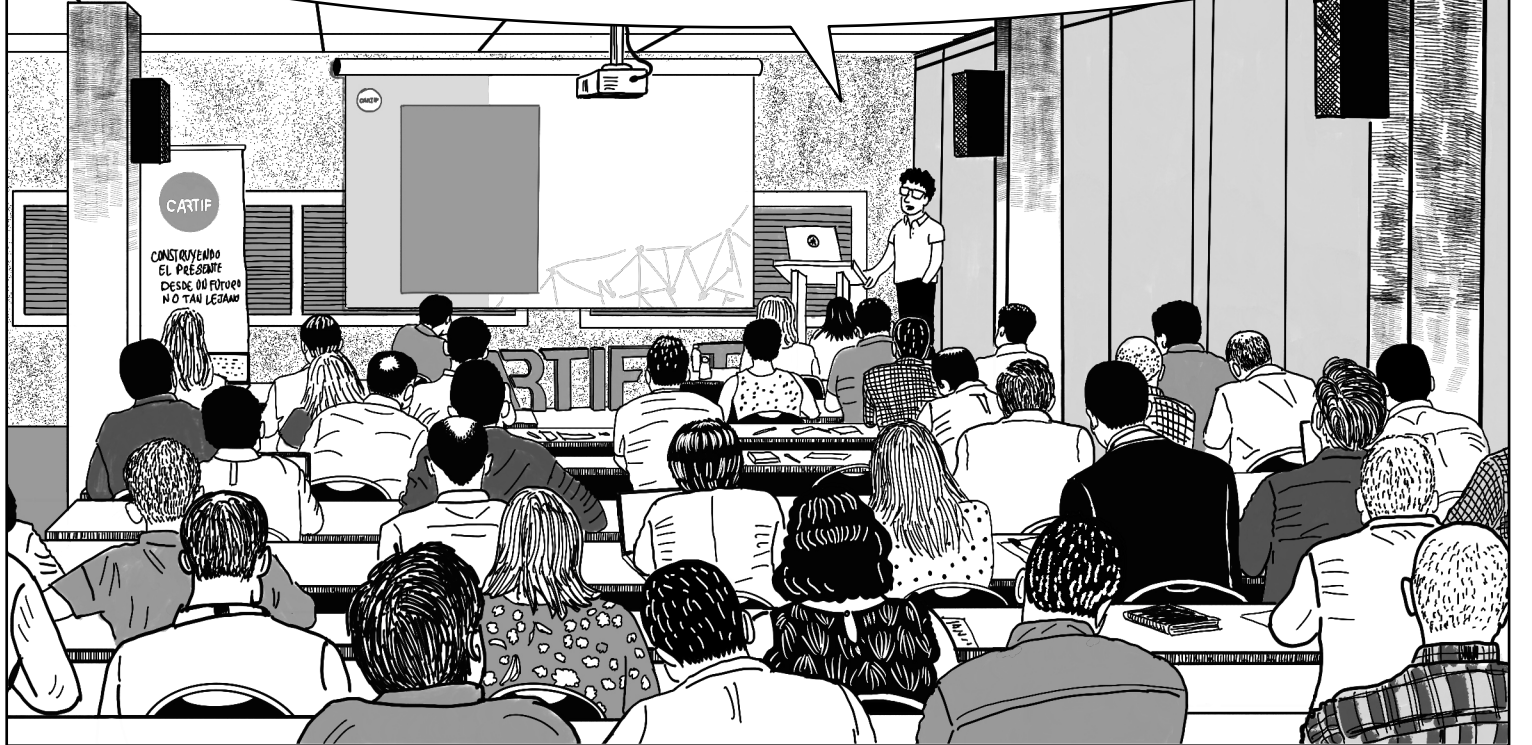


Digitalization applied to Decarbonization processes

Anibal Reñones

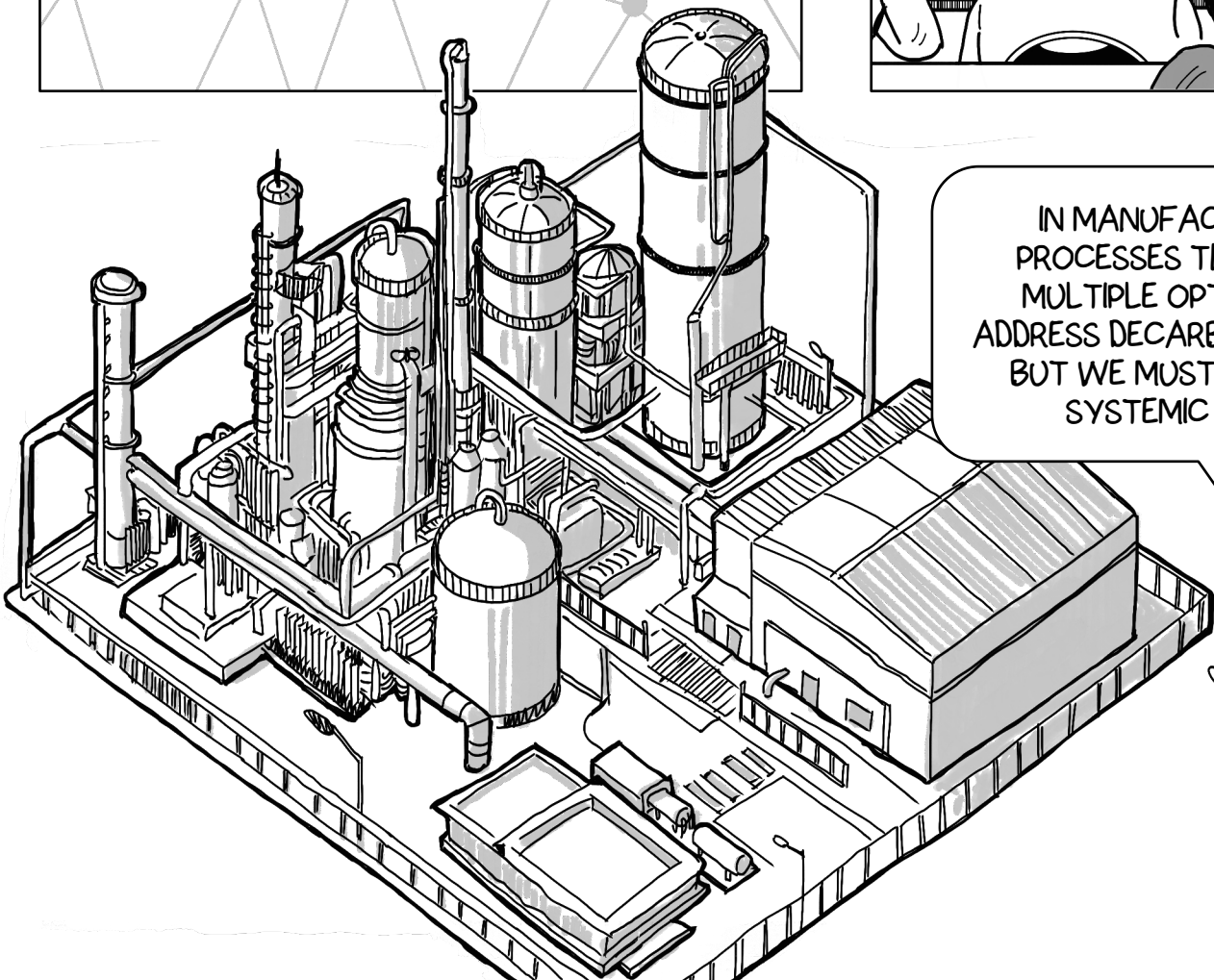
DIGITAL AND INDUSTRIAL SYSTEMS

GOOD MORNING, I AM ANIBAL REÑONES, PROGRAMS DIRECTOR FOR INDUSTRIAL AND DIGITAL SYSTEMS AT CARTIF. TODAY I WILL REVIEW HOW DIGITALIZATION — THAT IS, USING DATA, MODELS AND CONTROL TO MAKE BETTER REAL-TIME DECISIONS — IS APPLIED TO THE DECARBONIZATION OF PRODUCTION PROCESSES, MEANING THE REDUCTION OF CARBON DIOXIDE (CO₂) AND OTHER GREENHOUSE GAS (GHG) EMISSIONS.

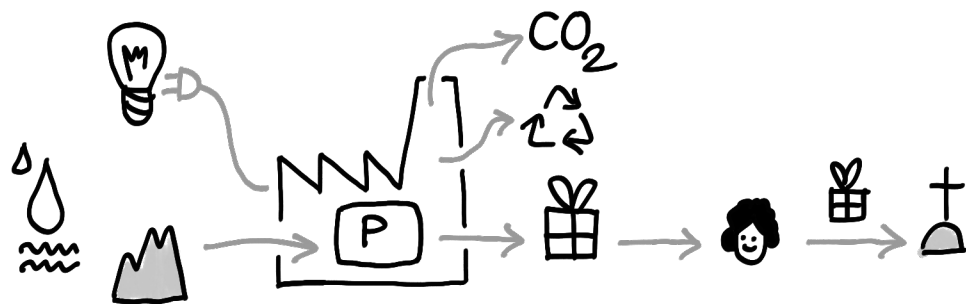


IN MANUFACTURING PROCESSES THERE ARE MULTIPLE OPTIONS TO ADDRESS DECARBONIZATION, BUT WE MUST ACT IN A SYSTEMIC WAY.

WE WILL SIMPLIFY THE FACTORY AND ITS PROCESSES SO THAT WE CAN REVIEW THE DIFFERENT ALTERNATIVES IN A REASONABLE TIMEFRAME.



THE FACTORY AND ITS PRODUCTION PROCESSES FORM AN OPEN SYSTEM WITH INPUTS, TRANSFORMATION PROCESSES THAT GENERATE OUTPUTS AND HAVE AN IMPACT ON EMISSIONS THAT WE SEEK TO MITIGATE OR ELIMINATE.



SOMETHING LIKE THIS...

... THIS PART ON THE RIGHT REPRESENTS THE LIFE CYCLE OF THE MANUFACTURED PRODUCT.



DECARBONIZING IS NOT JUST ABOUT REPLACING A MACHINE WITH A MORE EFFICIENT ONE.



TO ACHIEVE FULL DECARBONIZATION, WE MUST ACT ON THE ENTIRE SYSTEM: ON THE ENERGY CONSUMED ...

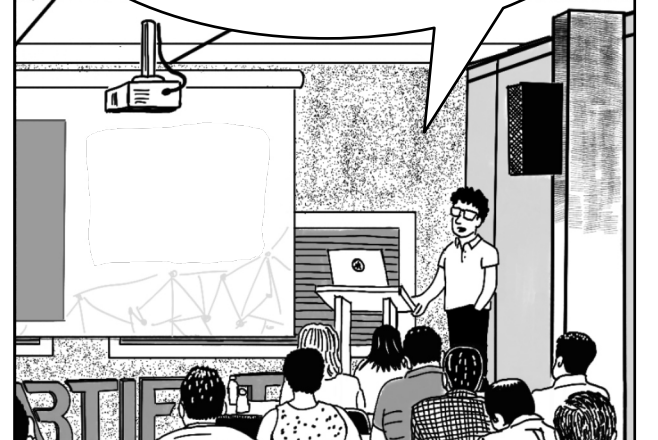
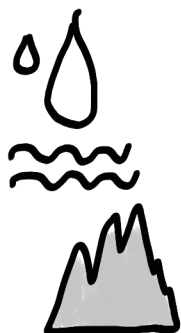
... THE RAW MATERIALS USED, INCLUDING NATURAL RESOURCES SUCH AS WATER...

TRANSFORMATION PROCESSES SUCH AS DRYING...

... THE MANUFACTURED PRODUCT.

... AND ITS USE AND END OF LIFE; IN SHORT, ITS FULL LIFE CYCLE.

THE TRANSFORMATION WE SEEK REQUIRES TRANSPARENCY, TRACEABILITY AND CONTROL — PILLARS PROVIDED BY DIGITALIZATION.

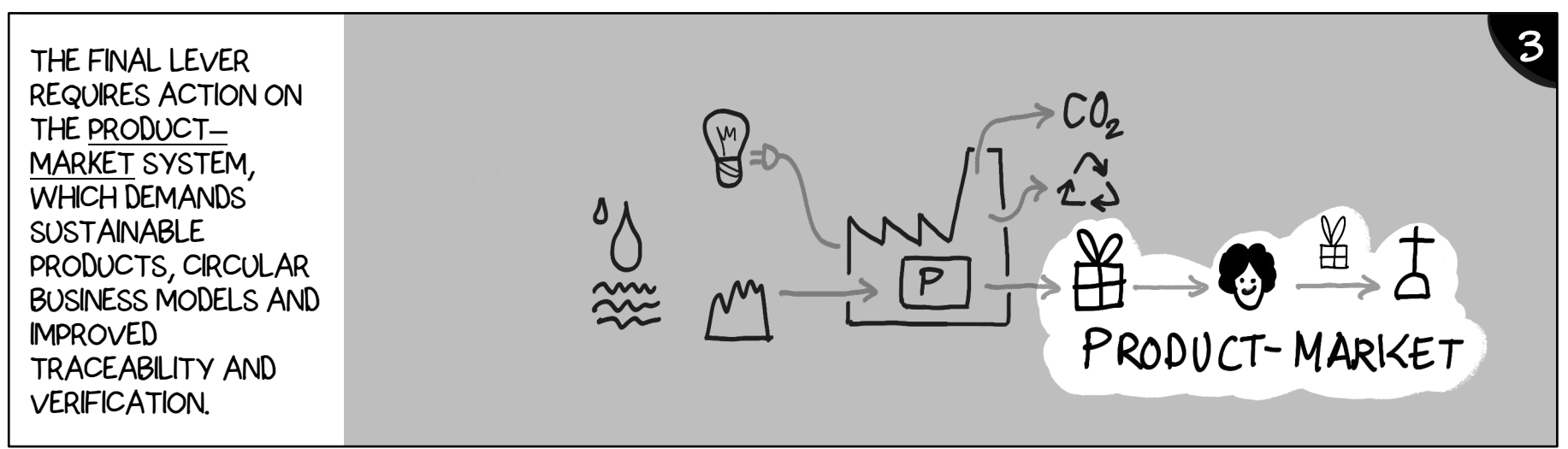
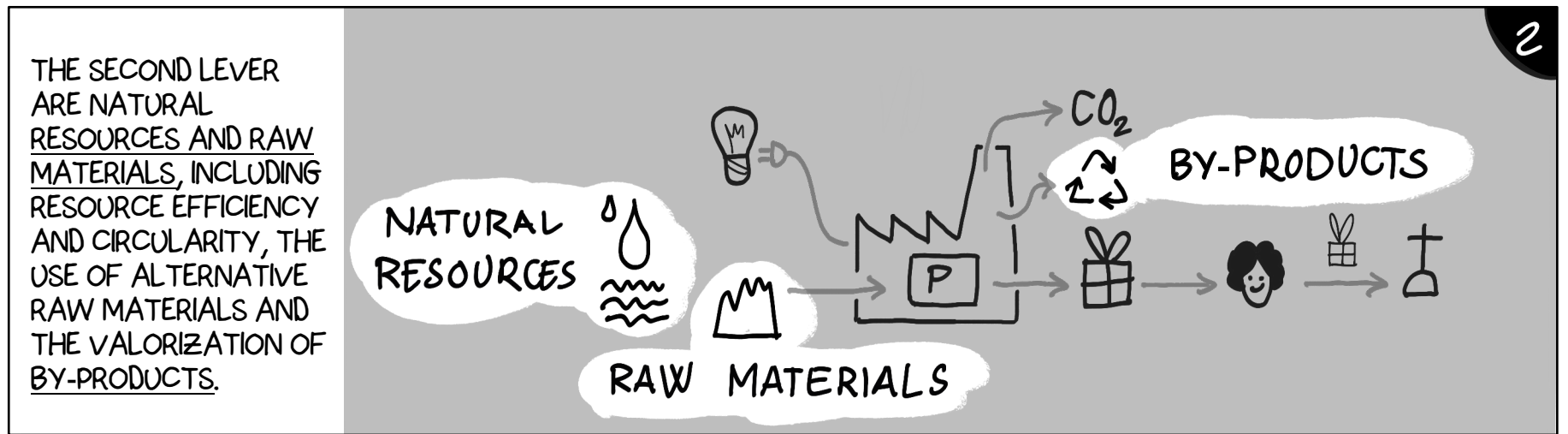
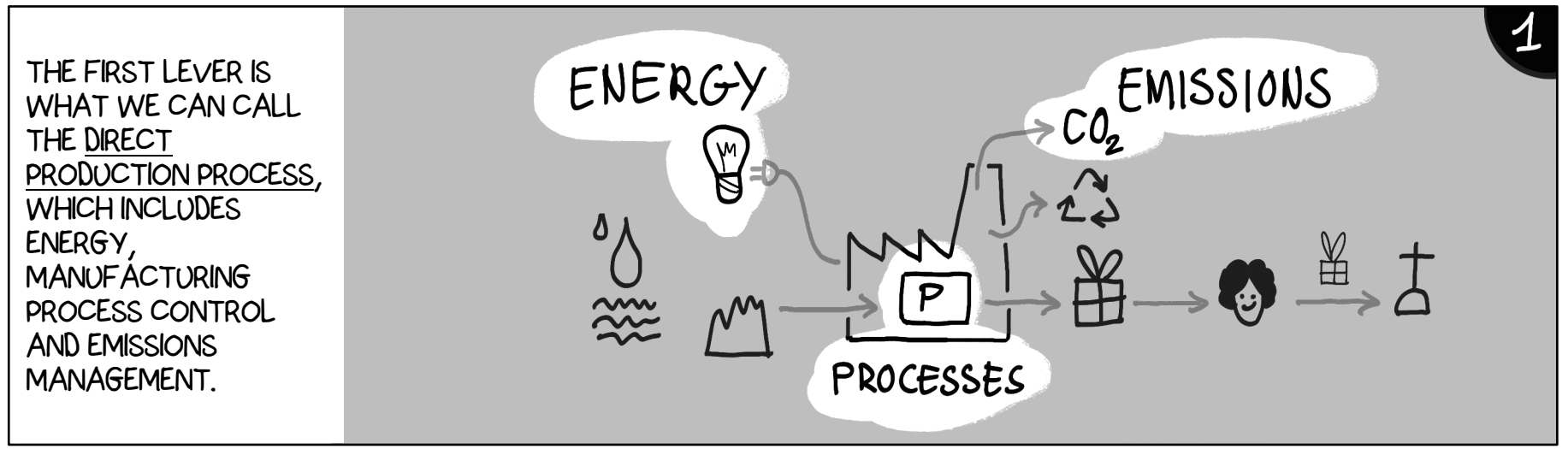


HOW CAN WE TACKLE ALL THIS DECARBONIZATION COMPLEXITY WITH DIGITALIZATION?

WHERE DO WE START?


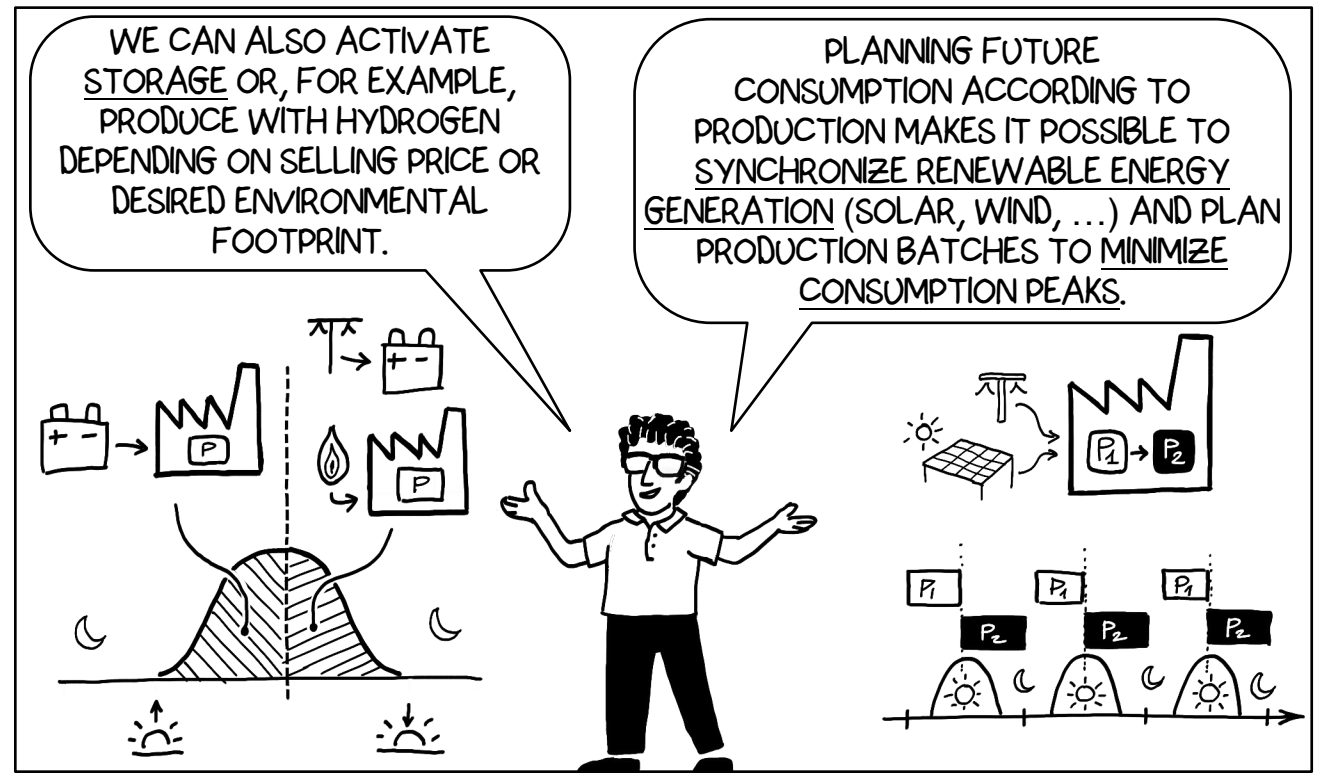
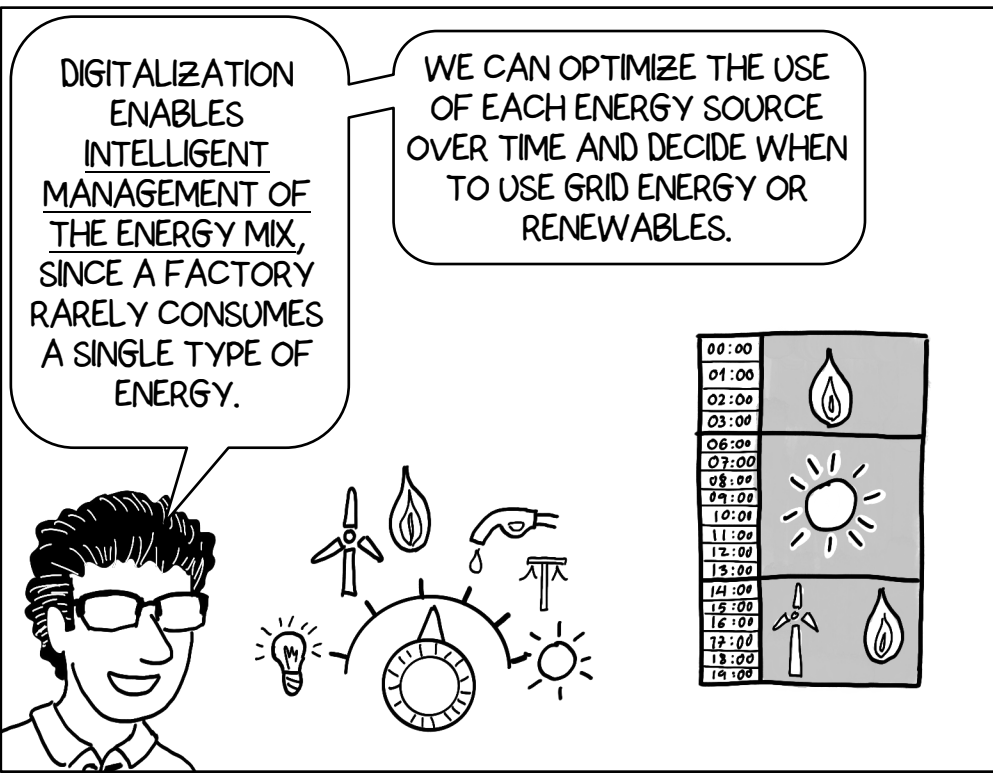
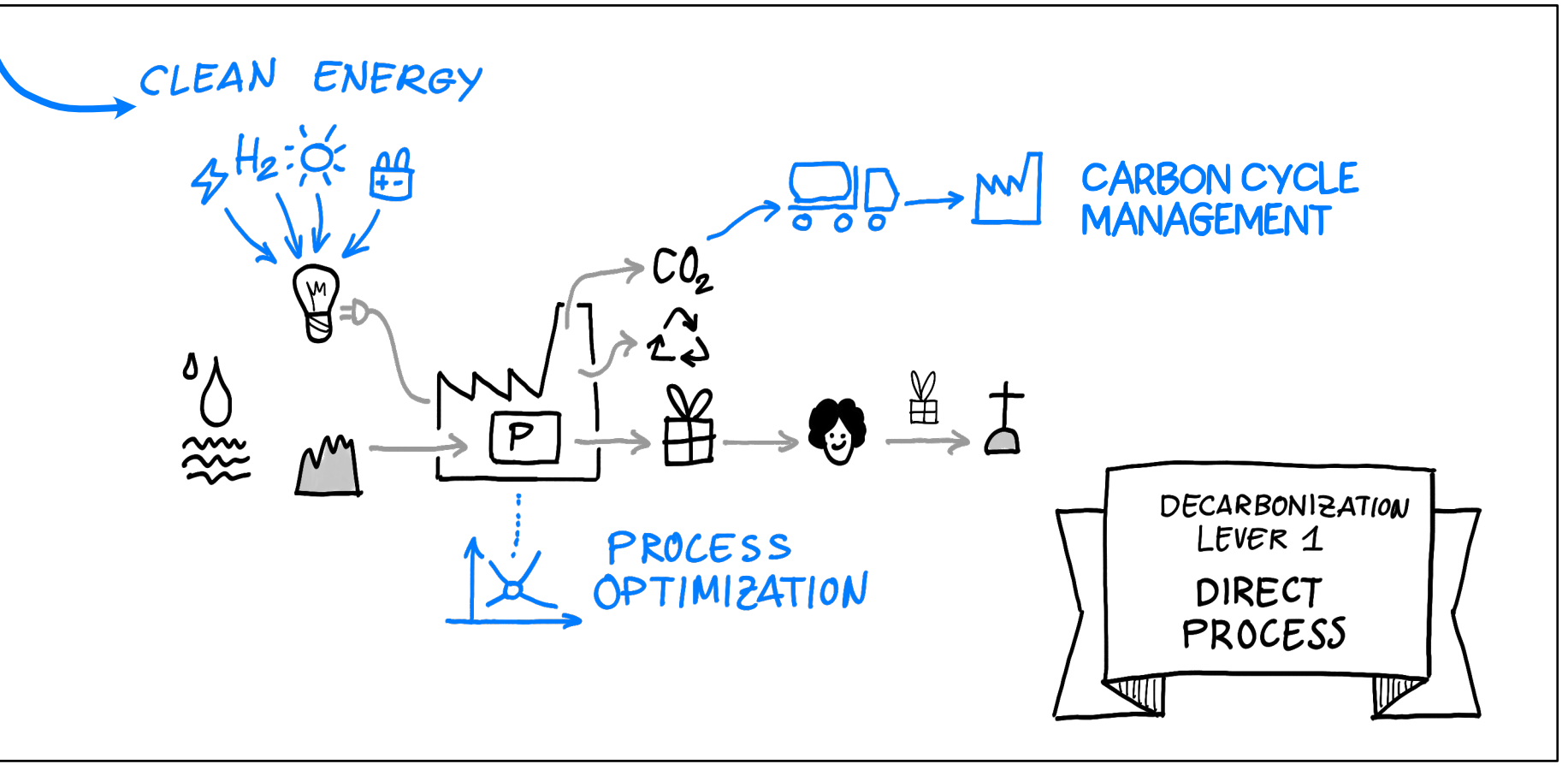
THE KEY: DIVIDE AND CONQUER.

WE NEED TO ACT ON SEVERAL FRONTS OR LEVERS AND PROVIDE ACTIONS DRIVEN BY DIGITALIZATION.

LET US START WITH THE LEVERS ACTING ON THE DIRECT PROCESS...

AS WE SAID, WE ACT ON THREE ASPECTS: ACHIEVING CLEAN ENERGY, OPTIMIZING THE PRODUCTION PROCESS AND MANAGING THE CARBON GENERATED.

WITH DIGITALIZATION, THE FACTORY BECOMES A "PROSUMER" THAT ACTIVELY MANAGES ITS CONSUMPTION AND GENERATION AND TURNS INTO AN ACTOR IN THE ENERGY MARKET.

ANOTHER ASPECT IS THE DYNAMIC OPTIMIZATION OF PROCESS CONTROL, WHERE WE CAN, FOR EXAMPLE, REDUCE ENERGY INPUT PER UNIT PRODUCED.

IF ENERGY PRICE OR CARBON FOOTPRINT INCREASES, THE PROCESS CAN AUTOMATICALLY LOWER TEMPERATURES OR SPEEDS IN NON-CRITICAL OPERATIONS AND STORE INTERMEDIATE PRODUCTS TO MAINTAIN PRODUCTION.

WITH THE HELP OF ARTIFICIAL INTELLIGENCE, WE CAN PREDICT KEY PROCESS VARIABLES FROM PROCESS HISTORICAL DATA AND THEN OPTIMIZE PROCESS CONTROL SO AS TO MINIMIZE ENERGY CONSUMPTION WHILE RESPECTING QUALITY AND OTHER CONSTRAINTS, SUCH AS A MAXIMUM TEMPERATURE IN A DRYING OR A TIME LIMIT IN A CHEMICAL REACTION. THE RESULT IS OPTIMAL PROCESS CONTROL PARAMETERS (P2), WHICH CAN BE CONTINUOUSLY UPDATED.

DIGITIZED PROCESS HISTORY DATA

AI PROCESS VARIABLES FORECASTING

PROCESS CONTROL OPTIMIZATION

A FINAL ASPECT OF THE DIRECT PROCESS LEVEL IS THE MANAGEMENT OF CARBON THAT WE UNAVOIDABLY GENERATE.

THE GOAL IS CO₂ CAPTURE AND VALORIZATION CONNECTED TO PROCESS DATA.

VALORIZATION THROUGH CARBON-BASED CHEMISTRY THAT TRANSFORMS CAPTURED CO₂ INTO CHEMICAL INTERMEDIATES SUITABLE FOR PRODUCING SYNTHETIC FUELS OR HIGH-VALUE CHEMICAL PRODUCTS.

OTHER OPTIONS INCLUDE BIOPROCESSES AND BIOCHEMICAL ROUTES USING MICROORGANISMS, ENZYMES OR, FOR EXAMPLE, ALGAE TO CONVERT CO₂ INTO BIOMATERIALS² OR INTERMEDIATE COMPOUNDS,

AND FINALLY, MEASURING THE CO₂ AVOIDED.

WE CONTINUE WITH THE LEVER ON RESOURCES AND RAW MATERIALS, WHERE DIGITALIZATION REDUCES NATURAL RESOURCE CONSUMPTION AND IMPROVES CIRCULARITY; FOR EXAMPLE, BY ADJUSTING THE PROCESS ACCORDING TO THE QUALITY OF SECONDARY RAW MATERIALS OR REUSING BY-PRODUCTS AS NEW RESOURCES.

CIRCULARITY AND RESOURCE EFFICIENCY

SECONDARY RAW MATERIALS

BY-PRODUCTS

DECARBONIZATION LEVEL 2
RAW MATERIALS AND RESOURCES

IN TODAY'S CIRCULAR ECONOMY CONTEXT, THE FACTORY RECEIVES RAW MATERIALS WITH DIFFERENT QUALITY, ESPECIALLY WHEN INCORPORATING SECONDARY RAW MATERIALS.*

THE USE OF DIGITAL TECHNIQUES SUCH AS COMPUTER VISION ALLOWS US TO ANALYZE THE QUALITY AND COMPOSITION OF THESE MATERIALS, ADJUSTING MANUFACTURING FOR EACH RECEIVED BATCH...

... ALL THIS INFORMATION CAN BE USED IN DIGITAL TWINS AND ADVANCED CONTROL (AS IN THE DIRECT PROCESS LEVER) TO REDUCE ENERGY AND WATER CONSUMPTION AND VARIABILITY.

AS WITH EMISSIONS, CERTAIN UNAVOIDABLE WASTE STREAMS CAN BE TRANSFORMED INTO NEW SECONDARY RAW MATERIALS AND CONTRIBUTE TO CIRCULARITY IN OTHER FACTORIES.

WE END OUR JOURNEY WITH THE LEVER FOCUSED ON THE PRODUCT-MARKET SYSTEM.

FULL DIGITALIZATION MAKES IT POSSIBLE TO DEMONSTRATE DECARBONIZATION, OPEN MARKETS AND CREATE NEW CIRCULAR BUSINESS MODELS.

PALANCA 3 DE LA DESCARBONIZACION PRODUCTO-MERCADO

MODELOS DE NEGOCIO CIRCULARES

SUSTAINABLE PRODUCTS

ALL THE DIGITALIZATION TOOLS SHOWN ENABLE FULL LIFE-CYCLE TRACEABILITY BY CAPTURING ASSOCIATED DATA.

THIS TRACEABILITY CAN EASILY BE TRANSFORMED INTO A RECORD OF THE PRODUCT CARBON FOOTPRINT, INFORMATION NEEDED TO CREATE THE SO-CALLED DIGITAL PRODUCT PASSPORT.

THIS PASSPORT ALLOWS US TO DEMONSTRATE REAL EMISSION REDUCTIONS TO THE CUSTOMER. THUS, DECARBONIZATION BECOMES A MARKET VALUE.

THE CUSTOMER CAN COMPARE PRODUCTS BEFORE PURCHASE OR KNOW WHAT WILL HAPPEN TO THE PRODUCT AT THE END OF ITS LIFE. THESE ARE SOME OF THE USE CASES OF THE DIGITAL PRODUCT PASSPORT, A KEY TOOL TO UNLOCK THE POTENTIAL OF NEW CIRCULAR BUSINESS MODELS.

THE THREE LEVERS WE HAVE SEEN HELP US STRATEGICALLY COVER THE FULL TRANSFORMATION CYCLE ASSOCIATED WITH DECARBONIZATION...

... (1) RESOURCES AND RAW MATERIALS: THE APPLICATION OF AI, COMPUTER VISION AND DIGITAL TWINS IMPROVES PROCESS EFFICIENCY AND ENABLES THE USE OF SECONDARY RAW MATERIALS...

... (2) CLEAN ENERGY: DIGITALIZATION MAKES IT POSSIBLE TO CHOOSE THE CLEANEST AVAILABLE ENERGY, OPTIMIZE CONSUMPTION AND QUANTIFY CO₂ AVOIDED...

... (3) PRODUCT-MARKET SYSTEM: THE DIGITAL PRODUCT PASSPORT AND TRACEABILITY MAKE IT POSSIBLE TO DEMONSTRATE DECARBONIZATION AND ACTIVATE CIRCULAR BUSINESS MODELS.

AS WE CAN SEE, DIGITALIZATION IS NOT JUST A TOOL TO "VIEW DATA", BUT TO TRANSFORM PROCESSES AND REDUCE EMISSIONS. DECARBONIZATION IS ACHIEVED IN DAILY OPERATIONS: WITH CONTROL, INTELLIGENCE AND TRACEABILITY.

THANK YOU FOR YOUR ATTENTION!

GRACIAS!

Anibal Refojes
Soluciones Industriales y digitales

* SECONDARY MATERIALS ARE RECYCLED OR REUSED SUBSTANCES THAT RETURN TO THE PRODUCTION CHAIN AS RAW MATERIALS.