different ways in which the private sector and the educational world work and define the mutual benefits for both parties.

In addition to supporting the relevance of the co-developed courses, the collaboration with OKNygaard has been an important factor in upskilling teachers, as the industry partner brought in new knowledge from the industry.

The project has given the teachers at the Green Academy Denmark a network in the sector. In addition, the kind of relationships that have been built during the project are deeper than those that come from a regular network. The teachers explain that it is easier to ask for

'This form of collaboration helps us to get closer to the reality of the industry that we are supposed to supply with employees with the relevant and demanded skills. The collaboration gives us the opportunity to learn what skills are in demand in the industry. This is highly important in order for Green Academy Denmark to stay relevant.'

(Source: Interview)



Peder Glud
Educational Manager,
Landscaping Department

Image: Green Academy Denmark

input or support when you have had the experience of working closely together.

As a next step in the EPLUG partnership, the Green Academy Denmark and a number of both national and international partners have initiated a project that specifically focuses on applied research in vocational education and training as a lever for scientific, technical innovation within urban space and water management. The aim is to respond to the current challenges in vocational education and training, such as the constant demand for innovative technical solutions that support climate adaptation and the green transition. In this context, the initiative aims to help VET students, professionals and government to jointly develop innovative solutions to concrete and real challenges that companies face in the urban space and water management sector.

The research focused on four areas:

1. Permeable pavement. (Permeable pavement is a porous urban surface composed of open pore pavers, concrete, or asphalt with an underlying stone reservoir.)

2. Soil and plant properties in engineered sustainable drainage systems
3. Rainwater systems
4. Green roofs.

It is planned that the knowledge gained from the applied research will be organised in a handbook and will also be used for the development of two different training modules.

2.5 TEACHER INVOLVEMENT WHERE POSSIBLE

The Green Academy Denmark has found that involving the teachers as much as possible in the greening of curricula and programmes supports the dissemination and implementation of green initiatives throughout the organisation. Therefore, the school management strongly encourages teachers' participation in international projects and other activities that bring new knowledge and innovative ideas to the school on how to integrate sustainability into different aspects of the education (and the school in general).

In line with the Lean Start-up management approach, the management strongly encourages the teachers to pursue new ideas and their interest regarding the green transition and sustainability. However, no teacher is forced to participate in international projects (or similar initiatives).

When teachers are involved in international projects, they are given a lot of autonomy and responsibility. In practice, this means that the teachers get to shape the outcome of the project themselves, as the school management believes that this autonomy and responsibility encourages and motivates them to produce an output of high quality and relevance for the school.

It is important for the teachers at the Green Academy Denmark to have a sense of ownership of the initiatives that support the greening of the curriculum. Teacher support is essential for their success. For example, one teacher may have a particular interest in biodiversity and pursue this, while another may have a personal interest in technology and therefore work on, for example, incorporating virtual reality into the classroom.

2.6 GREENING THE SCHOOL'S FACILITIES

The Green Academy Denmark is in the process of greening its buildings and facilities. This is an ongoing process, but the institution has already come a long way.

For example, the Green Academy is working to convert as many of its machines as possible from fossil fuels to electric alternatives. This not only contributes to the greening of the school, but also gives students the opportunity to experience the latest technology in the field, which is both motivating for them and helps them to acquire green skills.

Another example is the school's new boarding house. It has solar panels on its roof, which is also partially covered with vegetation (stonecrops and mosses), as well as state-of-the-art local rainwater harvesting throughout the area. Next up is a new sports centre which will also be built with sustainable materials and will have a with green roof.



FIGURE 8. THE NEW BOARDING HOUSE OF THE GREEN ACADEMY BUILT IN 2022. THE FACILITY HAS SOLAR PANELS AND SEDUM PLANTS ON THE ROOF



Image: DTI

3. GREEN CONTENT AND PROGRAMMES

Green Academy Denmark is an institution with programmes primarily within agriculture and landscape

gardening. Selected programmes and some essential subjects are displayed in Table 1.

TABLE 1. LIST OF PROGRAMMES AT THE GREEN ACADEMY DENMARK AND SELECTED SUBJECTS

- **Landscape gardening**
 - Soil, water and nutrition
 - Basic principles of landscaping
 - Plant knowledge
 - Plant health
- **Farming**
 - Livestock farming
 - Plant cultivation
 - Basic principles of ecology
 - Spurt technique
- **Forestry and nature conservation**
 - Forestry
 - Machinery and technology
 - Nature management
- **Animal keeping**
 - Ethology
 - Animal husbandry
 - Animal anatomy
 - Animal Welfare
- **Agricultural economics**
 - Strategy
 - Economics
 - Personal development
 - International relations



As many of the programmes offered by the school involve nature and animals in some way, it was natural for the school to think in terms of sustainability and content greening. However, although it was natural, it was not always easy.

3.1 SUSTAINABILITY INTEGRATION INTO EXISTING PROGRAMMES

In Denmark, the learning objectives for vocational education and training are set by the Ministry of Children and Education and, in recent years, these have been updated to incorporate objectives related to sustainability and the green transition. For the Green Academy Denmark and other Danish VET providers, the task is to translate the general and generic objectives into tangible, understandable and practical skills for the students to master.

The learning objectives of each subject are affected by the green transition in the sense that the greening perspective is an additional layer that must now be integrated into all programmes of the school. For example, when students are doing construction work, they need to learn to be aware of the kind of raw materials they are using and whether a

permeable coating should be part of it to lead away the rainwater, etc.

The Green Academy has developed a number of short courses for adult students (from companies established in Denmark or abroad) that revolve around biodiversity and sustainability. In recent years, this has really taken off as the demand for this type of course has increased in line with industry's growing interest in the green transition and the economic incentives to work sustainably.

What is even more interesting, however, is that the Green Academy Denmark is working on integrating sustainability and green aspects into more or less all of its existing programmes. Despite the obvious differences between the programmes, the VET provider understands that sustainability, biodiversity and carbon footprint reduction are important issues that need to be integrated into all programmes.

An example of the integration of sustainability into the Landscape Gardening programme comes from the Green Academy's participation in the EPLUG partnership. Here, it was necessary to start thinking in terms of biodiversity and sustainability in the creation of parks and gardens in the city,

FIGURE 9. TEACHING SITUATION FROM COURSE FOR INTERNATIONAL TEACHERS FROM FINLAND AND ROMANIA ON NEW TRENDS IN URBAN GREENING



Photo by Danish Technological Institute

as opposed to the classic tradition of focusing primarily on creating something purely exotic or aesthetic.

Another example of integrating sustainability into landscape gardening is teaching alternative ways of maintaining large areas of grass, for example, promoting biodiversity by not cutting down grass where possible. Other examples include instruction on how to reduce foreign raw materials and focus on and use local materials instead. In general, much of the integration of sustainability into existing programmes is about how to use the resources around you in the most efficient and environmentally friendly way.

In addition, the school has introduced a course called 'Climate Technique' (Klimateknik in Danish) as a module in all its training programmes. The course focuses entirely on sustainable practices and the application of technology in the relevant sectors. In this way, all students at the

school are introduced to the importance of sustainability and the green transition.

According to the Green Academy Denmark, an important factor for vocational schools to consider when greening curricula and training programmes is how to align this process with the students' field of interest. Students in agriculture and horticulture are typically hands-on and prefer practical work to classroom teaching. Therefore, sustainability needs to be translated into something simple and tangible. If the green transition is presented as something abstract and theoretical, there is a risk that many students will lose interest.

It is not difficult to translate the green transition into small, simple and tangible efforts – the difficult part is to convince teachers and students that seemingly simple efforts are part of an overall big solution.



4. PEDAGOGICAL APPROACH

4.1 HELPING STUDENTS TO UNDERSTAND THE GREEN TRANSITION AND ITS IMPACTS

The Green Academy Denmark believes that to be a landscape gardener in today's world, one must understand the concepts of sustainability and biodiversity and how they affect the well-being and experience of the users of parks and green spaces.

In the experience of the Green Academy Denmark, seeing the bigger picture (rather than seeing things only from one's own perspective) is incremental to understanding the green transition, at least when it comes to agriculture and horticulture. It is necessary to understand the contribution of a single initiative or action to the climate as a whole.

For example, when working with cuttings, there can be a different environmental impact depending on whether the cuttings are left for composting and integrated into the landscape, park or garden or they are removed. It doesn't make a lot of difference if one landscape gardener leaves the cuttings on site, but it does make a difference if all the professional gardeners integrate and reuse them.

It is this holistic understanding that students need to acquire in order to make a difference to the green transition at the societal level. This requires more explanation than was previously the case at the Green Academy Denmark. The traditional techniques and theories that have a long history within landscape gardening do not need as much explanation as these new initiatives that require a new way of thinking that goes

beyond just thinking about the aesthetics of a park or garden.

The Green Academy Denmark has found that it often takes more examples for the students to understand the principles and importance of thinking green and sustainable, and that the students often have many questions about the principles of sustainability and green initiatives.

Therefore, the teachers try to show examples of parks and gardens that have been developed successfully with sustainability in mind, as well as bad examples to show what happens when sustainability is not part of the planning.

At the moment, the Green Academy Denmark is experiencing a great demand from the industry from the landscaping industry for courses in floral areas in parks, gardens and other similar spaces to enhance biodiversity. In these courses, an understanding of the bigger picture is a prerequisite for understanding the consequences of leaving grass areas uncut for the insect and plant species that live there.

Similarly, the teachers at the Green Academy Denmark have found it necessary to emphasise the economic perspective as part of teaching sustainability. In particular, students in adult vocational courses need to be convinced in the economic rationale of the green transition for their own business in order to take it fully to heart and be motivated.

4.2 PRACTICE-ORIENTED TEACHING

The Green Academy Denmark has a strong tradition for working with practical learning. Apprenticeships are at the

heart of the school's pedagogy. This also means that the Green Academy Denmark generally tries to limit classroom teaching as much as possible and instead spend time on 'doing'.

From the Green Academy Denmark's point of view, this pedagogical approach is also the right one when it comes to teaching sustainability and green transition.

It is also one of the school's priorities to give students the time, space and opportunities to carry out projects with a creative angle that involve sustainability in some way. Teachers at the Green Academy Denmark experience that this kind of open assignment can make room for innovative solutions that support the green transition.

For example, the final project of the Landscape Gardening programme requires that sustainability or biodiversity is part of the project in some way and the students' projects are assessed on this parameter on an equal footing with other parameters.

Another example of practice-oriented teaching stemming from the EPLUG project is the partner organisation Aarhus Municipality. The Municipality has made part of the Aarhus waterfront available to the Green Academy for student projects. It is a great motivation for the students to have the opportunity to exhibit their work in a public place. This gives the students the opportunity to show their work to friends and family and to the general public. For example, the location was used to build and learn about insect hotels in 2021.

Another lesson learned by the Green Academy Denmark is that it is not enough to preach about the importance of the

green transition – you must also take action. A few years ago, the institution realised that it is difficult to convince students of the importance of the green transition if the school buildings do not reflect this belief. The school has therefore made great efforts in recent years to create more examples of sustainable landscape gardening on the grounds and it has given the students space to experiment with green solutions on the various grounds to underline that they not only talk about the Green Transition, but actively promote it.

4.3 THE USE OF INDUSTRY PARTNERS IN EDUCATION

As mentioned above, the Green Academy Denmark has a long and strong tradition of working with industry partners. This can involve the development of curricula and teaching materials, and in general learning about the current needs of the

industry. But there are also other types of cooperation at the school.

For example, the Green Academy has a strong partnership with Makita, the Japanese manufacturer of power tools. The Green Academy Denmark has an agreement with the company that allows the school to borrow the latest equipment on the market – sometimes even before the products are launched.

This can be of great importance for the development of students' skills. In recent years, many tools relevant to the horticultural industry have switched from petrol to electric power. This applies to wheelbarrows, lawnmowers, chainsaws etc.

The relationship with Makita means that the Green Academy Denmark has access to the latest tools for landscape gardeners. The opportunity to test and

FIGURE 10. ELECTRIC TOOLS PROVIDED BY THE JAPANESE COMPANY MIKITA – AN INDUSTRY PARTNER OF THE GREEN ACADEMY DENMARK



Image: DTI

get to know the latest technology is both motivating for the students and ensures that they acquire the skills to operate the green machinery that will be used by the companies in the future.

In return for access to the latest tools, which ensures that its students are trained in and able to operate the power tools of tomorrow, the Green Academy is involved in Makita's development work by providing feedback and input on the needs of the industry and the shortcomings of existing solutions.

Another example is the EPLUG project, which has given the school the opportunity to bring in guest teachers from the industry. This can serve several purposes. Firstly, it enhances the quality of education by touching on subjects that are outside the field of expertise of the school's teachers. It also gives the teachers the opportunity to acquire new knowledge. Finally, it contributes to the motivation of many students when they are confronted with people from 'the real world'. All in all, it has been a great success for the school, as the students at the Green Academy Denmark are highly motivated to learn when the teaching is done by professionals from the industry.

4.4 UPSKILLING TEACHERS

The teachers at the Green Academy Denmark are no different from the companies when it comes to the need for new skills. Therefore, as the industry's demand for knowledge about sustainability and greening increases, so does the need for teachers to acquire knowledge.

This can be challenging as putting teachers' knowledge to the test can

challenge their pride. However, getting teachers on board and open to acquiring the necessary skills and knowledge to teach students and provide them with the skills needed by industry is essential to the success of greening curricula.

An important factor in the upskilling of the teachers is the input from industry partners such as OKNygaard. According to the teachers at the Green Academy Denmark, once a teacher is employed in vocational education, the teacher's knowledge can quickly become outdated, as didactics and pedagogy take up a lot of time in preparing lessons and materials, so that subject knowledge can deteriorate.

However, having up-to-date subject knowledge is extremely important, especially when it comes to facilitating the green transition. Close collaboration and input on current trends in the industry are great ways of keeping teachers' knowledge up to date.

Therefore, the knowledge that the teachers gain by participating in different projects is very important, and therefore it is part of the school's strategy not to employ staff who only work on projects. According to the Green Academy Denmark, there is a risk that the new knowledge will eventually disappear or that it would never be fully activated and brought to life in new courses or teaching materials if the project is separated from the teachers.

It is a cornerstone of the Green Academy Denmark to insist that teachers participate in development projects in addition to teaching students. It can be difficult to follow this principle on a busy working day. But, according to the Green Academy Denmark, it is worth the effort.



5. CONCLUSION – KEY LEARNINGS ABOUT THE GREEN TRANSITION AT THE GREEN ACADEMY DENMARK

Innovative management approach

The Green Academy Denmark takes an innovative approach to handling the green transition, believing that the best solutions haven't necessarily been discovered yet. To foster an innovative mindset among its staff, the school has created a culture among teachers that encourages open-mindedness and experimentation inspired by the Lean Start-up management concept that prioritises experimentation. The school's initiatives must be based on industry

needs and feedback to ensure that green skills are relevant and needed.

The school's management trusts the teachers to try out new approaches and participate in new projects. While some teachers find this approach motivating, others do not. So the school tries to gently push the right teachers towards the right projects. The Green Academy Denmark sees its ability to experiment with new solutions as an important factor in its success in greening

educational programmes. In most cases, this has led to new knowledge and ways of approaching the green transition and greening the curriculum.

International outlook and constant search for new solutions

The Green Academy Denmark values seeking inspiration on different aspects of the green transition from other countries. The school has found great success in using new, innovative solutions from other countries. It also prioritises sharing its own knowledge and good practice with other VET providers, which now similarly encourage their students to study abroad and bring new ideas back to the school and showcase the students currently studying abroad through QR code linked videos to inspire other students.

Teaching the green transition in a holistic way

The Green Academy Denmark believes that to be a successful landscape gardener, you need to understand the concepts of sustainability and

biodiversity, and how seemingly small changes in the way you work can make a difference to the bigger picture. The school emphasises the importance of seeing the bigger picture and understanding the contribution of individual actions to the overall climate.

It also believes that this holistic understanding is necessary to make a difference at societal level and that it is relevant to all horticulture and agriculture programmes and therefore can and should be integrated into most subjects related to these fields.

Understanding the green transition may require more explanation and different perspectives that teachers need to make room for when developing and implementing green curricula. It takes both good and bad examples of sustainability to understand the rationale and the economic perspective, but according to the Green Academy Denmark this is a great way to motivate and engage students in the green transition.



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ANNEX

This report is based on desk research and a 3-day visit to the Green Academy Denmark in Jutland, Denmark. The visit took place between 6 and 8 December 2022.

The visit included three group interviews with the school's management, teachers and students. An interview was also conducted with the Academy's industrial partners.

INTERVIEW PARTICIPANTS GROUP INTERVIEW WITH TEACHERS/ TRAINERS:

- The interviewees were two teachers from the Green Academy Denmark — one affiliated with the agricultural education programmes and the other teaching in the horticultural education programmes.

The interview covered a number of topics. The focus was on the educational content of the school's programmes and the way these integrate the green transition. The interview also touched on the didactic approach.

GROUP INTERVIEW WITH THE MANAGEMENT:

- The interviewees were the head of horticulture and the international coordinator of the school.

The interview focused on various aspects, including the sustainable design of the school buildings and the strategic goals of the school in general. It also touched on the school's participation in the international CoVE *European Platform for Urban Greening* and the general collaboration with industry on various aspects of the school's activities.



CASE II

IFMEREETANGIER, MOROCCO

GROUP INTERVIEWS WITH STUDENTS:

A total of seven students took part in the group interview. The interviewees were adult students from Finland and Romania who participated in a course co-developed with the Green Academy Denmark's industry partner OKNygaard.

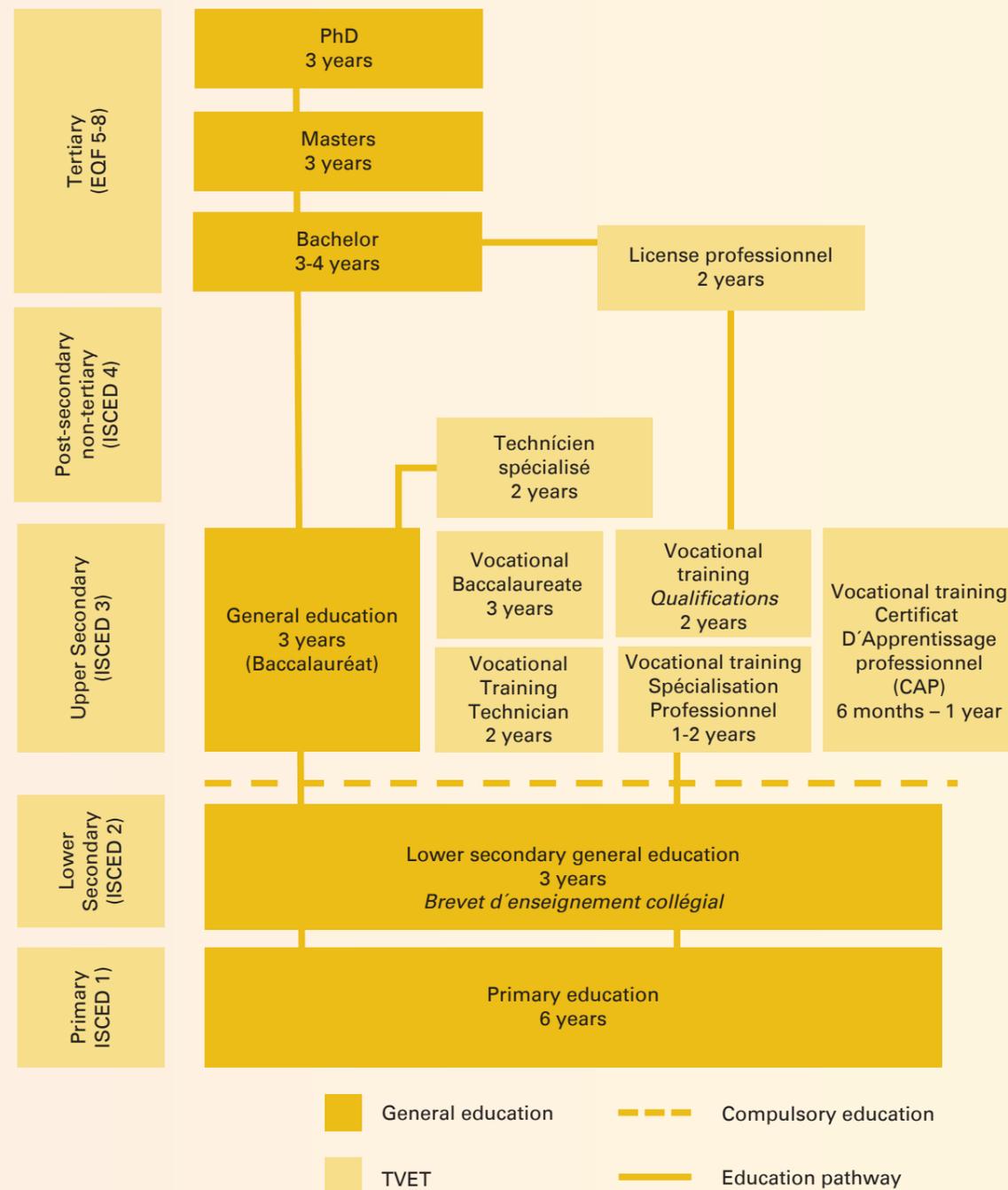
They focused on the students' perspectives of the skills they had acquired, the process of skills acquisition and the features that set the Danish course apart from others in their national VET systems.

ONE-ON-ONE INTERVIEW WITH EXTERNAL PARTNERS:

- Individual interviews were conducted with a representative from OKNygaard (the head of climate adaptation development)

The interview focused, among other things, on the nature of the collaboration between the external partners and the Green Academy Denmark, the partner's motivation to work with the school and the benefits it derives from the partnership.

FIGURE 2. OVERVIEW OF THE EDUCATION SYSTEM IN MOROCCO



Source: UNESCO, 2020

students are admitted on the basis of a lower secondary general education diploma.¹⁵ After 2 years of studies, this group of students is awarded a vocational technician diploma. This qualification gives access to the specialised technician programme.

Most IFMERE graduates enter the labour market after obtaining the degree of specialised technician. However, with this specialised technician qualification (Technicien spécialisé), it is possible to pursue further studies at the university level in Morocco. The certificate is also recognised in France for access to higher education.

¹⁵ In 2023, 20 out of 469 students were following the VET technician programme at the IFMERE Tangier.

Vocational training at public educational institutions is free in Morocco, but students must pay for board and lodging if they choose to enrol in a boarding school. Students must also pay an application fee. The IFMERE Tangier has accommodation for approximately 150 students on campus, which is fully booked. Half of the accommodation is reserved for female students.

Admission to the specialised technician programmes at the IFMERE is by competitive examination. After applying, the preselected candidates are invited to sit an entrance examination. The examination includes a written test on basic mathematics, physics, French and general knowledge in renewable energy and sustainable development. Finally, the applicants are invited to an interview to assess their motivation and communication skills.

FIGURE 3. TRAINING IN ELECTRICAL SYSTEMS AT THE IFMERE



Image: IFMERE

1.3 STRATEGIES RELEVANT TO THE GREENING OF VET

This section briefly outlines the policy background for greening initiatives at the IFMERE. It also presents some of the expected new strategic focus areas for the institution in the coming years.

1.3.1 National Energy Strategy and the foundation of the IFMERE

Morocco's National Energy Strategy (NES) is one of the most ambitious and comprehensive renewable energy strategies in the Middle East and North Africa (MENA) region. Based on the Paris Agreement, Morocco aims to reduce its greenhouse gas emissions by 42% by 2030 (Alhamwi, 2015). In order to achieve this target, Morocco plans to reduce energy consumption by 15% by 2030 and reach 52% of installed electricity capacity from renewable sources by 2030 (20% wind, 20% solar, and 12% hydropower).

To reach the 2030 target, Morocco aims to add around 10 GW of renewable energy capacity between 2018 and 2030, including 4 560 MW of solar power, 4 200 MW of wind power and 1 330 MW of hydropower capacity. The Moroccan government has commissioned large-scale projects to international companies, but the ambition is for Morocco to become a key player in the renewable energy market, while continuing to support and maintain existing renewable energy plants.

As part of the implementation plan for the NES, a decision was made to establish three Renewable Energy and Energy Efficiency Training Institutes (IFMERE) in the cities of Oujda, Tangier, and Ouarzazate as a public-private partnership.

The IFMERE is a pioneering VET provider of skills for the green transition.

For initial education and training, the IFMERE offers four different VET programmes in solar energy systems, wind power systems, photovoltaic installers, and energy efficiency. Each programme has a duration of 2 years, including modules of on-the-job training for a total of 4 months. The curriculum is developed in close cooperation with the industry and is continuously updated according to new industry requirements.

In adult education, the IFMERE offers a wide range of standard and tailor-made courses. The catalogue includes courses in photovoltaic solar systems, solar thermal systems, wind systems (including the Global Wind Organisation Certified Training for Wind Energy), energy efficiency, biogas, and electricity, as well as courses in cross-cutting skills such as quality assurance, safety and environmental skills.

All three campuses have workshop facilities with high-end equipment used for initial and continuing training.

1.3.2 LOOKING TO THE FUTURE

The IFMERE's work is closely linked to Morocco's national energy strategy and the 2030 targets for energy efficiency and reduction greenhouse gas emissions. If the strategy changes, IFMERE's work will undoubtedly also be affected. At the moment, there is no indication that Morocco plans to lower its ambitions in the energy sector.

Technology development is another important area for the IFMERE. Power-to-X technology in particular is of interest

to Morocco and therefore also to the IFMERE. Power-to-X describes a range of processes that convert electricity generated from renewable sources into other forms of energy or chemical compounds. The 'X' in the term refers to different end products, such as hydrogen, synthetic fuels, chemicals, or even food. The process typically involves using renewable electricity to split water molecules into hydrogen and oxygen through electrolysis, which can then be further processed into different products depending on the specific technology used (Danish Technological Institute, 2022).

Due to Morocco's location by the sea and the favourable conditions for wind and solar energy, Power-to-X is of great importance for the country's transition to a low-carbon economy. Consequently, it is expected that the IFMERE will become involved in Power-to-X in the coming years and may launch a training programme in this field. However, this will require knowledge cooperation with external partners.

Finally, to strengthen the institution's economy in the future, IFMERE will attempt to cover a larger portion of its budget from private funds. This requires a willingness in the market to pay for services provided by IFMERE and an increase in demand for competence development for employees in the energy sector. Renewable energy and energy efficiency are still relatively new in Morocco, so it is expected that demand will gradually increase as the market matures.

FIGURE 4. ON-CAMPUS TRAINING AT THE IFMERE



Image: IFMERE

2. MANAGEMENT AND ORGANISATION OF THE IFMEREE

This chapter outlines the overall organisational structure of the IFMEREE and the local organisation at the IFMEREE Tangier. It also briefly describes the funding behind the IFMEREE.

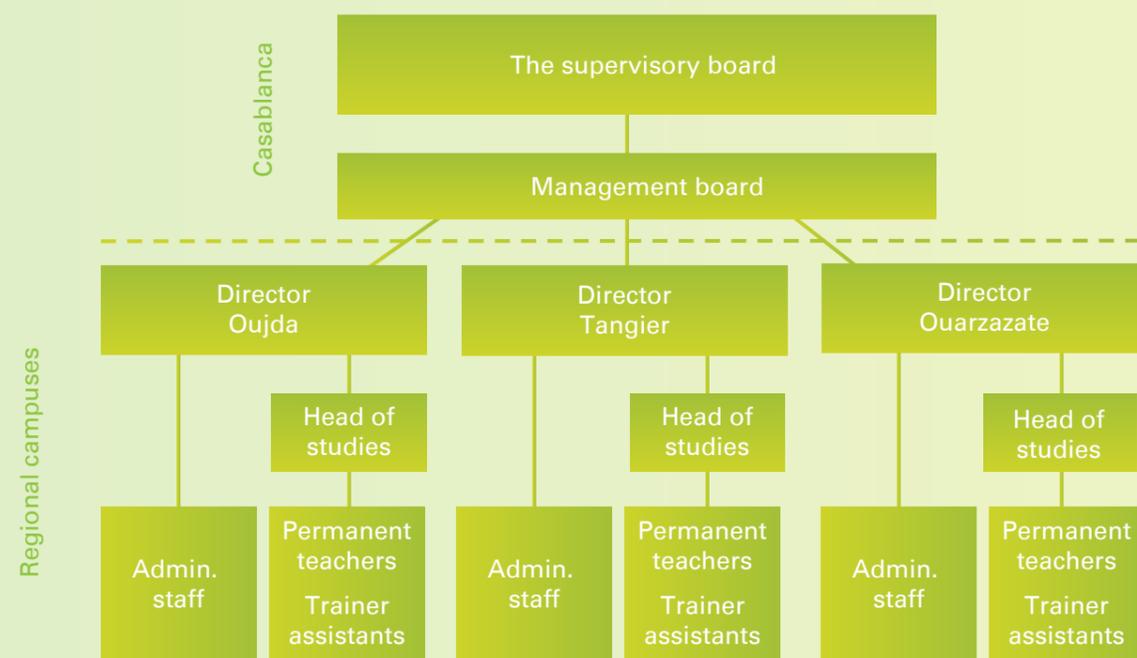
2.1 ORGANISATIONAL STRUCTURE

The IFMEREE is structured as a public-private partnership. According to the partnership agreement for the establishment of the IFMEREE, the

Moroccan government¹⁶ is responsible for constructing and equipping the Institute's campuses and delegates their management to a public limited company with a supervisory board and a managing board, called IFMEREE SA, whose capital is held equally by the IFMEREE's shareholders (IFMEREE, 2021). The overall organisation of the IFMEREE is shown in the diagram below.

¹⁶ The State Secretariat for Vocational Training, The Ministry of Energy, Mines and Sustainable Development, and The Ministry of Economy and Finance.

FIGURE 5. ORGANISATIONAL CHART



Source: Author's elaboration based on description shared by the IFMEREE

The executive decision-making power for the entire institution is vested in the Supervisory Board and the Board of Directors of the IFMEREE. The members of the Supervisory Board are representatives of the shareholder and meet twice a year. They define the overall strategy of the Institute and are involved in major decisions, such as investments. The current members of the supervisory board are as follows:

- Radouan Yessouf, Head of Department, Moroccan Energy Efficiency Agency (AMEE)
- Fouad el Kohen, National Federation of Electricity, Electronics and Renewable Energies (FENELEC)
- Abdelhamid Souiri, President, Federation of Metallurgical, Mechanical and Electromechanical Industries (FIMME)
- Hicham Bouzekri, Director for Research Development & Industry, Moroccan Agency for Sustainable Energy (MASEN)
- Amal Bouamam, Director, The National Office for Electricity and Drinking Water (ONEE)

Day-to-day decisions are taken by the Board of Directors, which consists of the following three members:

- Fouad el Kohen, Chairman of the Managing Board (FENELEC)
- Currently vacant, Member of the Managing Board (FIMME)
- Dr Anass Ait Laachir, Director of the IFMEREE Tangier and Member of the Managing Board.

The representatives of key industry stakeholders on the management board ensure a close and constant focus on the competence and service needs of the industry. The Board also manages

the three Campus Directors and handles coordination with the Ministry of Economy and Finance on the annual budget and funding needs.

2.2 CAMPUS ORGANISATION

On each of the three IFMEREE campuses, the local organisation is composed of a director, a head of studies, permanent teachers, administrative staff, and a head of workshops. Each campus director has autonomy in day-to-day management, but major decisions and investments, such as new equipment, must be approved the Board of Directors in Casablanca. Specifically, the campus director submits a request for an investment to the board, which then approves or rejects the request based on the strategy and the overall budget.

The Director of Studies is the main point of contact for teachers and ensures that all modules and courses are properly staffed. In addition to the permanent teaching staff, the IFMEREE also has contracts with a number of teaching assistants who are usually employed in the industry. They often contribute to specific modules such as Entrepreneurship or Technical.

The permanent teachers are graduates of engineering schools and have Master's degrees in Renewable Energy and Energy Efficiency'. Most have worked in the industry for a number of years before joining the IFEREE.

The IFEREE is ISO 9001 certified. This means that the Institute follows a quality management standard that outlines the requirements for the organisation to establish, implement,

maintain, and continually improve its quality management system (QMS). ISO 9001 covers a number of key areas, including customer focus, leadership, process management, risk management, performance evaluation, and continuous improvement (ISO, 2021).

In line with ISO 9001, the IFMEREER follows a human resources management system. As a result, permanent teaching staff benefit from technical and pedagogical training, enabling them to effectively manage the training of students. Training needs are identified and formulated by the teachers in a bottom-up approach but in coordination with the Director and the Head of Studies. Teacher training must be in line with the IFMEREER's strategy, but each campus is free to operate within the annual budget allocated for teacher training. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) was a close cooperation partner in the initial teacher training at the start of the IFMEREER (GIZ, 2020). It also played a key role in the selection of equipment for the three campuses.

2.3 FUNDING

The initial investment cost of the IFMEREER was MAD 95 million per campus or MAD 285 million in total (approx. EUR 25.75 million). A significant part of the initial cost was financed by contributions from three partners: the European Union (EUR 10 million in grant financing), the French Development Agency (EUR 10 million in the form of a loan), and EUR 2 million from the German

cooperation agency GIZ (in the form of equipment and teacher training).

The average operating budget of the IFMEREER Tangier is EUR 700 000. The composition of the annual budget is a mix of public funding and income from courses and services. As mentioned above, vocational training at public educational institutions in Morocco is free of charge. In terms of legal form, the IFMEREER is a public-private partnership, so the Moroccan government compensates the Institute for the training services it provides on behalf of the government. In addition to public funding, the IFMEREER receives an income from continuing training courses sold to private companies and from services provided to the industry. While 25% of the budget is covered by income from courses and services, the rest comes from the government. The Moroccan government also provides funding for investment in new equipment or facilities, but the IFMEREER must demonstrate the viability of the investment through a business case. In addition, the Institute is required to gradually increase the proportion of private funding from courses and services over the coming years, thereby gradually reducing the proportion of public funding.

In general, the IFMEREER is open to alternative sources of funding, such as private funding or funding from participation in EU programmes. However, at the time of writing, the IFMEREER does not receive any private funding and is also not involved in any EU-funded projects such as Erasmus+ or Horizon.

3. GREEN CONTENT AND PROGRAMMES

The IFMEREER Tangier offers vocational qualifications at the upper secondary and post-secondary non-tertiary levels. The vast majority of students follow a post-secondary non-tertiary VET programme leading to a specialised technician qualification. Out of almost 489 students at the IFMEREER Tangier, only 20 are following a programme at upper secondary level leading to a photovoltaic installer qualification. In the sections below, the three different types of programmes at post-secondary non-tertiary level (specialised technician) are briefly described (IFMEREER, 2021).

3.1 SPECIALIST TECHNICIAN PROGRAMMES

SOLAR ENERGY PROGRAMME

Solar energy technicians specialise in solar energy systems with a versatile profile that implements photovoltaic and low-temperature thermal solar systems (solar heating). The technicians assess the feasibility of such installations at the customer's premises and the equipment to be provided. Then they carry out the technical installation of the system. Solar energy technicians take care of the purchase of materials from suppliers and also provide after-sale service and the maintenance of equipment and installations.



FIGURE 6. MEASURING THE PERFORMANCE OF SOLAR PANELS



Image: IFMEREE

WIND ENERGY PROGRAMME

Wind system technicians specialise in the operation and maintenance of wind turbines (from a 100 KW machine to an array of machines of several MW). Technicians are required to be involved in all stages of the construction of a wind farm. They may be employed by the company that constructs and installs the wind turbine, or they may be employed by the paying customer. Wind turbine technicians contribute to the realisation of the project either by carrying out construction, quality, or safety tasks or by supervising the smooth running of work. During the operation phase, the technicians are responsible for the proper functioning of the wind farm equipment by carrying out interventions on the electrical and mechanical

equipment of the turbine, the high-, medium- and low-voltage substations and electrical networks, and on the roads and tracks within the perimeter of the wind farm. The technicians are also responsible for monitoring the operation of the wind turbine by following the various performance indicators and reports of the remote monitoring systems. They are also responsible for the reliability of the equipment and the productivity of the installed wind turbine. To this end, turbine technicians carry out preventative, remedial and predictive maintenance works on the equipment of the wind farm or wind turbine in compliance with safety and environmental instructions and the relevant regulations of the various trades involved.

ENERGY EFFICIENCY PROGRAMME

Energy efficiency technicians specialise in active and passive energy efficiency techniques. They have the skills to make design drawings, carry out calculations and assist in the preparation of specifications. They also participate in the operational planning of energy efficiency projects and perform quality assurance of follow-up works, such as site control, supervision, and compliance

with the standards prescribed by thermal regulations in Morocco. The specialist technicians acquire skills in civil, electrical and thermal engineering.

CURRICULUM DESIGN

The three programmes are all designed as 2-year programmes, each containing a number of modules of varying length. The table below shows the structure of an energy efficiency programme.

TABLE 1. 2-YEAR PROGRAMME WITHIN ENERGY EFFICIENCY

MODULE NUMBER	LEARNING OBJECTIVE	HOURS
1	Positioning in relation to the profession and the training process (Positioning concerns determining where the students want to work and their career goals)	30
2	Application of health, occupational safety and environmental protection rules	30
3	Mastering energy efficiency standards and regulations	30
4	Reading and interpreting plans and diagrams (building, mechanical, electrical, hydraulic or pneumatic) ¹⁷	60
5	Fundamental concepts of electrical engineering and electricity	75
6	Fundamental concepts of lighting	45
7	Fundamental concepts of electronics	60
8	Using a computer workstation	75
9	Operating and handling measuring devices used in energy efficiency audits	75
10	Fundamental concepts of fluid mechanics	90
11	Analysis and tracking of energy consumption	60
12	Counting and measuring plan implementation	75
13	Fundamental concepts of heat exchange	105

¹⁷ Hydraulics is a mechanical function that operates through the force of liquid pressure. Pneumatics: Tools and appliances driven by compressed air are defined as pneumatic devices.

TABLE 1. (CONTINUED)

MODULE NUMBER	LEARNING OBJECTIVE	HOURS
14	Establishing an energy balance	90
15	Introduction to practising the trade in a professional environment	180
16	Energy consumption cost accounting	60
17	Communication in a professional setting	75
18	Energy management system implementation	60
19	Energy consumption diagnostic equipment	75
20	Technical English	45
21	Energy audits of buildings	75
22	Energy audits in transport	60
23	Energy audits in industry	75
24	Problem-solving in the context of energy efficiency improvement	90
25	Development of an entrepreneurial mindset	45
26	Use of job search resources	30
27	Management of energy efficiency projects	60
28	Integration into a professional environment	480

Source: IFMERE

The first module is an introduction to the field of energy efficiency and renewable energy. Here, the students get a sense of what the field is all about, how the training is designed and structured and what kind of expectations the IFMERE, as an educational institution, expects from the students in terms of workload and effort. After the first week, the students are allowed to change to another programme. The content of modules 2 to 28 is tailored to the specific field (in the example above, to energy efficiency). The skills and competences acquired in most modules are technical in nature, but

the curriculum also includes transversal skills, such as digital skills, language skills, communication, entrepreneurship, and employability. Module 15 is a 1-month work placement in a company during the first year and module 28 is a 3-month practice placement in a company before the final examinations.

The curriculum for each of the programmes offered is regularly updated, as explained by Head of Studies, Mr. Hamza el Karch:

'We continuously develop our training programmes to align with the evolving

needs of the professional sector. As we analyse industry needs and consult with experts, we involve professionals from relevant fields to validate our training programmes. The involvement of the industry in this process is key! Our trainers are themselves trained to ensure they can deliver effective training.'

More specifically, IFMERE representatives organise an annual meeting with industry representatives, where they present an outline of the curriculum and gather feedback from professionals to adapt and further develop the programmes. In addition to the annual meeting, teachers gather input from the industry during placements and through ongoing dialogue and meetings with local and regional companies.

3.2 CONTINUING EDUCATION

As mentioned above, the IFMERE offers a range of training courses in photovoltaic solar systems, solar thermal systems, wind systems, energy efficiency, biogas and electricity, as well as courses that provide transversal skills, such as quality assurance, safety and environmental skills. The institution also tailors courses to meet specific industry needs. Courses typically last between 1 and 6 days.

One of the IFMERE's main assets as a continuing training institution is its high-end equipment, which, in some cases, is more advanced than the standard equipment in the industry. Another asset is the close cooperation with the industry, which allows industry specialists to become trainers on

FIGURE 7. SAFETY TRAINING FOR THE WIND ENERGY SECTOR



Photo: IFMERE

the continuing education courses. The IFMEREER's continuing education programmes and services thus benefit both individuals and businesses, and contribute to the development of teachers and trainers. The trainers involved in these services keep up to date with the latest industry trends and develop networks that can lead to better initial training delivery.

The courses are organised in a very flexible way in order to meet the needs of the industry. They can be delivered in a face-to-face or distance learning (online) format. The IFMEREER

Tangier has adult learners not only from Morocco but also from Spain, for example, professionals who work in the wind energy sector. The Global Wind Organisation Certified Training for Wind Energy in particular attracts international students.

The continuing training programmes are primarily designed for employees in the energy sector who wish to upskill or retrain. However, the IFMEREER also welcomes unemployed people who aim to improve their position on the labour market for renewable energy and sustainable development.



4. PEDAGOGICAL APPROACH

This chapter describes the pedagogical approach at the IFMEREER and how it is applied to support students in acquiring skills and competences related to sustainability.

4.1 PRACTICAL AND WORK-BASED EDUCATION

The pedagogical approach to learning can be briefly described as a learner-centred, facilitated learning approach with a focus on practical competences. Each module begins with the teacher explaining the learning objectives for the specific module to ensure that the students understand the purpose and the expected learning outcomes of the module. Learning sessions are often designed as a combination of an introduction to theory and practical exercises. However, there is a high degree of pedagogical freedom, as teaching can also be designed as a

project-based course or may include visits to companies. Each module ends with an examination. The detailed planning of teaching at the IFMEREER Tangier is done in collaboration between individual teachers and the Head of Education. The Head of Education also handles coordination with the two campuses in Oujda and Ouarzazate to ensure consistency across the entire IFMEREER institution, as the students on all three campuses should graduate with the same qualifications. The Head of Education can also, if necessary, draw on the resources of the other campuses, for example by loaning teachers from one campus to another.

USE OF SCHOOL FACILITIES FOR TEACHING

The school's workshop facilities provide access to technical equipment, which is an important part of teaching. The specialist technician programmes

FIGURE 8. MEASURING EQUIPMENT FOR WEATHER CONDITIONS



Photo: IFMERE

are aimed at specific occupations, so practice-oriented pedagogy is an important aspect of skills acquisition. For example, when learning about solar panels, the students have access to and work with actual solar panels. They can measure the performance of the panels, work out their optimal position, etc. There are also facilities on the school campus that are used as an integral part of the learning process. For example, a large part of the school's energy consumption is covered by solar panels mounted on the roofs. The data from these panels is actively used in the classroom, and the students are also involved in maintaining the equipment. Weather monitoring equipment has also been installed on campus. It is used

to teach optimal wind turbine set up. There is also a climate control system for heating and cooling the school buildings, which is used to teach energy efficiency.

STUDENT-TO-STUDENT TEACHING

Hands-on teaching usually involves students working together in small groups or pairs to solve a problem, develop a project or the like. This is based on the idea that students' learning outcomes improve when they have to explain theory and solutions to each other'. Much of the student-to-student teaching takes place in the context of project work. For example, students may be asked to build a wind turbine mock-up. This takes place in a project group with the teacher acting as a facilitator. In other cases, students make small videos of their work and present them to the class. The peer-to-peer approach is seen as important not only for achieving the learning outcomes, but also for developing soft skills, such as project management, presentation techniques, and the capacity to execute (self-efficacy).

PRACTICAL INVOLVEMENT

The pedagogical approach at the IFMERE is highly industry-focused. The curriculum is developed in collaboration with industry and companies are regularly involved in teaching. In some cases, students are given real data from the industry to work with. The exercise involves performance data that might be from a wind farm or a solar plants, which students use to make calculations. They also visit companies. In addition to the regular teachers, the IFMERE also has teaching assistants, who usually hold relevant jobs in the industry and teach part time. Finally, the students have internships with companies for a total of 4 months during the 2 years of training (see below).

FIGURE 8. STUDENTS LOOKING AT ENERGY DATA SETS



Photo: IFMERE

The close link with practice is a deliberate pedagogical choice. To implement Morocco's renewable energy strategy, there is a need for technicians who can enter the workforce immediately after graduation to help build wind farms or solar farms or work on energy efficiency. This is why the school makes a great effort to make teaching as practical as possible. Students need to know and understand the equipment they will encounter in companies and must be able to solve problems and work independently. In addition to technical skills, the IFMERE places great emphasis on the development of transversal skills.

THE LINK BETWEEN PRACTICAL TRAINING AND SCHOOL EDUCATION

In the first year of the programme, the students participate in a 1-month

internship in a company, while in the second year the training concludes with a 3-month internship. The purpose of internships is to enable students to test the skills they have acquired on-the-job and experience how a workplace functions in practice. The purpose is to also acquire new skills. Prior to the internship, students are given a set of research questions to be answered during the work placement. In addition, the students keep a logbook to ensure that their learning is clearly documented. The logbook must be approved by both an internal mentor and a teacher from the school. At the end of the placement, the students are required give a presentation at the school on what they have learned.

During the placement, the company will receive at least one visit from a teacher

from the school. The purpose of the visit is to ensure that the internship is progressing as planned and address any problems. It is also an opportunity for the teachers to get a feel for the practice and listen to the 'wishes and needs of the companies.

4.2 QUALITY ASSURANCE AND FEEDBACK LOOPS

Quality assurance and feedback loops play a crucial role in the pedagogical approach of the IFMERE. They offer several benefits, including helping teachers to identify areas where they can improve their teaching practices. Seeking feedback from students and the Head of Studies, teachers can identify their strengths and weaknesses and make necessary changes to improve their teaching methods. As Dr Anass Ait Laachir, Director of the IFMERE Tangier, explains:

'We prioritise the development of our trainers by implementing a feedback loop where students evaluate their performance. Using a two-axis format, we assess both the trainer's delivery of the material in the classroom and their ability to meet the needs of individual students. When students are struggling,

we hold meetings to address the root cause of the problem. Our teachers and trainers use the feedback to improve their skills and better respond to students' needs.'

Another important benefit of the feedback loop is that they encourage student engagement and participation in the learning process. When students are given the opportunity to provide feedback, they feel valued and heard. This creates a positive learning environment and encourages students to take ownership of their learning. Feedback loops also allow teachers to personalise their teaching approach to teaching to meet the needs of individual students. By collecting feedback on student progress, teachers can identify areas where students need additional support and adjust their teaching methods accordingly to help those students succeed.

Finally, quality assurance of the teaching is essential to ensure that teachers are held accountable for their performance. By establishing clear performance metrics and evaluation processes, teachers are more motivated to strive for excellence in their teaching.



5. CONCLUSION – KEY LESSONS LEARNED FROM THE GREEN TRANSITION AT THE IFMERE

This case study has examined the strategic approach to the green transition at the IFMERE Tangier, with a particular focus on the strategic anchoring, the pedagogical approach of the institution, the close cooperation with the business sector and the dedicated and qualified staff members of the institution. All four focus areas are key to professional excellence.

FUELLING MOROCCO'S ENERGY FUTURE: THE IFMERE'S ROLE IN ACHIEVING NATIONAL GOALS

The creation of the IFMERE is linked to Morocco's national energy strategy and the country's commitment to becoming more energy efficient and reducing greenhouse gas emissions by 2030. Morocco's greenhouse gas

emissions reduction strategy is based on a transition from fossil fuel-based energy production to wind and solar energy production. To support this transition, the country needs specialised technicians to support the wind and solar energy sector, both during the construction of the plants and during the maintenance phase. There is also a need for specialised technicians who can reduce energy consumption by implementing and promoting for energy efficiency solutions. The IFMERE is positioned as an important and attractive player in Morocco for external stakeholders — not least for private companies in the energy sector — thanks to its strategic positioning and the attention it receives from the government of Morocco.

BRIDGING THE GAP: LINKING THEORY TO PRACTICE

The IFMERE Tangier's pedagogical approach focuses on a learner-centred, hands-on approach to learning with an emphasis on developing practical skills. The main assets of the IFMERE are the degree of pedagogical freedom given to teachers and the close collaboration with practice — both in terms of curriculum development, the regular involvement of companies in the training and 4-month placement during the two-year training. The work placements provide students with the opportunity to test the skills they have acquired in real-world settings and acquire new skills. A key lesson is that the practice placements are closely monitored by the school to ensure that learning is taking place and that students are well looked after.

The school's facilities, such as solar panels and weather instruments, are also used as an integral part of the learning process. There is always a close link between theory and practice, which is emphasised as the most important aspect of the pedagogical approach. Finally, the IFMERE has a strong focus on providing students with transversal skills in addition to technical skills.

IFMERE AS AN INTEGRAL PART OF THE ECOSYSTEM

The IFMERE's management, teachers and stakeholders refer to the institution's close links with the energy ecosystem in Morocco when asked about its reputation as a centre of vocational excellence. Key players in the energy sector 'are represented on its supervisory and managing boards, and it has entered into agreements with industry partners for

student placements, teacher training and other services. While being an integral part of the Moroccan education system, the IFMERE is closely aligned with the development and labour market needs of the energy industry and must remain relevant and at the forefront of technological development to fulfil its mission.

The IFMERE also has relationships with international partners and receives international visitors, for example from countries in sub-Saharan Africa as well as Korea, the UK, France and Germany. These international visits and relationships offer several benefits, including professional development for management and teachers, and global networking. These benefits can lead to improved teaching, research, and opportunities for personal and professional development, ultimately enhancing the educational experience for the students and course participants.

QUALIFIED TEACHERS

The IFMERE's permanent teaching staff are all engineers with Master's degrees in Renewable Energy and Energy Efficiency, many with previous industry experience', many with prior industry experience. Teachers receive ongoing technical and pedagogical training to enhance their skills. The IFMERE's human resources are considered essential to its success, and they are carefully recruited and trained in line with the Institute's overall strategy. This integration of theoretical and practical knowledge allows the teachers to stay connected to the industry and ensures that their teaching remains relevant.

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ANNEX

This report is based on desk research and a 3-day visit to the IFMERE Tangier in Morocco. The visit took place between 11 and 13 January 2023.

As part of the mission, three group interviews were conducted with teachers and students of the Institute. In addition, several individual interviews were conducted with the management and an external partner.

INTERVIEW PARTICIPANTS

GROUP INTERVIEW WITH TEACHERS/ TRAINERS:

- Four teachers from the IFMERE Tangier were interviewed.

GROUP INTERVIEWS WITH STUDENTS:

- Two group interviews were conducted with a total of six students from the CoVE.

INDIVIDUAL INTERVIEWS WITH MANAGEMENT:

- Several individual interviews were conducted with the Director of the IFMERE Tangier and the Director of Education.

INDIVIDUAL INTERVIEW WITH EXTERNAL PARTNERS:

- One individual interview was conducted with an external partner from the wind energy sector.

CASE III

TAFE QUEENSLAND, ROBINA CAMPUS, AUSTRALIA





1. INTRODUCTION

This introductory chapter contains several sections of background information relevant to the case study. First, the TAFE Queensland and its Robina Campus are introduced. Other sections outline the Australian VET system and describe national and regional strategies relevant to its greening.

1.1 TAFE QUEENSLAND AND ITS ROBINA CAMPUS

TAFE (Technical and Further Education) Queensland is a government-owned, not-for-profit VET provider in the state of Queensland in north-eastern Australia. The origins of the organisation can be traced back to the establishment of a mechanical drawing class at the North Brisbane School of Arts in 1882 (TAFE Queensland, n.d.(a)). Today, the tertiary education provider generates revenue from the delivery of

industry-relevant training programmes at more than 60 campuses across the state of Queensland. TAFE Queensland provides a range of education and training, from entry level certificates and apprenticeships to bachelor's degrees, to more than 115 000 students annually in over 400 programmes (TAFE Queensland, 2022a). The VET provider divides these programmes into the following areas of study: business and IT, creative industries, education and community, environment and animal services, health and science, infrastructure and transport, service industries and trades. Most of the training on offer is initial vocational training. However, the VET provider also offers courses related to continuous vocational education and training (CVET). In addition, approximately 13% of the TAFE Queensland's student cohort are international students.

FIGURE 1. TAFE QUEENSLAND'S ROBINA CAMPUS



Photo: TAFE Queensland

This case study focuses specifically on TAFE Queensland's Robina Campus, pictured above. As a new campus, it opened its doors in July 2022, with an intake of 850 students in its first year, with capacity for an annual intake of 2 000 students. There are 57 teachers and trainers¹⁸ on the Robina campus, where students can study a range of vocational programmes, particularly in the trades. These include Catering, Early Childhood Education and Care, Hairdressing, Hospitality Management, Sport and Recreation and Tourism. Typical

students on the campus are young adults aged 19–21 years.

While a certain level of proficiency in English is required to join any course at the Robina campus, most courses on offer have individual entry requirements, for example for the courses or subjects that a student must complete before enrolment. TAFE Queensland generally recommends that students wishing to enrol for Foundation Skills and Certificate courses should have completed at least Lower Secondary Education or an equivalent level of education. For diploma or higher education courses, TAFE Queensland recommends that students have completed upper

¹⁸ This includes three Educational Team Leaders, two Short Course Facilitators, and 16 casual educators.

secondary education or gained equivalent competencies prior to enrolment (TAFE Queensland, n.d.(b)).¹⁹

The Robina campus is the newest of TAFE Queensland's six campuses in the Gold Coast region. It consists of a five-storey building which, among other facilities, houses training rooms, classrooms and student areas, as well as a café and a restaurant open to the public. Work on the campus site began in 2020 and was completed in the spring of 2022, following the construction and fitting out of the building.

In terms of its organisational structure, a Faculty Director is responsible for the day-to-day operation of the Robina campus. She is also part of the TAFE Queensland Gold Coast Region Senior Leadership Team, which is led by a General Manager and includes three executive directors responsible for Education, Culture and Faculty Support. The overarching supervising body for all VET provider's campuses is the TAFE Queensland Board, which has five members, including a chair. The board reports directly to the Queensland Government Minister for Training and Skills Development (TAFE Queensland, n.d.(c)).

1.2 VOCATIONAL EDUCATION AND TRAINING IN AUSTRALIA

This section provides a brief introduction to the national VET context, including

¹⁹ Year 10 corresponds to having finished secondary school (part of compulsory education in the national education system), while Australian students can choose to complete Years 11-12 at senior secondary school (Australian Government, 2022).

an overview of VET governance and funding in Australia.

1.2.1 A BRIEF OVERVIEW

Australia's VET system is central to the country's economic growth and business productivity. It provides a significant proportion of Australians with work-ready skills and qualifications across a wide range of industries. In 2019, for example, there were 4.2 million students receiving vocational education and training from more than 4 500 providers in Australia. At the time, this group represented a quarter of the Australian population aged 15–64 years (Ey, 2021).

VET qualifications can be gained at school, in the workplace and through other registered training organisations. Non-formal VET is provided by a range of public, private, community and industry sector providers. It can also be provided by one of more than 3 600 registered training organisations that deliver formal vocational education and training. Government agencies and training providers also deliver non-formal VET through community-based settings, the activities of civil society organisations, and employee training and development programmes for businesses. In 2018, the largest proportion of VET providers in Australia were private training organisations (3 099), followed by community providers (468), and schools (442). There were 53 TAFE institutes spread across different regions and metropolitan areas in Australia in that year (Unesco-Unevoc, 2018; Australian Government Productivity Commission, 2021).

The national VET system is diverse, with students of all ages and backgrounds having the opportunity to choose from more than 1 450 qualifications, 1 300 skill sets, and 750 courses. This also means that the Australian VET

system offers a wide range of career options, ranging from nursing, fashion, or floristry to avionics, small business management, or information technology and beyond (Department of Education and Training, 2018).

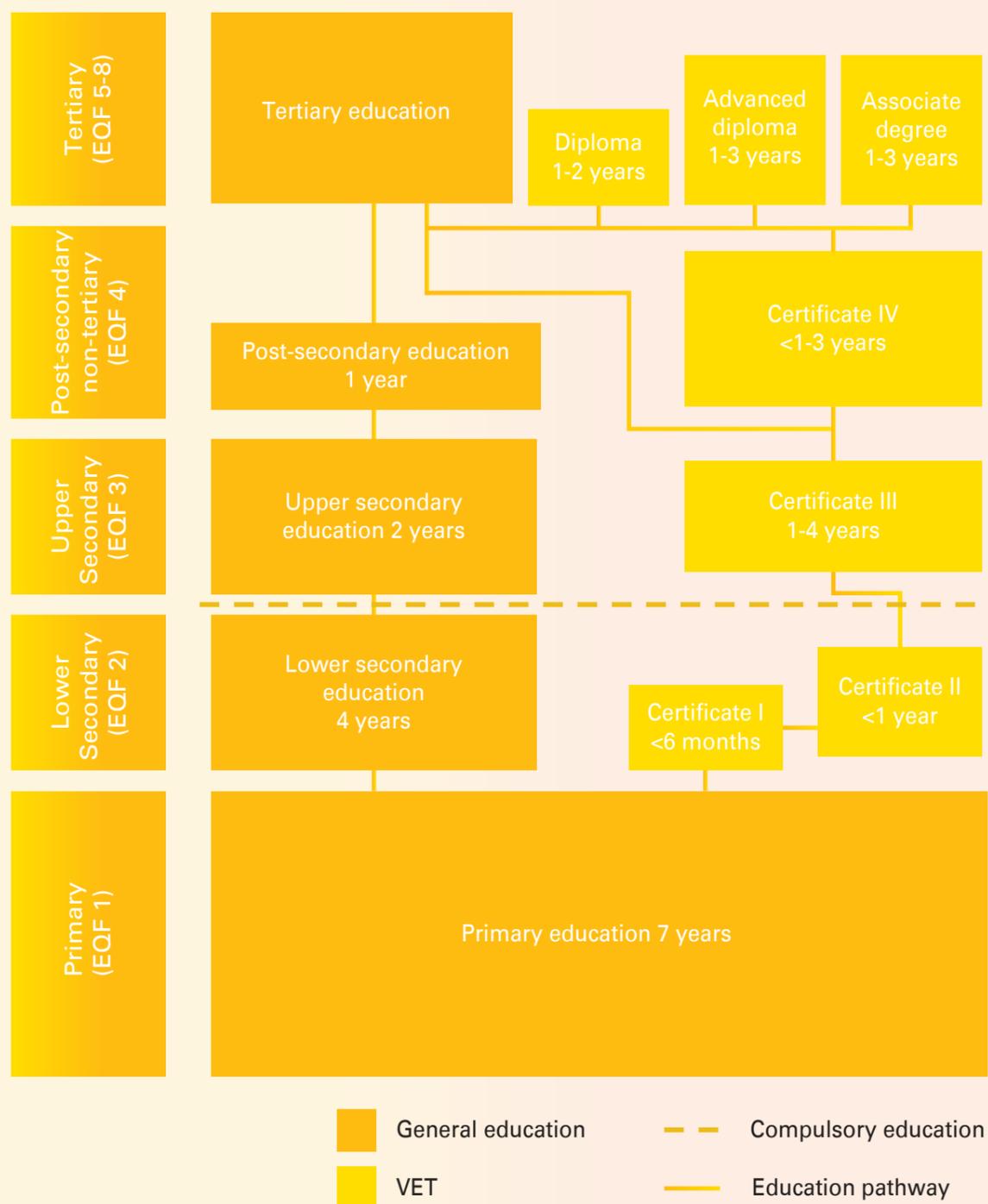
VET is integrated into the Australian education system at different levels. Primary and lower secondary education is compulsory in the country between the ages of six and sixteen. Most students who choose VET as an educational pathway do so after completing compulsory general education. At the same time, it is

possible for students in Australian secondary schools (at lower secondary level) to obtain VET certificates through training that combines classroom learning with practical experience in real or simulated workplace environments. Between 2010 and 2020, the number of secondary school students enrolled in VET ranged from 230 000 to 260 000 (Unesco-Unevoc, 2018; Misko, et al., 2021).

Figure 2 below shows how VET is integrated into the Australian education system and the different levels at which students can obtain VET qualifications.



FIGURE 2. STRUCTURE OF VET IN THE AUSTRALIAN EDUCATION SYSTEM



Adapted from Unesco-Unevoc, 2018, p. 5.

Students have the opportunity to participate in VET through full-time, part-time, or online learning that can be self-paced. They can also apply to registered training organisations in order to have skills, knowledge or relevant experience from previous informal or non-formal learning assessed and recognised in the form of nationally accredited qualifications (Unesco-Unevoc, 2018).

1.2.2 VET GOVERNANCE

The national VET sector is governed jointly by the Australian Government and state and territory governments. Currently, the temporary Skills National Cabinet Reform Committee is responsible for the ongoing reform of the VET system. The Committee was established in the wake of the Covid-19 pandemic in 2020 and consists of national, state- and territory-level ministers responsible for skills development. Its main priority is to ensure that the national education and training system is able to deliver a highly skilled and productive workforce to support the national and local economies (AISC, n.d.; NCVET, 2022).

The Australian Government's Department of Education and Training and the Department of Employment and Workplace Relations play a central role in VET governance and funding. The national departments collaborate with the state and territory skills departments responsible for the operation of the VET system at regional and local level.

The private sector and industry also play a key role in the development of the VET system, working with governments and VET institutions to ensure that it drives improvements in productivity and competitiveness across the economy. To support of this objective,

industry representative bodies, such as the Australian Industry and Skills Committee (AISC), provide advice on how to ensure that the VET system is responsive to national skills needs. A number of Service Skills Organisations have also been established. These are independent, professional service organisations that work with Australia's eleven government-funded Industry Skills Councils to review and develop training packages that meet the skills needs of specific sectors (Unesco-Unevoc, 2018; NCVET, 2022).

1.2.3 VET FUNDING

Responsibility for the funding of both formal and non-formal VET in Australia lies primarily with the Australian Government's Department of Education and the state government education departments. National government funding for VET is provided through a range of payments to the states and territories to support the delivery of VET. In addition, the Australian government has its own programmes focused on the development and administration of the national training system, basic skills for adults, and apprenticeships with the Australian Apprenticeships Incentives Program being one example (Unesco-Unevoc, 2018; Ferguson, et al., 2020).

At the same time, businesses and individuals also contribute significantly to the financing of VET, for example by purchasing training for their employees. The mechanisms mobilising private sector contributions include payments made by individuals, companies, and industries for specific training provided under contracts awarded on the basis of tenders. It is estimated that the total expenditure on VET by private employers in 2020 was AUD 5.6 billion. In comparison, total public spending on

of VET in the same year is estimated to have been AUD 7.4 billion (Burke, 2022). Finally, by law VET within Australia's formal education system is not provided free of charge. Students therefore also contribute to the funding of VET by paying tuition and administrative fees (Unesco-Unevoc, 2018).

1.3 NATIONAL AND REGIONAL STRATEGIES RELEVANT TO THE GREENING OF VET

This section focuses on the policy context for greening initiatives at the TAFE Queensland and its Robina campus. Firstly, it provides a brief introduction to the national government's actions to mitigate climate change. It then describes the national and regional initiatives relevant to the greening of VET.

1.3.1 NATIONAL CLIMATE CHANGE MITIGATION POLICY

Australia's commitment to climate action since the 1990s has been somewhat inconsistent. At times, the country has acted as an early adopter, for example, by being among the first to sign the first global treaty on climate change, which was adopted by the United Nations General Assembly in May 1992. The treaty, called the United Nations Framework Convention on Climate Change (UNFCCC), aims to stabilise greenhouse gas concentrations in the atmosphere to help protect ecosystems, food security, and the economy as a whole from the potential impacts of climate change. To meet its commitments under the UNFCCC, in December 1992 the national, state and territory governments adopted Australia's National Greenhouse Gas Response

Strategy. Australia was also the first country to establish a government agency dedicated to reducing greenhouse gas emissions, notably the Australian Greenhouse Office, in April 1998 (Talberg, et al., 2016).

At other times, however, Australian governments have reversed course and, for different reasons, limited the country's climate change mitigation efforts. Shortly after the establishment of the Australian Greenhouse Office in 1998, the Liberal government (made up of the Liberal Party and the National Party) under Prime Minister Howard, signed the Kyoto Protocol, but decided not to ratify it because of the potential harm to the national economy. This meant that Australia was not legally bound by the specific targets for limiting and reducing greenhouse gas emissions set out in the Protocol, which aims to operationalise the UNFCCC. Another example of the inconsistent nature of Australian climate change mitigation policy is the dismantling of the Australian Greenhouse Office and its incorporation into the Department for the Environment by a Liberal government in 2004, after it had been established by a previous Liberal government 6 years earlier (ibid.).

Despite what the above examples might suggest, the direction of Australian climate policy cannot be fully explained by the political orientation of the government in power. For example, the newly installed Labor Government under Prime Minister Rudd was quick to ratify the Kyoto Protocol in December 2007. At the same time, the subsequent Labor government first helped to negotiate a 2011 agreement to extend the Kyoto Protocol beyond 2012, but then hesitated to join a second emissions reduction commitment period from 2013-2020 (as

defined in the Doha Amendment to the Kyoto Protocol). In fact, it was not until 2015 that a Liberal government decided to ratify the second commitment period. This only happened after the government announced that the country was on track to meet and exceed its 2020 emissions reduction target under the Kyoto Protocol's first commitment period (ibid.).

Among the most notable climate actions at the national level in recent years was Australia's ratification of the Paris Agreement in November 2016 under the Liberal government led by Prime Minister Turnbull. In order to support international efforts to limit global warming to well below 2 degrees Celsius compared to pre-industrial levels, the country thus committed to a target of reducing its greenhouse gas (GHG) emissions by 26–28% by 2030 compared to 2005 levels (United Nations Climate Change, n.d.). One of the key climate change policy instruments designed to support the achievement of the national climate change targets is the Emissions Reduction Fund. It is a regulatory framework for Australia's carbon credit scheme that has been developed since 2007 and came into force in 2016 (Clean Energy Regulator, 2022). In addition, the Liberal government under Scott Morrison released Australia's Long-Term Emissions Reduction Plan in 2021, which proposed a target of reaching net zero emissions by 2050. The plan focuses heavily on technology investment and development. It outlines how the cost of low-emission technologies can be reduced, how they can be deployed at scale, and how they can be implemented to create new markets for Australian businesses and opportunities for international collaboration (Department of Climate Change, Energy, the Environment and Water, 2021).

In 2018, the UN criticised national efforts for not being sufficient to meet Australia's 2030 emissions reduction targets (UN Environment, n.d.). Under the current Labor government, which took office in 2022, Australia has raised its ambitions by passing legislation that commits Australia to a net zero target by 2050 and a 43% reduction in carbon emissions by 2030 compared to 2005 levels. However, there are concerns that the climate policies already in place are not sufficient to achieve these targets and that the current government needs to develop a more comprehensive climate policy (Climate Action Tracker, 2022).

1.3.2 NATIONAL INITIATIVES TO SUPPORT GREEN SKILLS

At the national level, there have been several initiatives focused on workforce development to support Australia's transition to a low-carbon economy. In particular, between 2009 and 2012, distinctive VET policies were developed and implemented in line with the climate change commitments of the two Labor governments in office during this period (Curtis, et al., 2018).

In April 2009, for example, the Australian government published its National Action Plan for Education for Sustainability. Based on an extensive community consultation process, it set out four strategies to promote sustainability in government, education, business and industry, and communities across Australia. The Action Plan uses a broad definition of sustainability that is linked to both environmental and social and economic considerations. The second strategy envisaged in the Action Plan, entitled 'Reorienting Education Systems to Sustainability', includes a target for the VET sector to integrate sustainability into all national curricula

and implement sustainable campus management (Australian Government, 2009(a)).

Another relevant example is the Green Skills Agreement (GSA), endorsed by the Council of Australian Governments in November 2009. It commits the Australian central, state and territory governments to collaborate with stakeholders representing employers, workers and the VET sector to ensure that the provision of skills for sustainability is an integral part of VET. The GSA offers the following definition of such skills:

‘Skills for sustainability, also known as green skills, are the technical skills, knowledge, values and attitudes needed in the workforce to develop and support sustainable social, economic and environmental outcomes in business, industry and the community’ (Council of Australian Governments, 2009(b)).

To promote the delivery of sustainability skills to apprentices, trainees, students and workers, the GSA sets out four objectives. These include the development of national standards for green skills in the Australian Quality Training Framework²⁰ and the revision of existing training packages to integrate green skills. The other two objectives are to upskill VET practitioners to facilitate green skills training and implement strategies to reskill vulnerable workers to prepare them for future job opportunities in a low-carbon economy (McDonald, et al., 2012).

²⁰ The Australian Quality Training Framework (AQTF) is the national set of compliance standards and essential conditions that a VET provider must meet to become a Registered Training Provider (RTO) in Australia (iVET, n.d.).

The 2009–2012 green skills policy included the Clean Energy and Other Skills Package. Introduced by the Australian government in late 2011, it established a funding initiative to provide tradespeople and professionals with renewable energy knowledge, advice, products, and services (ibid).

A 2018 report published by the International Labour Organization (ILO) noted that, following the more progressive period described above, there was a lack of green skills policies at the national level. In fact, the report found that there were no major developments in this policy area between 2012 and 2018 (Curtis, et al., 2018).

Since then, the Liberal government under Prime Minister Morrison (2019–2022) introduced a number of initiatives focused on improving skills and training. While none of these had an overarching focus on sustainability, some focused on skills development for green economy sectors that were expected to play a growing role in the national economy. For example, the 2020 Australian Government’s Modern Manufacturing Strategy emphasised the commitment to ensuring that the education system provides ‘workers with the skills to support uptake of automation, data analytics and artificial intelligence’ (Australian Government, 2020).

More recently, the current Labor government under Prime Minister Albanese has committed to allocating AUD 62 million to training to support a skilled renewable energy workforce and to conducting a Clean Energy Capacity Study to map the specific skills needs in the sector (O’Connor, 2022). The national government has also set out its vision



for a longer-term VET reform under a new National Skills Agreement. While it does not refer directly to green skills, it includes an objective for VET to help develop a domestic workforce that can deliver on current and future priorities by providing ‘critical and emerging industries at a national, state and local level with the skilled workers they need’ (Australian Government, 2022).

1.3.3 INITIATIVES FOR THE GREENING OF VET IN QUEENSLAND

State and territory governments have been actively involved in the greening of VET in the past. The New South Wales government, for example, funded the first state-based green skills initiative in 2008. 3 years later, the South Australian government undertook a series of efforts to enhance the capacity of South Australian TAFEs to deliver green skills (McDonald, et al., 2012).

The State of Queensland has also taken steps to strengthen the greening of VET over the past two decades. Following the implementation of its Climate Change Strategy (Climate Q) in 2008,

the state of Queensland committed to several initiatives focused on green skills provision. These included the creation of a Green Building Skills Fund in 2009, which subsidised green skills training for 3,000 third- and fourth-year apprentices in the construction industry. In the same year, the state of Queensland developed a sustainability policy and action plan for the VET sector. This included the Skills for a Low Carbon Economy initiative, which aimed to identify and address key green skills issues and opportunities in three carbon-intensive sectors of the regional economy: automotive, energy, and mining (Queensland Government, 2009; McDonald, et al., 2012).

In 2017, the Queensland Climate Transition Strategy was launched under the heading ‘Pathways to a clean growth economy’. It set a target for the state to achieve zero net emissions by 2050, in line with Australia’s ratification of the Paris Agreement. The strategy also outlined how the Queensland Government planned to achieve this, including an increased focus on renewable energy and

electric mobility, as well as research and innovation efforts across a range of sectors. Skilling Queenslanders for jobs in the new economy was also part of the recommended approach. In the 2017 Climate Strategy, the State Government committed to working with local governments and key stakeholders to develop local and regional jobs plans, as well as working with the State's industries and communities to develop training plans for low and zero emission jobs (Queensland Government, 2017).

To further strengthen the development of its VET sector, the State of Queensland released the Skills for Queensland strategy in 2019. Notably, it does not contain any references to green skills or sustainability. Instead, it describes in more general terms how jobs in the state's future labour market

will require different and higher-level skills, with the regional VET sector given a central role in terms of addressing this issue by preparing an adaptable and skilled workforce (Queensland Government, 2019).

More recently, the Queensland Government announced its Energy and Jobs Plan in September 2022. The plan includes an investment of AUD 62 billion to deliver clean, reliable and affordable energy across Queensland. It also sets new renewable energy targets for the state of 70% by 2032 and 80% by 2035. In terms of supporting workers, the Energy and Jobs Plan aims to deliver a Future Energy Workforce Roadmap and to establish two new regional transmission and training hubs (Queensland Government, 2022(a); Queensland Government, 2022(b)).



2. MANAGEMENT AND ORGANISATION OF THE ROBINA CAMPUS

This chapter outlines the organisational structure and management of TAFE Queensland's Robina campus. It also presents the sustainability objectives defined by the campus management against the background of relevant institutional strategies. Finally, the chapter describes the resources and facilities available to the management and staff of the Robina campus as they work towards achieving these goals.

2.1 ORGANISATIONAL STRUCTURE

The Robina Campus is one of six TAFE Queensland campuses in the Gold Coast region.²¹ There is a Senior Leadership

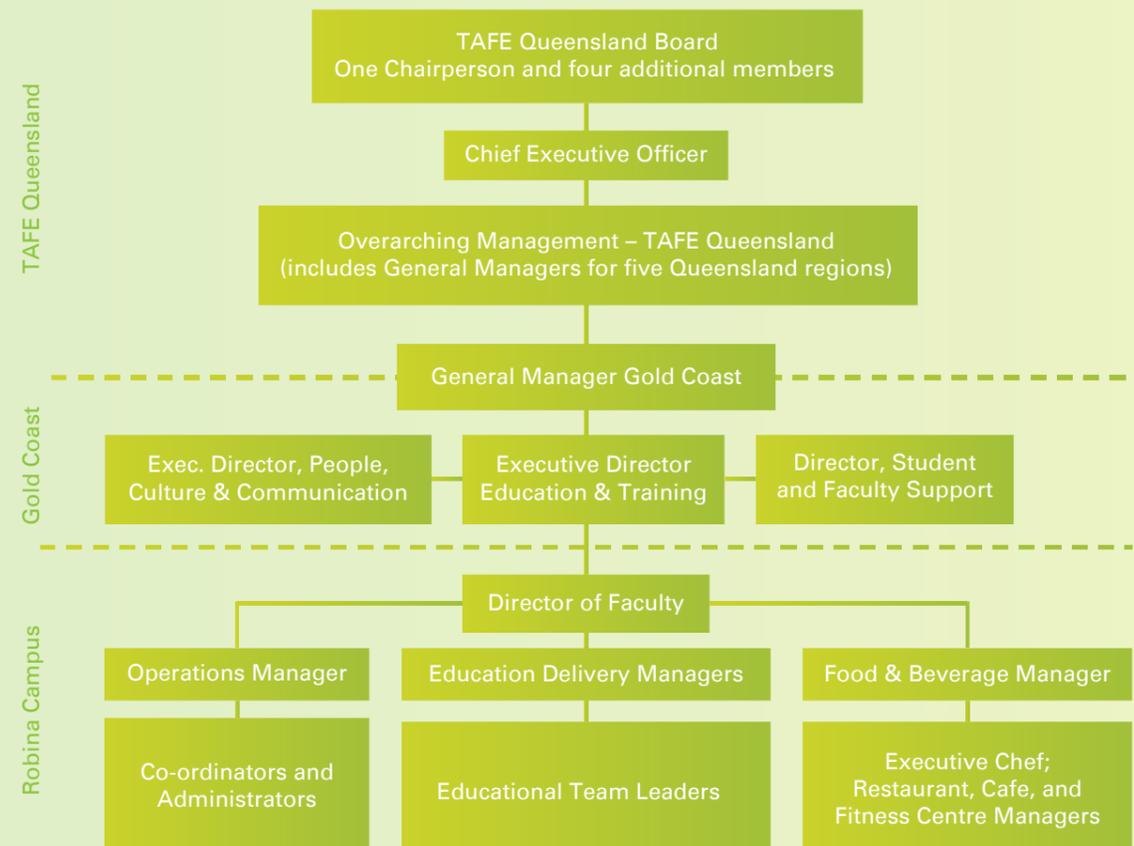
Team in place responsible for the overall management of these campuses. It is headed by a General Manager and also includes three Executive Directors who are responsible for Education and Training, Culture and Communication, and Student and Faculty Support. The other members of the Senior Leadership Team are four Directors of Faculty who are responsible for specific campuses (in addition to management staff responsible for quality assurance, finance, technical support and business development).

The diagram below illustrates the organisational structure of the Robina campus. It also shows how the management of the campus is linked to the Senior Leadership Team in the Gold Coast region and to the overall management of TAFE Queensland.

²¹ The region spans from Coolangatta in the south to Coomera in the north.



FIGURE 3. ORGANISATIONAL CHART



Author's work based on internal charts provided by TAFE Queensland.

As shown in Figure 3, there is a Faculty Director who is responsible for the day-to-day operations of the Robina campus. She reports to the Executive Director responsible for Education and Training in the Gold Coast region and to the General Manager for that region. The latter is also part of the overall management of TAFE Queensland, which is led by the Chief Executive Officer under the Board of the TAFE Queensland.

The Robina campus has a café, bar, restaurant and a gym (see also section 2.4). These are open to the public and run by staff and students. Within the

organisational structure, there is a Food and Beverages Manager who manages an Executive Chef and managers for the above facilities.

While there is no specific sustainability position, such as a 'Greening Officer', on the management team of the Robina campus or the Gold Coast campuses, TAFE Queensland has established its own Social and Environmental Sustainability Committee. The committee, which is described in more detail in section 2.3, is currently made up of TAFE Queensland staff from across the state.

2.2 SUSTAINABILITY GOALS OF THE ROBINA CAMPUS

The Robina campus was conceived as a flagship for TAFE Queensland in terms of integrating environmental and social sustainability into VET. Senior management with responsibility for the Gold Coast region were heavily involved in developing the vision for the campus in terms of designing a green campus and integrating sustainability into the curriculum.

During the design and construction of the Robina campus, TAFE Queensland

developed and implemented its Social and Environmental Sustainability Action Plan 2020-2024. In the plan, TAFE Queensland outlines its sustainability goals and describes the strategies and actions to be implemented to achieve these goals. The United Nations Sustainable Development Goals (SDGs) are a central element of the Action Plan, which emphasises that VET has a key role to play in achieving these goals. Throughout the four-year plan, TAFE Queensland is committed to supporting sustainability by focusing on eight priority areas, which align with ten of the United Nation's seventeen SDGs. The infographic below summarises the VET provider's key commitments in this regard.

FIGURE 4. THE EIGHT PRIORITY AREAS LINKED TO TEN OF THE UNITED NATIONS SUSTAINABILITY GOALS IN THE TAFE QUEENSLAND'S SUSTAINABILITY ACTION PLAN



Source: Adapted from TAFE Queensland, 2021

Each of the eight focus areas outlined above is linked to specific actions and outcomes in TAFE Queensland's Strategic Plan. The plan identifies who in TAFE Queensland's senior management is responsible for implementing these activities. For example, in relation to sustainable water management, TAFE Queensland intends to promote the wider use of water-efficient appliances and increased rainwater harvesting and storage. The Chief Financial Officer has overall responsibility for the implementation of these actions, which are to be achieved in close collaboration on water sustainability issues with the Queensland Department of Employment, Small Business and Training (as the owner of TAFE Queensland's infrastructure and assets).

TAFE management in the Gold Coast region had already begun to work strategically with the UN SDGs in the planning of the Robina campus, prior to the release of TAFE Queensland's Sustainability Strategy for 2020-2024. Recognising that the campus will serve as a flagship for the integration of sustainability into VET, the leadership responsible for the Robina campus has committed to all UN SDGs. The priority objectives for the campus initially covered only six SDGs but are now aligned with the eight focus areas and ten SDGs highlighted in TAFE Queensland's Sustainability Plan.

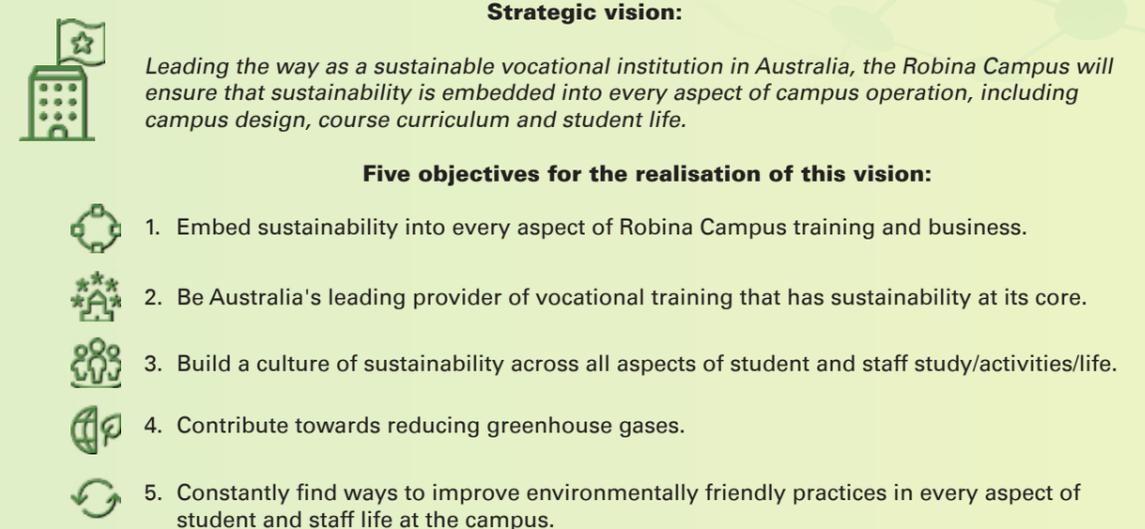
With this in mind, the Robina campus was selected as the first of TAFE Queensland's campuses to seek accreditation under the Sustainability Tracking, Assessment and Rating System (STARS). The system is a

transparent, self-reporting framework that helps colleges and universities to measure their progress in terms of sustainability. STARS was developed by the Association for the Advancement of Sustainability in Higher Education, based in the US and Canada (AASHE, n.d.). As a framework for assessing sustainability practices, it considers several dimensions. These include the integration of sustainability into the curriculum, the engagement of staff and students, and the planning and management of sustainability initiatives by senior management. There are four levels of STARS accreditation, from bronze to platinum. The Robina campus management has appointed a project manager to coordinate the accreditation process. Management's current plan is to apply for Bronze accreditation by mid-2023. In each of the following years, the campus intends to aim for a higher STARS rating, i.e. silver, gold, and platinum.

To make progress with its priority goals and to work towards achieving STARS accreditation, management has initially developed a 12-month Robina Campus Sustainability Plan. Through further consultation with staff, students, and external stakeholders, the aim is to develop a 3-to-5-year strategic plan. Currently, the plan for the Robina Campus includes the strategic vision illustrated in the infographic below.

In working towards the objectives presented in Figure 5, management can draw on a range of human and financial resources as well as the newly built campus facilities. These are described in the following three sections.

FIGURE 5. VISION AND OBJECTIVES SET OUT IN THE ROBINA CAMPUS SUSTAINABILITY PLAN



Source: Internal document

2.3 HUMAN RESOURCES

As mentioned above, TAFE Queensland has established an organisation-wide Social, Environmental and Sustainability (SES) Committee. The committee consists of 13 key members of staff from different regions and a student representative. Staff members are associated with a range of roles and responsibilities. They include, for example, TAFE Queensland's General Manager of Operations (who chairs the committee), TAFE Queensland's Director of Assets and Infrastructure and the Regional Directors of Educational Support Services. The General Manager responsible for the Gold Coast region, including the Robina campus, is also a member of the committee.

The primary role of the SES Committee is to work towards the implementation of TAFE Queensland's Social and Environmental Sustainability Action Plan

(see section 2.2) across all regions. In support of this objective, the committee carries out a range of activities, including:

- Providing a regular forum for the exchange of ideas, opinions, and information on sustainability issues.
- Encouraging and facilitating discussion relating to TAFE Queensland's social and environmental sustainability practices.
- Identifying and discussing areas for improvement in sustainability practices.
- Providing updates on ongoing projects in support of TAFE Queensland's Social and Environmental Sustainability Action Plan.

(Source: TAFE Queensland, 2021)

At the Robina campus, a local sustainability committee has been established to promote sustainability

initiatives at the campus. The committee, which has 13 members, meets once a month, with the General Manager and Executive Director for TAFE Queensland in the Gold Coast Region attending on an ad hoc basis. There are seven staff members on the committee, including the Faculty Director and various administrative staff. There are also six student members, with the Robina campus management planning to recruit students to the committee on an annual basis. In line with the campus sustainability plan, the committee is mandated to:

- Focus on opportunities to educate and engage staff, students and the community by promoting awareness of the Sustainable Development Goals in focus at the Robina Campus and how these goals relate to sustainability issues related to campus operations and industry practices in the sectors for which training is provided on campus.
- Encourage student and staff participation in relevant activities and events on and off campus that demonstrate and enhance TAFE Queensland's commitment to sustainability.
- Identify, report and recognise 'best practice' examples of cases where staff or students have worked with industry or the community on initiatives that promote sustainability.

(Source: internal document)

The work of the Robina Campus Sustainability Committee is supported by an Engagement and Events Officer on campus. The officer is responsible for developing an annual calendar and ensuring that events and activities for students, staff and the local

community with a sustainability theme take place on a weekly basis. One specific example was a joint initiative with the neighbouring Robina High School in November 2022, where students and staff were encouraged to collect used linen for recycling. The items collected were donated to an Australian homewares brand's recycling programme, which uses them to make new towels. Other examples include information sessions (e.g., on the correct use of recycling bins), social media events (sharing of student-produced content to raise funds for charity), and pop-up marketplaces (e.g. selling handmade alternative Christmas gift wrapping made from recycled materials in stalls in the campus atrium).

In general, the efforts to integrate sustainability into the Robina campus are driven by a culture that is based on the recognition and acknowledgement that it is important to strive for greater sustainability and climate responsibility. From staff working in the campus café or restaurant to teachers, trainers and management, there is a shared concern about how to reduce the carbon footprint of the Robina campus. The Director of Faculty has been involved in forming a community of practice with Educational Team Leaders, teachers, and trainers around the sustainability goals of the campus. They use an online communication platform to share relevant external resources, such as teaching materials, articles, and case studies, as well as examples from their own practice that demonstrate how sustainability can be integrated into specific training programmes and lessons. Students are also described by management as being engaged and actively contributing with ideas to

support the sustainability goals of the Robina campus.

While the culture at the Robina Campus is clearly informed by the fact that the campus is intended to be a flagship for TAFE Queensland's commitment to sustainability, it is also driven by strong leadership. The General Manager responsible for TAFE Queensland in the Gold Coast region is a passionate advocate for embedding social and environmental sustainability into campus design, course curriculum and student life across the campuses of the VET provider. She has recently completed the UNESCO-UNEVOC Technical and Vocational Education (TVET) Leadership Programme, the 2022-2023 edition of which focused on 're-thinking TVET

systems and programmes to anticipate demand, adapt and take action for a just and green transition' (UNESCO-UNEVOC, 2022). The text box below contains some of the General-Manager's thoughts on sustainability work at the Robina campus.

ROBINA CAMPUS BUILDING AND FACILITIES

The Robina Campus took two and a half years to build and officially opened in July 2022. It is the first VET campus in Australia to be 'designed from the ground up to be sustainable in building, fit-out, procurement, curriculum, operations, and culture' (TAFE Queensland, 2022b). The physical campus consists of a five-storey building with a wide range of facilities. It was built to National Australian Built



Karen Dickinson
General Manager
TAFE Queensland
Gold Coast

'There is a lot of pride in what we are doing at the Robina Campus. We might be early in our journey, but we are 100% committed to doing innovative things in the future. We want to share our message on sustainability, not only with our students, but more broadly with the community. The foundations for the Robina Campus were laid about 3 years ago and particularly the past 18 months have been quite intensive in terms of developing our people and their commitment to sustainability. But we were always very clear on having plans in place, for example, in terms of finding a way to educate our staff on sustainability. Thirteen of our senior leaders completed a sustainability course with Cambridge University. There was quite a lot of upskilling for senior leaders with regard to the Sustainable Development Goals with the intention that these leaders would cascade their insights into the wider organisation. The recruitment process also focused on a commitment to sustainability – we said to people: 'To work at this campus, you have to be committed to sustainability and act as a role model in living and breathing that commitment every day.' Last but not least, there was the whole concept of one team, where staff across campus, including the different educational teams, collaborate on working towards our sustainability goals.'

Source: Interview quote. Image by TAFE Queensland.

Environment Rating System (NABERS) 5, the second-highest level in the national rating system that measures the environmental performance of Australian buildings and tenancies. Level 5 is labelled 'Excellent', with the highest NABERS rating being 6 – Market-leading building (NABERS, n.d.). It should be noted that the Robina campus received a silver award in the construction category at the 2022 World Federation of Colleges and Polytechnics Awards of Excellence. The Federation is an international network of national and regional associations of colleges providing leadership in workforce education for the global economy (WFCP, n.d.).

Campus facilities include a café (The Seedpod Café) and a gym (TQ Fitness) on the ground floor. Upon entering the main entrance to the campus building, step into an atrium with a seating area, several flat screen monitors and two large projectors used to project images and videos onto the ceiling (see Figure 6). As well as being used to disseminate various types of information, the flat screens regularly display the monthly performance of the campus in terms of electricity and water consumption, solar energy produced for the grid and the amount of waste recycled.

The atrium pictured above provides access to the café, customer centre, staff offices, and stairs to the lower and upper levels of the building. The basement provides underground parking facilities, locker rooms and showers for both staff and students. There

are also charging points for electric cars, bikes, and scooters. It is part of the Robina Campus Active Transport Strategy to enable students and staff to use alternative forms of transport to the campus and give them the chance to freshen up and change clothes, for example, after cycling or running to the campus.

The upper floors of the campus building house an auditorium, training spaces, classrooms and the Robina Events Centre, a conference and banqueting facility. The training spaces include a hairdressing and barber salon, a beauty salon, childcare facilities (i.e. rooms designed for nursery activities) and training kitchens. On the top floor, there is the Green Fields Bar & Restaurant which, like the Campus Café, is partly student-run. Customers of the bar and restaurant can enjoy their meals and drinks on the outdoor terrace, which is covered but otherwise open air.

A number of campus facilities and services are designed to allow for members of the public to enter and experience the Robina Campus. The café, bar and restaurant, gym, and the hairdressing and beauty salons are all open to the public. This gives not only gives the community access to a range of services, but also allows the students who work or train in the facilities to practise their skills in a real business environment. The images below show some of the facilities at the Robina campus.

FIGURE 6. ATRIUM OF THE ROBINA CAMPUS DURING ITS GRAND OPENING



Image: TAFE Queensland

FIGURE 7. FACILITIES AT THE ROBINA CAMPUS. CLOCKWISE FROM TOP LEFT: HAIRDRESSING SALON; BEAUTY TRAINING SALON; CAMPUS BAR AND RESTAURANT OUTDOOR SEATING AREA; PUBLIC ACCESS GYM



Images: TAFE Queensland

Designed with sustainability in mind, the Robina Campus also incorporates a number of special features that promote energy efficiency and reduce its carbon footprint. There are 250 solar panels on the roof of the building (see Figure 8 below), which can produce around a third of the energy needed to power the building, depending on weather conditions and the building's electricity consumption. For example, during the summer months when humidity levels are high, the use of air conditioning in the building causes a spike in energy consumption. In addition to the solar panels, the campus has a rainwater-fed irrigation system. The building has sensor-activated lighting – mainly using energy saving LEDs – and features solar glass, which is a specially coated glass designed to reduce the amount of heat entering the building.

In general, energy consumption is monitored using a building management system, which can also be used to centrally control lighting, air conditioning or other related infrastructure of the building. For example, a student member of the Robina Campus Sustainability Committee noticed and reported to management that screens and monitors in classrooms and training areas often remained on overnight. The building management system was then used to create an override switch that turns off the equipment at the end of the day.

Recycling is another aspect that campus features promote. There are colour-coded recycling bins on every floor of the building, allowing users to sort waste by type, such as compostable organic waste, plastic and metal food containers, and bottles, cans and beverage

FIGURE 8. ROBINA CAMPUS BUILDING. THE SOLAR PANELS ON THE ROOF AND THE OUTDOOR SEATING AREAS OF THE RESTAURANT (TERRACE UNDER THE ROOF) AND OF THE CAMPUS CAFÉ (NEXT TO THE CAR PARK) ARE VISIBLE



Images: TAFE Queensland



cartons. The Robina campus also has an industrial-grade, closed composting system. It converts about 80% of the organic waste from the campus café and restaurant (around 140 kg per week) into rich fertiliser.

The infographic below provides an overview of the campus facilities as they relate to energy efficiency and sustainability.

As noted in the infographic above, the Steering Committee involved in the fit-out of the building made a significant effort to source sustainable furniture, carpets, and other interior items. For example, the carpet in the atrium was sourced from a local supplier, with both the carpet's nylon fibres and the rubber underneath made from recycled materials. Tables, wooden floors, and decorative walls in other

FIGURE 9. OVERVIEW OF THE CAMPUS FACILITIES SUPPORTING CARBON FOOTPRINT REDUCTION AND SUSTAINABILITY

 <p>250 solar panels on the roof of the campus building produce around one-third of the energy needed to power it.</p>	 <p>Sustainable fit-out – interior items, such as furniture, procured according to high sustainability standards.</p>
 <p>Solar glass used for the building's windows reduce the amount of heat entering the building.</p>	 <p>Colour-coded recycling bins placed on all floors of the campus building.</p>
 <p>Sensor activated lighting helps reduce energy consumption.</p>	 <p>Industrial grade composter turns approx. 80% of the organic waste from the campus café and restaurant into fertiliser.</p>
 <p>Building management system is used to maximise energy efficiency of the campus building.</p>	

parts of the building were made from old railway sleepers, telegraph posts and other types of recycled wood. While completing the campus fit-out, management followed the state government's minimum procurement standards for sustainability, but also applied stricter evaluation criteria. This was done to ensure environmental sustainability, by focusing on the procurement of items produced locally and/or in a climate-friendly manner, as well as in favour of social sustainability, by aiming to buy from companies that ensure fair working conditions and wages for the workers producing the relevant items. It can be added that management continues to adhere to the procurement standards described as far as possible, for example by applying them to the purchase of food ingredients and beverages for the café, bar and restaurant on campus.

2.4 FINANCIAL RESOURCES

As a State-owned VET provider, TAFE Queensland relies on public funding. It has to get approval from the Queensland Government to make significant investments or procurements, including when they promote sustainability. For example, to establish the Robina campus, TAFE Queensland had to submit a Cabinet Budget submission to the Queensland Treasury. In order to secure the State Government's support

for the project, TAFE Queensland had to set out in its submission how much it would cost to develop the campus and what value it would add once completed.

In the specific planning of the Robina Campus, it was decided that TAFE Queensland would lease the building, which today is owned by the state government (while a private contractor has been tasked with external facility management). While the Queensland Government financed the construction of the Robina Campus building, TAFE Queensland also received 10 million Australian Dollars (AUD) from the Queensland Department of Employment, Small Business and Training for its fit-out. This is equivalent to 5,9 million euros. As a total project cost of more than 23 million AUD (13,57 million euros) had been approved, TAFE Queensland also used around 13 million AUD (7,67 million euros) of its own budget towards the same purpose.

Against this background, the Robina campus represents a significant investment by both the State of Queensland and TAFE Queensland in the integration of sustainability into VET. At the same time, it is important to emphasise that the VET provider's access to funding for sustainability initiatives generally depends on relevant budget allocations by the Queensland Government.



3. SUSTAINABILITY IN CONTENT AND PROGRAMMES

This chapter focuses on how sustainability is integrated into the training programmes at TAFE Queensland's Robina Campus. It examines both educational content and curriculum development, and the professional development of teachers and trainers in relation to sustainability.

3.1 EDUCATIONAL CONTENT

In line with the Robina Campus Sustainability Plan, campus management has worked to integrate sustainability across the curriculum and into student life on campus. In terms of formal education, an effort has been made to link every single course unit in all educational programmes to the sustainability focus areas outlined in the plan. At the same time, the campus design and sustainable initiatives not directly linked to specific educational programmes promote

knowledge and values that support climate responsible and socially just practices.

Within the training programmes offered at the Robina campus, knowledge and skills related to environmental sustainability are primarily taught to VET students by showing them how practices in relevant industry sectors can be made 'greener', for example by using resources more efficiently and implementing waste management systems. For example, hairdressing and beauty therapy students are being taught about chemical content of beauty products so that they can identify which products are more biodegradable than others. These students are also taught how to use resources efficiently, for example, by optimising the amount of beauty products used for an individual treatment and limiting the use of water, detergents and electricity when sanitising equipment.

A focus on waste management and recycling is characteristic of most of the training programmes at the Robina campus. Within the hairdressing programme, there is a collaboration with the social enterprise Sustainable Salons. It provides a specific system for separating waste for recycling and organises the logistics of transporting sorted waste to recycling centres. The system gives students experience in terms of minimising the amount of waste sent to landfill, while also enabling the reuse of hair clippings which, with the help of Sustainable Salons and external partner, are turned into fertiliser or upcycled into wigs and hair mats for oil spill containment. As well as learning how to separate waste, cookery students are also shown how organic waste from the kitchen can be turned into rich fertiliser through the use of the industrial grade composting system on campus (see section 2.4). The manure is currently given to the social enterprise Raba Urban Farm, which runs a community farm and garden. According to the Culinary Education Team Leader, the aim of the arrangement is to eventually use the food grown on the farm with the manure in the training kitchen and restaurant on campus. Some of the vocational students trained on campus have already visited the Raba Urban Farm and worked on creating their own raised garden beds.

Another specific example is the use of natural resources by students in early childhood education and care. Part of this training programme is a focus on nature play, known in Australia as 'bush kinder', where children are given the opportunity to engage in unstructured in natural environments (i.e. forests and beaches). Students in this area practise using natural objects from these

environments, such as sticks, pine cones and shells, in educational activities with young children. At the Robina campus, Early Childhood Education and Care students, for example, have used natural objects to make festive decorations. They also learned how to create small worm farms using organic waste to make compost.

The Educational Team Leaders, who are responsible for training in the different fields of study offered at the Robina campus, emphasise that the integration of sustainability into the training programmes is an ongoing process. At the time of writing, the campus has been in operation less than a year and it is the clear aim of management, teachers, and trainers to identify and disseminate an increasing number of approaches that will enable students to act in an environmentally responsible and resource-efficient manner in their future careers.

At the Robina Campus, there is also a lot of non-formal learning on sustainability taking place. There is, for instance, a collaboration between the campus and the Robina State High School on an initiative called 'Containers for Change'. Students from both educational institutions are involved in collecting and returning drink containers to dedicated recycling facilities in exchange for a small refund (10 Australian cent (about 5,9 euro cents).²² Received refunds are given back to the community, for example, by being used to sponsor a local scout club or the work of other non-profit organisations.

²² Unlike some other countries, Australia does not have a national deposit return scheme for drink containers.

As previously mentioned in section 3.1, the Engagements & Events Officer at the Robina Campus is responsible for ensuring that sustainability related events take place on campus on a weekly basis. Past events have included an information session on the Robina Campus Active Transport Strategy, which supports both environmental and social sustainability goals. On the one hand, encouraging students to use alternative transport modes to get to campus helps to reduce greenhouse gas emissions. On the other hand, encouraging students to walk or cycle to campus helps to promote student health and well-being. To support the latter, management conducted a survey among students about their commuting habits. Management encouraged them to complete the survey by announcing that one randomly selected respondent would win a brand new electric bike.

Another example of an initiative that supports environmental sustainability across the campus is the paperless policy at the Robina Campus. To reduce the use of resources, both staff and students are encouraged to minimise the use of paper and instead use digital devices to share and store information. Delivering paperless education is made possible in part by Robina Campus being established as TAFE Queensland's first 'Bring Your Own Device' campus. Students are encouraged to bring their own laptops or tablets to class, while those without access to suitable devices can borrow electronic tablets with wireless network connectivity. These loan devices, along with slightly more advanced electronic tablets provided to all campus, were procured with sustainability in mind. This means that the campus management considered various factors, including environmental

performance criteria, when deciding which devices to purchase.

In general, it can be said that many individual initiatives across the campus have contributed to the third of the five strategic objectives of the Robina Campus Sustainability Plan, namely 'building a culture of sustainability'. The café, bar and restaurant offer locally or regionally produced food and drinks, while public displays inform students and staff about the energy and resource efficiency of the campus. Some of the walls in the campus building are decorated with messages about the importance of environmental sustainability and the UN SDGs, while some of the carpets and meeting room tables in the building are made from recycled materials. These examples demonstrate a holistic approach to the integration of sustainability at the Robina campus and are expected to influence student awareness and learning.

3.2 CURRICULUM DEVELOPMENT

As the primary purpose of TAFE Queensland is to provide training and skills for the workplace, the VET provider must be responsive to the skills needs of the relevant industry sectors. The TAFE Queensland's management therefore meets with industry sector panels on a regular basis to discuss the content of training programmes with industry partners. However, there has been little input from industry in terms of the curriculum for the training programmes offered at the Robina campus. Instead, the 'greening of the curriculum' has been primarily driven by the strategic sustainability goals of both TAFE Queensland and the Robina campus management.

As noted above, six of the UN's seventeen SDGs were initially selected by the Steering Committee responsible for the development of the Robina campus as a framework for the embedding of sustainability in VET²³ (the sustainability focus areas were subsequently aligned with TAFE Queensland's overarching Social and Environmental Sustainability Action Plan). Several activities were undertaken by management and education team leaders to link the selected SDGs to each of the training programme delivered at the Robina campus. These included, for example, the identification of best practices that demonstrate responsible production methods in a relevant industry, with management and education team leaders looking not only at local workplaces but also further afield. In addition, a mapping of relevant legal instruments, such as policies, industry standards and codes of practice that promote sustainability was conducted.

As described in more detail in section 4.3, teaching staff were supported by the Educator Capability Manager at TAFE Queensland in the Gold Coast region in embedding sustainability into each training programme. To achieve this, faculty were asked not only to collect best sustainability practices from industry and elsewhere, but also to plan how and when these could be most effectively communicated to students within specific training programmes. For example, in learning

²³ SDG 3: Good Health and Well-being, SDG 4: Quality Education, SDG 5: Gender Equality, SDG 8: Decent Work and Economic Growth, SDG 12: Responsible Consumption and Production, and SDG 13: Climate Action.

about the importance of experiencing nature for child development students in early childhood education and care might learn how unstructured outdoor play or gardening is linked to young children's wellbeing. Another example could be the latest industry standards for handling waste from chemical consumables in hair and beauty salons. As one of the education team leaders points out, the 'sustainability stories' serve a dual purpose. Firstly, they are used by teachers and trainers to share experiences or knowledge that can help students be more sustainable manner in their future careers. Secondly, they are also intended to focus on why it is important to do so (How stories are used as part of the pedagogical approach at the Robina campus is described in section 5.1)

3.3 TEACHER TRAINING TO SUPPORT SUSTAINABILITY INTEGRATION

There has been a systematic approach to developing the sustainability skills of all staff at the Robina campus. All 13 members of the Senior Leadership Team (see section 2.1) completed the Cambridge University (UK) Sustainability Essentials for Business online course (University of Cambridge, n.d.). The course is designed to help participants develop a common understanding of sustainability and how to promote it within organisations. The course, which takes approximately 8 hours to complete, focuses on broader sustainability objectives related to social, environmental and economic factors. In addition, management of TAFE Queensland in the Gold Coast region developed a 4-hour sustainability orientation programme,

which explores the seventeen UN Sustainable Development Goals (SDGs) in greater detail. All staff working at the Robina campus completed this online programme before starting work at the campus.

In terms of teacher training, a professional development programme on sustainability for teachers and trainers was conducted over a 6-month period prior to campus opening. It focused primarily on how teachers and trainers could embed educational content related to six selected SDGs into the curriculum (see footnote 6). These represented the Robina Campus' priority sustainability goals at the time, which were later aligned with TAFE Queensland's overarching sustainability plan. The professional development programme was facilitated by the Educator Capability Manager of TAFE Queensland in the Gold Coast region. She held individual sessions of between 1 and 3 hours with the various educational teams responsible for the courses offered on campus. At the sessions, the education team leaders, teachers and trainers worked to develop a clear 'sustainability story' for each of the programmes being delivered at the Robina campus. This involved considering how each competence unit (or cluster of units) could be linked to one or more of the SDGs that are the focus of the campus. The participants in the professional development programme used a

workshop template for this process. Among other things, it allowed for the listing of local workplaces that demonstrate good sustainability practices as well as relevant examples of industry policies, procedures, and standards that could be used in course delivery. The template also encouraged consideration of the actual delivery of educational content related to the selected SDGs, such as what equipment or resources would be required. Teachers and trainers were also asked to consider how to best use of the digital technologies available at the Robina Campus in this context (see section 4.2 for a description of some of these technologies). Each teaching team participated in a total of 8 hours of facilitated sessions. In between sessions, they were given a series of individual tasks to further develop the embedding of sustainability in the programmes for which they were responsible.

Since the opening of the campus and the start of educator delivery, further professional development has been facilitated through a peer observation and feedback process implemented by the education team leaders. The online communication platform mentioned above (section 3.1), which is used by all education staff to share experiences and teaching resources on sustainability, also contributes to the professional development of teachers and trainers at the Robina campus.



4. PEDAGOGICAL APPROACH

This chapter describes the pedagogical approach at the Robina campus and how it is being used to support students in acquiring skills and competencies related to sustainability. The final section examines the students' experiences of the sustainability focus of the campus.

4.1 PRACTICAL AND JOB-FOCUSED TRAINING

The pedagogical approach at the Robina Campus is strongly characterised by the provision of practical training for students. Thanks to the training facilities available on campus, vocational students are taught in a professional environment. Early Childhood Education and Care students, for example, prepare for their future work in nurseries in a

room equipped with toys and furniture designed for children. In other areas of study, students are given the opportunity to gain relevant work experience on campus. For example, Sport and Leisure students may work in the campus gym, which is open to the public. Here, they practise developing personalised exercise plans for clients and instructing them in the proper use of the equipment. Hospitality management students develop their skills by serving food and non-alcoholic drinks in the café, bar and restaurant on campus, some of which are run by students. Similarly, beauty and hairdressing students learn in a salon environment where part of their training involves providing beauty services and haircuts to private clients.

FIGURE 10. PROVISION OF TRAINING IN PROFESSIONAL SETTINGS. CLOCKWISE FROM THE LEFT: COOKERY STUDENT BEING SUPERVISED IN THE TRAINING KITCHEN; HANDS-ON TRAINING IN THE CAMPUS HAIRDRESSING SALON; THE TRAINING ENVIRONMENT FOR EARLY CHILDHOOD EDUCATION AND CARE STUDENTS



Images: TAFE Queensland

Across the various training programmes, efforts are made by the responsible teaching teams to demonstrate and apply sustainable practices. As mentioned earlier, examples include waste sorting in the training kitchen and hairdressing salon, and the use of natural resources in early childhood education and care. Optimising the use of beauty products and resources for sanitising equipment in the beauty salon to the minimum amount needed is another example. Put simply, students at the Robina campus learn responsible ways of producing and consuming by first being shown and then trying them out. In this way, they gain practical knowledge of how to carry out tasks

they may be given in their future careers in a more sustainable way. Greening initiatives implemented across the Robina campus, including recycling efforts, a paperless policy and procuring local and/or sustainably produced food and inventory, reinforce sustainability messages in the educational content. Teachers and trainers are also expected to act as role models, reflecting on their own behaviour and continually striving to be more sustainable. In line with TAFE Queensland's decision to make the Robina campus a flagship for sustainability, management and educators at the campus aim to help students develop a sustainability mindset. As mentioned by several

teachers and trainers, one of the aims is to create a 'trickle-down effect', where students going out into their community and workplaces inspire others to think about and adopt more sustainable practices.

In section 4.3 it was mentioned that teachers and trainers were supported by a facilitator in creating 'sustainability stories' to link the training they provide to the UN SDGs in focus at the Robina campus. The use of the term 'stories' has since become part of the vocabulary or culture at the campus. Teachers and trainers regularly start individual units by sharing inspirational practices that they have either witnessed themselves in a relevant industry or learned about from other sources. As one of the teachers explains, the use of stories in this way is about sharing experiences that bring the curriculum or theoretical content to life:

'Storytelling is part of our applied learning approach. It helps students to unpack their knowledge. Teachers regularly share their industry experience with students in the form of a story, which helps to make practical examples more tangible and concrete. When students return from their placements, they often come back to their teachers and mention that they have been able to see the examples that the teachers shared in the classroom in action. Students are thus able to make links to what they have learned.'

(Source: Interview with teachers)

As well as describing good practice, the stories are also used by teachers

to encourage students to reflect on examples from industry practice that are not particularly environmentally friendly, for example. In this context, the students themselves are encouraged to share relevant experiences from internships or part-time jobs. For example, one student mentioned that there was no waste management in the hotel where he worked as a kitchen assistant. This led to a discussion with his teacher and fellow students of what he could do to promote recycling in his workplace.

In their community of practice, teachers and trainers share sustainability stories that they have used with, or that have come from, their students. As one of the teachers pointed out, this enables trainers to build on these shared experiences and use them in different training programmes to engage students in thinking about how practice in their profession could become more environmentally and socially responsible.

4.2 TECHNOLOGY ENABLED ACTIVE LEARNING SPACES

At the Robina campus, audio-visual technology is used to create learning environments that are more inclusive and offer different ways for students to participate in education and training. The so-called Technology Enabled Active Learning (TEAL) spaces not only contribute to minimising the use of paper on campus, but more importantly enable different forms of interaction and blended learning among students. For example, the campus has several

collaborative spaces where students who are physically present can engage in group work with other students participating remotely. These rooms are specifically designed for online conferencing, with wireless internet connectivity, webcams and flat-screen monitors that enable face-to-face online interaction between students on and off campus (see Figure 11 below).

Classrooms are equipped with similar equipment, allowing teachers and

students to wirelessly stream content from their digital devices to screens in the classroom. This allows all students in the classroom and those following a course unit remotely to receive the shared information. Management worked with IT professionals to ensure compatibility between all devices, including the campus's 'bring your own device' policy.

In a number of training areas, including the training kitchen and the hairdressing

FIGURE 11. USE OF AUDIO-VISUAL TECHNOLOGIES AT THE ROBINA CAMPUS. CLOCKWISE FROM TOP LEFT: INSTRUCTIONS ARE BEING FILMED IN THE HAIRDRESSING SALON WITH A CAMERA POINTING AT INSTRUCTOR AND THE CLIENT; STUDENTS WORK ON THEIR OWN DEVICES WHILE FOLLOWING SHARED CONTENT ON THE CLASSROOM FLAT SCREEN; TWO AREAS FOR STUDENT GROUP WORK WITH ONLINE VIDEO CALL EQUIPMENT; A COOKERY TRAINER GIVES A DEMONSTRATION IN THE TRAINING KITCHEN WITH STUDENTS BEING ABLE TO FOLLOW HIS INSTRUCTIONS FROM A DIFFERENT ANGLE ON THE SCREEN ON THE LEFT



Images: TAFE Queensland and DTI

and beauty salons, rotating cameras are set up to capture different work areas. For example, cameras are used to film close-ups of instructors demonstrating how to do a particular task. In cookery, this might be how to fillet a fish or decorate a cake with icing. In the hairdressing salon, students might be shown how to use a curling iron or how to use a particular haircutting technique. The cameras in the classrooms can capture these demonstrations from different angles for two purposes. On the one hand, the filmed content is shown simultaneously on several screens placed in the training room, allowing all students to follow relevant demonstrations, including those who cannot see directly what the trainer is showing because their view is blocked by other students or equipment. On the other hand, the filmed demonstrations can be accessed, synchronously or at a later time, by those students who follow the instructions online (see Figure 11 below). In this context, the technology-enhanced active learning spaces at the Robina Campus allow for different ways of receiving education and training, while at the same time helping to make VET provision more inclusive.

To enable teachers and trainers to work in the flexible learning spaces, which use a range of digital technologies, they received additional training. The Educator Capability Team designed a training programme to ensure that all educators understood how specific technologies could be used to further engage students. An emphasis was placed on how the technologies could best be integrated with the applied learning principles used at the Robina campus.

While the use of the technologies described is not necessarily sustainable in itself, the use of Technology Enabled Learning Spaces is a central part of how sustainability education content is delivered to students.

4.3 STUDENT ENGAGEMENT WITH SUSTAINABILITY

Students at the Robina campus emphasise that there is a holistic approach to promoting climate responsibility on campus. They mention the way in which they are taught to minimise their use of products and how to dispose of waste in a sustainable manner as specific examples. At the same time, they seem very receptive to what they are learning about sustainability. Several students describe how they have become more aware of their own carbon footprint or use of resources in everyday situations, such as driving their car or brushing their teeth with the tap running. Others emphasise that the practical nature of their training at the Robina campus makes it relatively easy to apply what they learnt about sustainability in other settings, both at work and at home, for example in relation to recycling and resource efficiency in general.

Students are highly motivated to acquire knowledge and skills related to sustainability. While some simply stated that working towards a more environmentally and socially sustainable society is 'the right thing to do', none of the students interviewed identified anything they learn about sustainability at Robina campus that

they did not consider 'useful' when asked. In addition, some students stated that what they have learned about resource and energy efficiency and sourcing more sustainable consumables had provided them with the necessary skills to contribute to a green transition in the industries in which they plan to work.

In addition, the students interviewed describe how receiving vocational training has influenced their values, with one student saying that it is 'contagious to learn and talk about sustainability'. Some of them shared that they are quick to notice the contrast between, for example, recycling practices at the Robina campus and at home. They describe that they are having conversations with friends and family about how small steps towards more sustainable behaviour can collectively have a significant impact in the fight against climate change. In this context, students emphasise that they appreciate the practical focus of the campus. They

mention that what they are learning is relatively simple and relatable, while also being demonstrated to them in a hands-on way, which the students find engaging.

With regard to the use of digital devices and audio-visual technologies, students point out that these technologies provide opportunities for more flexible learning. Some of the students interviewed stated that they prefer to use their digital devices rather than reading and writing on paper, partly because information is easier to store and find when needed. Other students highlighted the use of audiovisual devices for filming and showing trainers' demonstrations on flats screen monitors and/or their digital devices as helpful for their learning. In general, the students interviewed expressed that the educational staff at the Robina campus were doing an excellent job in terms of providing students with sustainability skills through practical and job-focused training.





5. CONCLUSION – KEY LESSONS LEARNED ABOUT SUSTAINABILITY INTEGRATION AT THE ROBINA CAMPUS

This case study examines the strategic approach to the green transition at TAFE Queensland with a particular focus on the integration of sustainability into campus design, the curriculum and student life at the VET provider's Robina campus in the Gold Coast region. The Robina campus has been designed as a flagship for the promotion of environmental and social sustainability. Senior management at TAFE Queensland

with responsibility for the Gold Coast region has been heavily involved in developing the vision for the campus, with a view to designing a green campus and embedding sustainability into the curriculum and campus culture.

The newly constructed five-storey campus building incorporates a number of features to support of energy efficiency and carbon footprint reduction,

including solar panels on the roof, solar glass (reducing the amount of heat entering the building), an industrial grade composting system electric bike and scooter chargers and a building management system. Management has made a special effort to ensure the sustainable fit-out of the building, with a focus on sourcing furniture and other interior items that are as far as possible were locally/nationally produced under good working conditions and preferably from recycled materials.

Specific strategies and approaches for embedding of sustainability have been developed by senior management at TAFE Queensland and by the Robina campus management team at local level. A Social, Environmental and Sustainability (SES) Committee has been established at the TAFE Queensland level. Its primary role is to implement TAFE Queensland's Social and Environmental Sustainability Action Plan, for example by identifying and addressing areas for improvement in sustainability practices. The Action Plan is structured around eight focus areas that align with ten of the United Nation's seventeen Sustainable Development Goals (SDGs).

While the above-mentioned Action Plan was being developed at TAFE Queensland, the Gold Coast regional management team responsible for the Robina Campus was working on its own strategy for embedding sustainability in VET. They first chose the United Nations SDGs as a framework for this process. The priority goals for the campus initially included six SDGs that TAFE Queensland as a whole is focusing on. These include SDG 4: Quality education; SDG 8: Quality job outcomes; and SDG 12: Responsible consumption and production.

The Robina Campus management has developed a specific sustainability plan for the campus, which includes a 12-month strategy to be further developed into a strategic plan with a time horizon of 2 to 5 years. One of its key objectives is to support the implementation of activities that will help the campus become the first VET institution in Australia to be accredited under the Sustainability Tracking, Assessment and Rating System (STARS). The system is a transparent, self-reporting framework helping colleges and universities to measure their progress within sustainability.

To support the embedding of sustainability into the VET curriculum, there has been a systematic approach has been taken to develop the skills of all staff at the Robina campus. While the senior leadership team completed an online course from Cambridge University called Sustainability Essentials for Business, all staff working at the Robina Campus completed an online introduction to the seventeen United Nations SDGs. In terms of teacher training, a professional development programme on sustainability for teachers and trainers was delivered over a 6-month period prior to campus opening. It focused primarily on how teachers and trainers can embed educational content related to the six selected SDGs in each unit (or cluster of units) of their training programmes. In addition, the Faculty Director and teachers and trainers at the campus have formed a community of practice around the delivery of sustainability-related educational content.

The pedagogical approach at the Robina campus is primarily characterised by practical and job-focused training. Some of the campus facilities, such as a café,

bar and restaurant, hairdressing and beauty salons and a gym, are partly student-run and open to the public, enabling students to gain relevant work experience on campus. It can be added that opening up the campus to the community has a pedagogical function in itself, as citizens can directly experience exemplary sustainability when using the campus services described.

Particularly in the vocational training areas of the campus, students learn about responsible ways of producing and consuming by first being given demonstrations and then being given the opportunity to try out the practices shown. They thus gain practical knowledge and skills to act in a more sustainable way. To this end, campus management and teaching staff have also established collaborations with social enterprises, such as Sustainable Salons and Raba Farm, which are leading initiatives to promote sustainability in hairdressing and horticulture, respectively.

Greening initiatives that are implemented cross the Robina campus, including recycling efforts, a paperless policy, and the sourcing of local and/or sustainably produced food and inventory, reinforce sustainability messages in the educational content. One of the overall aims of the Robina Campus is to

help students develop a sustainability mindset so that they spread sustainable ideas and practices in their community and work life in the future.

Skills provision at the Robina Campus is also characterised by Technology Enabled Learning spaces, which involve the use of audio-visual technology in combination with digital devices to create learning environments that are more inclusive and offer different ways for students to participate in education and training. These learning environments do not only help to minimise the use of paper on campus, but more importantly allow for different forms of interaction and blended learning between students.

In conclusion, it can be emphasised that there is evidence of a holistic approach to the embedding of sustainability in VET at the Robina campus. The campus building has been designed with energy and resource efficiency in mind, while management and teaching staff are working with students and external stakeholders to create a culture of sustainability across campus. There are well-defined strategic approaches to the embedding of environmental and social sustainability into the curriculum, while management is already working towards external accreditation of the overall process undertaken to promote sustainability at the Robina campus.

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ANNEX

This report is based on desk research and a 3-day visit to TAFE Queensland's Robina campus between 28 and 30 November 2022.

The mission included six group interviews conducted with the management of TAFE Queensland and its Robina campus, and with ten students. Four individual interviews were conducted with external partners, including not-for-profit organisations and a local high school, the Director of Asset Planning and Management and the Educator Capability Manager. Finally, a plenary discussion was held with most of the stakeholders interviewed, with the exception of students and external partners.

INTERVIEW PARTICIPANTS

GROUP INTERVIEW WITH THE MANAGEMENT OF TAFE QUEENSLAND AND THE ROBINA CAMPUS:

- The interviewees were the General Manager of TAFE Queensland Gold Coast (overseeing all six TAFE Queensland campuses in the Gold Coast region), the Faculty Director of the Robina campus and the three Educational Team Leaders working at the campus.

The interview covered a wide range of topics including a general introduction to TAFE Queensland as a public VET provider. The green design of the campus and its facilities were discussed. This included descriptions of the Robina campus' recycling initiatives and the use

of an industrial composter. Management also talked about their process of working with the UN Sustainability Goals (SDGs) as a framework for how sustainability is embedded in the Robina campus.

GROUP INTERVIEW WITH THE ROBINA STATE HIGH SCHOOL:

- The interviewees were the Principal of the Robina State High School and the teacher leading the student volunteer group 'The Sustainables'.

The group interview with the local high school, which is adjacent to the Robina campus, focused on collaboration around joint recycling and waste management initiatives.

GROUP INTERVIEW WITH FACILITIES MANAGEMENT:

- The interviewees were the General Manager of TAFE Queensland Gold Coast and a Director with responsibility for Assets, Facilities & Occupational Health and Safety.

George Anderson introduced the Robina Campus' Building Management System, how it is currently used and its potential to increase energy efficiency at the Robina campus. Part of the interview included a discussion of the procurement standards used to fit out the building.

GROUP INTERVIEW WITH TEACHERS:

- The interviewees were the Faculty Director of at the Robina Campus,

three Educational Team Leaders and teachers working in Early Childhood Education and Care, Educational Support, Cookery, Adult Tertiary Preparation and Beauty Therapy.

The interview with the teachers and their team leaders focused, in particular, on how they had worked to integrate the UN SDGs into educational content. They described some of the additional training they had received and how they tried to link each unit of a course or training programme to, in particular, the selected SDGs in focus at the Robina campus.

GROUP INTERVIEW WITH STUDENTS:

A group of ten students (attending different courses, including early childhood education and care, culinary arts and beauty therapy) were interviewed with education team leaders and teachers who were present during the group interview (and provided additional comments from time to time). Students emphasised that what they are learning about sustainability is meaningful to them and that they are able to transfer the sustainable practices they are learning at the Robina Campus to other professional settings, for example, as apprentices or when working as students in local hotels.

SECOND GROUP INTERVIEW WITH SENIOR MANAGEMENT:

- The interviewees were the Faculty Director at the Robina Campus, the Director of Student and Faculty Support at the Robina Campus and the Engagement and Communication Manager at the campus.

The interview focused on the Robina campus' Active Transport Strategy which — an initiative aimed at students to encourage them to use more

sustainable and active forms of transport (e.g. bicycles, electric scooters and public transport to and from the campus instead of cars). Parts of the strategy were discussed, and interviewees highlighted which facilities at the Robina Campus supported the strategy (e.g. changing and shower facilities to enable students to walk or cycle to campus in warm weather).

INDIVIDUAL INTERVIEW WITH THE EDUCATOR CAPABILITY MANAGER:

- The interviewee was the Manager of Educator Capability.

Mrs Brigette Hall is responsible for teacher training and continuous professional development. She was able to share the general approach of how teachers were introduced to the UN SDGs in general and how they were prepared through various workshops to integrate the selected SDGs in focus at the Robina campus into their individual training programme and/or course units.

INDIVIDUAL ONLINE INTERVIEW WITH SUSTAINABLE SALONS (EXTERNAL PARTNER):

- The interviewee was a customer service manager from [Sustainable Salons](#).

Sustainable Salons is a not-for-profit organisation that typically works with hairdressing salons across Australia, helping them to recycle waste from hair care products and collect hair cut off customers. This is collected and turned into wigs or special equipment to absorb spilled oil. During the interview a presentation was given on the waste bins designed by Sustainable Salons and placed in the barbering and hairdressing classroom at the Robina Campus,

and how Sustainable Salon collects, transports and recycles relevant waste materials.

INDIVIDUAL ONLINE INTERVIEW WITH THE ASSET PLANNING AND MANAGEMENT DIRECTOR:

- The interviewee was the TAFE Queensland Gold Coast Asset Planning and Management Director.

This interview focused on additional information regarding the funding of the Robina campus with a particular focus on procurement procedures/standards and resources spent on the sustainable fit-out of the campus.

INDIVIDUAL INTERVIEW WITH THE RABA FARM:

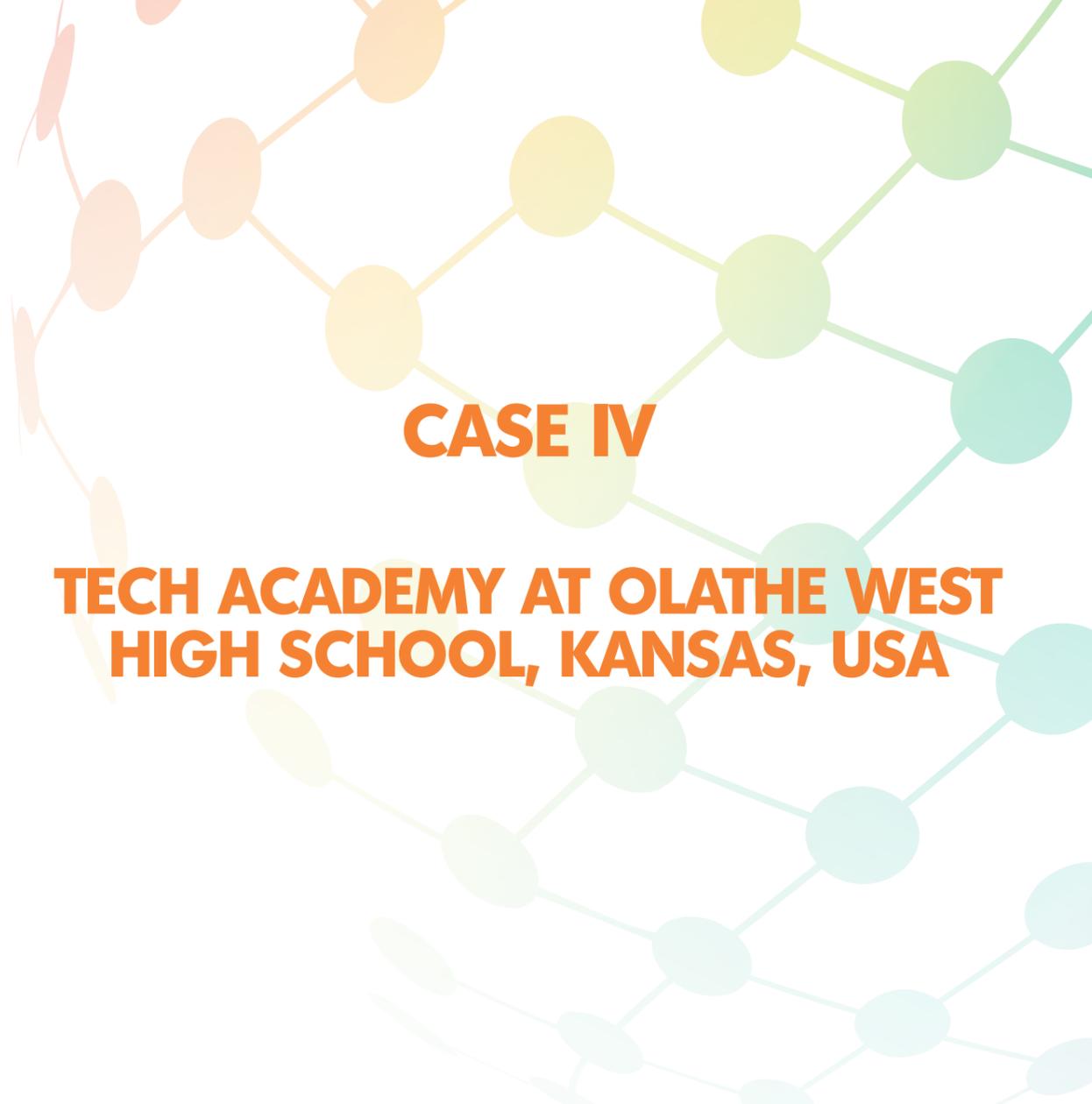
- The interviewee was the Director of the [Raba Farm](#).

The Raba Farm is a community farm, which was established recently with the intention of becoming a social enterprise. It is currently run by Stevyn Tonta with the help of several volunteers. Students from the Robina Campus have visited the farm to sow seeds and plant trees. Eventually, the compost produced at the Robina Campus will be used to grow of plants and vegetables on the Raba Farm for use in the campus café and restaurant.

PLENARY DISCUSSION

- The plenary discussion was attended by the General Manager of TAFE Queensland Gold Coast (who oversees all six TAFE Queensland campuses in the Gold Coast region), the Director of Faculty at the Robina Campus, four Educational Team Leaders, three teachers (in Early Childhood Education and Care, Educational Support and Beauty Therapy), the Executive Director of Education and Training at TAFE Queensland Gold Coast and the Assets, Facilities & Occupational Health and Safety Director.

The plenary session was held at the very end of the 3-day visit to the Robina campus. The visiting consultant from the Danish Technological Institute began by summarising what he had observed as some of the initial key findings regarding the sustainability efforts at the Robina campus. The participants then highlighted some additional aspects and answered some additional questions. The discussion covered most of the issues summarised in the section above, but also touched on the future 'greening' plans for the Robina campus and TAFE Queensland in general.



CASE IV

TECH ACADEMY AT OLATHE WEST HIGH SCHOOL, KANSAS, USA





1. INTRODUCTION

This introductory chapter contains several sections that provide background information. First, the Olathe West High School is introduced as the educational institution that hosts the Green Tech Academy (GTA) programme. Other sections outline the vocational education and training (VET) system in the United States and describe the national and regional strategies relevant to the greening VET.

1.1 OLATHE WEST HIGH SCHOOL AND THE GREEN TECH ACADEMY

The Green Tech Academy (GTA) programme is an integral part of Olathe West High School in the city of Olathe, Johnson County, Kansas.²⁴ It has

²⁴ In the American education system, high schools (with the exception of 'junior high schools') represent upper secondary education. With regard to the International Standard Classification of Education (ISCED), this corresponds to the last year of middle education (ISCED 2) and the whole of secondary education (ISCED 3). High schools are typically attended by students aged 14-18 years, covering grades 9 to 12 (Stephens, et al., 2015).

approximately 1 600 students, typically between the ages of 14 and 18 years, and approximately 95 faculty staff. The Olathe West High School is the newest out of five public high schools in the local school district. It opened in 2017 and the GTA was established at the same time.

The high school is governed by the Olathe Public Schools' Board of Education, which has seven board members. They represent three different districts (with one board member representing the entire Olathe school district) and meet once a month. The overarching supervisory authority for the Olathe West High School is the Kansas State Department of Education (Olathe Public Schools, 2022; Kansas State Department of Education, 2022).

The high school consists mainly of a three-storey building with a floor area of approximately 35 000 m². It is designed with four wings – one of which one houses the GTA programme – and also includes an auditorium, a media centre, gymnasiums and a centrally located common learning space and library.

FIGURE 1. OLATHE WEST HIGH SCHOOL



Image: DTI

In addition to the GTA, the high school also houses a Public Safety Academy, which provides students with the knowledge and skills necessary to pursue post-secondary education in firefighting or law enforcement. Both academies are part of fifteen so-called 21st Century Academies that have been established in the school district. Their origins can be traced back to efforts by the Olathe Public Schools about 20 years ago to create educational programmes that would allow students to build on their own interests while learning specific knowledge and skills that could be applied either in further education or a relevant career field. In developing these academies, the local school district focused heavily on the skills needs of the workforce, for example, by consulting with businesses through surveys and focus groups (Olathe Public Schools, n.d.(a)).

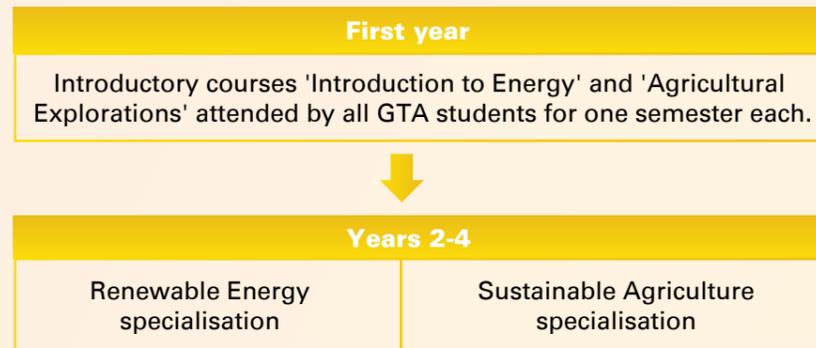
About a quarter of all students in Olathe's five public high schools (2 313 students) attended one of the fifteen 21st Century Academies in the 2021–2022 school year. Out of these,

83 students were enrolled in the GTA programme in the same period (Olathe Public Schools, n.d.(b)).

Against this background, the Green Tech Academy programme consists of a four-year VET programme with two specialisation strands to which prospective high school students can apply. After an initial screening of applicants and a subsequent interview process, students are admitted to the programme, which they attend in high school alongside other 'traditional' classes (e.g. mathematics, English and social studies). In their 'freshman year' (first year of high school), GTA students introductory courses together, after which they choose to join one of the two specialisation strands, as shown in the figure below. Each specialisation strand represents a Career and Technical Education (CTE)²⁵ pathway that provides students who complete it with access to further education or specific career fields.

²⁵ Career and technical education is the term used in the US instead of VET (Unesco-Unevoc, 2021).

FIGURE 2. GREENTECH ACADEMY – GENERAL PROGRAMME STRUCTURE



Source: Author's draft

This case study looks at the greening of VET at the Olathe West High School, with a particular focus on the Green Tech Academy programme and its approaches to teaching green skills. As shown in the diagram above, the programme provides students with knowledge and skills related to two specific areas of study, namely energy (particularly renewable energy sources) and agriculture (with a focus on environmental sustainability). The GTA programme's approach to teaching green skills is primarily based on promoting project-based learning and critical thinking among students. It aims to provide students with an in-depth understanding of their chosen area of specialisation and is responsive to changing skills needs of the regional energy and agriculture sectors (Green Tech Academy, n.d.(a)).

1.2 VOCATIONAL EDUCATION AND TRAINING IN THE USA

This section provides a brief introduction to the national VET context, including an

overview of how VET is governed and funded in the US.

1.2.1 A BRIEF OVERVIEW

The term used for vocational education and training in the United States (US) is 'career and technical education' (CTE). It is an essential part in the US workforce development system, providing students of all ages with both academic and technical vocational skills. CTE programmes in the US are organised in line with the National Career Clusters Framework. It defines 16 career clusters grouping a total of 79 different career pathways according to commonalities and sectoral affiliations. For example, there are career clusters in finance, health sciences and manufacturing.²⁶ Career pathways represent a set of interrelated education and training strategies and support services that enable VET students to obtain the credentials needed to be employed

²⁶ The two clusters relevant to the case study on GTA are 'Agriculture, Food & Natural Resources' and 'Science, Technology, Engineering and Mathematics'.

in a particular occupational field or to progress to a higher level of education (Advance CTE, 2022; Edgerton, 2022).

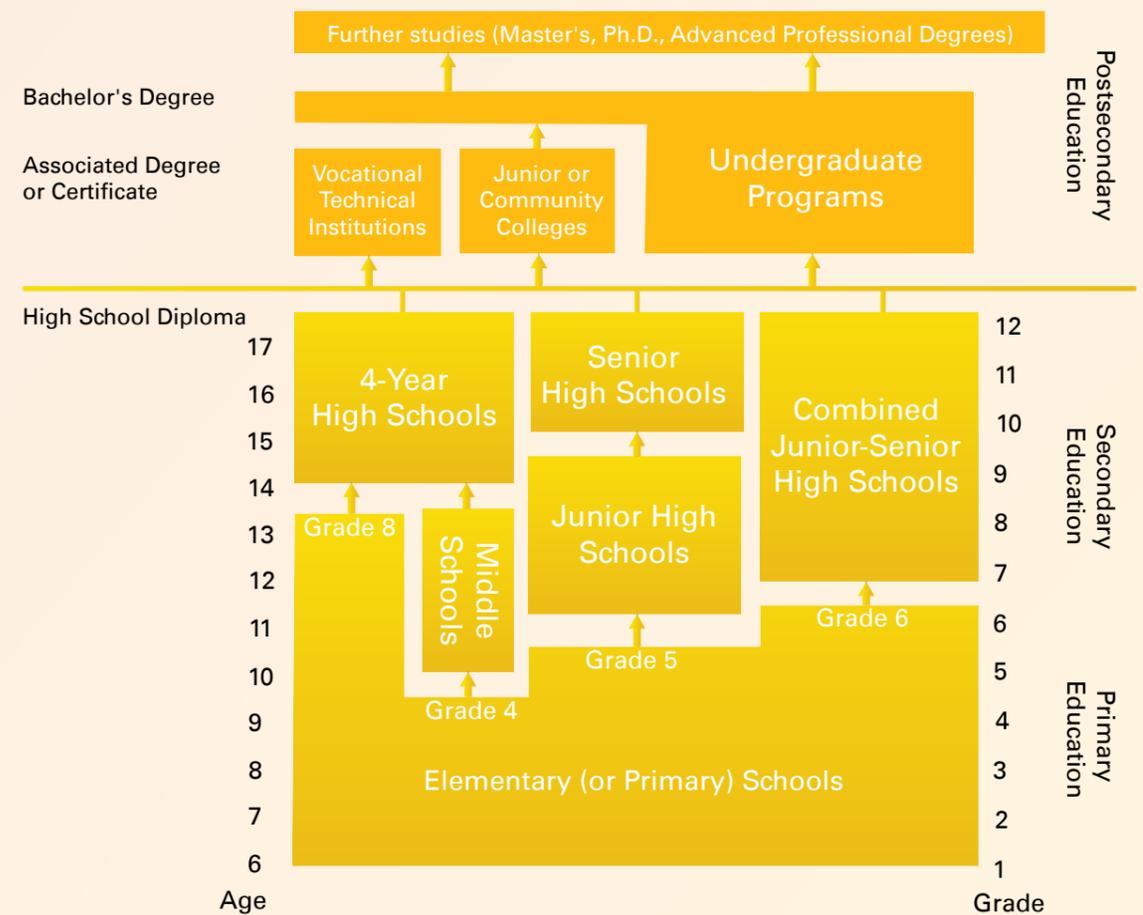
At the secondary level, VET typically takes place in high schools, as well as in regional career and technology centres, community colleges and correctional facilities.²⁷ The VET courses offered in

these settings can broaden students' education, for example by exposing them to different career options at an early stage. In addition, students who complete a career pathway receive an industry-recognised credential that enables them to enter the workforce directly in a relevant industry sector.

Within post-secondary education, common VET providers are community colleges, vocational schools, and employers offering apprenticeships and

²⁷ Secondary education covers ISCED levels 2 (Lower secondary) & 3 (Upper secondary).

FIGURE 3. STRUCTURE OF THE US EDUCATION SYSTEM



National Center for Education Statistics, n.d.

on-the-job training. Students enrolled in VET programmes at this level can typically earn industry-recognised credentials after 1 to 2 years of education or training. Postsecondary VET programmes lead to credentials at or below the associate degree level in the US education system, as illustrated in part below (Unesco-Unevoc, 2021; Edgerton, 2022).

There are about 12.5 million high school and college vocational students in the US, with the average high school student taking more credits²⁸ in CTE than any other subject area, except English. However, the proportion of high school students who complete enough CTE credits to earn an industry-recognised credential is relatively small. According to the latest available data covering all US states (from 2013), 88% of public high school graduates earned at least one CTE credit, while only 20% earned at least three CTE credits related to a single occupational area (Unesco-Unevoc, 2021; Edgerton, 2022).

In terms of non-formal VET, apprenticeship programmes are typically aimed at individuals with some years of existing work experience. The main providers of apprenticeship programmes are community and technical colleges. Employer-owned or -operated institutions and vocational schools also offer such programmes. In 2021, there were more than 593,000 participants in so-called registered apprenticeships (i.e. apprenticeship programmes registered with the US Department of Labor)

²⁸ A course credit is a standardised measurement of student course taking with one credit signalling the successful completion of one course lasting a full academic year (U.S. Department of Education, 2019a).

(Unesco-Unevoc, 2021; U.S. Department of Labor, 2021). It is estimated that a similar proportion of American workers participate in unregistered apprenticeships (Tamar & Lerman, 2019).

1.2.2 GOVERNANCE OF VET

The public education system in the United States has a decentralised structure with control exercised at the local, state and federal levels. While the responsibility for education delegated to each individual state, the federal government enacts legislation to fund public education. Under the influence of federal legislation, each state creates its own legislative framework, which every public school in the state must follow. At the same time, decisions about curriculum development, specific educational content and course levels are made at both state and local level.

The primary responsibility for the governance of public VET in the US lies with the local education agencies. These represent the different school districts into which the states are divided. Each school district has a local board whose members are elected citizens from relevant district. The main aim of more than 14 000 local education agencies is to ensure that education reflects local values and priorities. They are also intended to remove, to an extent, the governance of public education from the political influence of the federal government.

The system of VET governance in the US is further complicated by the different ways in which the states delegate responsibility for the administration of VET, secondary, and post-secondary education. For example, almost all government-supported skills training that takes place outside of the education

system is delivered through the Office of Apprenticeship and the Job Corps vocational training programme, both of which are administered by the US Department of Labor (Stone Iii & Lewis, 2010; Unesco-Unevoc, 2021).

1.2.3 VET FUNDING

In the US, VET is funded by all three levels of government: federal, state and local. However, it should be noted that the federal share is significantly lower than the funding provided at state and local level.

At the federal level, funding is provided through the Office of Vocational and Adult Education (OVAE), a unit of the US Department of Education responsible for the implementation of federal VET legislation. States wishing to receive federal funds for their VET systems must prepare and submit to the OVAE a plan describing how the funds will be used. Similarly, states require local education agencies to prepare and submit plans describing how they intend to spend the funds allocated to a particular state at the local level.

State approaches to the financing of VET vary. Some states do not provide any dedicated funding for VET, instead funding VET programmes through general education budgets and existing state aid facilities. Other states do earmark funding specifically for VET providers or programmes, for example by supporting VET offered at comprehensive high schools, community or technical colleges through dedicated funding facilities (Stone Iii & Lewis, 2010; Foster, et al., 2014).

1.3 NATIONAL AND REGIONAL STRATEGIES RELEVANT TO THE GREENING OF VET

This section focuses on the policy background to the greening initiatives at the Olathe West High School and the GTA. It begins with a brief introduction to national and regional government policies that support climate change mitigation. This is followed by an outline of the national efforts to support the provision of green skills. Finally, the section examines the relevant regional strategies and VET development.

1.3.1 NATIONAL AND REGIONAL CLIMATE CHANGE MITIGATION POLICIES

The three most recent US governments have taken varying positions on addressing the impacts of climate change and transitioning to a green economy.

Under President Obama, the US was one the 196 parties that adopted the Paris Agreement at the 2015 United Nations Climate Change Conference (COP 21).²⁹ In doing so, the US government committed to limiting the nation's greenhouse gas (GHG) emissions in an attempt to keep global warming to below 2 degrees Celsius compared to pre-industrial levels (UNFCCC, n.d.). Prior to joining the Paris Agreement, the Obama administration took action to mitigate climate change, including efforts to increase America's

²⁹ The abbreviation COP refers to Conference of the Parties to the United Nations Framework Convention on Climate Change. These conferences are held once a year.

use of wind, solar and geothermal energy, while also setting higher fuel economy standards for road vehicles (Executive Office of the President, 2013). A key policy of the Obama administration in this context was the Climate Action Plan, which aimed to further reduce domestic carbon pollution, increase US resilience to the impacts of climate change and lead international efforts to mitigate climate change (Environmental and Energy Study Institute, 2015).³⁰

The US administration under President Trump (2017-2021) chose to withdraw from the Paris Agreement a few months after taking office, arguing that it contained conditions which placed an unfair and unacceptable burden on US businesses, workers and taxpayers. More broadly, the Trump administration took a number of steps to roll back the environmental regulations implemented by the previous US administration, including policies aimed at reducing GHG emissions (Pitt, et al., 2020; Daley, 2020).

In the absence of federal leadership on climate change mitigation, US states and regions have developed and adopted their own environmental policies aimed at reducing GHG emissions, for example by promoting renewable energy, energy-efficient buildings, and a more sustainable transport system (Ricketts, et al., 2020). Following the US administration's withdrawal from the Paris Agreement in 2017, a small group of state governors

³⁰ The Climate Action Plan's goal to cut carbon pollution is aligned with President Obama's commitment to reduce greenhouse gas emissions by 26-28% below 2005 levels by 2025 (The White House, 2014).

formed the U.S. Climate Alliance. It has since grown into a bipartisan group of governors from 23 states (and Puerto Rico), representing more than half of the US economy and population (United States Climate Alliance, n.d.(a)).

Each member state of the alliance (which does not include Kansas, where the school of this case study is located) is committed to achieving climate goals in line with the Paris Agreement, for example by accelerating new and existing policies to reduce GHG pollution by promoting the deployment of clean energy at state and federal level (United States Climate Alliance, n.d.(b)).

Since taking office in early 2021, the current Biden administration has rejoined the Paris Agreement and proposed comprehensive environmental measures across all economic sectors to achieve its ambitious climate goal of net-zero GHG emissions by 2050 (United States Department of State and the United States Executive Office of the President, 2021). In particular, the Biden administration has pledged to invest USD375 billion in climate change mitigation action, a measure that is expected to lower US emissions by up to 44% by 2040 (Cabral & Sherman, 2022).

1.3.2 NATIONAL INITIATIVES TO SUPPORT GREEN SKILLS PROVISION

As responsibility for education lies at the state and local level, there are no federal policies directly aimed at greening VET. However, there are examples of state-level stakeholders working together to address this issue across the US.

One notable initiative is the incorporation of the so-called Green and

Sustainability Skills Statements into the existing National Career Clusters Framework in 2012. The initiative was led by Advance CTE, a national non-profit organisation representing state CTE directors, and supported by a grant from the US Department of Education. The statements define learning objectives for CTE students in green and sustainability skills and knowledge. They were integrated into six existing career pathways that were expected to have the greatest need for workers with green skills.³¹ Similarly, the National Career Cluster Framework has expanded to include a set of standards for transversal green skills and knowledge applicable to all career clusters (Advance CTE, n.d.(b)). In the case of the Agriculture, Food and Natural Resources career cluster, for example, the green learning objectives for students include the ability to 'research geographical and demographic data to identify relationships between the environment, economy and social justice in different geographical areas', and 'the advantages and disadvantages of green/sustainability efforts led by [...] businesses, government agencies, not-for-profit organisations and individuals' (Advance CTE, 2012).

Another example of cross-regional collaboration on the greening of CTE is the SEED Center (Sustainability, Education and Economic Development),

³¹ The six career pathways that were expected to have the greatest need for green workers were Agriculture, Food & Natural Resources; Architecture & Construction; Information Technology; Manufacturing; Science, Technology, Engineering & Mathematics; and Transportation, Distribution & Logistics (Advance CTE, n.d.(b)).

an initiative launched by the American Association of Community Colleges in 2010. Now administered by the National Council for Workforce Education³², it aims to help enhance existing sustainability and clean technology education programmes at community colleges. With this in mind, the SEED Center offers relevant professional development opportunities, including workshops, webinars, and mentoring sessions, for administrators and faculty at these colleges. On its website, the centre also offers a wide range of curricula curated by industry and higher education experts as well as detailed guides, tools and best practice examples for community college administrators and faculty working on sustainability initiatives (American Association of Community Colleges, 2011; SEED Center, n.d.).

1.3.3 REGIONAL STRATEGIES FOR VET DEVELOPMENT AND THE GREEN TRANSITION

As part of its obligations to report on the intended use of federal education funds, the state of Kansas has submitted its most recent Career and Technical Education development strategy to the U.S. Department of Education. The Kansas State Plan for Career and Technical Education for 2020-2023 states:

'The strategic vision for Kansas CTE is that of an innovative system that provides premier technical education, prepares students for careers of the future, and promotes the growth and

³² A not-for-profit organisation working specifically on workforce issues facing community colleges and providing a forum for administrators and teachers and trainers in VET (NCWE, n.d).

success of Kansans’ (U.S. Department of Education, 2019b).

Among the actions defined in the State Plan to achieve this overarching goal are:

- Engaging employers in the development, implementation, and review of career pathways;³³
- Providing affordable, accessible, and equitable high-quality VET;
- Implementing effective work-based learning.

It should be noted that the State Plan for VET does not explicitly refer to the green transition or the greening of VET. There is no mention of terms such as ‘sustainability’ or ‘green skills’. Instead, there are more general descriptions of how the economy and labour market have changed in the recent past and calls for VET to adapt accordingly. For example, the State Plan for VET emphasises that:

‘Technological advances and global competition have transformed the nature of work. Tomorrow’s jobs will require more knowledge, better skills, and highly flexible workers who continually update their knowledge and skills.’ (U.S. Department of Education, 2019b)

When it comes to defining the specific skill needs to be addressed by VET, the State Plan for VET refers to the 16 career clusters and 37 career pathways approved by the State of Kansas³⁴. It further states that the career pathways will be reviewed on a regular basis.

³³ See section 1.2.1 for a description of career pathways.

³⁴ For an overview, see US Department of Education, 2019b, pp 12–13.

Such re-evaluations are to be based on input from stakeholders in secondary and post-secondary education, as well as business and industry. The process is designed to ensure that the courses and programmes offered meet current skill needs while taking into account labour market projections.

The State Plan also refers to comprehensive local needs assessments to align VET programmes with local education needs in different state counties or education districts. It emphasises that the content of secondary and post-secondary programmes, and the evaluation of their efficiency, should be based on these assessments (ibid).

The 2020 Comprehensive Needs Assessment for the Overland Park/Johnson County region, where Olathe West High School is located, identifies regional skill needs and maps the strengths and weaknesses of public VET programmes in the region. Most relevant to this case study, that the assessment highlights strong industry demand for skills related to sustainable agriculture and engineering (which is the career pathway associated with renewable energy) in secondary VET. However, like the Kansas State Plan for VET, it does not refer directly to green skills needs or job demands (Schwartz & Mauppin, 2020).

In contrast, the 2021 Regional Climate Action Plan for the Kansas City region (covering ten counties, including Johnson County) explicitly addresses these issues. It sets out a voluntary framework for local action towards ‘a thriving green economy and a healthy natural environment’ (Mid-America Regional Council, 2021). The Action Plan is structured around a series of

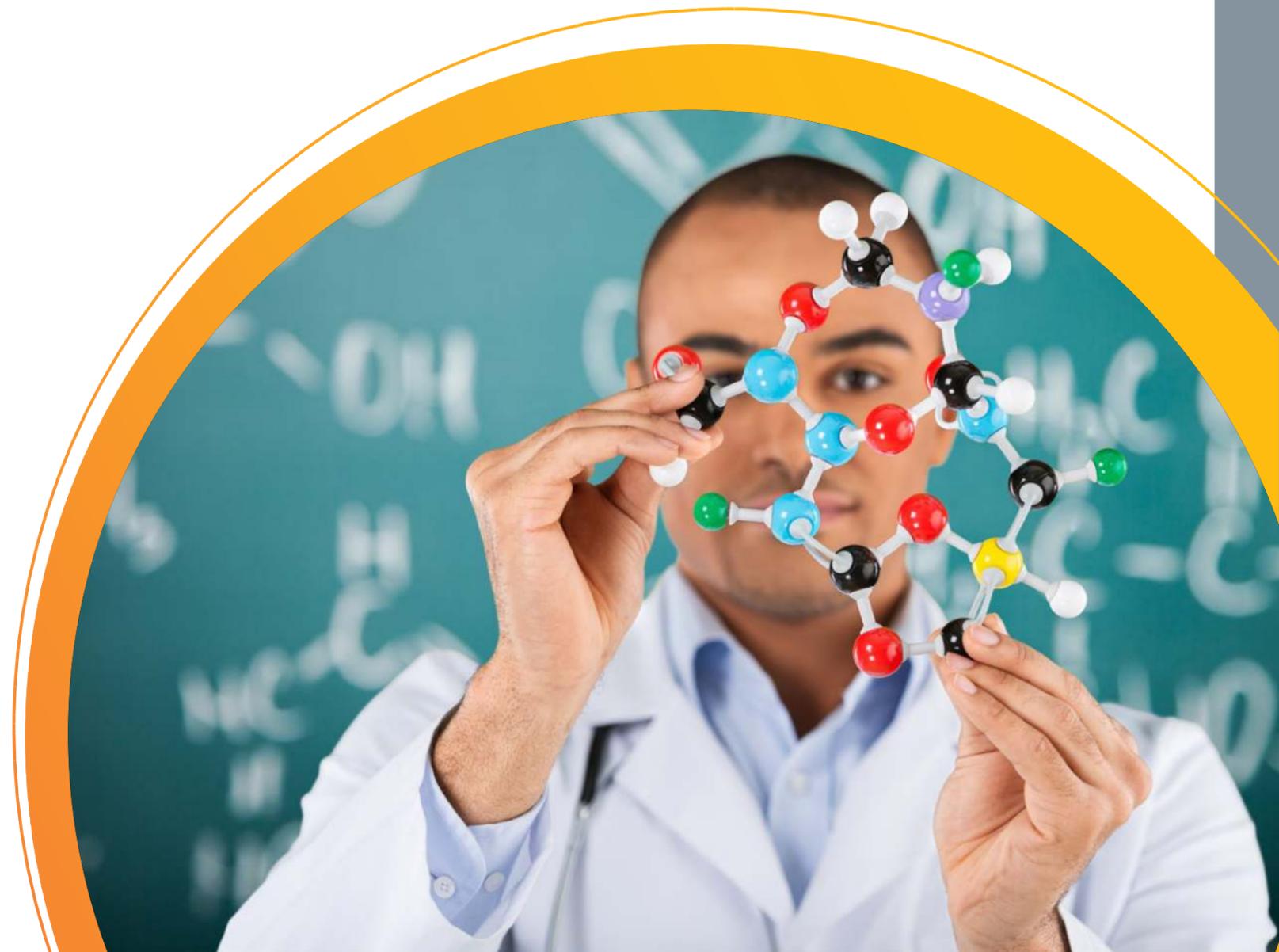
goals in eight different areas, including transportation, energy production, and finance and innovation. In the latter area, the Plan sets the following goal:

‘Leverage the green economy through job training and the innovation ecosystem to accelerate climate action.’ (ibid.)

Among the partners listed as enabling the achievement of this goal are workforce development programmes, trade organisations and VET providers. The Climate Action Plan also specifically highlights the renewable energy sector

in this context as ‘one of the largest employers in a previously oil and gas driven economy’ (ibid.).

In summary, the regional strategies relevant to the development of VET emphasise its role in supporting economic growth – not only by addressing current skills demands, providing career pathways that prepare students for ‘the jobs of tomorrow’. There is evidence that changes in technology, global competition and the transition to a greener economy are likely to shape the nature of these jobs.



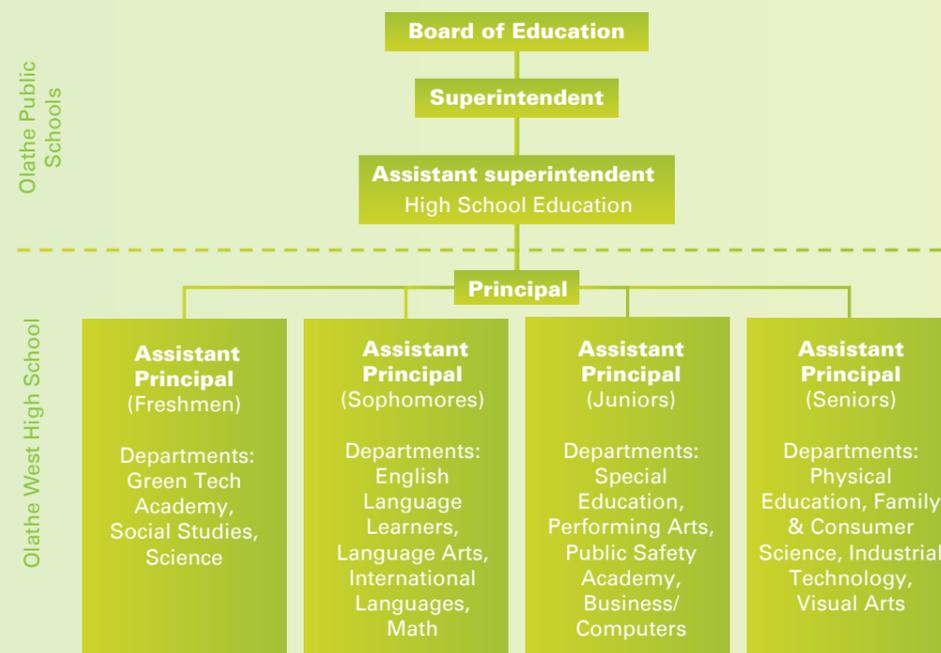
2. MANAGEMENT AND ORGANISATION OF THE OLATHE WEST HIGH SCHOOL AND THE GREEN TECH ACADEMY

This chapter outlines the organisational structure and management of the Olathe West High School and its Green Tech Academy (GTA) programme, and examines the green goals of the school. It also describes the various resources available to the management and staff of the Olathe West High School in their efforts to green the school, with a particular focus on the teaching staff associated with the GTA programme and the main building and facilities of Olathe West High School.

2.1 ORGANISATIONAL STRUCTURE

The diagram below illustrates how the governance of the Olathe West High School is organised. It also shows how the school leadership is linked to the Olathe Public Schools District Board of Education. As mentioned earlier, the board has seven members representing different districts and meets once a month. The overarching supervisory

FIGURE 4. ORGANISATIONAL CHART



Olathe Public Schools, n.d.(c); Olathe West High School, n.d.(a)

authority is the Kansas State Department of Education (see Figure 4 below).

As shown in Figure 4, Olathe West High School has a principal who reports to the assistant superintendent responsible for high school education on the Olathe Public Schools leadership team. There are four Assistant Principals at the High School who are responsible for Years 1 to 4 and a number of departments. The Assistant Principal responsible for first-year students (freshmen) also supervises the GTA programme.

While there is no 'greening officer' or 'sustainability manager' in the leadership team at the Olathe West High School, greening initiatives are driven primarily by the assistant principal in charge of the GTA programme. According to the school Principal, she was recruited for this position in particular because of her strong positive attitude towards the aims of the 21st Century Academies (see section 1.1) and her personal motivation to promote renewable energy and sustainability in a wider sense.

2.2 GREEN GOALS

The school's leadership emphasises that the Olathe West High School is relatively young and will continue to change and further develop, including in terms of greening initiatives. While the school has been designed with sustainability in mind, the assistant principal in charge of the GTA programme emphasises that more can be done to green the campus. In terms of the programme, she states that the aim is to also develop 'a truly sustainable programme' that promotes and benefits from the green aspects of the Olathe West High School building (see Chapter 3 for more information).

The school's principal emphasised that one of the main objectives of the GTA programme is twofold. One is to support students who want to study engineering at university and go on to higher level jobs in the renewable energy sector. On the other hand, the school wants to give other students access to jobs in the sector that require only a high school diploma and some additional training. In this context, the principal pointed out that a large electric vehicle battery manufacturing plant is being built near the Olathe West High School. Similarly, the superintendent noted that there are large wind farms in western Kansas and solar farms in the neighbouring Colorado, highlighting the extensive green technology job opportunities in the region.

The Olathe Public Schools Strategic Plan for 2021-2026 does not refer to specific greening goals. It defines the ideal Olathe Public Schools graduate in terms of the cognitive, personal, and interpersonal skills they will have acquired as part of their school education (Olathe Public Schools, 2021). However, the management of the Olathe West High School has developed more specific greening goals (in the form of SMART Goals³⁵) for GTA students to be achieved in the next few years. Some of these are listed in the table below.

The main building of the Olathe West High School was designed with energy efficiency in mind. The school has applied for LEED certification for the

³⁵ The SMART approach to goal setting emphasises that goals are clear and reachable. As an acronym, SMART stands for: Specific; Measurable; Achievable; Relevant and Time-bound (Haughy, 2014).

TABLE 1. SMART GOALS FOR THE GREENTECH ACADEMY PROGRAMME

IMPLEMENTATION PERIOD	GREENING GOAL
2022–23	By the end of their junior year, all students will have experienced at least two trips to expose them to energy and sustainability disciplines. Examples include landfills, wind farms, utility control rooms and water treatment plants. Trips will also serve for students to see and recommend updated 'greening practices' to the high school campus and the academy.
2023–24	GTA students will be provided with at least four CAD-capable workstations to use in courses and for potentially implementing 3D modelling projects around the high school campus.
2024–25	GTA students will be provided with drones capable of mapping the landscape and native grasses to enable students to make recommendations for increased greening and water retention methods.
2025–26	GTA students will be provided with and help install a wind turbine (workable size) on school property to be utilised for training wind turbine technicians and decrease the high school's carbon footprint.

building.³⁶ While the U.S. Green Building Council certification process is ongoing, the high school hopes to achieve LEED certification by the end of the winter 2023 semester.

In addition, the Olathe West High School was named the 2021 Kansas Green School of the Year for its green facilities, including laser engraving machines,

farm bots, and 3D printers (KACEE, n.d.). Other green goals of the Olathe West High School include making better use of the building features, such as monitoring the local weather to maximise the efficiency of the school's solar panels. As the principal points out, the placement of solar arrays – on the south side of the school and facing towards the adjacent main road – was chosen in part to send a message to the surrounding community about the school's greening efforts and the existence of the GTA programme.

³⁶ LEED stands for Leadership in Energy and Environmental Design.

Community outreach in support of sustainability can be described as a greening goal in itself. Students, at least those enrolled in the GTA, adopted and cleaned a local stream in the past or shared information about the programme at community events, such as career fairs for primary school students. Not-for-profit organisations looking to make their own practices more sustainable have received support from GTA students, according to the assistant principal responsible for the programme. She also emphasises that she would like for the programme to be a valuable partner for local small and medium-sized enterprises in the future, for example in helping them reduce their carbon footprint.

In general, the college has a relatively high degree of autonomy in setting and pursuing greening goals, at least to the extent that these are aligned with national and regional change strategies and state-wide plans for VET development (see section 1.3). Funding for relevant greening initiatives is mentioned as a typical barrier to implementation, although both school management and teachers point to a wide range of opportunities for obtaining grants to support of greening activities in this context (including federal (e.g. Carl D. Perkins funds) and state grants, as well as funding from private foundations).

2.3 HUMAN RESOURCES

As mentioned above, there is no position within the administration of the Olathe West High School dedicated solely to the development and implementation of greening initiatives. Such initiatives therefore need to be coordinated by the management team.

The high school as a whole has approximately 95 teaching staff and a number of other support staff, including counsellors and secretaries who work with staff, students and their families. Students on the GTA programme are taught primarily by two teachers – or 'facilitators' – as they are known internally. Each facilitator has overall responsibility for one of the two specialisation strands, namely sustainable agriculture and renewable energy. The renewable energy facilitator has a background in biology studies and also holds a Master's degree in Education, Teaching and Learning and is pursuing a Master's degree in School Leadership. The sustainable agriculture facilitator holds a Bachelor's degree in Science in Agriculture and is about to complete a Master's degree in Education, Teaching and Learning.

2.3.1 TEACHER TRAINING TO SUPPORT THE TEACHING OF GREEN SKILLS

GTA teachers are encouraged by the Olathe West High School management to attend business conferences or seminars as part of their own professional development. For example, the Renewable Energy teacher has been supported by GTA management to visit wind and solar farms to inform his teaching. The sustainable agriculture teacher emphasises that he tries to attend as many relevant business conferences as possible. Teachers also stress the importance of working closely together with industry partners, both to develop their own skills as educators and to introduce their students to individual businesses and career opportunities.

With this in mind, both the principal of Olathe West High School and the assistant principal responsible for the

GTA emphasise the importance of continuing to work with industry partners to keep up with their developments and needs. According to them, GTA teachers need to be lifelong learners and attend industry events as developments in the industry outpace the development of textbooks for teacher training. In general, the management of the high school and the academy programme are willing to find funding for industry-based training for GTA teachers, if the teachers believe that this will lead to a higher quality of the skills provided by the programme. According to the assistant principal in charge of the GTA programme, the Olathe West High School has few links in the United States with other educational institutions, including universities, that offer training in sustainable technologies. This in itself limits the opportunities for academically led professional development for GTA teachers. At the same time, the principal of Olathe West High School highlights the existing collaboration with the Kansas State University and its College of Agriculture to provide opportunities for teacher training in sustainable agriculture.

Teachers themselves describe how their professional development is supported by regular contact with industry stakeholders. They find it helpful to gain knowledge and expertise stemming from specific professional experiences, while having the freedom to integrate this into their teaching as they see fit. Getting to know industry stakeholders, for example at conferences, enables them to reach out to them and get answers to specific questions they may have in relation to the subject they teach.

2.4 SCHOOL BUILDING AND FACILITIES

As noted above, the Olathe West High School consists primarily of a three-storey building with a floor area of approximately 35 000 m², but also includes an American football stadium, tennis courts, and track and football fields. The main building has four wings, two of which house the school's 21st Century Academies (i.e. Green Tech Academy and Public Safety). These two wings contain open classrooms with spaces for experimentation, where teachers and their classes rotate according to the scheduled activity. In addition to an auditorium, a media centre, performing arts centre, gyms and a centrally located common learning space and library, the main building also provides individual learning spaces for student group work. The so-called collaboration rooms can be used as blended learning spaces as they are equipped with wall-mounted screens and internet access, allowing students to participate in group work remotely.

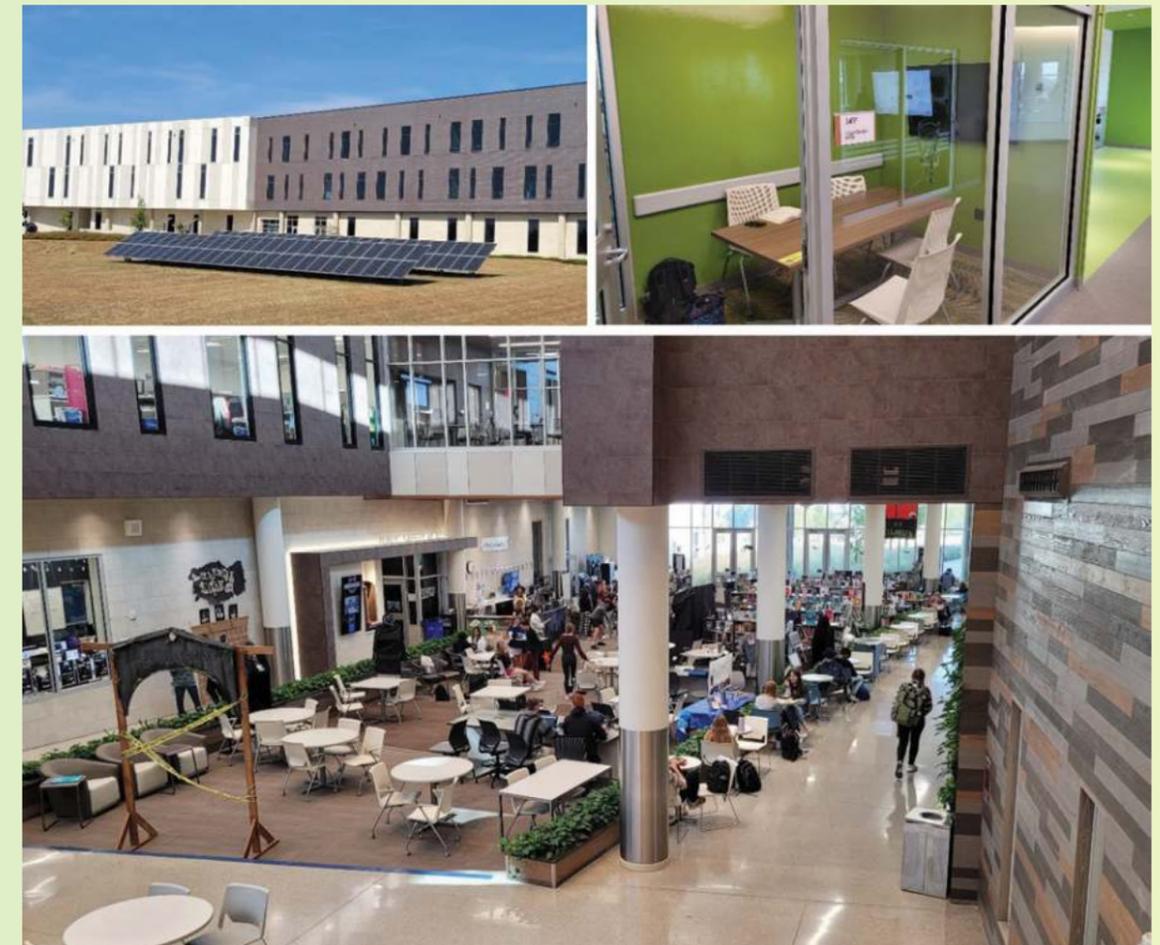
The selected site for the school building and its design promote optimal energy efficiency. As well as the large rectangular windows on all sides of the building, it also has a large skylight window above the atrium, which also houses the library. To reduce energy consumption, the interior of the building receives a lot of natural light. In addition, sensors and a building monitoring system ensure that lighting is automatically dimmed or switched off, depending on whether relevant areas are in use or not. Outside, on the south-

side of the building, there are two solar panel arrays, each consisting of 52 solar panels. The solar panel system is capable of producing up to 1 350 kWh (at peak output) and is used to power parts of the main building, including the wing that houses the GTA programme, resulting

in a net-zero carbon footprint. During the summer break, excess energy from the solar panels is fed back into public grid.

The images in Figure 5 show the building and the facilities of the Olathe West High School mentioned above:

FIGURE 5. CLOCKWISE FROM TOP LEFT: THE SOLAR PANELS ON THE SOUTH SIDE OF THE OLATHE WEST HIGH SCHOOL; ONE OF THE COLLABORATION ROOMS; THE ATRIUM WITH COMMON LEARNING SPACES AND THE LIBRARY, WHICH RECEIVES NATURAL LIGHT THROUGH ITS SKYLIGHT AND THE BUILDING'S LARGE RECTANGULAR WINDOWS



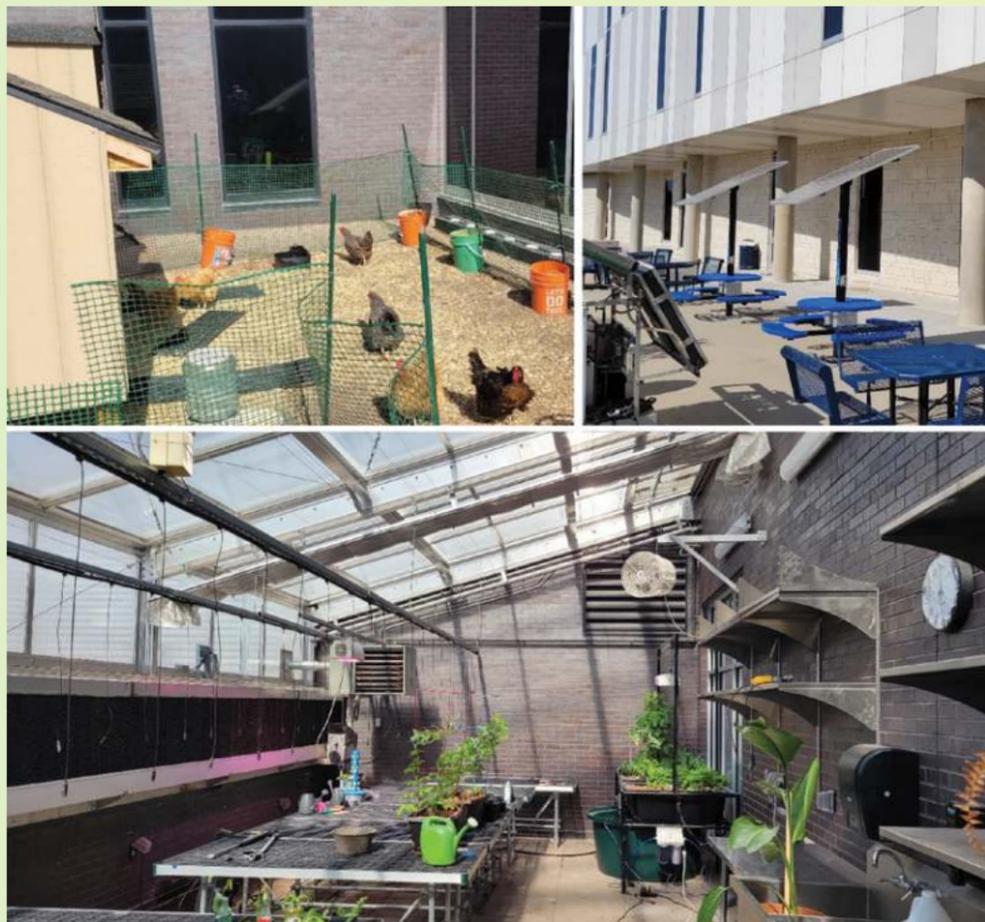
Images: DTI

Other 'green' features of the high school include two picnic tables equipped with solar panels that allow students to charge their mobile devices with solar energy. In addition, the architecture of the building allows rainwater to be collected from the roof and used to irrigate areas such as the lawns surrounding the high school. There is also a roof space that was originally intended for a garden but is now used for a chicken coop made from recycled

materials and a fenced area for the twelve chickens to roam in.

On the second floor of the main building there is a greenhouse with a hydroponic garden, where teachers and students can grow plants without the use of soil, using water and mineral nutrient solutions instead. There are plans to develop this into an aquaponic system where the addition of aquacultures of small fish will reduce the need for fertiliser. Finally, the

FIGURE 6. CLOCKWISE FROM ABOVE LEFT: THE CHICKEN COOP ON THE ROOFTOP; PICNIC TABLES WITH SOLAR PANELS; GREENHOUSE WITH HYDROPONIC GARDEN



Images: DTI

high school encourages students recycle, for example by providing different coloured bins for sorting waste in some areas of the main building. Students are served school meals on polystyrene trays and the Olathe West High School has a machine that can crush the trays into bricks that can be used in construction. However, school officials say that recycling is not currently being fully utilised, in part due to the disruption to the high school's daily operations during the Covid-19 pandemic.

In addition to the facilities shown in the images above, it is important to highlight some of the technical equipment available to GTA students. These include several 3D printers, which students have used for project work, for example to create prototypes of a hydroponic gardening system they have designed or to print the blades of small wind turbines. The GTA programme also makes educational use of the building monitoring system at the Olathe West High School. For example, it is used to teach students in their first year at the academy about how to conduct energy use benchmarking and to identify equipment, systems and processes that use energy in a building, including their impact on overall energy use. Another piece of equipment that can be highlighted is a portable 'solar cart', which is a mobile stand for two solar panels on wheels. The design allows for the solar cart to be moved outside of the building and the angles of the installed panels to be adjusted for solar production and storage. The cart is used in tandem with the Academy's 'Small Wind and Solar PV Installation Pro' training system – also installed on a mobile stand with wheels – which enables students to learn how to install and test small wind and solar systems.

2.5 FUNDING

The Olathe West High School was opened in 2017 and its construction cost approximately USD 90 million. (approximately EUR 80 million at the time). It was financed through a school bond that had to be approved by the voters of Olathe, with the resulting debt of the local school district to be paid mainly by local taxpayers (Alcock, 2016).

Whenever administrators or teachers want to add new facilities or equipment to the high school, they tend to make use of a variety of funding sources. Historically, these have included both public and private funding opportunities, such as:

- The Kansas Energy Program, which is funded by the Kansas Corporation Commission.
- Federal Career and Technical Education (CTE) funds for the energy and agriculture pathways.
- Carl Perkins funding for new equipment.
- Department of Energy funding for wind activity centres.
- Sponsorships from private companies, such as Good Energy Solutions, a Kansas-based solar installer.

Source: EESI, 2020; Pickerel, 2018

According to school officials, there are many ways to fund the greening of the Olathe High School. For example, the assistant principal responsible for the Green Tech Academy points to a strong willingness on the part of the local community to help fund equipment and activities related to the academy programme.



3. GREEN CONTENT AND PROGRAMMES

This chapter describes how sustainability is integrated into the curriculum and instruction of the Green Tech Academy programme at the Olathe West High School.

3.1 EDUCATIONAL CONTENT IN THE GREEN TECH ACADEMY

Students in the GTA programme take a number of 'regular' classes together with other students at the Olathe West High School, such as English, maths, biology, history, or physical education. There is no strategic approach at the high school to integrate green content into these classes. However, there is some collaboration between GTA teachers and their the high school counterparts. In mathematics classes, for example, this collaboration has resulted in students conducting energy audits of various Olathe high schools by calculating electricity consumption and the associated cost per square metre.

As part of their enrolment on the GTA, students are initially introduced to different aspects of the two specialisation strands of the programme under the heading 'Investigations in Green Tech', which refers to the courses 'Intro to Energy' and 'Agricultural Explorations'. These are taught in grade 9 and are designed to help students choose which specialisation, either renewable energy or sustainable agriculture, they would like to pursue in the remaining 3 years of the GTA programme. Students on the programme are also required to take Advanced Placement Environmental Science, a college-level course, in their last 2 years of high school.³⁷ The table below gives an overview of how the two specialisation strands of the GTA programme are structured.

GTA Renewable Energy students are prepared for careers or further study in a

³⁷ This course is completed by passing a national test leading to a college credit. It was developed by the American College Board. For more information, see AP, 2020.

TABLE 2. STRUCTURE OF THE TWO SPECIALISATION STRANDS OF THE GREEN TECH ACADEMY PROGRAMME

	GRADE 10	GRADE 11	GRADE 12
RENEWABLE ENERGY STRAND	Energy & Sustainability	Energy Industry Fundamentals	Green Tech Senior Capstone (individual student project)
SUSTAINABLE AGRICULTURE STRAND	Sustainable Resource Management	Plant & Animal Science	

variety of energy and engineering fields. They learn about different fossil and renewable energy sources and how they are converted to electricity to power, for example, electric vehicles or buildings. In the renewable energy strand, students are given the opportunity to build and test a small wind turbine, learn about basic electrical installations and how to wire up a solar panel, as well as learning about energy efficiency in buildings and how it can be improved.

This can be further illustrated by describing some of the specific skills that students specialising in renewable energy should acquire. In learning about the economic, environmental, and social impacts of energy production and consumption, the learning outcomes for students include the ability to understand the positive and negative aspects and impacts of both renewable and non-renewable energy. They will also be taught how the technologies for producing energy from biomass, solar, wind, water and waste work and how they have been developed. In the context of energy use in transport, students will be able to analyse the similarities and differences

between different types of engines, including compression ignition, electric, gas, and rocket engines.

Courses for students enrolled in the Sustainable Agriculture strand focus on providing them with relevant skills for careers or further study in agriculture, food and natural resources. On completion of this strand, students will have sound knowledge of plants, animals, and food production and distribution. They will develop relevant skills, for example, by learning about livestock and visiting livestock farms, managing a flock of laying hens, and conducting research that can help improve agricultural practice.

For example, the specific learning outcomes for the Plant & Animal Science course include the ability to differentiate between the nutritional needs of animals at different stages of growth and in different production systems, and the ability to investigate and explain the relationship between past, present and emerging applications of biotechnology in agriculture. Other learning objectives are to successfully use soil surveys to

determine crop yield class for different parcels of land in an area and use identification techniques to determine wildlife or insect species.

In terms of the mandatory standards for the learning outcomes of the courses taught on the GTA programme, teachers point out that they are quite broad and not difficult to meet. Both GTA teachers and management at the Olathe West High School emphasise that they want the programme to go beyond the state-wide standards for green and sustainability programmes to allow for deeper exploration and learning with the courses taught at the academy.

3.2 CURRICULUM DEVELOPMENT

GTA management and faculty are highly responsive to developments and skills needs within relevant industries when selecting educational content and defining the learning outcomes for the courses included in the programme. The GTA programme has its own advisory group comprised of 15 members representing a range of companies, including architects Hoefer Welker, Kiewit Engineering Group, and Corteva Agriscience. Management and GTA teachers meet formally with the Advisory Board twice a year, with more informal contact by phone or email. The board members can be described as quite active. As well as providing advice on curriculum development, they also support the academy in more direct ways. In addition to sponsoring equipment or field trips, stakeholders

also actively contribute to students' education.

For example, a representative from Kiewit Engineering Group has taught individual lessons in his field of expertise, namely Geographic Information Systems³⁸, in the Advanced Placement Environmental Science course. In addition, the engineering group has offered internships to students in the past and plans to organise visits by GTA students to some of its construction sites (the company has built solar, wind and hydroelectric infrastructure, for example).

Architects Hoefer and Welker got involved to help the renewable energy students learn about energy efficiency in buildings. After dividing the students into groups, architects from the firm challenged each group to build a physical model of an energy-efficient and comfortable home in a specific climate for a specific region of the US. For example, while one group had to consider the relevance of the humid and relatively warm climate of Florida to their design, another group had to take into account the colder climate of north-eastern states such as Maine. As the students worked on the project, they were assigned a mentor from Hoefer and Welker who they could contact directly with any questions or issues they needed help with. Architects from the firm were also present when the students

³⁸ In general terms, Geographic Information Systems are computer systems used to create geographic maps and analyse geographic data (Dempsey, n.d.).

presented their results, after which the architects provided critical feedback.

Management and GTA teachers have made a concerted effort to create an active advisory group made up entirely of industry stakeholders who want to support the educational goals of the GTA programme. Before the two current facilitators were recruited to teach the programme in 2021, the Advisory Board was, in the words of one of its members, merely comprised

of 'a list of 40 names that were not participating members'. The current 15 board members routinely attend the relevant meetings and are very communicative about the skills they are looking for in future employees. It should also be noted that the industry partner representatives interviewed for this case study explicitly emphasised a strong commitment to promoting sustainability, highlighting that supporting a green transition is important from both an economic and a value perspective.





4. PEDAGOGICAL APPROACH

This chapter describes the pedagogical approach that characterises the Green Tech Academy (GTA) programme and how it is used to support students in acquiring green skills.

4.1 PROBLEM-BASED LEARNING

An important aspect of the pedagogical approach in the GTA programme, although more widely used at Olathe West High School, is problem-based learning. It aims to help students

learn about a subject through the experience of trying to solve an open-ended problem. The aim is not to find a definitive solution to the problem, but to use the problem as a driver and motivator for student learning (Cornell University - Center for Teaching Innovation, n.d.). In line with this approach, the two GTA teachers regularly set students with individual or group tasks that introduce them to specific open-ended problems and relevant background information. In some cases, this may be a complex issue,

such as how to tackle food insecurity in developing countries. In other cases, the problem may be simpler, for example, students may be asked to imagine that they are an alternative energy consultant recently recruited from university and need to summarise the benefits of a renewable energy source of their choice to their fictional new colleagues.

GTA students are usually given the opportunity to work on specific aspects of a problem that they find particularly interesting. This is done to motivate them to learn about the problem and work on possible solutions to (parts of) it. In addition, teachers encourage students to follow their personal interest in a relevant problem in a way that goes beyond the

original framework of an assignment planned or given by the teachers. This is best illustrated by the example of a student specialising in sustainable agriculture. She was originally assigned to investigate whether hydroponic systems are more sustainable than traditional forms of agriculture and summarise the advantages and disadvantages of using hydroponic systems to grow food. While working on the assignment, she learned that these systems can be expensive and wanted to find a way to produce them at a lower cost. With the help of her teacher, she used 3D design software and 3D printers to successfully produce first a small and then a larger prototype of hydroponic systems, both of which are shown below.

FIGURE 7. 3D PRINTED HYDROPONIC SYSTEMS DESIGNED BY A GTA STUDENT SPECIALISING IN SUSTAINABLE AGRICULTURE



Images: DTI



In light of the above, it is important to note that the two teachers on the GTA programme are referred to as facilitators (rather than teachers or trainers) because this title reflects their role in facilitating student-centred learning.

Another important aspect of GTA's problem-based learning is the facilitators' effort to stimulate critical thinking through classroom discussion. They emphasise the importance of meaningful, critical conversations between teachers and students – as well as among students – to help the students evaluate the possible outcomes and implications of proposed

solutions to a given problem. The aim of the approach is to get students to identify and ask important questions, which includes a strong encouragement for GTA teachers to also question the content taught.

According to the assistant principal of the Olathe West High School, who is responsible for the GTA programme, the two GTA facilitators were hired because of their willingness to grow and accept that they might not have all the answers to the questions that students have. The two facilitators reflect on their pedagogical approach and practices in the text box below:



Andrew Miller
Green Tech Facilitator
(Renewable energy)

'The technologies linked to renewable energy are still emerging. Therefore, I must be willing, as an educator in this field, to learn alongside the students about relevant new developments. The answers to some of the questions that my students ask may not be contained in available teaching materials, as they are linked to evolving issues and technologies. Part of the approach at Green Tech Academy is to continue working with identified problems. This may sometimes entail accepting that there is no clear-cut answer to a complex question.'



Matthew Milholm
Green Tech Assistant
Facilitator
(Sustainable agriculture)

'It is important to not be afraid of being wrong. Learn to teach yourself and that your students can teach you. And if there's an issue, work with your students to find a solution. Teachers typically feel that they have to have a solution for every problem. But students are here to learn and to grow. And part of this is running into issues and then trying to solve those issues. So, if you run into an issue, let your students have an opportunity to explore and try to answer that on their own. They will probably teach you something along the way when doing just that.'

(Source: Interview quotes. Images: Olathe West High School)



4.2 EXPERIMENTAL LEARNING AND PRACTICAL EXPERIENCE

Students on the GTA programme are taught in a variety of classrooms, depending on whether the planned educational activity focuses on desk-based work or requires different learning spaces, such as workbenches, sinks or food preparation surfaces. Experimental learning in the form of so-called 'labs' is another essential part of the programmes' pedagogical approach. For example, students in the renewable energy strand conduct tests using the mobile solar cart and solar panel training system to learn about the performance of solar panels and how it is affected by

changing weather conditions. As part of the extra-curricular activities offered through the GTA programme, students can use the Academy's 3D printers and garage-like workspace to help build an electric vehicle.

Experimental learning can also take place in the form of a baking lesson. The sustainable agriculture teacher used such an approach to teach first-year students about the nutritional value and protein content of food. He had received the teaching material from a bakery science student at Kansas University and decided to try it out. The students were given three almost identical muffin recipes – the only difference being high, low, or no

added soy protein. After baking, the students were asked to compare the muffins in terms of average height, texture and taste, before writing up their findings. Based on their findings, students were asked to discuss whether they would be willing to have a muffin with a smaller size or perhaps a different texture because it was the healthier option, or whether the taste and visual quality outweighed the health aspect.

Practical experience is also encouraged in the GTA programme in a number of ways. For example, students learn about sustainable use of resources by growing food, such as lettuce, using hydroponic systems in the school's greenhouse and

by using the food to feed animals (see Figure 9 below).

Although some of the food they receive is bought from local producers, the chickens on the school's roof regularly receive food grown by the students. The student naturalist programme also involves the sustainable agriculture teacher who collaborates with the high school teacher. The programme has a dedicated animal cage room for small mammals such as hamsters, rabbits and rats, and reptiles such as lizards and snakes. These are mostly former pets that their owners no longer wish to keep. GTA students specialising in sustainable agriculture regularly feed these rescued animals while learning about their nature and

FIGURE 8. WORKSPACE WITH 3D PRINTERS IN THE BACKGROUND ON THE LEFT AND THE ELECTRIC VEHICLE BUILT BY STUDENTS AS PART OF EXTRA-CURRICULAR ACTIVITIES ON THE RIGHT



Image: DTI

FIGURE 9. GTA STUDENTS SPECIALISING IN SUSTAINABLE AGRICULTURE FEED SHELTERED ANIMALS WITH LETTUCE GROWN IN THE OLATHE WEST HIGH SCHOOL GREENHOUSE



Image: DTI

characteristics from the teacher of the naturalist student programme.

Another example of encouraging hands-on experience is the green wall at the entrance to the wing of the Olathe West High School that houses the Green Academy. Students help look after the plants on the wall shown below, and are encouraged to take a plant home to start their own green wall. In this way, while helping students learn the basics of plant care, the wall contributes to a greener learning environment in the school building.

With this in mind, it is important to describe how teachers in the GTA programme work to combine the problem-based learning approach with

practical experience. This is typically done by combining theoretical learning, for example where students are required to carry out their own desk-based research on a topic before experiencing or working with it in a more practical way. One of the approaches used in this regard is field trips. For example, GTA students have visited wind and solar farms to experience first-hand some of the technologies they have been studying.

Finally, students are encouraged to gain practical experience by participating in a range of non-compulsory extra-curricular activities. GTA students can earn so-called 21st Century Endorsements, which are special notations on the certificates that students receive upon completion

FIGURE 10. PLANT WALL IN THE ATRIUM OF THE OLATHE WEST HIGH SCHOOL MAIN BUILDING AND THE ENTRANCE TO THE GREENTECH ACADEMY FACILITIES



Photo: DTI



of the GTA programme. They can serve as an indication for colleges and employers that a student has shown particular dedication and commitment in a particular area. GTA students can earn endorsements in a variety of ways, including participation in academic conferences and work-based learning experiences outside of the school day, including internships and client-based projects (Olathe Public Schools, n.d.(d)). For example, some sustainable agriculture students attended a national convention of the youth organisation 'Future Farmers of America' (FFA)³⁹, where they participated in workshops on growing plants, poultry science and dairy quality, among other things, and met with the agriscience and agribusiness

³⁹ The primary goal of the youth organisation is to prepare its members for leadership and careers in the science, business and technology of agriculture (see ffa.org for more information).

representatives. Teachers on the GTA programme also help students compete in a number of competitions. In the past, GTA students have, for example, participated in the 'KidWind Challenge' (where teams of students design, build and test small-scale wind turbines and solar structures).

4.3 STUDENT MOTIVATION

Students on the GTA programme are very positive about learning through hands-on experience, with some students emphasising that working on individual or group projects is less boring because they can get away from their desks and have discussions with their peers or teachers in the open learning environments. Other students describe that there is a limited amount of textbook reading and note taking, as students are often engaged in different projects, with the students interviewed highlighting some of the projects



5. CONCLUSION – KEY LESSONS LEARNED FROM THE GREENING OF VET AT THE OLATHE WEST HIGH SCHOOL

This case study examines the approaches to the greening of VET at the Olathe West High School in Kansas, USA, with an emphasis on the Green Tech Academy as the high school's vocational programme focused on providing skills in renewable energy and sustainable agriculture.

One of the key resources that support sustainability and green skills provision at the Olathe West High School is the school's main building and facilities. The high school has been designed with energy efficiency and environmental sustainability in mind. The architecture of the main building makes good use of natural light, while sensors used together with the building's digital monitoring system and the two solar panels outside, further contribute to a reduced electricity consumption, thus reducing the high school's carbon footprint.

The GTA programme has been successful in making good use of the school's facilities for the provision of green skills. Renewable energy students gain hands-on experiences by wiring-up and testing solar panels or making small wind turbines using 3D printers, while sustainable agriculture students build and maintain hydroponic gardening systems and care for the high school chickens by feeding them with produce from these systems.

GTA students appreciate and are motivated by their teachers' pedagogical approach, which emphasises both problem-based learning and hands-on experience. Students regularly work on projects centred around open-ended problems that require research and critical thinking, primarily in the areas of energy and agriculture. They are encouraged to ask critical questions and are expected not only to discuss with their peers but also challenge what they are taught in the classroom. To support a learning environment where this is possible, teachers are expected to be open-minded and willing to continually learn and develop. They regularly attend relevant business conferences and seminars to keep abreast of the latest developments in the areas in which they teach.

Although there is no dedicated 'greening officer' at the Olathe West High School or attached to the GTA programme, the school management and GTA teachers are committed to the greening of VET. This is partly reflected in the greening goals mentioned during the interviews for this case study, including the intention to increase composting and recycling efforts as well as the long-term goal of becoming a partner for local small and medium-sized enterprises seeking advice on how to make their practices more sustainable.

Another reason for the commitment to providing green skills is related to the

mentioned above, such as building a small energy efficient house, a miniature electric vehicle or working with solar panel installations. Students say that individual projects prepare them for a career by teaching them how to design and build things, manage processes and develop interpersonal skills or, as one student put it, '*problem-solving skills*'.

Another motivating factor for the students is the teachers, whom they see as passionate and supportive. They also emphasise that the teachers' encouragement of critical discussions and debates in the classroom contributes to their development as public speakers and presenters. Teachers' willingness to be open and supportive of individual students' interests is also highlighted, with students describing this approach as an important aspect of learning on the GTA programme.

Students are also motivated to engage in GTA courses because they recognise the importance of a green transition – with some students saying that there is no real alternative to promoting the wider use of renewable energy and a

more sustainable use of resources in general. In this sense, they feel that learning on the GTA programme is preparing them for the future. In this context, the students interviewed also emphasised the programme's focus on industry partners and the expected demand for skills in renewable energy and sustainable agriculture. Some of the students have attended GTA advisory board meetings and met and spoken with industry partners.

There is also a general feeling among the students interviewed that, as GTA students, they are part of something special. This is partly due to the main building and facilities of the at Olathe West High School, which they describe as special and in keeping with educational content of the GTA programme. For example, students highlight the natural lighting, the solar panel arrays, the hydroponic garden and the chicken coop. The same students also mention that it contributes positively to the learning environment that all students share the same values when it comes to sustainability and the green transition.



strong industry focus, at least in terms of the GTA programme. As a so-called 21st Century Academy Programme, the GTA was developed in consultation with external stakeholders, particularly with regard to the expected skills needs of local and regional employers. The GTA management and teachers have made a concerted effort to create an active Advisory Board for the Academy Programme, which has in the past contributed in a variety of ways to support GTA students, whether by sponsoring field trips, offering internships or even engaging in educational projects. Advisory Board

members from relevant industries contribute to the development of the GTA programme's curriculum by providing input on the skills they are looking for in future employees.

In conclusion, the particular strengths of the GTA programme's lie in its applied pedagogical approach, which involves problem-based learning and the integration of available facilities and technologies into educational activities, coupled with close collaboration with industry partners that actively contribute to and support the programme.

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ANNEX

This report is based on desk research and a 3-day visit to the Olathe West High School in Johnson County, Kansas, USA – focusing on the Green Tech Academy (GTA) as the school's green VET programme. The visit took place from 19 to 21 October 2022.

As part of the mission, three group interviews were held with school's leadership, as well as with teachers and students in the GTA programme. A series of one-on-one interviews were held with one student and one of the Academy's industry partners. Finally, a plenary discussion was held with most of the stakeholders interviewed, with the exception of the students.

PARTICIPANTS IN THE INTERVIEWS

GROUP INTERVIEW WITH TEACHERS/TRAINERS:

- The interviewees were two teachers from the Olathe West High School and the two facilitators teaching in the Green Tech Academy programme.

The group interview covered a range of topics. These included the educational content of the GTA programme, how it is developed by teachers at the school, and the role of government regulations in this context. The didactic approach of the GTA programme, which encourages self-learning by the students and the practical application of the acquired knowledge, was also discussed. Of the four teachers interviewed, two were the facilitators teaching in the GTA programme, while the other two were a student naturalist

teacher and an environmental science teacher at the Olathe West High School.

GROUP INTERVIEW WITH MANAGEMENT:

- The interviewees were the principal of Olathe West High School and the assistant principal, who is also the GTA programme supervisor.

The group interview with the high school's/GTA leadership focused on several aspects, including the sustainable design of the school building and how it was developed to support student learning and to communicate to the wider community about the GTA and its sustainability activities. Management's vision for the college in general and for the GTA programme (e.g. attracting students from diverse socio-economic backgrounds and providing them with skills that are in demand now and will be more so in the future), the quality and importance of partnerships between GTA and external stakeholders (especially business), and student engagement in the GTA programme were also discussed.

INDIVIDUAL / GROUP INTERVIEWS WITH STUDENTS:

A total of five interviews with students were conducted. One was with an individual student who, at the age of 14, is not part of the GTA programme but was given the opportunity to attend some of the classes associated with the programme, as he is strongly considering applying. The following four group interviews were with GTA students in either their first ('freshmen'), second ('sophomore') or third ('junior')

year of the programme. Due to time constraints, no interviews were conducted with senior students who are in their last year of the GTA programme.

The interviews focused on the students' perspectives of what skills they have acquired, how they have acquired them (e.g. didactic approaches used in the GTA), and what they thought was special about the GTA programme.

ONE-ON-ONE INTERVIEWS WITH EXTERNAL PARTNERS:

- Individual interviews were conducted with two representatives from different business partners of the GTA programme, namely from architectural firm **Hofer Welker** and the **Kiewit Engineering Group**.

The individual interviews focused, among other things, on the nature of the collaboration between the external partners and the GTA programme as well as the partners' motivation for working with the GTA and the benefits they derive from the partnership. Specific contributions from the partners, such as

guest lectures, a design project focusing on sustainable housing and funding for equipment.

PLENARY DISCUSSION

The plenary meeting took place at the end of the second day and before any interviews with students had been conducted (due to time constraints). It was attended by most interviewees for this case study, with the exception of students, and with the addition of a representative from **Corteva Agriscience** who had recently decided to try to support the GTA programme, particularly the sustainable agriculture pathway. The plenary discussion covered a wide range of topics. To begin with, the DTI consultant summarised his findings from the conducted interviews and invited panel members to comment on this summary. A discussion followed that touched on the green design of the building that houses the GTA programme, the teachers and their didactic approach, the importance of promoting green skills and working together with businesses, among other issues.

CASE V

TEMASEK POLYTECHNIC SINGAPORE



1. INTRODUCTION

This introductory chapter presents background information relevant to the case study at hand. It begins by introducing the Temasek Polytechnic and the School of Engineering. Other sections outline the vocational education and training (VET) system in Singapore and describe national and regional strategies relevant to its greening.

1.1 TEMASEK POLYTECHNIC AND THE SCHOOL OF ENGINEERING

Temasek Polytechnic (TP) is a post-secondary vocational education institution and statutory board under the Ministry of Education in Singapore.

FIGURE 1. MAIN CAMPUS OF TEMASEK POLYTECHNIC



Image: Temasek Polytechnic

The Temasek Polytechnic was established in 1990 and has grown into a large educational institution with more than 13 000 students and more than 1 400 staff. It offers 36 diploma courses in six schools, as shown below. A Polytechnic Diploma course is equivalent to EQF level 5.

O-level students and graduates can apply for admission to the TP. The Singapore-Cambridge GCE 'O' Level Programme is a two-year programme that prepares students for proficiency in one or two languages, mathematics, science and humanities.

The TP is the third polytechnic established in the country. As industry-focused institutions, polytechnic graduates in Singapore are in high demand for jobs or well-prepared for university studies. Polytechnics in Singapore admit most of their students after secondary school, usually at the age of 16-17 years, i.e. after 10 years of formal education. A diploma in a specialised field of study is awarded after

completing 3 years of academic studies and an industrial placement.

Internships are a cornerstone of the polytechnic education system. Typically lasting between 12 and 26 weeks, TP's internship programme exposes students to the work of the very industry they will be working in after graduation. The TP has an industry network that gives students access to a wide range of companies and academic institutions in Singapore and abroad.

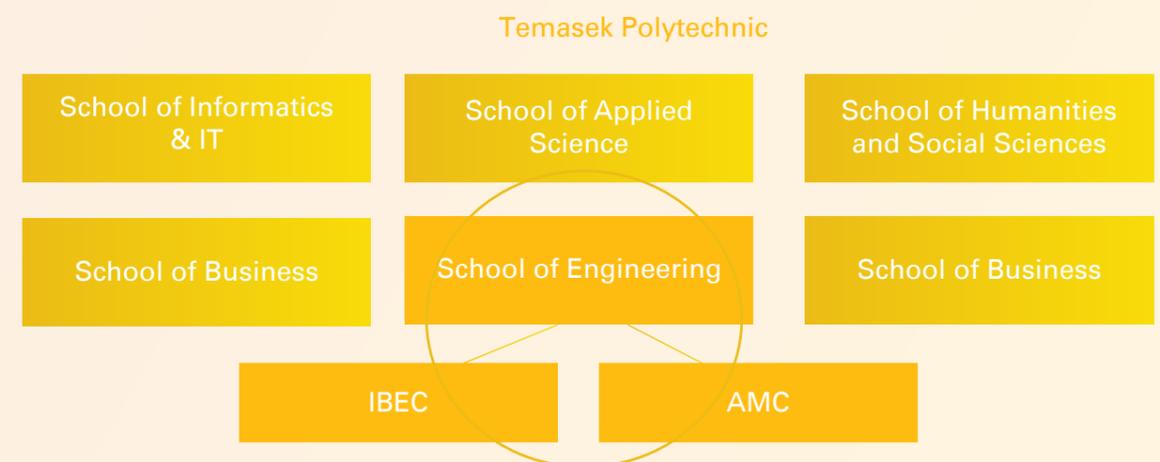
The School of Engineering

The case study visit took place at the School of Engineering, focusing on the two centres — the Advanced Manufacturing Centre (AMC) and the Integrative Built Environment Centre (IBEC).

The Integrative Built Environment Centre (IBEC)

was established on 7 January 2022 as an important part of TP's support for the Singapore Green Plan and the BuildSG movement. It is a centre that promotes multidisciplinary

FIGURE 2. DEVELOPED BY DTI BASED ON INFORMATION PUBLISHED ON TP'S WEBSITE



teaching and learning.⁴⁰ By providing training in the latest technologies, the IBEC seeks to advance the nation's push for sustainable development and the transformation of the built environment sector. The centre covers a wide range of related fields, specialising in areas such as digital architecture, intelligent building systems and smart facility management. The scope of the centre is broad, as it can be accessed by students in pre-employment training as well as those continuing their education.

The Advanced Manufacturing Centre (AMC) is an applied and skills-based training centre in the field of advanced manufacturing, which involves the use of innovative and advanced technologies to improve products and processes by enhancing the cyber-physical integration of manufacturing. For example, the AMC houses a complete end-to-end 'live' smart factory on campus which is based on AI and data-driven. The AMC is open to pre-employment and continuing education students. It has established industry partnerships and offers opportunities to work on proof-of-concept projects and provides consultations to companies to support their digitalisation and Industry 4.0 transformation.⁴¹

The School of Engineering and the two centres were selected for the case study because they are significant examples of VET institutions that highlight the integrative use of digital tools to support learning for sustainability. For example, it is highlighted that the IBEC will

40 <https://www.tp.edu.sg/about-tp/media-centre/press-release/temasek-polytechnic-launches-integrative-built-environment-centre.html>.

41 <https://www.tp.edu.sg/research-and-industry/centres-of-excellence/centres-under-school-of-engineering/advanced-manufacturing-centre.html>.

'enable 'plug and play' for learning with technology and data-driven facilities management systems, so that students fully understand the importance of timely intervention in a real-world environment that reflects the needs of the sector. The Advanced Manufacturing Centre (AMC) was selected for the case study because of its extensive use of advanced digital tools to promote sustainability education.

At the same time, the School of Engineering and its two centres are considered representative of Temasek Polytechnic (TP) as a whole, as the TP has established sustainability goals that apply to all schools.

1.2 VOCATIONAL EDUCATION AND TRAINING IN SINGAPORE

This section provides a brief introduction to the national VET context and outlines how VET is governed and funded in Singapore.

Vocational Education and Training in Singapore is called TVET (Technical Vocational Education and Training) and the term TVET has been used in the text below. The TVET system in Singapore is illustrated in the figure below. The polytechnics offer TVET programmes at ISCED levels 5 to 8.

The duration of the programmes is 3 years and the entry requirements are GCE O-Level, GCE A-Level, PFP or completion of a programme at the ITE.

The figure below shows Singapore's education system, including the TVET system.

The post-secondary TVET system in Singapore comprises eight institutions:

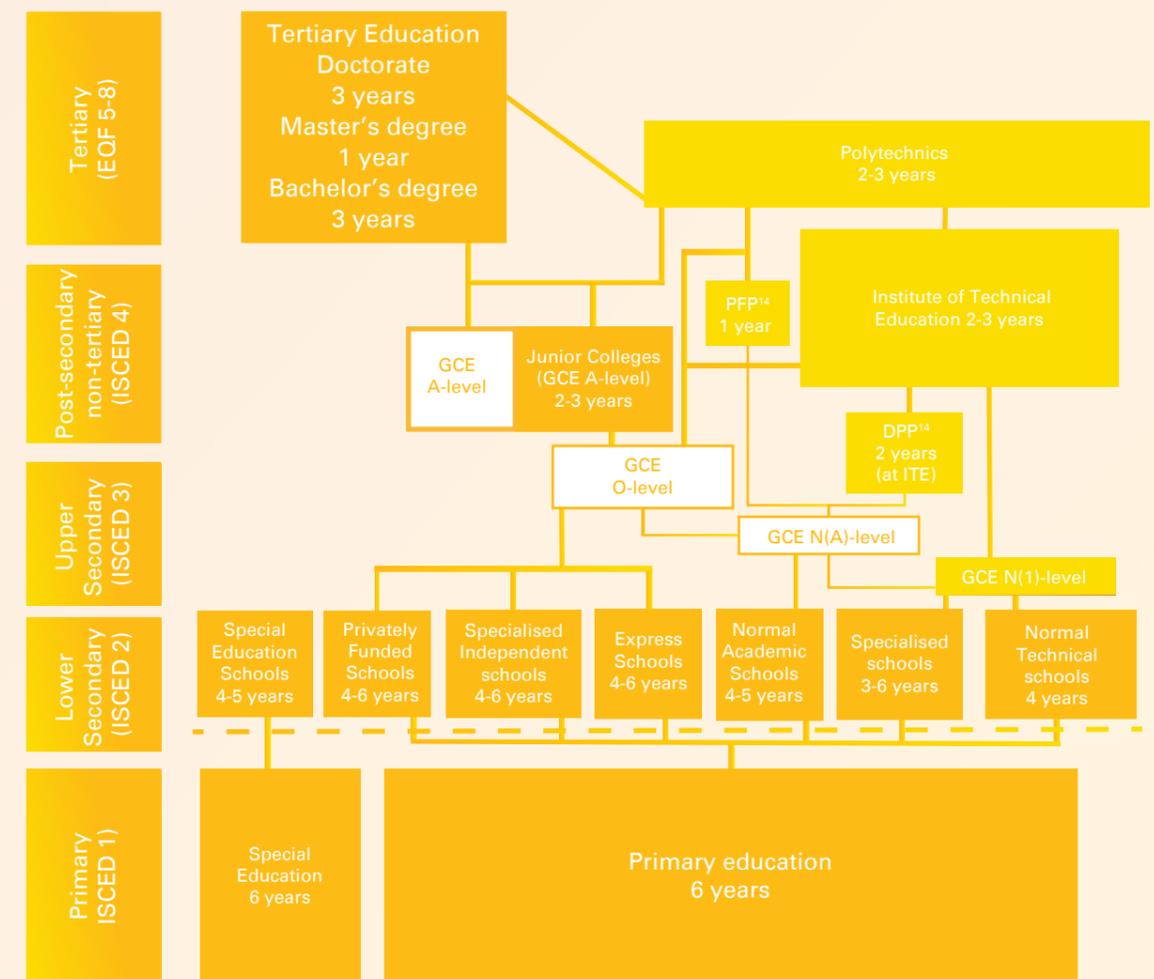
three Institutes of Technical Education, which offer primarily vocational training at certificate and higher certificate level, and five polytechnics (including the Temasek Polytechnic), which offer 3-year para-professional diplomas as well as advanced and specialist diplomas. Para-professional means that the graduates work as technical assistants, for example assisting engineers or other professionals.

The participation rate in post-secondary vocational education and training is

comparatively high at 65% of school leavers, with all entrants having at least 10 years of schooling before entering TVET.⁴² The overview below shows that 40% of the entrants to the polytechnics come directly from lower secondary

42 Varaprasad, N. (2022). Vocational Education and Training in Singapore. In: Symaco, L.P., Hayden, M. (eds) International Handbook on Education in South East Asia. Springer International Handbooks of Education. https://link.springer.com/chapter/10.1007/978-981-16-8136-3_10-1#citeas.

FIGURE 3. STRUCTURE OF SINGAPORE'S EDUCATION SYSTEM



Source: Unevoc Country profile 2020) UNESCO Country profile

education (4/5 years), while the rest (after lower secondary level) come from junior colleges or the Institute of Technical Education.

Governance

The governance of the TVET system and the provision of skills that meet the needs of the labour market and businesses are based on close cooperation between government institutions, employers, industry associations and trade unions.

Collaboration takes place through a detailed network of committees and is guided by industry transformation roadmaps for each industry sector. The constant and rapid change in the labour market is a fundamental challenge for TVET institutions in terms of faculty readiness, curriculum change and facilities upgrades. For this reason, TVET institutions, such as the TP, have close links with industry, which co-designs and implements programmes with the institutions. The government, through its various economic and employment agencies, is actively involving the private sector in the transformation and restructuring of industry, and training institutions are a key component in this effort.

The key legislation and government institutions that govern the TVET system in Singapore are as follows:

The National Manpower Council

comprising the Ministry of Trade and Industry (MTI), the Ministry of Manpower (MOM) and the Ministry of Education (MOE), is responsible for national skills manpower planning and training. The MOE oversees the implementation of policies introduced by SkillsFuture Singapore (SSG), which is a statutory board under the Ministry

of Education (MOE). Thus, in Singapore, the government is the main provider of education and training, and the institutions are governed by boards whose members are appointed by the government. However, the institutions are relatively autonomous and have the authority to not only deliver the programmes but to also award their own qualifications. This means that they both set and deliver the national standards for education and training.

SkillsFuture Singapore (SSG). The SSG drives and coordinates the implementation of the national SkillsFuture movement. The SSG Board provides guidance and advice to the SSG Management on all matters within the purview of the SSG's purview, including its policy, regulatory and promotional functions. It also reviews and approves SSG's strategic plans and budgets. The SSG Board members come from a variety of backgrounds, including trade unions and the private and public sectors. This enables the SSG to draw on their different perspectives and experience. Working with leading sectoral agencies, employers and trade unions, the SSG develops medium-term manpower and skills plans for each key sector to support industry growth and productivity efforts. These Sectoral Manpower Strategies identify sector-specific manpower and skills needs over a five-year period and outline a holistic set of measures to address these needs.

Workforce Singapore Agency (WSG).

The WSG oversees the transformation of the local workforce and industry to meet ongoing economic challenges. WSG promotes the development, competitiveness, inclusiveness and employability of the workforce

at all levels. The WSG Board and Management have established a framework to ensure strict adherence to good corporate governance practices. The WSG Board provides guidance and advice to the WSG Management on all matters within the remit of competence of the WSG, including its policy, operational and promotional functions. The WSG Board also reviews and approves WSG's strategic plans and budgets. The WSG Board members are drawn from a wide range of backgrounds, including the trade unions and the private and public sectors, in order to draw on their diverse experience and perspectives.

Industry Transformation Programme, Roadmaps (ITM). Roadmaps have been developed (2016) for 23 industries to address issues within each industry and deepen partnerships between government, business, industry, trade associations and chambers of commerce and industry.

The Future Economy Council (FEC)

has the overall responsibility for the implementation of the Industry Transformation Maps (ITMs). The FEC has six sub-committees. Each sub-committee oversees a group of ITMs within the same broad industry cluster. The ITMs are grouped into six clusters: manufacturing, built environment, trade and connectivity, essential domestic services, modern services and lifestyle. Each ITM will consist of a growth and competitiveness plan supported by four pillars: productivity, jobs and skills, innovation, and trade and internationalisation.

The Skills Framework, which is an integral part of the Industry Transformation Maps, is jointly

developed by employers, industry associations, trade unions and the government for Singapore's workforce. The Skills Framework provides key information on the sector and employment, career pathways, occupations/job roles, and existing and emerging skills needed for the occupations/job roles identified. It also provides a list of training programmes for upgrading and mastering skills. The Skills Framework aims to create a common skills language for individuals, employers and training providers. This facilitates the recognition of skills and supports the design of training programmes for skills and career development.⁴³

Quality Assurance Framework

In addition to the overall governance of the VET system described above, the Ministry of Education has established a detailed quality assurance framework (in 2007).

The ITE Quality Assurance Framework (IQAF) and the Polytechnic Quality Assurance Framework (PQAF) have been established to ensure that the ITE and polytechnic systems and structures for resource allocation, human resource management and other organisational processes are properly aligned to enable them to achieve their mission.

The Quality Assurance Frameworks are based on a 5-year assessment cycle and involve the following main steps:

1. Each institution conducts an institutional self-assessment against 25 institutional objectives in five areas: Governance and Leadership, Management and Strategic Planning,

⁴³ Further details can be found here: <https://t1p.de/1ecl>.



Teaching and Learning, Industry Linkages, and Service.

2. The institution submits its Institutional Self-Assessment Report (ISAR) to the MOE prior to the site visit.
3. An External Review Panel (ERP) commissioned by the MOE then conducts a 5-day EV (site visit). The review culminates in a qualitative report (EV report), which confirms good practices and identifies areas where improvement action is required or recommended.
4. Quality Improvement Projects: The institution then submits action plans with clear milestones across the areas for improvement identified in the EV report. A progress report on the action plans and the issues raised by the EV at the annual Performance Review Forum with the MOE is also required.

Funding

Funding for TVET comes from three main sources: government funding, student fees and the private sector.

Government financing

The Ministry of Education (MOE) provides development and recurrent funding to all educational institutions, including TVET institutions, such as the Institute of Technical Education and the five polytechnics. The total amount of development funding varies according to the annual needs of each institution. These needs vary greatly depending on the type and level of education. However, the general trend is that the expenditure of TVET institutions, and the expenditure per student, is continuously increasing. In 2015, for example, the amount spent

on one TVET student per year was equal to about SGD 12 000 (about USD 8 830 and about 8,211 euros). In general, students enrolled in TVET courses are required to pay fees. Under certain programmes, such as the Continuing Education and Training Pillar 3, courses at Institutes of Higher Learning (IHL) are subsidised by the government up to 70% of the course fees for Singaporeans and permanent residents. The remaining net fee can be paid through the Skills Future Credit, a government-sponsored initiative that supports individuals in their pursuit of lifelong learning.

Private funding

In addition to government funding, contributions are also being generated from the private sector. To this end, the Temasek Polytechnic General Education Fund was established⁴⁴ in 2003 to:

- provide scholarship, bursaries and other assistance to students;
- support students' education-related projects/activities;
- support student and staff exchanges with industry and other institutions;
- bring renowned experts, lecturers, and speakers to TP;
- provide seed financing to establish centres of excellence in strategic areas of teaching and research;
- promote the continuous training and development of staff, and
- do all things necessary or appropriate to promote and fulfil the mission of TP.

The TPGEF receives donations from individuals, companies and organisations, which are matched by

⁴⁴ https://www.tp.edu.sg/content/dam/tp-web/microsites/annual-reports/2018_19/gef.html.

grants from the MOE. The TPGEF also generates interest earned from the investment of funds.

1.3 NATIONAL STRATEGIES RELEVANT TO THE GREENING OF VET

The Singaporean government has made environmental sustainability and climate change mitigation a prominent policy agenda. The Singapore Green Plan 2030, or the Green Plan, is a nationwide movement to advance Singapore's national agenda on sustainable development. The Green Plan sets out ambitious and concrete targets for the next 10 years, strengthening Singapore's commitments under the UN's 2030 Sustainable Development Agenda and the Paris Agreement, to achieve the long-term net zero emissions by 2050.

The plan includes a long list of concrete targets for the future. Some of these are shown in the table below.

NATIONAL INITIATIVES IN SUPPORT OF GREEN SKILLS PROVISION

The Green Plan 2030 places environmental sustainability and climate change mitigation at the forefront of national policies and strategies. In addition, significant initiatives have been launched to support the provision of green skills in the field of education. Supporting the provision of green skills involves all parts of the education system. This means that we cannot isolate national initiatives that address the vocational education and training system. TP's management describe the TP as taking inspiration from many of the national initiatives and adopting energy-saving technologies and sustainable practices, described in more detail in section 2.2.

FIGURE 4. GREEN PLAN 2030 EXAMPLES OF TARGETS

City in Nature

2026 target:

- Develop over 130 ha of new parks, and enhance around 170 ha of existing parks with more lush vegetation and natural landscapes.

2030 targets:

- Double our annual tree planting rate between 2020 and 2030, to plant an additional 1 million trees across Singapore
- Increase nature parks' land area by more than 50% compared to the 2020 baseline
- Every household is within a 10-minute walk from a park

Energy Reset

2030 targets:

- Increase solar energy deployment five-fold to at least 2 GWp, which can meet around 3% of our 2030 projected electricity demand and generate enough electricity to power more than 350 000 households a year (1.5 GWp by 2025, which can meet around 2% of our 2025 projected electricity demand and generate enough electricity to power more than 260 000 households a year)
- 200 MWh of energy storage systems deployment beyond 2025, which can power more than 16 000 households a day.
- Best-in-class generation technology that meets heat-rate/emissions standards and reduces carbon emissions.
- Diversified electricity supply with clean electricity imports

Greener Infrastructure and Buildings

2025 target

- Reduce energy consumption of desalination process from current 3.5 kWh/m³ to 2kW h/m³
- Singapore's first integrated waste and used water treatment facility to be 100% energy self-sufficient (Tuas Nexus)

2030 targets:

- Green 80% of Singapore's buildings (by Gross Floor Area) by 2030
- 80% of new buildings (by Gross Floor Area) to be Super Low Energy buildings from 2030
- Best-in-class green buildings to see an 80% improvement in energy efficiency (over 2005 levels) by 2030 Long-term target: Reduce desalination energy further to 1 kWh/m³

Source: <https://www.greenplan.gov.sg/targets>

In 2021, the Ministry of Education in Singapore launched a series of educational initiatives from primary to tertiary level. The initiatives are designed to promote sustainable living, empower students to do their part for the environment and strengthen green efforts in line with the national sustainability agenda under the Singapore Green Plan 2030. Support for the provision of green skills provision involves all parts of Singapore's education system, including TVET.

The Eco Stewardship Programme

The Eco Stewardship Programme builds on current environmental efforts in all schools, from primary to pre-university levels, through the 4Cs – Curriculum, Campus, Culture and Community.

Curriculum

The Ministry aims to update and enhance teaching and learning about sustainability within the science and humanities curriculum from primary to pre-university level.

Campus

Infrastructure in all schools will be enhanced with sustainability features, including more trees, energy efficient technologies, and the use of Solar Nova. Solar Nova is a government programme launched in 2014 to accelerate the deployment of solar panels in Singapore.

Culture

Students will be encouraged to practise sustainability by adopting daily habits such as reducing energy consumption and food waste, conserving water and recycling. Schools will strengthen sustainability efforts by enhancing

relevant school policies, including those on energy and water conservation and waste management.

Community

Schools will use community partnerships to expand environment-related volunteering and enrichment opportunities for students. The Ministry wants to increase students' awareness of future 'green jobs', such as jobs in green urban design, renewable energy and sustainability technology, water management, food sustainability and urban agriculture and green financing.

Pilot sustainability features

The Ministry of Education plans to harness solar energy and reduce energy consumption and waste generation in Singapore schools. The aim is to reduce net carbon emissions from the school sector by two-thirds by 2030, and for at least 20% of schools to be carbon neutral by 2030. The pilot will focus on developing school-based environmental policies and programmes to help schools reduce their carbon footprint and raise students' awareness of their carbon footprint.

New Science Centre to boost public education on sustainability

A new Science Centre in Singapore, which is to be developed in the Jurong Lake District, will showcase innovative sustainability technologies, through programmes and exhibits to continue to further engage youth and the public to inspire sustainable lifestyle changes. The new Science Centre Singapore will also partner with schools to enhance their programmes, including conducting sustainability learning journeys and mentoring students to lead their peers.



2. MANAGEMENT AND ORGANISATION OF THE TEMASEK POLYTECHNIC

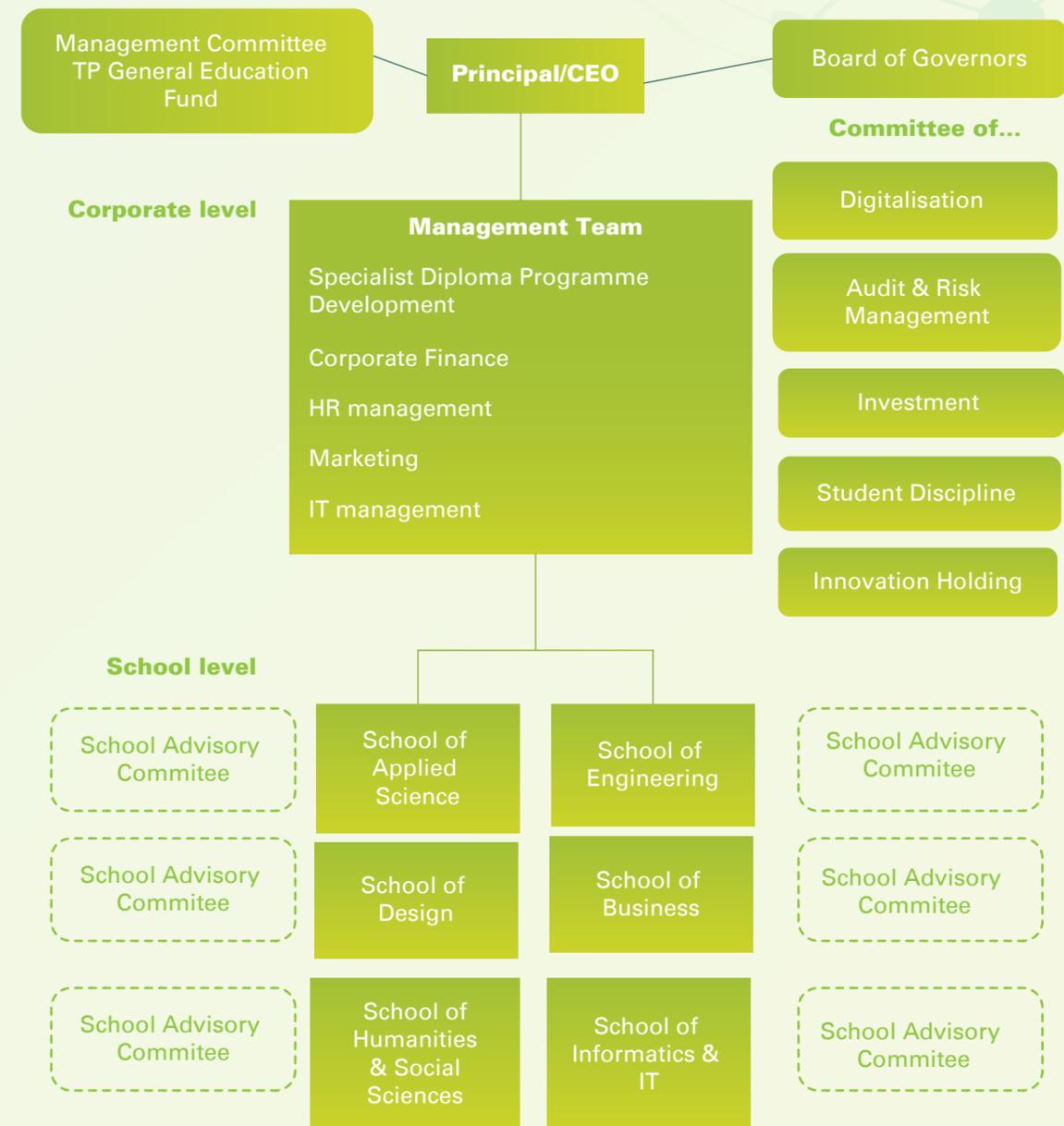
2.1 ORGANISATIONAL STRUCTURE

This chapter outlines Temasek Polytechnic's organisational structure and management. It also presents the sustainability goals set by management against the backdrop of relevant national policies and strategies. Finally, the chapter describes the resources and facilities that Temasek Polytechnic's management and staff can draw upon in working towards realising these goals.

Temasek Polytechnic (TP) is a large organisation with corporate level and school level management. Corporate level management involves the overall management of TP's programme development, finance/budgeting,

human resources management, IT management and marketing. At CEO level, the management is overseen by the Board of Governors, which represents government institutions/ministries, industry/sector organisations, experts/researchers, government agencies and other stakeholders. In addition, a number of committees are established at the corporate level and at school level (School Advisory Committees). The committees represent relevant government institutions, industry associations and companies that are related to the field. The numerous committees reflect the fact that TP's management is based on close collaboration with the industry partners and other external stakeholders in order to ensure the industry-relevance of skills provision.

FIGURE 5. ORGANISATIONAL STRUCTURE OF THE TEMASEK POLYTECHNIC



Source: Annual report

Programme and course delivery is managed at school level and centre level. In summary, the organisation and implementation of the sustainability and the green transition is a top down

process that involves all three levels of TP management:

1. At the corporate level, decisions are taken on programme development,

- sustainability goals and the integration of sustainability/green content into the curriculum. Thus, TP's corporate management is the *decision maker* as to which sustainability goals and trends are to be addressed in the curriculum.
- At school level, the management is the *implementer* and initiator of new sustainability-related learning activities and projects.
 - Management at centre level, such as the Advanced Manufacturing Centre (AMC) and the Integrative Built Environment Centre (IBEC), which manage the details of the implementation.

Overall, the management of the green transition is described by the management as a multi-stakeholder, collective effort involving industry, government and staff. Subject development is managed by subject leaders, while project managers curate major projects for students in various digital areas such as digital twin, AR/VR, IoT, BMS, data analytics and visualisation.

2.2 TEMASEK POLYTECHNIC'S SUSTAINABILITY GOALS

The Temasek Polytechnic has set sustainability goals (using four pillars of action) that apply to all of its schools⁴⁵:

- Curriculum: sustainability is integrated into the curriculum.
- Collaboration: collaboration with the industry to ensure that skills are industry-relevant.

- Campus: TP is committed to a greener campus infrastructure and environment through the use of environmentally friendly equipment.
- Community: a staff-led TP Eco-Campus Committee and a student-led Green Interest Group promote sustainability efforts on campus and in the community.

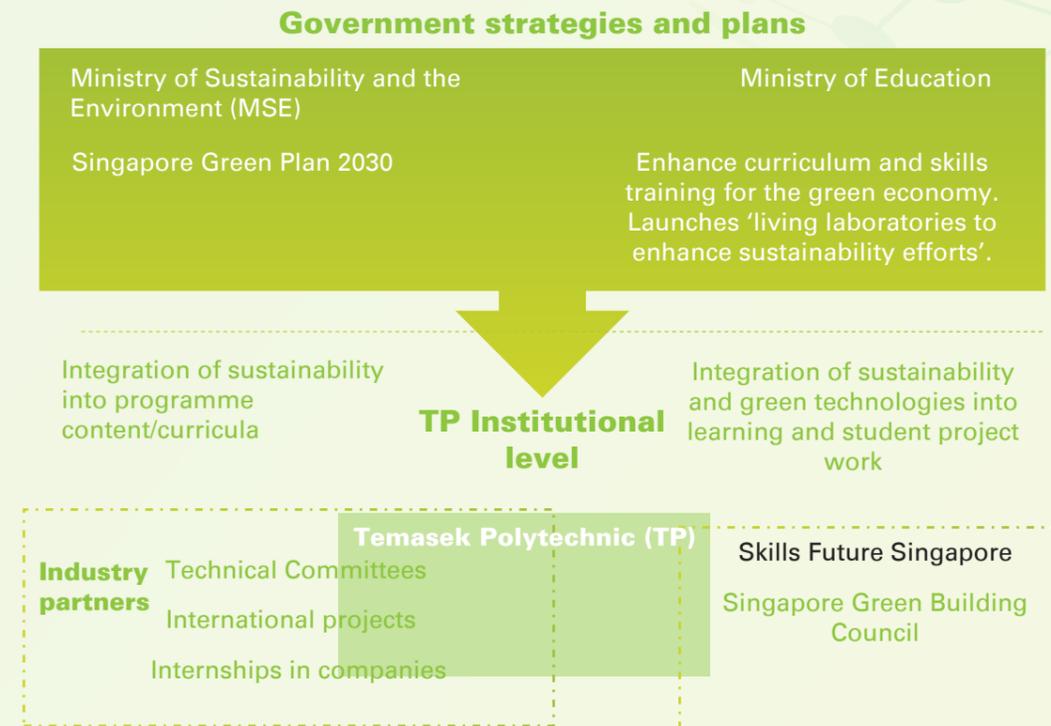
How is the green transition (content, programmes, pedagogy) supported by TP's management and the School of Engineering? The management believes that the green transition at the Temasek Polytechnic and the School of Engineering is supported by a combination of curriculum development, research, major projects, competitions, study tours and community engagement to equip students with the knowledge and skills needed to address environmental challenges and promote sustainability and environmental awareness.

Singapore's green transition is supported by a variety of resources, including financial, technical, and human resources. These resources are organised and managed through a combination of government initiatives, private sector investment and public-private partnerships. The TP executives interviewed that the government plays a key role in organising and channelling resources towards the green transition.

The model below shows that the integration of sustainability into programme content/curricula is shaped by a combination of government strategies and collaboration with industry partners in technical committees at institutional level.

⁴⁵ <https://www.tp.edu.sg/research-and-industry/sustainability.html>.

FIGURE 6. GOVERNMENT STRATEGIES AFFECTING THE INSTITUTIONAL LEVEL OF TP



Source: developed by DTI

The Temasek Polytechnic management interviewed believes that the Green Plan 2030 is a key guiding strategy for Temasek Polytechnic's contribution to a greener economy and for the greening of the institution and its activities. For example, management states that one of the pillars of the Green Plan is renewable energy. As a result, the TP has installed a solar system on the roof of the institution and has undergone an energy audit of the building's energy consumption. The TP has also switched to the use of LED lighting.

As the figure above shows, the integration of sustainability into learning and student project work is being shaped by the Ministry of Education

(MOE), which continually enhances the curriculum and skills training to prepare students for the green economy. The MOE has launched the IBEC as part of the 'Living Laboratories' initiative to strengthen national sustainability efforts. The term 'living laboratories' was first used by the MOE in the last decade to express the policy idea that higher education institutions should use their own campuses as 'living laboratories' to support national research and talent development efforts. Launched in January 2022, the Integrative Built Environment Centre (IBEC) aims to train about 2 000 students and working professionals in various aspects of sustainability and the built environment through internship opportunities, real-world project

collaborations and exposure to the latest technologies in the sector.⁴⁶

At the Temasek Polytechnic, the Singapore Green Building Council (SGBC) is also involved in developing green initiatives. The SGBC is a national not-for-profit, non-governmental organisation that is part of the global network recognised by the World Green Building Council. In 2022, the SGBC and Temasek Polytechnic (TP) signed a Memorandum of Understanding (MOU) for students from TP's Diploma in Green Building & Sustainability (GBS) and Integrated Facilities Management (IFM) programmes to undertake a structured internship programme with the SGBC and its member companies.

A GREEN CAMPUS AND GREEN BUILDINGS

TP's green campus status is certified by accreditation: the TP has a platinum Green Mark certification. The Green Mark certification scheme was launched in January 2005. It is a green building rating system designed to assess the environmental impact and energy performance of the building. It provides a comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design, and best practice in the construction and operation in buildings.⁴⁷

Temasek Polytechnic has initiated several activities to develop a green campus

that serves as a 'living laboratory' for sustainability. The TP and its buildings have been accredited by Singapore's Green Building Accreditation Scheme. In addition, in 2019 the Temasek Polytechnic Engineering School became an authorised training partner of the IES. This partnership supports the Building & Construction Authority's (BCA) goal of making at least 80% of Singapore's buildings green by 2030, by providing comprehensive training to the industry. Both IES and Temasek Polytechnic are developing and promoting digital technologies in the green building industry in Singapore.⁴⁸

These are some key features of the green campus:

Rainwater harvesting. In 2012, the TP became the first educational institution to implement a rainwater harvesting system to irrigate its entire campus.⁴⁹

Solar energy harvesting. The TP has installed solar panels on the roof of the building to facilitate further research into photovoltaic technology while increasing electricity supply.

Green roof and walls. TP has green plantations on the roof and the walls (3 480 m² of green roof and 640 m² of living walls) on the façade of the new building. According to the website, the green roof and walls embody the spirit of the Polytechnic's continuous efforts to be environmentally friendly and sustainable. They also serve

46 <https://www.moe.gov.sg/news/press-releases/20220308-strengthening-our-contributions-towards-the-green-economy-and-empowering-the-next-generation-of-sustainability-leaders>.

47 <https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme>.

48 <https://www.iesve.com/discoveries/news/2986/temasek-olytechnic-becomes-authorised-training-partner>.

49 https://www.tp.edu.sg/content/dam/tp-web/microsites/annual-reports/2012_13/highlights.html.

as a reminder to the Polytechnic's students of the need to be sensitive to their environment and encourage its protection and preservation.

Waste management. The TP has also established a waste management system, where waste is sorted for recycling and reuse.

PROFESSIONAL DEVELOPMENT OF TEACHERS

An important factor in the green transition is that it is supported by the teachers' skills and professional development. To help them keep up with ever-changing practices of industry, polytechnic teachers can upgrade their skills through industry placements or postgraduate courses. This is why work placements are offered to teachers who want to update their insight and technical knowledge. In addition to workplace attachments and training courses, teachers can develop their skills by participating in projects, consultancy work or by experiencing real-world projects in the Technology Development Centres. Teachers at TP can also enhance their skills through overseas study tours. To support teachers' professional development, the Temasek Polytechnic conducts research, consultancy, and staff exchange programmes with several institutions outside of Singapore and hosts faculty from the ASEAN countries under the auspices of the Initiative for ASEAN Integration (IAI).

The teachers interviewed said that industry placements are very useful to gain insight into industry practices and technologies that are important for the green transition.

Management estimates that, on average, 10% of the teaching staff is involved in industry placements for continuous professional development (CPD). The school encourages 10% of staff to undertake industry placements and 90% of staff to participate in CPD through webinars, training, conferences, exchange sessions, publication of papers, involvement in projects, guest speakers, etc. CPD activities are usually carried out on the teachers' own initiative. However, the school management encourages staff to take initiative for their professional development in addition to the organisation's CPD plan.

The TP is very flexible in terms of the duration and form of industrial placements. It can be part-time (as little as 8 hours/week) up to years. The school always encourages staff to work on their professional development. The management emphasises that staff involvement and keeping abreast of the latest industry trends is also beneficial to the students. The companies selected for placements can range from SMEs (small and medium-sized enterprises) all the way to MNCs (Multi-national companies), depending on the needs.

The organisational unit responsible for the professional development of teachers at the TP as a whole is the TP Staff Capability Development Department, which deals with staff competency frameworks, courses and digital learning, career planning and transition, industry engagement/attachment, the digital mentoring programme and workday guides. The CPD system and the relevant processes are available on the intranet.

According to the management interviewed, there are no budgetary restrictions on staff willing to undertake training, further study, industrial placements, etc.

INTERNATIONAL GREEN PROJECTS

At the institutional level, the TP also collaborates with industry partners on international green projects, that transfer technology and know-how. For example, the TP has implemented international co-operation projects with developing countries, such as Cambodia. In October 2017, a group of 11 students participated in an Overseas Internship Programme (OCP) trip to Cambodia to help install solar lighting in Trang village (where there is no electricity) and teach basic vocational English to underprivileged students in the Aoral and Trang education centres. As well as carrying out their mission, the student volunteers also had the opportunity to interact with local residents by chatting, playing games and taking part in cultural performances, or explore the city and roam the countryside. The Global Studies course is compulsory for all students, and it offered by the Temasek Polytechnic's Centre for Transcultural Studies.⁵⁰

THE LEARNING ACADEMY

In terms of pedagogy, Temasek Polytechnic's management emphasises self-directed learning through the use of pedagogy, tools and structures that help

students develop intrinsic motivation and take ownership of their learning. This approach is based on, and aligned with, the government's EdTech Plan.

At the institutional level, the Learning Academy is also an important body that oversees the pedagogical approach and the skills of the teaching staff. The Learning Academy designs and delivers professional development programmes for TP's staff in areas such as learning-teaching, the use of technology for learning, including e-learning, and learning analytics. The Learning Academy also provides professional development opportunities by guiding teachers in their teaching. The Learning Academy also conducts research into the effectiveness of initiatives on student learning in areas such as self-directed learning, problem-based learning, technology-enhanced learning, and learning analytics.

The Learning Academy oversees the pedagogical approach across all five polytechnics. However, at each institution, there is a 'mini-learning academy' (5-6 people) responsible for the development and adaptation of educational content and the integration of sustainability into subjects. At the institutional level, the Learning Academy conducts continuous assessment and quality control of the institution's pedagogical approach and e-learning environment.

⁵⁰ <https://www.tp.edu.sg/research-and-industry/centres-of-excellence/centre-for-transcultural-studies.html#academic-subjects>



3. SUSTAINABILITY IN CONTENT AND PROGRAMMES

This section describes how sustainability is integrated into curricula and educational programmes and how students work with sustainability in their engineering projects.

EDUCATIONAL CONTENT

The structure of a 3-year diploma programme comprises six semesters, including five that are school-based. During one semester the student can study abroad or do an internship in a company. The final semester includes a major assignment that requires the student, to develop his and/or her own experimental project, often in collaboration with other students.

In total, there are 43 diploma courses offered by the Temasek Polytechnic, of which 11 are provided by the School of Engineering. How many of these have

some green content or sustainability elements? Using the search engine, it is possible to get an estimate of how many 'green' diplomas there are: 38 programmes come up when the word 'sustainability' is used in the search engine. This means that sustainability is integrated in some way into almost all programmes and shows that sustainability is not a 'sector' or a limited subject, but rather a perspective that is relevant to almost any field of activity.

It is rather complex to quantify the number of programmes related to sustainability, as there can be modules related to sustainability-related as well as whole programmes. Therefore, for this case study, the management of The School of Engineering has developed an overview sustainability-related degrees and courses.

FIGURE 7. TABLE OF SUSTAINABILITY RELATED PROGRAMMES

CATEGORY	TITLE
Pre-employment education and training (PET) courses related to sustainability:	<ul style="list-style-type: none"> ■ Diploma in Architectural Technology & Building Services ■ Diploma in Integrated Facilities Management ■ Diploma in Clean Energy ■ Diploma in Sustainability Science and Management
Continuing education and training (CET) courses related to sustainability:	<ul style="list-style-type: none"> ■ Initiating Environment Sustainability in Corporates (A one-day workshop that helps businesses to explore how they can improve their indoor environment quality and understand more about environmental sustainability.) ■ Refrigerant Handling for Chiller (A course designed to help develop capabilities within the refrigeration and air-conditioning industry) ■ Introduction to Energy Storage Systems ■ Energy Management & Sustainable Design ■ Grid-Connected Solar Photovoltaic System with Battery Storage ■ Fire Alarm Systems and Maintenance ■ Fire Safety Management ■ Specialist Diploma in Building Information Modelling (BIM) Construction & Asset Management
Modules in existing courses related to sustainability:	<ul style="list-style-type: none"> ■ Eco-Architecture Design 1 & 2 ■ Introduction to the Built Environment ■ Building Management Systems ■ Building Performance Modelling ■ Building Systems Modelling ■ Energy Management & Audit ■ Integrated Design Studio ■ Facility Operations & Maintenance ■ Building Information Modelling Collaboration ■ Air Conditioning & Mechanical Ventilation ■ Energy Management & Audit ■ Sustainable Facilities Management
Sustainability topics integrated into existing module(s) taken by all students.	<ul style="list-style-type: none"> ■ Sustainability & Climate Action
Teaching facilities dedicated to sustainability	<ul style="list-style-type: none"> ■ Integrative Built Environment Centre ■ Clean Energy Research Centre

Source: developed by the management of The School of Engineering

Here are some examples, which show how the subject is integrated into programmes.

The table shows that diplomas in very different fields all have sustainability perspectives integrated into the

FIGURE 8. TABLE OF SUSTAINABILITY RELATED DIPLOMA PROGRAMMES

TITLE OF DIPLOMA	PROGRAMME'S REFERENCE TO SUSTAINABILITY
Diploma in Architectural Technology & Building Services (T29)	The programme addresses issues on the nation's sustainable development agenda, such as climate change, carbon emissions and environmental degradation.
Common Science Programme (T70)	Subjects ranging from chemistry and microbiology that offer current and highly sought-after skills, such as data analytics, sustainability, and laboratory safety.
Diploma in Apparel Design & Merchandising (T20)	History and impact of fashion over time and create purposeful pieces that consider social trends, such as ethical and sustainable fashion.
Diploma in Chemical Engineering (T33)	<p>Chemical engineers play a key role in ensuring environmental sustainability and tackling global issues such as poverty and disease.</p> <p>This multidisciplinary field brings together mathematics, chemistry, physics, biology, and engineering to understand how raw materials are processed to give us the products we use in our daily lives, including fuels, paints, biodegradable plastics, medicines, cosmetics, personal care products, food, water, and many others.</p>
Diploma in Product Experience & Design (T35)	Throughout the integrated programme, students are guided to research, explore and understand consumer priorities. This will enable them to design, produce and deliver real value and satisfaction to the consumer, with sustainable design at the forefront.

Source: developed by the management of The School of Engineering

programme: For example, the Diploma in Architectural Technology & Building Services makes direct reference to the Singapore Green Plan 2030, which envisions buildings that address issues on Singapore's sustainable development agenda. The Diploma in Apparel Design & Merchandising incorporates sustainable fashion and the Diploma in Chemical Engineering emphasises that chemical engineers play a key role in ensuring environmental sustainability.

The process of developing a new programme typically involves the senior managers from TP's department responsible for specialist diploma programme development and the management team at school level (for example the School of Engineering will be involved as the diploma provider). The TP management and industry representatives then form a technical committee where they develop proposals for a syllabus of the basic content of the programme. The draft proposals are then discussed with the Skills Agency and the Ministry of Education.

Sustainability content is continuously developed in collaboration with industry partners and government institutions.

The integration of sustainability into programme content and in the curricula is an ongoing process carried out by the institutional management in close collaboration with industry partners. Typically, the TP works with industry partners that provide specific environmental technologies/solutions. For example, the TP collaborates with the industry partner A-GAS, which provides technological solutions for the reprocessing and reuse of refrigerant,

a working fluid used in the refrigeration cycle of air conditioning systems and heat pumps.

The opportunity to develop new courses and programmes may come from various industry partners or government institutions. For example, the idea for a new course on the reprocessing and reuse of refrigerant (chiller) gas, a highly potent GHG emission, was suggested by the National Environment Agency (NAE), when a new regulation was introduced, which requires companies to reprocess and reuse chiller gas.

A-GAS, a company with technical expertise in chiller gas reuse⁵¹, was asked by the NAE to contact the Temasek Polytechnic in order to explore the possibility of developing a chiller gas reuse training course for businesses. Many companies did not know how to comply with the new regulation.

Since October 2022, the companies involved the installation, maintenance or decommissioning of water-cooled chillers are required to employ at least one certified refrigerant gas technician to carry out or supervise water-cooled chiller maintenance work that involves the handling of refrigerants.

The course has been developed jointly by the National Environment Agency (NEA) and the TP and is designed to equip chiller gas technicians in the refrigeration and air-conditioning (RAC) industry with the essential knowledge and skills to correctly

⁵¹ A chiller gas is a refrigerant, working fluid used in the refrigeration cycle of air conditioning systems and heat pumps where in most cases they undergo a repeated phase transition from a liquid to a gas and back again.

FIGURE 9. CHILLER GAS EQUIPMENT



Source: TP photo

handle refrigerants during installation, maintenance and decommissioning works on water-cooled chillers.

The course is delivered jointly by TP lecturers at the IBEC and industry experts who have the requisite experience in refrigerant handling. The IBEC houses a 'live' chiller system that cools the centre and doubles as a key training facility.

As mentioned above, collaboration with industry partners is an important element in TP's development of curricula programmes for specific courses and programmes, as it is a key element of TP's educational approach to provide students with industry-relevant skills. Therefore,

TP's own facilities on campus are being developed to simulate current industry operations. In the area of sustainability, the TP has established the following centres in collaboration with industry.

- the Integrative Built Environment Centre (IBEC), which provides training and co-creation of sustainable solutions for the built environment sector;
- the Clean Energy Research Centre (CERC), which disseminates technologies in advanced energy conversion and storage, smart power systems, and energy sensors and analytics to co-create innovative solutions to mitigate climate change;
- the Centre for Urban Sustainability (CUS), which focuses on two R&D

thrusts of Solid Waste Management and Recycling for Strategic Building Materials, and Food Waste Reduction and Recycling;

- the BeyonDesign Centre (BDC), which has an interdisciplinary approach to exploiting new opportunities that are presented by technological, cultural and social change.

Collaboration with industry partners is described in more detail in the next section on integrating sustainability into curricula/programmes.

The integration of sustainability content takes place in technical committees

The development of the curriculum content and the skills/competences for a given programme/course takes place in a technical committee with representatives of the Temasek Polytechnic and industry organisations.

The formulation of green skills/competences for a programme, e.g. facility management, uses the Skills Lists developed by the Skills Agency, as the 'basic building blocks'. The external industry partner interviewed, the Singapore International Facility Management Association (SIFMA), explains that the development of relevant skills for a particular programme, e.g. Integrated Facility Management, takes place in a technical committee with representatives from SIFMA, several SIFMA-certified companies, and the TP. As an industry partner, SIFMA has access to a wide range of certified firms, ensuring that the programme is based on a deep and up-to-date understanding of the companies' use of technology and their needs. The school then presents its draft curriculum based on the Skills Future agency's framework and asks: 'Is this what the industry wants?' At the next stage,

the programme content is negotiated with SIFMA and the companies in a process that typically involves 5–6 technical committee meetings. During the meetings the syllabus gradually becomes more detailed and is circulated for comments from industry associations and certified companies.

Integrating sustainability into curricula and programmes

In principle, there is a direct link between the Singapore Green Plan and the Integrative Built Environment Centre (IBEC), which was established to support the Singapore Green Plan and the BuildSG movement. The IBEC aims to advance Singapore's drive for sustainable development and transform the built environment sector by providing training in the latest technologies. As mentioned above, the IBEC integrates sustainability into its Integrated Facility Management programme and works closely with the Singapore International Facility Management Association, as a key training and research centre for the sector. To provide practice-based training, IBEC uses the building's equipment and systems to give students a hands-on look at operating buildings sustainably. The equipment includes a chiller system, lift and escalator set-ups, security processes, which use artificial intelligence, an electric vehicle laboratory, etc.

As such, the Integrated Facility Management programme is linked to the Green Plan and the government's Smart Nation digital strategy. The course provides a multidisciplinary skill set to improve the integration of building systems, processes, and smart technologies to enhance the overall management of building facilities. The programme includes subjects such as Virtual Design & Facility Planning,

Building Information Modelling, and Sustainable Facility Management.

Another example is Architectural Technology & Building Services (ABS), which provides skills that enable students to contribute to making buildings more sustainable and resistant to environmental degradation. The ABS students interviewed mentioned that the curriculum includes technologies such as Revit and Building Information Modelling (BIM) for passive design strategies and software simulation for assessing the energy efficiency of buildings. Some of the students explained that passive design is an approach that uses the structure of buildings to maintain a comfortable temperature without the need for additional heating or cooling. The students interviewed also explained that Revit can be used to create a digital model of the building that can be used to simulate and optimise its energy use. The students described how they are given assignments where they have to develop a building design that takes into account various criteria, such as energy optimisation and sustainable use of resources.

Scanning all buildings to provide digital data for optimising energy use

There is a synergy between sustainability and going green, and the use of digital tools and data to monitor and optimise building functions and energy efficiency. The Temasek Polytechnic uses its own buildings a 'living laboratory' for sustainability.

In 2018, all buildings were scanned using 3D laser technology, which converted all building data into virtual data that is available for projects. Then, in 2021, the TP installed more than 3 000 sensors across its campus to extract real-time data that can identify potential faults and

predict changing conditions. In terms of sustainability, these insights will allow the educational institution to adjust its operations with a view to improving efficiency and reducing its carbon footprint. The data collected from the 3 000 sensors is fed into a digital twin — a virtual replica of the physical campus. Data from air conditioning and mechanical ventilation systems will be monitored to keep temperature and humidity at healthy levels. Data from the various mechanical and electrical systems will be aggregated on the facilities management platform, enabling the Temasek Polytechnic to optimise energy consumption.

The scanned digital data are accessed and used by students and faculty in courses related to modelling of buildings and their energy use. For example, in the Integrated Facility Management programme, digital data from scanned buildings is used in the Digital Delivery Management certification. Another example is the use of digital building data for the Diploma in Interior Architecture & Design, where the data is used for architectural design and digital visualisation.

The building's energy system and other technical equipment have been transformed into simulated and real-world environments

A key pedagogical element of teaching at the IBEC is putting together various systems and machinery normally found in buildings to give students a hands-on look at the sustainable operation of buildings. These include a chiller plant, lift and escalator installations, security processes using artificial intelligence and an electric vehicle laboratory.

The IBEC has also made one of its escalators available for training and offers a course leading to a

FIGURE 10. A LEICA 3D LASER SCANNER AT THE IBEC ENABLING 3D SCANNING OF BUILDINGS



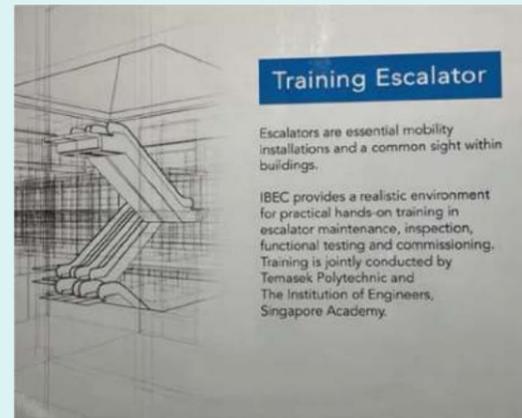
Source: DTI photo

qualification as a BCA-accredited lift and escalator inspector. Similarly, the institution's rooftop solar panels are monitored from a large control room that doubles as a laboratory where students can use digital sensor data for projects.

The Temasek Polytechnic's Advanced Manufacturing Centre (AMC)

The AMC has adopted a consistent pedagogical approach to advanced manufacturing that enables hands-on learning in a realistic environment. The Centre houses an end-to-end 'living' factory that produces high-mix, low-volume products, applying a multi-disciplinary experimental learning pedagogy. The Centre uses technology and equipment to train skills such as

FIGURE 11. TRAINING ESCALATOR



Source: DTI photo

AI@Edge, Robotics and Automation, Industrial Internet of Things (IIOT), Big Data Analytics, 3D Computer-aided Design (CAD) and Modelling, Additive Manufacturing, Augmented Reality 3D Maintenance and Training, as well as IOT Cyber Security⁵². The AMC equips students with specialist software skills in virtual design and Building Information Modelling (BIM) that enable them to create predictive energy performance and energy consumption bioclimatic simulations. Such bioclimatic simulations are used in the diploma course in Architectural Technology & Building Services.

The AMC provides skills sets in mechanical and electrical (M&E) systems, coupled with automation technology for data analysis, to ensure energy efficiency and smart building management.

⁵² <https://ssia.org.sg/temasek-polytechnic-advanced-manufacturing-centre/>.

4. PEDAGOGICAL APPROACH

This chapter analyses Temasek Polytechnic's pedagogical approach and how it supports the students' acquisition of sustainability skills.

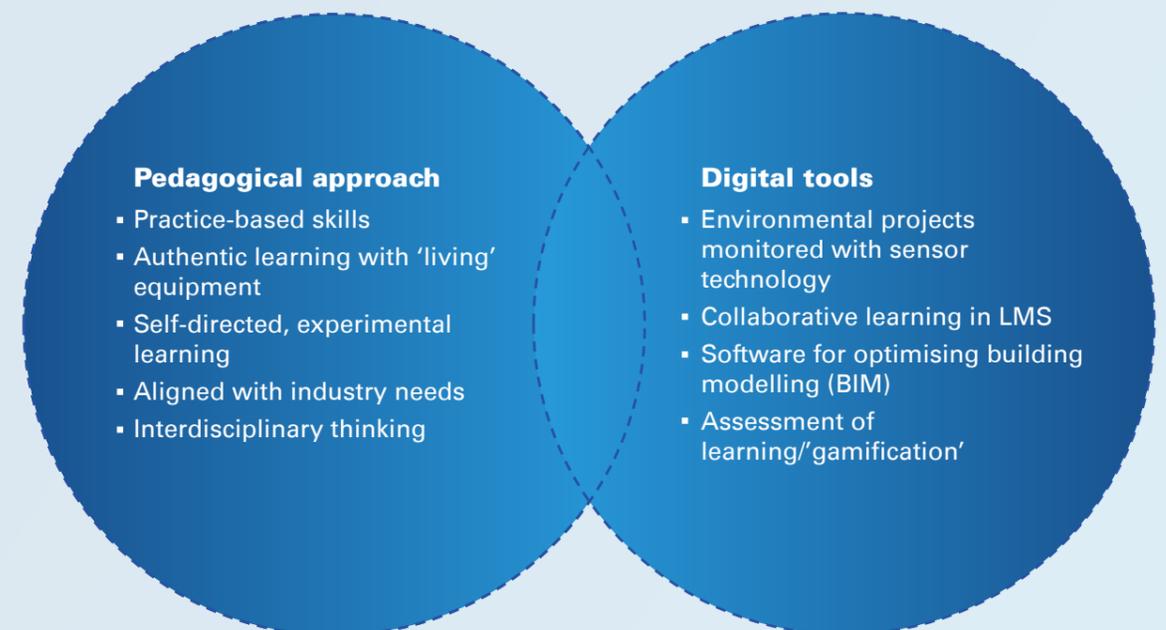
PRACTICE-BASED AND SELF-DIRECTED LEARNING

Temasek Polytechnic's pedagogical approach is based on a Practice-based and Skills Education (PSE) framework that emphasises the focus on providing authentic learning to prepare learners for and in the world of work. In collaboration with industry partners, curriculum and

programme content is aligned with industry and real-world environments.

Practice-based and self-directed learning is based on an interplay between the pedagogical approach and the digital tools. The figure below illustrates how TP's pedagogical approach is supported by digital tools which are used when the students work with sustainability. The digital tools include sensor technology for extracting data from experimental projects and software used in architectural design (for example Revit) and in building management (BIM). The

FIGURE 12. PEDAGOGICAL APPROACH OF TP



Source: developed by DTI

Learning Management System (LMS) enables students to work collaboratively in groups via channels set up for the purpose.

The following sections describe how the pedagogical approach supports students work with sustainability and how digital tools are used in the learning process.

AUTHENTIC 'LIVE' EXPERIENCE WITH BUILDING'S EQUIPMENT AND SUSTAINABLE ENERGY SUPPLY

Temasek Polytechnic's use of its own building's equipment for energy supply and energy management allow students to experience a 'live' and realistic working environment. The TP emphasises a hands-on approach where students are involved in 'live' and real collaboration with companies and clients working on the TP's buildings. For example, students experience professionalism by working with real clients and building owners when TP partners with school designers. The economic income from assignments and collaboration with companies are used to improve facilities of the school campus.

Working with solar energy technology gives students hands-on experience because all equipment is accessible. For example, the solar panels on the roof of the building are connected to classrooms full of sensors, monitoring equipment, oscilloscopes, inverters, and software that allow students to analyse and optimise solar energy supply.

Monitoring of the solar panels allows students to measure and see how even minor damage to the solar cells affects their efficiency.

The solar cells on the roof of the Temasek Polytechnic also allow experimentation with different environments, for example painting the surface under the solar panels white to enhance solar reflection, which can increase the energy yield.

At the same time, the IBEC buildings are used as a 'living laboratory' where energy use, temperature, humidity, lighting and many other functions are monitored, and where data can be reviewed and extracted for educational

FIGURE 13. SOLAR PANELS (LEFT) AND CONTROL ROOM (RIGHT)



Source: DTI photos

FIGURE 14. DAMAGE TO SOLAR PANELS (LEFT) SOLAR PANELS SEEN FROM BELOW (RIGHT)



Source: DTI photos

purposes. The pictures below show the large TV display.

Student projects experimenting with solar energy

As the students develop an understanding of solar energy and experiment with the technology in various multidisciplinary projects. Experiments with solar energy are conducted by students on the Diploma in Architectural Technology & Building Services or the Diploma in Interior Architecture & Design programme.

Several student projects were presented during the visit. The picture below shows a project that experimented with solar panels producing solar energy in combination with algae production. The project is a good example of multidisciplinary learning as algae

production is based on collaboration with students with biological/agricultural knowledge.

As shown in the pedagogical model above, the student project also involves digital tools in the form of sensor technology that monitors the process and extracts data for statistical analysis. To extract data for documentation and analysis of the process, all parameters of the energy production are monitored with appropriate sensor technology.

Hand-on self-directed learning

Hands-on, experimental and self-directed learning is well reflected in the students' work on their own engineering projects. As they develop their technical equipment for the experiments, they collect the components they need in what are called 'libraries of technical spare parts'.

FIGURE 15. TV MONITORS SHOWING THE FUNCTIONS AND NETWORKS OF THE TP BUILDING



Source: DTI photos

FIGURE 16. STUDENT PROJECT ON SOLAR PANELS



Source: DTI photographs

FIGURE 17. 'LIBRARY OF SPARE PARTS' WHICH STUDENTS CAN USE TO COLLECT PARTS FOR THEIR OWN TECHNICAL PROJECTS



Source: DTI photos

MULTIDISCIPLINARY LEARNING

TP also emphasises multidisciplinary (or interdisciplinary) learning which typically means that students develop projects in collaboration with students from different subjects, courses or schools.

Multidisciplinary learning is applied when students work on topics related to sustainability. In the plenary meeting, the representatives of teachers and management interviewed gave examples of how multidisciplinary learning is used in collaborative projects. The multidisciplinary projects are typically organised at school level, for example in the School of Engineering, where there are Diploma Units (of lecturers) who focus on major projects. The Diploma Units will identify projects that require expertise from different courses and will involve students from different areas and programmes.

Students working on multidisciplinary projects will be supervised by staff from different courses who have the relevant

expertise. There is a general principle at the TP that students on all diploma courses are given access to the IBEC when they need to use technical facilities of the Centre for their projects. The IBEC focuses on multidisciplinary learning and encourages collaboration between the students, staff members and industry partners in the diverse fields of engineering, design and IT. Pupils from any of the TP schools can work together on multidisciplinary projects. This depends on how sustainability is linked to other areas under the project. Contacts and links between different schools can be initiated by students or teachers, in some cases through social media, where students post updates on project activities. In some cases, teachers can enhance multidisciplinary projects by giving students tasks that require them to work together with students from other schools.

For example, the students will be given an assignment on 'urban farming'.

Students from the School of Applied Science will cultivate the plants intended to grow in specific conditions, while students from the School of Engineering will work on the part of the building where the plants will grow. The students will work together on how to use sensor technology and other digital tools to monitor and optimise the urban farming process. The digital tools in the LMS support collaborative group learning. When the students work together in the LMS, they do this through a channel that is only accessible to students in the group. The channel allows the students to exchange messages and files with each other. The collaborative nature of the LMS is supported by Blackboard Collaborate, an integrated video conferencing tool within the LMS, which enables real-time online engagement and real-time chat, audio and video conferencing.

The interviews with students and teachers indicate that the LMS is seen by both parties as an excellent platform that supports a progressive learning process (both individual and collaborative).

In the plenary meeting, management emphasised that interdisciplinary thinking is an important pedagogical approach. When students are paired and work together across different disciplines, they work and learn together, propose solutions together – and they see how the knowledge from each discipline enhances the final solution.

Looking to the future, horizontal and cross-curricular learning activities will be given even higher priority. In the plenary meeting, the management explained that there are plans to develop more horizontal qualifications across

all TP schools (where students work on sustainability and climate change). TP represents many different technical fields that are related to environmental issues, such as food, agriculture, buildings, transport and infrastructure.

The management has explained that the horizontal approach is key to the students' multidisciplinary work on sustainability, which includes a subject called 'Sustainability and Climate Action'. The aim of this core subject is to raise students' awareness of sustainability and climate change issues.

Sustainable architectural building design applying digital using digital software

The technical subjects related to sustainable architectural design and building management are becoming increasingly digitalised. Students described that when they work with sustainable architectural design, they estimate that about 90% of the programme content is related to digital software tools. When working with architectural building design, students use Revit to design, document, visualise, and deliver architectural, engineering and construction projects. In Revit, the students can apply the integrated energy analysis, which allows them to simulate and improve the energy performance of buildings. Using integrated energy analysis, the students can perform calculations related to passive design, where the structure and climatic factors of buildings themselves can minimise energy consumption. For example, calculations can be made on daylighting metrics and annual solar gain. Revit includes several different ways of collaborating with other students who are also using the software. One student explained that when working in Revit,

multiple Revit models can be linked together, allowing a group of students to collaborate on multiple models at the same time. In addition, Revit includes an internal feature called Dynamo, which is a graphical programming interface that allows students to customise the building information workflow.

Industry placements

As TP continues to collaborate with industry partners, industry placements are offered to students. For example, the TP collaborated with the company A-GAS on a course on the recycling of refrigeration gases. In connection with this collaboration, two student internships have been provided and more are expected in the future. Internships in Singapore are governed by the Employment Act. Interns and trainees may only be employed for a

short period of time to broaden their exposure to the industry or to train for a long-term role. Although internships are paid/funded by the employer, there is no minimum remuneration for interns under the Employment Act. Therefore, internship programmes may be unpaid. However, employers are encouraged to provide monthly stipends to cover food and travel expenses incurred by the interns during the period of employment.⁵³ Student Internship Programmes (SIP) usually start between March and October and generally last from 16 to 26 weeks. SIPs are usually carried out with local organisations in a relevant industry where students undertake various activities and experience problem solving in practical, real-life situations. Alternatively, a SIP can be undertaken overseas (OSIP), where students can gain global experience.

⁵³ <https://singaporelegaladvice.com/law-articles/employment-rights-interns-trainees-singapore/>.

5. CONCLUSION – KEY LESSONS LEARNED FROM THE GREEN TRANSITION AT THE TEMASEK POLYTECHNIC

TP's green transition is aligned with government strategies and policies

The TP managers and teachers interviewed have explained that government support is an important factor in the green transition. Governmental strategies, such as the Green Plan 2030 and the BuildSG movement, are seen as important political guidelines for the progress of the green transition and as a basis for the institutions.

Indeed, the establishment of TP's Integrative Built Environment Centre (IBEC) is part of the Ministry of Education's (MOE) 'Living Laboratories' initiative, which aims to enhance national sustainability efforts' initiative. At the institutional level, the Temasek Polytechnic aligns its curricula with MOE's strategies and Singapore Skills Future is helping to implement them.

Curriculum content and 'being a green centre' are also part of the transition

The green transition involves integrating sustainability into curriculum content and 'being a green centre'. To this end, the TP has launched several activities to develop a green campus that acts as a 'living laboratory' for sustainability. For example:

- **Rainwater harvesting.** In 2012, the TP became the first educational institution to implement a rainwater

harvesting system to irrigate its entire campus.⁵⁴

- **Solar energy harvesting.** The TP has solar panels on its roof to facilitate further research in photovoltaic technology while supplementing its electricity supply.
- **Green roof and walls.** TP has green plantations on its roof and walls (3 480 m² of green roof and 640 m² of living walls on the façade of the new building).
- **Waste management.** The TP has implemented a waste management system that sorts waste for recycling and reuse.

The DTI believes that these initiatives can be seen as visible manifestations of being a green centre and developing and sharing of green values.

Integrating sustainability into the curriculum in close collaboration with industry

The integration of sustainability and new technologies into curricula typically takes place in a technical committee set up specifically for a particular programme/course to be developed. The technical committee includes representatives of the TP, the industry association of a

⁵⁴ https://www.tp.edu.sg/content/dam/tp-web/microsites/annual-reports/2012_13/highlights.html



given sector and companies that have been certified by the association. For example, a course/programme was developed in collaboration with the industry partner Singapore International Facility Management Association (SIFMA). Another course/programme on the reprocessing and reuse of refrigerant gas was developed in collaboration with the company A-GAS. Courses/programmes are updated on a regular basis (at intervals of about 2 years).

The pedagogical approach supports the development of industry-relevant practical green skills

TP's pedagogical approach effectively supports the students' development of practical green skills that are highly

relevant to industry. The key elements of this effective synergy are:

- **Students have direct access to 'live' energy technology and building equipment.** The TP has turned its solar power system and internal building equipment into a 'living' laboratory to give students a hands-on look sustainable building operations using digital monitoring tools. This includes a cooling system, lift and escalator installations, security processes that use artificial intelligence, and an electric vehicle laboratory. In addition, all buildings have been 3D scanned and the readings have been converted into digital data, which can be fed into

digital twins and other replicas of the physical campus. The students and teachers interviewed say that the close access to technical equipment and 'real' digital data is a great benefit to the learning process.

■ **The students implement collaborative, multidisciplinary experimental sustainability projects**

The students implement collaborative sustainability projects that involve students from other schools and combine various areas of knowledge. For example, these can combine solar energy and algae production or urban farming or building design and agricultural technology. Students learn how knowledge from each discipline enhances the final solution.

■ **The students develop skills and knowledge through self-directed learning**

Hands-on, experimental and self-directed learning is well reflected in the students' work on their own engineering projects. As they develop their technical equipment for experiments, they collect the components they need in 'libraries of technical spare parts' and have access

to workshops, where they can work in collaboration with other students.

The centre shares its excellence in sustainable innovation with other schools and through international projects around the world

Temasek Polytechnic's excellence in solar energy systems and other sustainable building technologies is widely shared both at the national and international level. At the national level, primary schools and other upper secondary schools are invited and introduced to its solar energy supply system and other projects. At the international level, the Temasek Polytechnic 'exports' its know-how and implements projects jointly with developing countries. In partnership with industry, it has implemented a number of sustainability projects in different countries. For example, in 2017 the TP implemented a project in Cambodia, which involved students installing solar lighting in villages without electricity.

ABBREVIATIONS

AUD	Australian Dollars
CoVE	Centre(s) of Vocational Excellence
CTE	Career and technical education (term used in the US for VET)
DTI	Danish Technological Institute
EPLUG	European Platform for Urban Greening
ETF	European Training Foundation.
FENELEC	The National Federation of Electricity, Electronics and Renewable Energies in Morocco
FIMME	The Federation of Metallurgical, Mechanical and Electromechanical Industries in Morocco
GHG	Greenhouse gas
GSA	Green Skills Agreement
GTA	Green Tech Academy
GW	Gigawatt
IFMERE	Institut de Formation aux Métiers des Energies Renouvelables et de l'Efficacité Énergétique
KW	Kilowatt
MW	Megawatt
OVAE	Office of Vocational and Adult Education
SDGs	Sustainable Development Goals (referring to the United Nations SDGs)
SES	Social Environmental and Sustainability
TAFE	Technical and further education (the term used in Australia for VET)
TEAL	Technology Enabled Active Learning spaces
US	United States
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vocational education and training