出國報告（出國類別：考察）

考察德國西門子公司、安能集團之供應鏈制度規劃及新科技在供應鏈智能化與物流上之運用

服務機關：台灣電力股份有限公司

姓名職稱：材料處副處長孟祥國

派赴國家：德國

出國期間：108.12.9~108.12.21

報告日期：109.2.10

摘要

過去十年間，顛覆商業模式與市場的雲端運算、數據分析、數位體驗，如今已成為了商業與科技策略不可或缺的基本要素。而區塊鏈、虛擬實境議題更成為近年驅動創新的關鍵，而本公司各經營層面也面臨數位化的衝擊，供應鏈管理模式的選擇變的更多元、材料供應更即時、變革的壓力是持續不斷的、唯一不變的是持續的改變，因此，此次參訪行程是要了解國際知名企業西門子公司及 EnBW 公司在因應數位科技的衝擊及供應鏈運用數位工具的作為。共計 10 天的參訪，綜觀這二家公司在因應數位化的共同作法包括(1)企業在創新的過程，必須有包括策略改變及流程變革的決心 (2)管理需進行跨單位共同合作，並發展新的作業模式，(3)同時也須考量數位科技所帶來的資安、隱私與法規風險問題。

目次

壹、考察目的

一、 緣起

隨著物聯網科技之進步，各種長距、低成本感應器於電網以及供應鏈之應用、相關智能化感應及監測器應用到電力關鍵器材及設備運轉之即時回饋及履歷管理越發普及，故透過參訪西門子公司及安能集團瞭解其在供應鏈相關數位轉型推動重點及運用情形，作為發展本公司供應鏈架構及供應鏈平台未來發展之參考。

另安能集團近年來致力於持續調整組織內部結構與推動德國的能源轉型，在逐步達成去碳化和淘汰核電的同時，不斷擴大再生能源發展之業務佔比，包含利用水力、風力和太陽等自然能源，進行再生能源發電，故該公司之再生能源計畫供應鏈策略及運作情形亦為本次參訪之重點。

二、 參訪目標：

1.瞭解電力相關產業之行動裝置、大數據、自動化或溯源管理在提升供應鏈之發展及運用情形，作為發展及強化本公司供應鏈架構之參考。

2.瞭解物聯網新科技之發展、應用於電力器材及物流之方式，以求優化本公司供應鏈管理模式，並應用於後續關鍵器材設備之管理，藉此提升管理效率、減省人力。

3.瞭解他國電力器材供應鏈新科技、智慧電網之應用以及相關管理制度之配套調整，及因應新科技管理制度之重要 KPI 項目，以求精進本公司供應鏈智能化管理。

貳、考察過程

一、行程

Siemens 公司為本公司重要供應商之一，該商在供應(採購)制度之設計及實際運作，尤其是在供應商管理部份頗值深入研究，經指派於 108 年 12 月 9 日至 12 月 13 日前往該商進行考察，以作為本公司相關制度未來研究發展之參考，EnBW 則是德國最大的能源供應公司之一，近年來，隨著能源市場數位化步伐的加快和客戶期望的變化，該公司成立數位轉型專案辦公室，針對核心業務以數位化方式轉變其業務模式和流程，其做法值得本公司學習，因此轉機至司徒加特於 108 年 12 月 16 日至 12 月 17 日前往該商進行考察。

中文姓名：孟祥國				姓名代號：040028		
	起 始 日	迄 止 日	前 往 機 構	機構所在國家城市	詳 細 工 作 內 容	
			機構名稱	國 家 城 市 名 稱		
1	1081209	1081210			去程：台北-維也納-柏林	
2	1081211	1081213	Siemens AG，Power Generation Services Division	德國柏林	參訪重點- 1. 供應鏈策略及運作方式。 2. 供應鏈相關數位轉型推動重點及運用情形。 3. 物流作業數位化及智能化運用。	Siemens 邀請函
3	1081214	1081214			交通：柏林-司徒加特	
4	1081216	1081217	EnBW	德國司徒加特	參訪重點- 1. 再生能源計劃之供應鏈策略及運作情形。 2. 供應鏈相關數位轉型推動重點及運用情形。	EnBW 邀請函
5	1081220	1081221			返程：司徒加特-慕尼黑-巴黎-台北	

二、考察觀察重點

西門子公司是一家有著 150 多年歷史、橫跨數個產業的跨國集團，國際總部位於德國慕尼黑。主要業務集中在工業、能源、醫療、基礎設施與城市四大業務領域。是一家有著百年歷史、橫跨全球數個產業。全球集中化採購是該公司採購策略與抑制採購成本的關鍵，各產業的分支機構其採購均是公司整個全球採購網的一部分，因此與分布在全球各個角落的眾多供應商，如何協同合作？做到“精益採購”？成為我們值得瞭解的議題

(一)全球統一採購

過去很長一段時間，西門子公司通信、能源、交通、醫療、照明、自動化與控制等各個產業部門(Division)根據各自的需求獨立採購。隨著西門子公司的逐漸擴大和發展，採購部門發現不少的元件材料設備需求是重疊的：通信產業需要訂購液晶顯示元件，自動化和控制分部也需要購買相同的元件。由於購買數額有多有少，選擇的供應商、產品質量、產品價格與服務差異非常大。西門子公司因此設立了一個採購委員會(Procurement Council)，來協調全球的採購需求，把六大產業部門所有公司的採購需求彙總起來，這樣，西門子公司可以用一致地政策主張與供應商進行溝通，該全球採購委員會直接管理全球物料經理(Commodity Manager)，每位物料經理負責特定物料全球性採購，尋找合適的供應商，達到節約成本的目標，確保物料的充足供應。

另西門子採購系統還有一個特色是，在採購部門和研發設計部門之間有一個“高級採購工程部門”(Advance Procurement Engineering，APE)。作爲一座架在採購部和研發部之間的橋梁，高級採購工程部的作用是在研發設計的階段就用採購部門的眼光來看問題，充分考慮到未來採購的需求和生產成本上的限制。

(二)分合有度、專業分工

集權的中央型採購策略，仍需要反應靈活的地區性採購部門來進行實際操作。由於產業鏈分布在各個國家，西門子公司在各地區採購部門的角色很不一樣。日本西門子移動公司採購部門的角色類似於一個協調者，由於掌握著核心技術，日本的供應商如東芝公司和松下公司直接參與了西門子手機的早期開發(Early Supplier Involvement，ESI)。西門子公司需要知道哪些需求在技術上是可行的，哪些是不可行的，而東芝和松下等企業也要知道西門子公司想要得到什麼產品，採購部門的主要工作就是與日本供應商的研發中心進行研發技術方面的協調、溝通和同步運作。反觀中國西門子公司採購部的角色重心就不同了。其主要任務是利用中國市場的廉價材料，降低生產成本，提高西門子手機的全球競爭力，而中國低廉的材料價格已經成爲西門子手機征戰全球性市場的一大利器。

(三)全球一致性的供應商管理策略

西門子全球擁有 256 個採購部門中擁有 1500 名一線的採購人員。其中的 2 萬家供應商被指定爲第一選擇，他們的數據被存儲到了西門子內部的系統中。爲了確定採購政策的落實，西門子對這些供應商進行了分類及差異化管理機制：

1. 對供應產品的分類

(1) 依供應商的產品分為以下四類：

A. 高科技含量的高價值產品：如電力供應、中央處理器 (CPUs)的冷卻器、定製的用戶門陣列（gate array，一種封裝在一個晶片里的許多邏輯門的幾何結構，製造時可以在內部把門相互連接起來去執行一種複雜的操作，因而可以作為標準產品使用。一種經編程後可以實現某種特殊目的的門陣列通常稱為用戶門陣列。

B. 用量大的標準化產品：如印刷電路板、集成電路存儲器 (ICs)、稀有金屬、鍍鋅的錫片 。

C. 高技術含量的低價值產品：需要加工的零件、繼電器、變壓器。

D. 低值標準化產品：如金屬、化學製品、塑料、電阻器、電容器。

(2) 依價值分類

A. 供應風險

依供應材料設備技術複雜性和實用性來衡量對該供應商的依賴程度的標準。

對一個特定的供應商的供應風險的衡量標準包括：

-- 供應材料與設備有多大程度的非標準性；

-- 如果我們更換供應商，需要花費哪些成本；

-- 如果我們自行生產該部件，困難程度有多大；

-- 該部份的供應源的缺乏程度有多大。

B. 採購價值影響或是獲利能力

影響西門子的供應商關係的底線的衡量標準是與該項目相關的採購支出的多少。

2. 不同產品的採購策略

西門子與供應商的關係的性質和密切性程度由上述四種分類來決定。

(1) 高科技含量及高價值產品採購策略是技術合作型，其特點是：

A. 與供應商保持緊密關係，包括技術支持和共同負擔研發經費；

B. 長期契約；

C. 共同努力標準化和技術的傳承；

D. 集中於製造過程和質量保證程序，如內部檢驗；

E. 通過電子資訊交換平台和電子郵件優化訊息交流；

F. 在處理獲取基礎材料的瓶頸方面給予協助。

(2) 用量很大的標準化產品

A. 全球尋找供應源；

B. 開發一個採購平台以彙整國際供應商商情系統；

C. 在全世界尋求相應的合格供應商；

D. 安排接受過國際化培訓的最有經驗並且最稱職的採購人員。

(3) 高技術含量的低價值產品

A. 採購策略是保證有效率
B. 質量審查和專用的倉儲設施
C. 保有存貨和建有預警系統的安全庫存計劃
D. 策略性存貨（安全庫存）
E. 在供應商處寄售存貨
F. 特別強調與供應商保持良好的關係。

(4) 低價值的標準化產品

A. 採購策略是有效地集中處理
B. 通過電子系統減少採購業務成本
C. 物流工作，如倉儲、需求計劃、報告等工作採外包方式辦理
D. 增加對數據處理和自動訂單的運用
E. 運輸流程的簡化
F. 努力減少供應商和條款的數目。

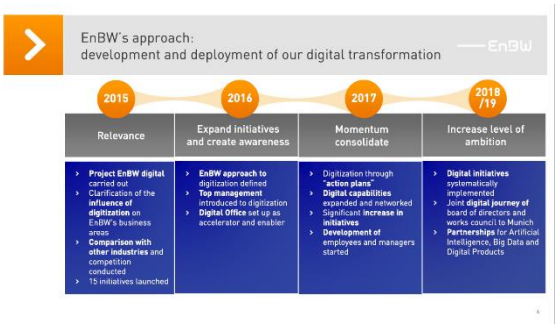
Siemens 公司亦如本公司採用 SAP 系統，資訊管理對每一項協同合作的流程都很重要，攸關協同合作成敗的關鍵要項，因為供應鏈協同合作有賴於有效的資訊分享，其次企業與主要供應鏈夥伴的關係也仰賴有效的資訊管理與協調，達到物流與資產利用率最佳化。現有的資訊科技能讓 Siemens 公司能夠處理橫跨供應鏈上的大量資料並進行分析。使該商供應鏈的整體績效及機會的創造更容易理解，其明顯的效益包括資訊透明化及減少供應鏈上的庫存量。此外，更強調供應鏈上的資訊交換效率有利於相關成本作業計劃、品質管控及溝通等的資訊交流，並保持資訊的一致性和準確性。因此，協同合作除企業內部單位合作外，與供應商的互信也是計劃的成敗關鍵之一，如計劃未能建置在互信的基礎上，將事倍功半或甚至徒勞無功。協同合作是對供應鏈的管理及控制與改善的有效策略，成本會因無效率的流程的減少，而提升營運中的物料透明度，增加資產利用率因此提高，未來將繼續維持該項策略以提升整體供應鏈效益。隨網路科技的發展，目前該商供應商包括庫存、產能及生產計畫與排程均可透過供應鏈管理平台與需求資訊彼此共同分享，再經由數據彙整分析，綜合平衡供料風險、訂單、產能、庫存和成本，此點對集團化，多組織運作環境尤為重要。

資料來源：
Adrian Prietzel： VP for Global Parts Management, Inventory & Warehouses
Michael Neudecker： Senior Project Manager Large Gas Turbine Fleet
Horst Michaelis：Project Manager Large Gas Turbine Fleet

二、EnBW 數位轉型

EnBW（能源巴登-符騰堡股份公司）是德國最大的能源供應公司之一，成立於 100 多年前，為約 550 萬客戶提供電力、天然氣、水和能源相關產品和服務。它由許多子公司組成，包括 Netze BW，它負責 EnBW 的網路管理，包括網路運營和網路擴展。近年來，EnBW 在社會一片能源轉型的呼聲中，只好被迫改變，過去幾年大幅調整集團的商業模式，轉攻再生能源和電網，改做風電的開發商。該公司如今擁有 47 座陸域風場、2 座離岸風場和 7 座生質能發電廠，成了德國媒體眼中的「綠巨人」。

隨著能源市場數位化步伐的加快和客戶期望的變化，該公司成立數位轉型專案辦公室，目前正針對核心業務以數位化方式轉變其業務模式和流程。在供應鏈部分推動項目內容包括從手動流程轉移到基於 Web 和行動化的流程，跨客戶和供應商運營。構建了新的應用程式和介面，以數位化和整合銷售和服務、採購、訂購和交付流程。作業流程已經簡化和自動化，並且可以根據業務要求快速輕鬆地進行更改。這些流程的改進不僅提高了效率和成本節約，隨著線上客戶數量以及線上服務訂單的數量的增加為客戶和供應商提供了更快、更佳的服務和支援。在採購實務上該商強調共同參與落實計劃性的採購。以往採購部門多為受委託辦理採購，無論是採購項目內容、規格條件、辦理時程等，採購部門通常均忠實辦理所指定個案無從表達意見，惟隨著採購策略的改變及資訊系統的建置，對重要材料物料的採購，關係人的共同參與成為提升採購績效重要的功能。**計劃性的採購即是在建置不同單位間需求整合的平台，從年度請購需求計劃擬定開始，包括供應商生產排程規劃、採購及履約風險評估與需求單位人員及供應商共同合作**，採取跨功能的運作模式進行，各關係人不但可提供專業意



見，更可依需求規劃設計最佳採購模式以整合公司各單位對質、時程、價及量的需求，有效運用採購體系內資源達到適質、適價、適量及即時供料的採購目標。

另隨著數位化和大數據帶來的新機遇，該商採購管理階層需重新思考採購的附加價值。用料單位、採購之間的傳統組織界限，以及整個供應鏈之間的界限，將變得越來越模糊，採購部門作為供應商的主要介面，可以抓住一些新機會，在企業內增加其特有的價值主張，例如**運用新的網路科技，採購可以為自己創造新的商業模式，從成本中心轉向利潤中心。之所以能夠做到這一點，是因為採購同時擁有供應商及用料單位的需求，提供了採購創新的動機。**採購部門向供應商和用料單位提供訊息。透過將數據提供給供應商，並將其訊息提供和客戶使用資料貨幣化。反過來，供應商可以利用其產品有關的附加資訊，生產更有針對性的規格和應用，更具成本效益和功能效率的產品，使買賣雙方目標及利益一致達到雙贏的結果，因此採購供應鏈數位化的成效亦可由其附加價值的提升與否作為重要的衡量標準。

另該商在數位轉型上，亦表示資安及保障個人隱私工作的重要性，強調越來越多會議及資料交換透過公司網路連接到外部網路進行溝通，而這也代表著越容易成為駭客及網路犯罪份子的目標，數位轉型不會因此停下腳步，因此，數位轉型的同時，資安系統也要跟著進步。EnBW 公司已改採用包含自動化安全回應系統，以回應永不停歇的網路攻擊並透過教育訓練讓預防網路犯罪觀念貫穿整個公司，為所有員工提供定期且全面的資安教育，讓每位員工擔負起 IT 的資訊安全責任，久而久之，已形成注重資訊安全的文化。

資料來源
Hanne Multhaupt：Project Manager International Procurement
NilsBeeckmann：Head of Project Services
Anastasia Navyshny：Project Services
Prof. Nikolaus Elzw：Director Technology

本次出訪為初步瞭解到(1)Siemens 公司數位轉型之採購制度與實務運作及(2)EnBW 公司在數位轉型上的策略性想法，此行經由該商在台分公司協助及考察期間拜會該商權責業務人士幫忙下，取得相當多資料，對於關鍵問題，亦能就其所知詳細解答，受益良多。本次出國計畫能圓滿順利完成，在此表達感謝。

參、心得及建議

本次考察主要係為瞭解參訪廠家在數位轉型架構下的各項工作重點與推動歷程，期間先後與該二公司相關人員進行討論交流，事後回想，二家公司在面對數位轉型衝擊下，無論在採購及物料管理策略甚至做法上均大同小異，並對提升供應鏈效益的努力留下深刻的印象值得我們學習，經整理各項心得及建議如下，期能對本公司採購及供應管理持續精進作業能有所助益。以下就本次考察心得及建議說明如下：

一、採購及供應策略的轉變

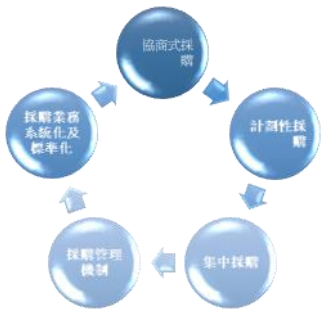
本公司自 101 年 ERP 上線、102 年「材料管控專案小組」的成立至目前公司轉型，其間採購相關議題的討論及所推動的各項精進方案都遠超過傳統對採購屬業務性工作的認知，在策略上財物採購採集中採購、而朝統一管理的策略方向發展，採購管理的功能的發展日漸清晰明確，唯對照參訪公司的發展仍有可精進處，說明如下：

1. 採購(供應)政策應屬公司整體策略，列入目標體系並應與其他系統相互結合且彼此影響
2. 將採購績效提升為公司經營績效改善的具體表現
3. 強調採購供應鏈的附加價值包括供應商管理、規格整併及採購模式多元化
4. 運用數位科技提升整體供應效率與效能。

由上述說明，完整的採購供應體系並不僅是採購單位(部門)的業務，用料單位、成本管理單位、策略擬定管理者及事業部等都必需加入才有可能達到合理化的目的，並應將整個供應關係以資訊系統連結形成供應網路。因此，為進一步提升本公司整體採購績效，在落實策略面成效上需從 KPI 值去觀察，參考 Siemens 及各標竿企業，分別為 1.擴大集中採購 2.採購作業及管理數位化，茲進一步分別說明：

1. 整合供應體系資源擴大集中採購

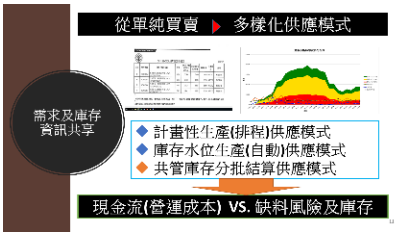
   集中採購是已經在執行的工作，但本公司所推動的集中採購應不限於作業面的工作，而應有將有限資源最有效運用策略層次的思考，透過集中採購政策的指引，以全公司的角度彙整共通材料需求，不僅以一個訂單或一個單位為整合基礎，而是將一定期間內(2~3 年)公司整體需求為規劃範圍，透過單位或事業部間資訊共享、標準化作業及總成本控制，並考慮區域性等因素，將需求項目及數量併入一個長期契約。目前本公司材料集中採購金額已達 80%，惟採



購項目僅約 45%，餘 55%項目仍由數以千計的請購、採購及驗收人員辦理，對照辦理集中採購所動用的時間及人力資源，其差距是非常可觀的；對比 Siemens 及 EnBW 公司之集中程度更是天地之差，因此持續擴大集中採購規模，應是衡量落實此項政策的重要指標。

2. 採購作業及管理數位化

數年前當時雖然沒有數位轉型的名稱，本公司卻完成了推動數位轉型最重要的基礎建設-ERP 系統的導入。隨著數位網路的發展，用料計劃或採購需求、庫存、耗用情形及生產排程已可有效彙整，資料均可數據化，買賣雙方可共同思考以往受限於資訊無法整合而致無法實施的供應模式例如計畫性生產(排程)供應模式、庫存水位生產(自動)供應模式、零庫存的 JTT 庫存管理模式、共管庫存分批結算供應模式或電子商務等變的指日可待，採購供應模式由目前相對單一的改變可依物料特性採不同的多元供應模式。



二、管理作業及管理機制的重塑工作

參照 Siemens 公司全球统一採購、分合有度、供應商管理策略。採購的價值建立在能替公司降低總成本的基礎上，材料處應可努力致力發展方向包括：

(1) 庫存採購到需求驅動的採購
(2) 對採購及商品的管理延伸到對供應商資源的管理
(3) 採購方式單元化到數位化多元化採購模式
(4) 數據彙整管理到數據分析與運用

茲進一步分別說明如下；

(一) 庫存採購到需求驅動的採購

在傳統的採購模式中，採購的目的就是為了補充庫存，即為庫存而採購，採購過程缺乏主動性，採購計劃較難適應需求的變化。在供應鏈管理模式下，採購活動則是緊緊圍繞用戶需求而發出訂單，不僅可即時滿足用戶需求，而且可減少採購費用，降低採購成本。

本公司供應鏈注重於資源整合，是利用管理理念和網路訊息技術，整合不同單位、不同階段、不同類型材料的管理資源，並結合需求、採購、倉儲、撥配與物流及後續品質管理一體的供應鏈服務模式，追求實現供應鏈上下游資源整

合、優勢互補和資源共享的目標。在資源整合供應鏈管理模式下，供應商要按照買方所需物料的時間與數量即時供貨。採購方式是用料需求的需求單驅動採購訂單，再驅動供應商製造的所謂訂單驅動模式。採購管理由間接、被動（庫存驅動）改變為主動（訂單驅動），真正做到即時反應單位的需求，進而能使採購、庫存成本得到大幅度的降低，提高了資金及庫存周轉的速度。整合後供應鏈是開放的網狀結構，讓供應鏈上各個環節和要素直接對接溝通，供應商的參與、共享的系統平台、關係人之間即時訊息揭露，整個整合過程會因彼此互動達到動態持續優化的效果，有效的提高整體效益。

(二) 對採購及物料管理延伸到對供應商資源的管理

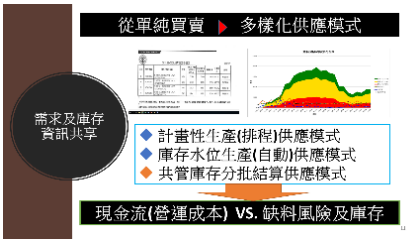
在以往的採購模式中，採購管理注重對內部資源的管理，追求採購流程的優化、採購環節的監控或與供應商的談判技巧，對與供應商之間的合作缺乏足夠的關注，其原因多為缺少有效的資訊互通的平台，彼此間訊息蒐集及管理的不易。但隨著網路資訊的發展，在供應鏈管理模式下，快速的轉向對外部資源及供應商和市場的管理，例如 SCM/SRM 的發展及大數據的運用，增加了與供應商的訊息溝通和市場的分析，加強了與供應商在產品質量控制等方面的合作，追求計劃性超前控制及供需雙方合作雙贏的局面。

供應鏈管理部門包括採購部門一般而言應保證供應之物料達到適時、適質、適量、適價、適地的目標，這就是 5R 原則。在過去幾年當中，尤其是網路數位技術一日千里的發展，有關供應鏈管理有著一個最顯著的變化，就是企業開始有能力了解供應商的產製能力，進而能主動協助提升供應商能力。本處在關鍵性材料管理上，亦復努力朝此方向努力，希望藉由共享平台的開發，得以彙整內部與外部供應相關資訊的串接與運用，其中包括各階段測試數據蒐集以瞭解品質可改善項目，揭露 2 年期需求計劃預作規劃以縮短產製時程及訂單處理即時性以簡化訂購作業等多項效益。為實現此目標，公司內部資訊的適度揭露當屬必要外，供應商及其協力廠商相關資訊的提供更是有效提升供應鏈效能的關鍵因素。舉例而言，本處採購之 GIS 或其他關鍵性材料設備，如能掌握供應商協力廠所提供之關鍵材料例如 GIS 電驛之供應時程及產能，對縮短 GIS 整體供應時程將有重大之影響。這樣垂直整合關鍵的供應商成員資源，將物料管理觸角延伸到對供應商資源的管理，最終能達到進一步提高本公司供應鏈整體效能。

(三) 由單一到數位多元化採購模式

數年前當時雖然沒有數位轉型的名稱，本公司卻完成了推動數位轉型最重要的基礎建設-ERP 系統的導入。集中採購策略的推動所呈現的效益就是其中最好的例子，以契約類別為例，我們有發電機組配件統購契約、分組分量開口契約、跨單位集中採購契約等各位耳熟能詳的採購方式都是拜資訊共享後的成效，大幅提升了採購的附加價值。

另隨著數位網路的發展，用料計劃或採購需求、庫存、耗用情形及生產排程已可有效彙整，買賣雙方可共同思考以往受限於資訊無法整合而致無法實施的供應模式例如計畫性生產(排程)供應模式、庫存水位生產(自動)供應模式、零庫存的 JTT 庫存管理模式、共管庫存分批結算供應模式或電子商務等變的指日可待，採購供應模式由目前相對單一的變的可依物料特性作多元的供應模式。除這些較大議題外亦可一同解決目前供應鏈運作中所遭遇各種因訊息不足所造成的困難，利用分享的資訊加上一點巧思創造多樣化的供應模式，達到降低本公司與供應商營運成本的同時，也同時降低台電公司缺料的風險及庫存金額抑制的目標。



(四) 數據彙整管理到數據分析與運用

隨著供應鏈變得越來越複雜及網路科技的運用，供應鏈協同資料將為本公司數位化驅動的動力。數位時代資料的運用首當其衝的就是處理大數據的挑戰，本公司在 101 年引入 ERP 系統，部分數據已經在系統有一定的數據量，物料庫存，領料數據，訂單數據，收貨數據等並在 108 啟用供鏈管理平台(SCM 系統)，進一步擴充供應鏈相關資訊蒐集模板規模，針對庫存及採購，目前已具備了一定的分析基礎。因此儘管有大量的數據資料庫，到底如何應用大數據？以目前本處供應鏈範圍，在彙整相關數據資料後，可運用在下列工作。

1、供需檢討到訂單處理自動化

目前不少國內外企業內部訂單或稱撥配補貨、需求，或逕向外部訂購需求均已採用自動訂購或補貨機制，以成本管控嚴格的台塑為例，每天以自動訂單處理件數即已高達數萬件。目前本公司訂貨和補貨的基本是物料需求計劃（MRP）。由於複雜的供應鏈網路，物料計劃是一個非常複

雜的過程，MRP 計劃運行產生採購申請或計劃訂單，是控制員可以轉換為採購訂單或生產訂單的前提。需求計劃不僅限於數量計劃，還需要考慮時間表，不容易滿足實際需求。目前較為業界所關注發展的是需求驅動的物料需求計劃，是以實際用料資料的演算方式推估未來用料需求，針對策略性材料設備需求其特點包括(1)使用供應鏈結點創造獨立性(解耦點)來阻止牛鞭效應及(2)設定庫存緩衝區以每週或更短得期間動態調整方式來推動訂單的產生。

2、評鑑作業數位化到品質數據分析

依執掌內容，材料處品質管理的數位轉型涉及不僅是讓評鑑或處理材料設備不良回饋流程和文件數位化而已，還需要將結果產生的資料用於品管流程精進、材規修正、降低品質風險及決策等所有環節當中，因此品質管理數位化成為後續發展數據分析工作的基礎建設。目前在推動數位轉型工作多著重在數位化，但資料運用仍停留在資料驗證後效益及可行性分析上。因此繼供應鏈管理平台之後，本處已規劃專案，預計 109 年底完成品質管理相關數據彙整平台後，相關數據分析將陸續展開，以作為建置更有效及具附加價值的品管機制得基礎工作。

三、數位轉型下的資安防護

在數位轉型時，須同步評估如何保障內部資料安全性，包含：Web Server、Database 以及 Email…等，若因流程改造產生疏失，導致內部或客戶資料的外流，甚至引來駭客惡意攻擊那就得不償失了。以往的資安防護習慣是以內外實體隔離方式將可能產生的資安漏洞降到最低，然而現今多採用雲端軟體服務，以利用雲端的擴充效益、節省成本以及可獲得更高端的維運架構，降低 IT 人員在資安管理上的負擔。因此，為了兼顧數位化與安全性，因此未來可慎選具有資安防護的雲端服務及資安管理工具，例如監控報表功能、密碼強度控制等，以落實資安政策。

肆、結語

很多國際企業早已不把採購當作花錢的單位而是利潤中心，因為對部份微利的產業，採購單位替公司在降低總成本的效益常常大於業務部門所創造的利潤。展望公司未來經營環境，較以往更加複雜，一般採購就規模或降低成本貢獻度而言，遠不如燃料採購，然而塑造一個有效率、追求績效的採購供應鏈體制，

其成效及價值是多方面多緯度的，出國考察觀察到一個成功且屹立百年的企業集團，在採購物料管理方面仍不斷的追求更有效的經營模式，值得令人省思。目前本公司面臨轉型，各相關單位無不急欲塑造經營績效的時刻，或許採購供應鏈績效的提升，其努力的過程及成果更能彰顯本處甚或本公司在提升經營績效最佳的註腳。

伍、附件

1. 參訪議題摘要
2. Siemens 公司及 EnBW 公司簡報資料

附件 1 - 參訪 Siemens 討論議題摘要

Supply chain managers face issues on a daily basis which require direct attention and quick response. In Taipower’ s daily routine operation, there are some of the issues that affect supply chain managers:

1. What are the major issues facing supply chain managers and how it affects the logistic function?
2. Managing Inventory

   Managing inventory goes beyond counting how many boxes are sitting in your warehouse. It’ s a balancing act. Keeping enough inventory on hand so that all customer and client expectations are met. Appropriate timing prevents delays. Appropriate quantity prevents insufficient inventory while reducing effect on profits.

   Please advised what methodologies or KPI are implemented to evaluate their performance in order to balance those multiple goals.

3. Managing Suppliers

   Along with managing inventory comes managing suppliers. Taipower’ s Supply chain managers are responsible for identifying the quailed suppliers, make sure their products meet the requirements, and performance in execution the Contracts. They’ re also responsible for finding suppliers with consistent and reliable service at a price that doesn’ t hurt our bottom line. Above all, each step requires thought and a process and must comply with the integrity requirements.

   Please advise how Siemens categories your suppliers, the ways to build the relationship, and the KPI applied to evaluate their performance. We are also interested to learn your Compliance System.

4. Maintaining Quality

   The globalization of supply chain brings concerns about the quality of products that are made in other countries. Particularly when components of a product need to meet regulatory standards. This puts us at risk of recalls. Taipower’ s supply chain managers are responsible for ensuring suppliers and their products maintain quality standards.

   Please advise how Siemens keep the Supplier providing high quality products in long

term aspect and pursuits up-to-date technology at the same time.

5. Reduce order variability

   Variability in order patterns is a well-known driver of costs in supply chains. Variability causes Taipower to build up inventory, which is expensive. Inventory swings amplify as they move up the supply chain, causing the bullwhip effect.

   In the efforts to reduce the fluctuation of demand, our experience proves the prediction results are unworkable. Please advise your experience to cope the issue of Irregularity.

6. Risk management

   Companies that are too reliant on few supplier are vulnerable if that supplier can't meet demands. Taipower's supply chain managers must mitigate risks so that a typhoon in southern tip of Island doesn't halt the maintenance jobs in North part of Taiwan.

   Adequate backup plans help ensure that the Taipower's supply chain is flexible to handle changes. We need to learn how Siemens deal with the risk issue of providing sufficient and qualified products.

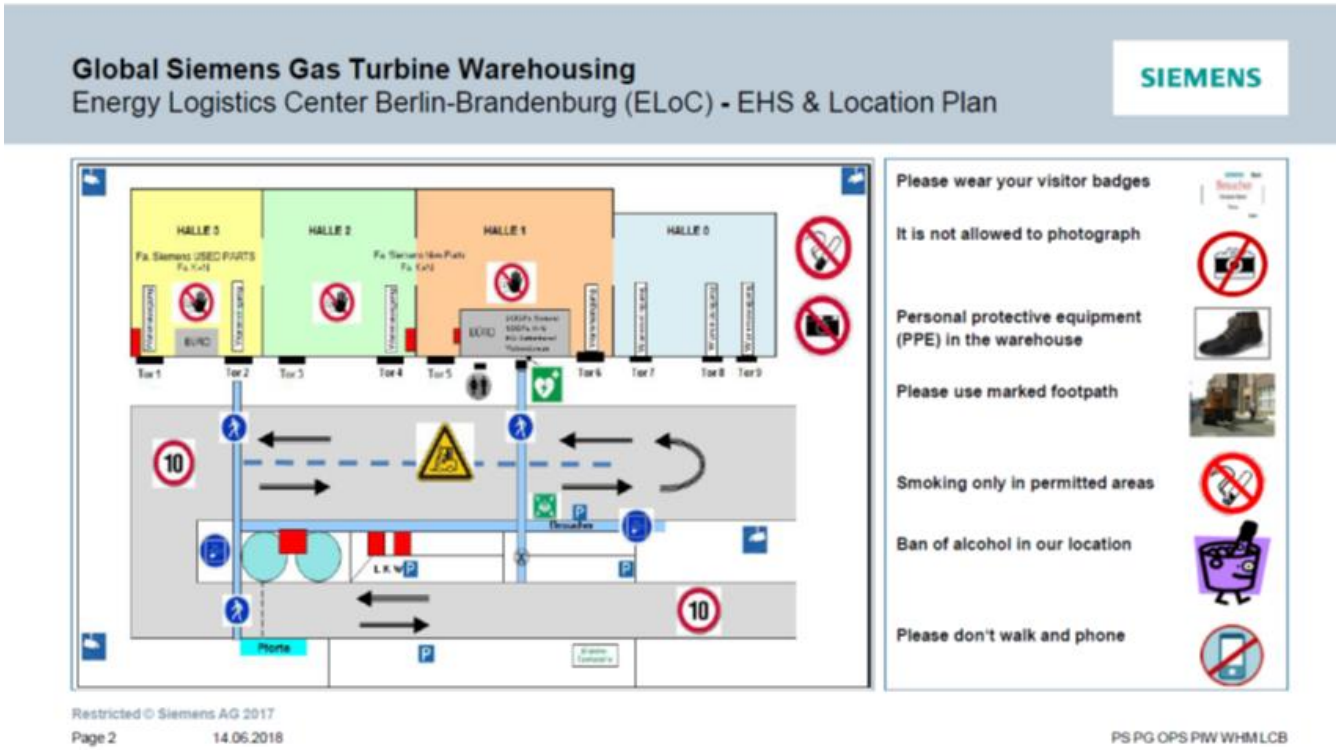
7. Digital transformation on Supply Chain Management

   Digital transformation is perhaps the hottest topic across the world of technology at the moment. Currently, Taipower's management is also focus on the issue of digital transformation, with no doubt, supply-chain vision should be aligned with the company's strategic goals. We also recognize that supply-chain transformations must extend to both technology and operations. However, reluctance to move forward with digital transformation of the supply chain, is apparent throughout the regarding managers. The growing talent gap, perceived risks, the ability to manage the change and collating clean data to drive digital capabilities, are just a few points holding decision makers back.

   Therefore, how does Siemens value the need of digital transformation in Supply Chain Management? And what are your suggestions on this issue?

8. GPS tracking &RFID technology, cloud architecture, and Big data analytics are the feature of digital transformation in supply chain management.

附件 2—Siemens 公司簡報資料



Emergency number

SIEMENS

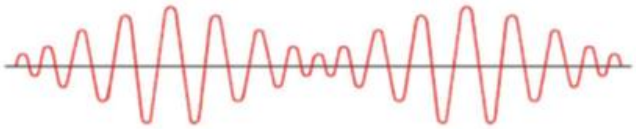
Important emergency telephone code:

- Emergency
- Fire

112

⇨ Plant Security

In case of fire you will hear a fire alarm signal:



Global Siemens Gas Turbine Warehousing
Energy Logistics Center Berlin-Brandenburg (ELoC) - Key Figures

SIEMENS

Customer Focus

Immediate supply of spare parts in case of emergencies
24/7 service

Goods-Receipts
In average ~ 30.000 Line items

Goods-Issues
In average ~ 120.000 Line items

Building / Infrastructure

Approx. 65.000 m² total area with 35.000 m² in warehouse
Building phase: 03/01/2010 until 08/01/2010
Building phase ELoC extension: 07/01/2017 until 12/31/2017

Stocked Materials

~30.000 Material-Styles
~2.000.000 Individual parts
Parts weight range from 1 gram up to 40 tons

Quality Key Facts

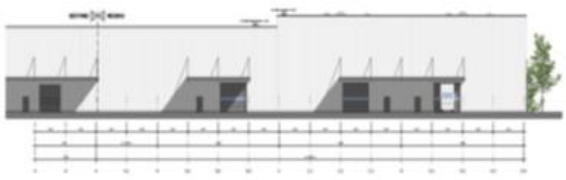
FY17 Cycle count deviation: 2.516 Euro
FY17 Warehouse-OTD: 99,99%

80 audits since commercial operation: no recommendations
GRC passed 6th time in a row with 91 of 91 possible points

Warehousing Expansion
Energy Logistics Center – Consolidation Project

SIEMENS

Energy Logistics Center - Consolidation Project
- Logistics Center extension by ~ 9.200 m² storage space
- Ready to use until: 12/31/2017



Layout Bodenlager Step 0:

Link Brandschutzkonzept Step 0

Revisionsanlagen Anbau

Global Siemens Gas Turbine Warehousing
Energy Logistics Center Berlin-Brandenburg (ELoC) - Key Figures

SIEMENS

PS PG OPS PIW WHM LCB

Logistics Management
- Implementation of customer service solutions
- Logistics contract management
- Logistics performance & process management:
  - Receiving
  - Storage
  - Picking & packing
- Warehouse configuration and standardization
- Technical reporting

Location Management
- Lease contract management, site management
- Site optimization to ensure the implementation
- Implementation of governmental, legal, county and insurance related regulations and requirements:
  - Air freight security and site security
  - Environmental, health and safety
  - Fire protection, building protection

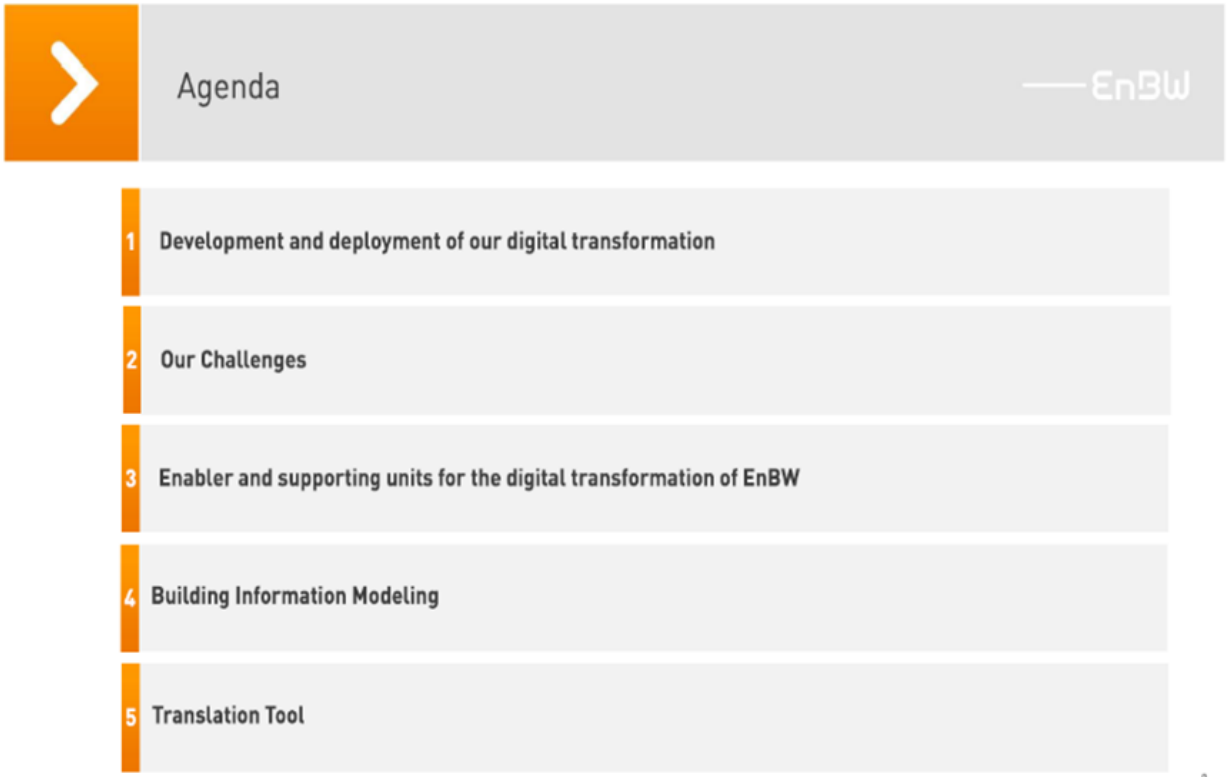
PS PG OPS PIW WHM NET

logistic network solutions based on harmonized of processes, support of synergy projects

SIEMENS

Thank you for your attention!

附件 2--EnBW 簡報資料



A snapshot of what recently happened in our industry - from a digital point of view

innogy

- Own innovation hub with **130** people
- **12** business models commercialized so far
- R&D staff: **260** people
- High venture capital expenses: **130 million €**
- **Six-figure sum** of investment in a blockchain startup

sonnen

- Battery storage + PV system + community
- Sales increase from **4.5 million €** in 2013 up to **50 million €** in 2016
- **Market share of 22 %** in Germany and Europe in 2016
- Goal: **doubling** the sales on a yearly basis

e·on

- **Cooperation with Google** for estimation of the solar potential of **7 million buildings** in Germany
- „2020 Leadership" – **Executive Program** to establish **new leadership requirements** in the digital age

NEXT KRAFTWERKE

- Operator of one of the **largest virtual power plants** in Europe
- **Networking of 4,500 plants** with a generation capacity of approx. **3,500 MW**
- Annual average **growth rate of 14 %**

3

EnBW's approach: development and deployment of our digital transformation

Our general challenges are...

EnBW

A) Products & Processes

- **Adaption** to changed customer needs due to increasing digitalization
- **Increasing the speed** of development and customization of products
- New and re-thinking of existing **processes** from end to end
- **Data** as base for new businesses and general optimization

B) Technology

- Spotting and evaluating **trends**
- Learning to handle and control **new technologies**
- Using technology as a **driver for (new) business**

C) People & Organization

- Creating new ways of **collaboration**
- Developing an understanding of **digital leadership**
- Developing digital **skills**

Digitalization affects the entire EnBW, thus we decided on a broad-based digital transformation of our core business

EnBW

		Description	Decision driver	Our principles
1	**Digital transformation of core business**	**Responsibility for digitalization** within existing organization **Own profit and business responsibility**	**High ambitions for digital transformation** of the whole core business **High and long-lasting** effects **Different challenges** and priorities for each business area Strategy aims for **further development of all business segments** Changes **within the entire company**	**Responsibility** for the digital transformation is within business **Top-down push** from the management as well as... **...bottom-up push** by communities, grassroot efforts and development of digital skills **Digital Office** supports the changes with its own abilities and resources
2	**Central Digital Unit**	**Chief Digital Officer (CDO)** as a new role **Transfer of digital business** to a central unit **CDO has profit responsibility**		
3	**Spin-Off**	**Transfer** of digital business to a new subsidiary **Subsidiary has profit responsibility**		

Skills of the corporate Digital Office...
... at the disposal of the business.

EnBW

Skills **Projects**

Digital Business	Digital Ways of Work	Technology	Data & Analytics	Products	DO Lead
▪ Use case development ▪ Business development ▪ User experience	▪ Agile organization ▪ Agile working ▪ acceleration	▪ Prototyping ▪ Blockchain ▪ Artificial Intelligence ▪ Internet of Things ▪ Augmented Reality	▪ Use Case development ▪ Data mining ▪ Data science	▪ Product ownership ▪ Implementation / responsibility	▪ Leadership ▪ Portfolio agent ▪ Challenging large digital initiatives

Approach for the power generation business units:
one single digital officer power generation

EnBW

digital officer power generation ⇄ Digital Office

„Funding pot" | Supporter of initiatives + „Digital Enabler" | Portfolio management | Further tasks responsibilities

Tasks

- Promoting digitalization
- Challenger
- Support
- Creation of transparency
- Prioritizing
- Control, setting priorities

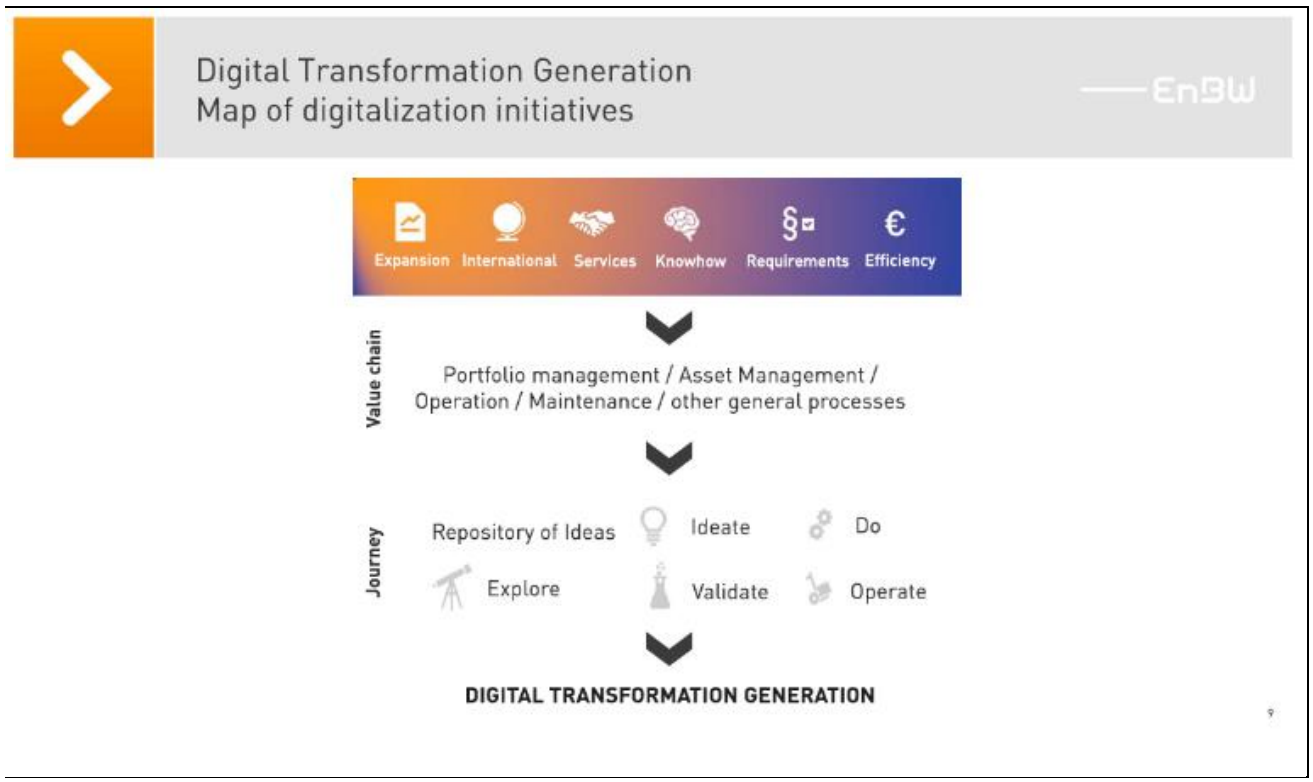
Skills

Authority to decide on start, end and "parking" the support of initiatives from funds of the central funding pot in the phases:

Explore | Ideate | Validate

Responsibilities / Duties

- Budget responsibility via central funding pot
- Support of committee work in the Digital Management Board
- Representing the interests of generation in digitization working groups


Digital Transformation Generation
Map of digitalization initiatives
EnBW
Expansion
International
Services
Knowhow
Requirements
Efficiency
Value chain
Portfolio management / Asset Management /
Operation / Maintenance / other general processes
Journey
Repository of Ideas
Ideate
Do
Explore
Validate
Operate
DIGITAL TRANSFORMATION GENERATION


THINK BIM –
Building Information Modeling
Tobias Räder
EnBW

Digital methods potentially lead to cost savings by reducing common problems in construction projects

EnBW

Common problems in construction projects

- Average cost overrun by 80% and time variance by 20 months in construction projects[1]
  - Wembley Stadium (UK): 81%
  - The Channel Tunnel (UK-France): 145%
  - Denver International Airport (USA): 167%
  - Scottish Parliament (UK): 4040%
- Complex planning process with a large number of involved parties
- Sequential planning and insufficient coordination of the involved parties
- Time-consuming and error-prone double work between the different parties

The use of **digital methods** is a major demand of the German Federal Ministry for Transportation and Infrastructure

Digitalization in the construction industry

- The use of digital methods facilitates
  - ... the coordination between different parties,
  - ... the integration of simulations,
  - ... the management of the construction process,
  - ... and the transfer of building information.
- Efficiency savings of 50% and 20% savings of influenceable costs through digital methods[2]
- **However:** Digitalization in the construction industry is way below the average across all industries[3]
- An emerging trend:
  Building Information Modeling

Source: 1) The construction productivity imperative, McKinsey 2019; 2) Digitalisierung der Baubranche, Roland Berger 2016; Digitale Transformation in der Bauindustrie, BearingPoint 2017; Baubranche aktuell – Wachstum durch Digitalisierung und BIM, PWC 2018; BIM Task Group/UK, 2018; 3) Top 500 Digitaler Index Deutschland, Accenture 2016

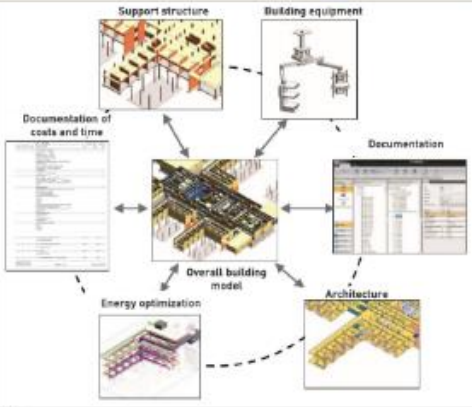
11

Building Information Modeling digitally captures and combines all relevant data about buildings

EnBW

- **Building Information Modeling** (BIM) refers to a **digital method** of mapping buildings with **all their relevant information** over their **entire life cycle** using a consistent, digital building model
- The **detailed building model** ("digital twin") is enriched with information by **all project participants** throughout the entire planning process

In an interdisciplinary BIM project, each department has its own model. These separate models can be combined to create an overall building model.



- In addition to the 3D geometry, additional non-geometric information such as type information, technical properties or costs are available
- Simplified simulations, analyses and calculations based on the building information

Source: Stufenplan Digitales Planen und Bauen, Bundesministerium für Verkehr und digitale Infrastruktur 2015

12

In contrast to the traditional planning process, the BIM-supported planning process shifts the planning effort to early project phases

EnBW

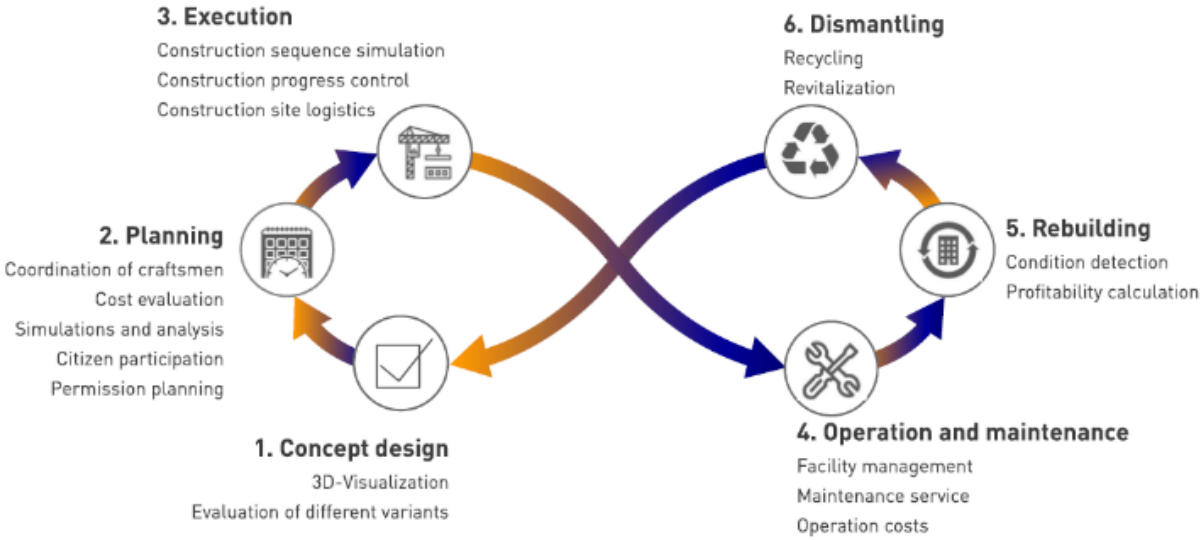
Traditional construction planning process with CAD in 2D and/or 3D	BIM-supported planning process
Main effort of the planning process in late phases	Shifting the planning process into early phases, in which digital variants are compared with each other
Changes of design in late phases leads to increased costs When changes are made, all drawings and quantities must be adjusted manually All involved parties must compare drawings and quantities with their technical plans	Planning changes are directly available to all parties in the overall model Linkage between building components, costs, and time increases the transparency Misunderstandings and errors can be identified at an earlier stage (e.g. simplified collision check)
Building information for analyses are not transferred directly, but must be entered manually	Masses and quantities can be drawn automatically from the overall building model
Transfer of building information to the facility management and maintenance involves losses of information	Early involvement of the facility management in the planning process to ensure consistent information

Source: BIM-Richtlinienreihe VDI 2552, VDI 2019

13

BIM not only covers the planning phases of construction projects, but also supports the operation, maintenance and dismantling of the buildings

EnBW



Source: BIM-Leitfaden für Deutschland, Bundesinstitut für Bau-, Stadt- und Raumforschung 2013; Identifying Use Cases and Data Requirements for BIM Based Energy Management Processes, Mcglinn et al. 2016

14

The implementation of BIM potentially lead to improvements along the entire life cycle of a building

EnBW

Improvement potentials through BIM

Early error detection
Up to **10%** cost savings through clash detection

More reliable planning of influenceable costs
Up to **40%** fewer unscheduled change requests

Improved communication and coordination
Improved coordination between all parties through the digital overall model

Faster project completion
Up to **7%** shorter construction time in the execution phase

Basis for life cycle optimization
Reduction of operation costs up to **9%**

Higher building efficiency
Up to **3,5%** Increased energy efficiency through early simulation

Continuous availability of all relevant information
Digital twin mirrors the actual building

More efficient maintenance
On the basis of the comprehensive information, maintenance can be planned more efficiently

Source: Einführung der BIM-Methodik - Digitales Planen und Bauen., DB Netze AG 2017; BIM-Vorgaben, DB Stationen und Service AG 2018; Motivation, Strategie und Umsetzung der BIM Methode, Siemens Real Estate 2017; How the U.K. forged a path to global BIM standards, Bernstein 2019; UK Government Construction Strategy, BIM UK Task Force 2018

15

Despite the identified need for action, Germany still lags behind in introducing BIM

EnBW

DE **Current status of BIM in Germany**

- Publishing of an **implementation plan (2015) for BIM** by the German Federal Ministry for Transportation and Infrastructure
- **Until 2017**: Preparation phase
  - Standardization, Guidelines, checklists, and first pilot project
- **2017-2020**: Extension of pilot projects in order to gain experience
- **As of 2020**: Comprehensive implementation of BIM
  - BIM as standard for public tenders

Current status of BIM in other countries

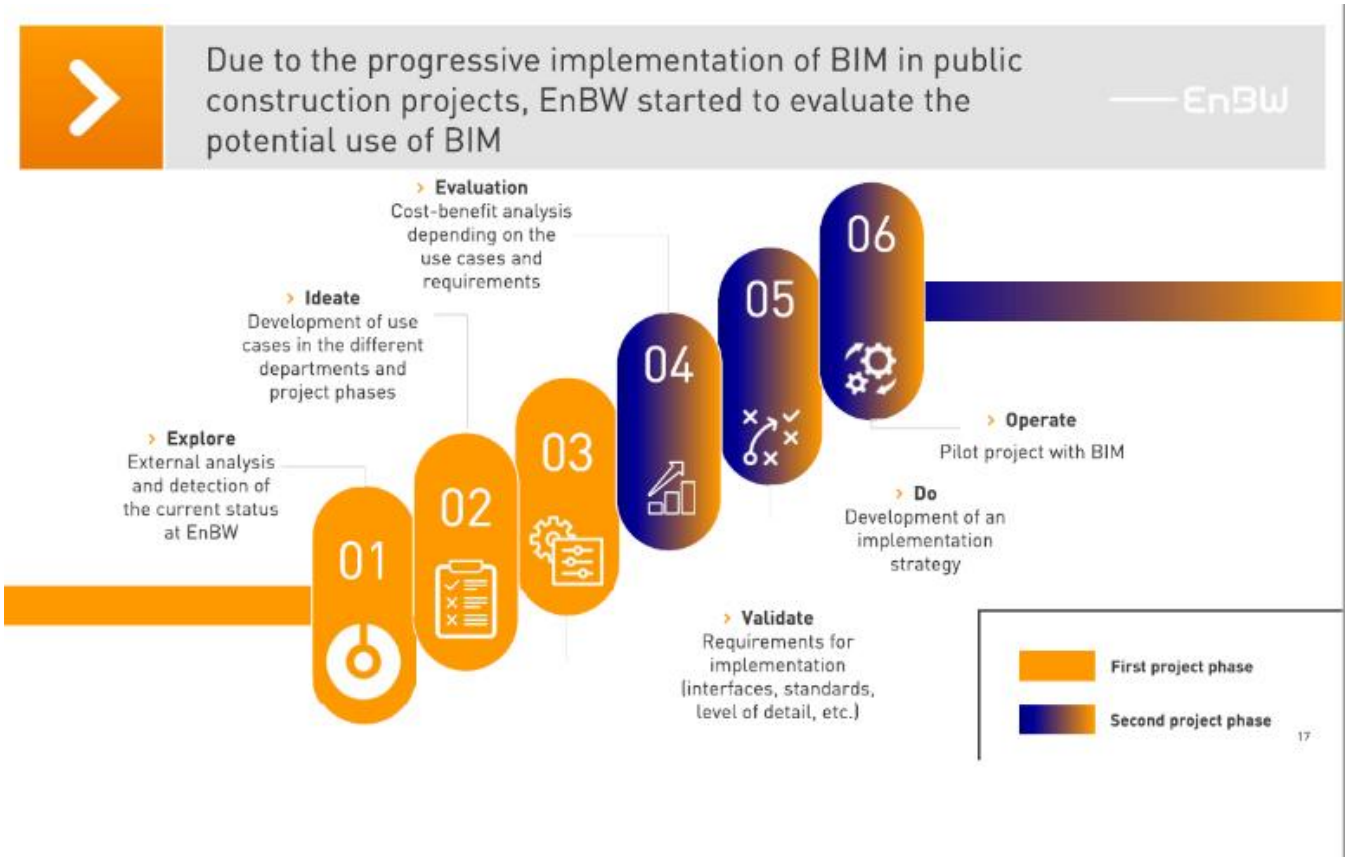
- **BIM is already obligatory for public tenders in many countries**

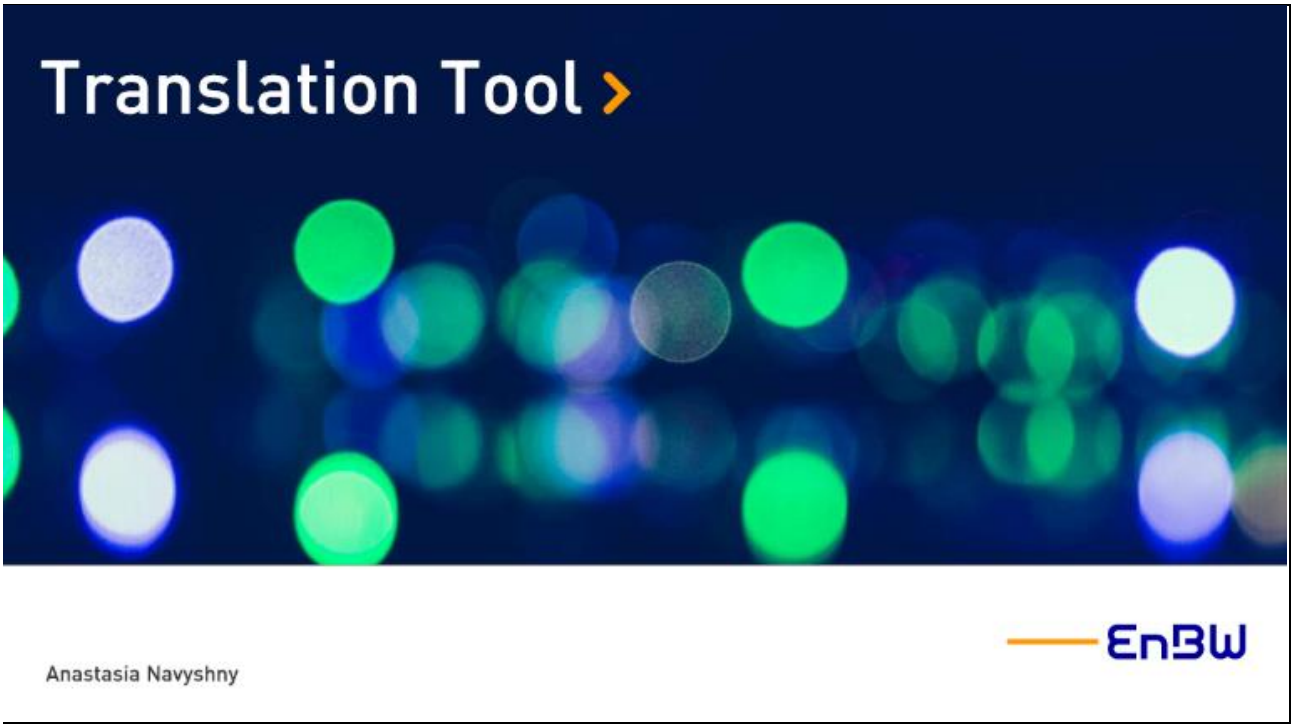
USA	Singapore	Finland	Norway	Denmark
2000	2004	2007	2010	2010

Netherlands	Sweden	UK	Switzerland	Germany
2012	2015	2016	2018	As of 2020

Source: Stufenplan Digitales Planen und Bauen, Bundesministerium für Verkehr und digitale Infrastruktur 2015; Verbreitung, BIM (Welt) 2017; BIM im internationalen Vergleich, BIM Task Group/UK 2018

16


Due to the progressive implementation of BIM in public construction projects, EnBW started to evaluate the potential use of BIM
EnBW
Explore
External analysis and detection of the current status at EnBW
Ideate
Development of use cases in the different departments and project phases
Evaluation
Cost-benefit analysis depending on the use cases and requirements
Validate
Requirements for implementation (interfaces, standards, level of detail, etc.)
Do
Development of an implementation strategy
Operate
Pilot project with BIM
01
02
03
04
05
06
First project phase
Second project phase
17


Translation Tool
EnBW
Anastasia Navyshny

Mission "Internationalization"

EnBW

Selective internationalization in selected regions and business areas/markets

- **Offshore:** Use of opportunities in Europe, Taiwan and USA
- **Onshore:** Generate growth in France and Sweden
- **PV:** Growth opportunities in Germany and other markets

19

Going international: translation services are a significant key factor for business success

EnBW

Analyzing EnBW's current offshore wind project „Hohe See"
Real-life document traffic in an offshore project from design phase until start of installation:

2016 2017 2018 › Over 20.000 documents

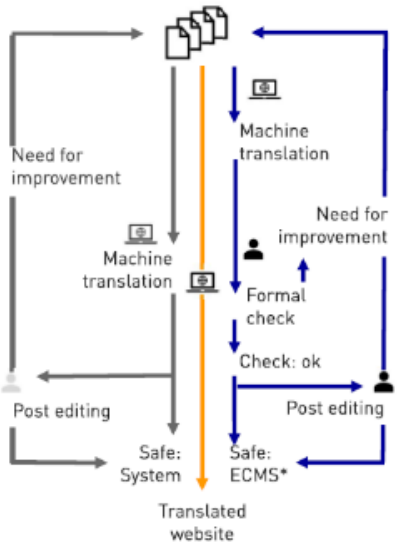
Future international projects: > 20.000 documents per project of which some have content in local foreign language

challenges ›
- language
- Content
- costs
- time
- quality

› **need for efficient, time-saving translation service**

20

Depending on the project task different requirements occur: three basic use cases need to be covered



1. Translations for the **offshore** sector are translated (optionally plus **post-editing**) and stored in the **engineering content management system** (ECMS). * Link via API
2. **Websites** must be translated (e.g. language: Mandarin)
3. **Daily use**, e.g. translation of mails/ attachments, or also for **due diligence** activities, etc.

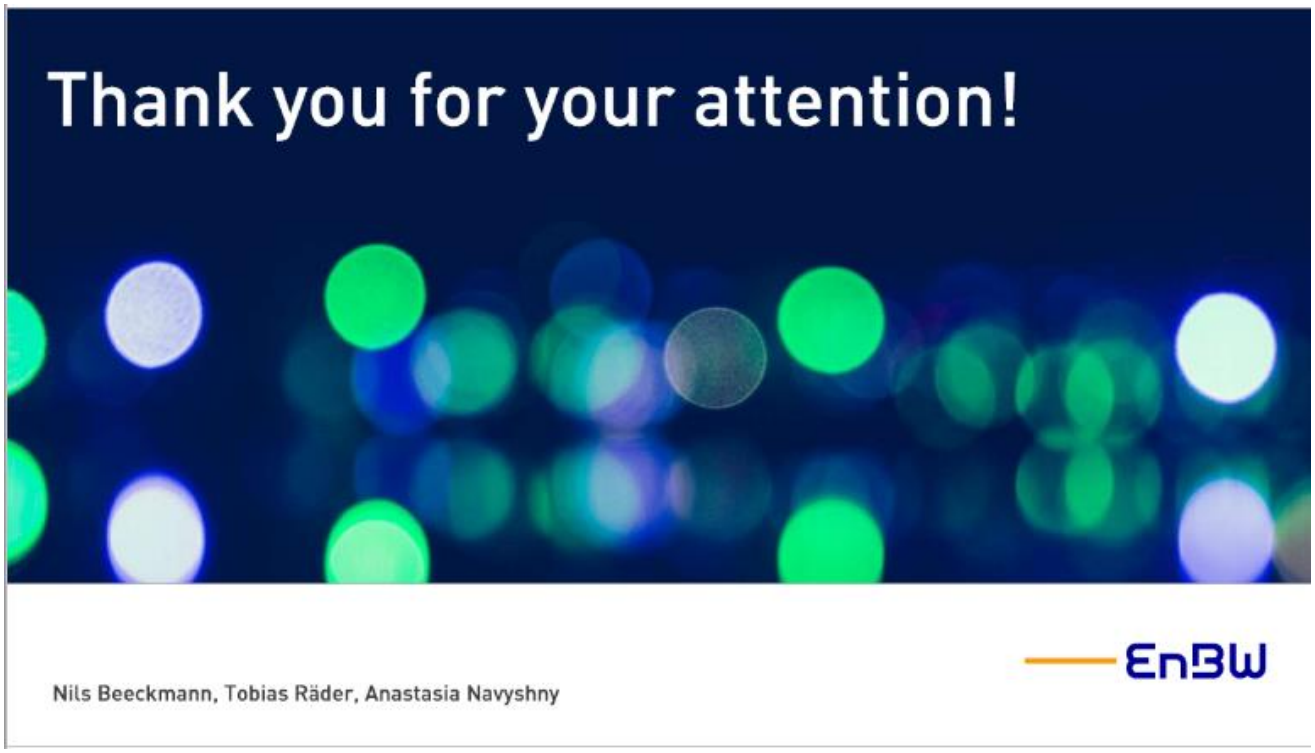
21

Introduction and operation of an intelligent software tool for automated translation of various contents in different languages

Formal requirements | **Login** | **Data storage** | **Non-functional requirements**

- Translation of documents (1000+ pages), e-mails, diagrams, drawings, Internet pages with the option of editing the documents in the desired format.
- Providing currently needed languages: English, Chinese (traditional and modern), French, Swedish, German.
- Capable of applying new language packages as needed.
- Reading/editing of formats as: pdf, xlsx, docx, pptx, dwg.
- Transferring and provisioning of documents into ECMS.
- Providing post editing process with skilled human translators to meet highest quality standards.
- creating a translation memory.
- Consideration of legal, company specific and technical specifications and terminologies.

22


Thank you for your attention!
Nils Beeckmann, Tobias Räder, Anastasia Navyshny
EnBW

EnBW Generation Technology Division

>Generation Assets

EnBW Generation –Core Business

EnBW Energie Baden-Württemberg AG (EnBW) Generation Technology Division is EnBW´s Center of Competence for Planning, Construction and Operation of Power Plants and has a well-balanced generation portfolio consisting of own power plants, shares of power plants and long-term power purchasing agreements. Generation is based on :

- Gas
- Coal
- Nuclear Energy
- Water
- Wind on- and offshore
- other Renewable Energy Sources

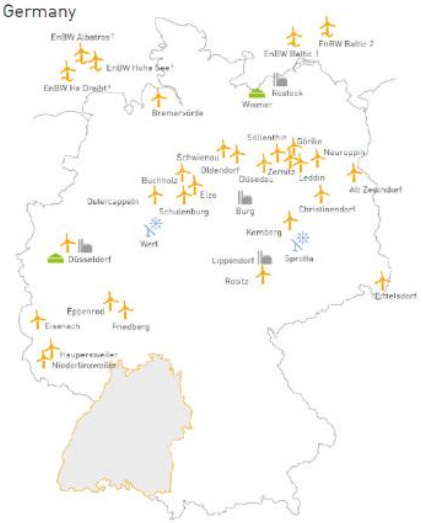
As a subsidiary company of EnBW (98,45 %) **EnBW Kernkraft GmbH (EnKK) responsibly** operates **the following nuclear power plants:**

- Neckarwestheim
- Philippsburg
- Obrigheim

EnBW Generation –Power Plant Sites of the EnBW Group[1]

EnBW

Germany



Baden-Württemberg

- Onshore wind farm
- Offshore wind farm
- Photovoltaic power plant
- Hydroelectric power plant
- Biomass power plant
- Conventional power plant
- Nuclear power plant

[1] Long-term procurement agreements and partly owned power plants are included in own electricity production.
[2] Partially or completely in the grid reserve (NetzResV).
[3] At the project planning/ planning stage.
[4] At the project development stage.
[5] Currently being dismantled.

3

EnBW Generation –Generation Portfolio

EnBW

	Generation Portfolio in MW		Own Generation by Primary Energy Source in GWh	
	31.12.2017	Share	2017	Share
Renewable Energies	**3,381**	**25,9 %**	**8,290**	**16,5 %**
Run-of-river	1,034	7,9 %	5,012	10 %
Wind onshore	540	4,1 %	661	1,3 %
Wind offshore	336	2,6 %	1,416	2,8 %
Storage/pumped storage (using natural flow of water)	1,327	10,1 %	946	1,9 %
other	144	1,1 %	255	0,5 %
Thermal Power Plants	**9,673**	**74 %**	**41,904**	**83,5 %**
Lignite	875	6,7 %	6,027	12,0 %
Hard coal	3,523	26,9 %	12,977	25,9 %
Natural gas	1,448	11,1 %	3,436	6,8 %
Nuclear	2,933	22,5 %	17,532	34,9 %
Pumped storage (not using natural flow of water)	545	4,2 %	1,721	3,4 %
other	349	2,7 %	211	0,4 %
Total	**13,054**		**50,194**	

4

EnBW Generation – Overview of Power Plant Sites
Nuclear Power Plants

Own Power Plants:

- Kernkraftwerk Philippsburg (KKP)
- Gemeinschaftskernkraftwerk Neckarwestheim (GKN)
- Kernkraftwerk Obrigheim (KWO)*

Supply/purchase Contracts:

- Fessenheim (F)
- Cattenom (F)


Obrigheim


Philippsburg


Neckarwestheim

* operation ceased on May 11, 2005, as a result of the nuclear energy consensus.

5

EnBW Generation – Overview of Power Plant Sites
Fossil-fired Power Plants


Rheinhafen-Dampfkraftwerk Karlsruhe

Own Plants:

- Altbach/Deizisau
- Heilbronn, Walheim, Marbach
- Karlsruhe
- Stuttgart-Münster, Stuttgart-Gaisburg


Restmüllheizkraftwerk Stuttgart-Münster


Heizkraftwerk Heilbronn

Investments, Supply/ purchase Contracts:

- Kraftwerk Lippendorf
- Großkraftwerk Mannheim
- Kraftwerk Rostock
- Fernwärme Ulm GmbH
- Heizkraftwerk Pforzheim


Heizkraftwerk Altbach/Deizisau

6

EnBW Generation – Business
Environmental Services

With the Waste-to-Energy Plant in Stuttgart-Münster and the subsidiary company **T-plus GmbH,** EnBW AG disposes approx. 30 % of municipality waste volume of Baden-Württemberg.

EnBW Biomasse GmbH supplies biomass fired power plants, like the Fernwärme Ulm GmbH, with wood (used and new).

MSE GmbH utilises approx. 350.000 t sewage sludge from all Germany – mainly by co-combustion in our conventional thermal power plants.

7

EnBW Generation – Overview of Power Plant Sites
Hydro-electric Power Plants

Own Plants:

- Rudolf-Fettweis-Werk Forbach
- Pumping Storage Plant Glems
- Illerkraftwerke
- Run-of-river hydro plants Murg, Nagold, Enz, Glatt, Neckar, Jagst, Kocher, Argen, Aach und Donau

Investments, Supply/purchase Contracts:

- 26 run-of-river hydro plants at Neckar (through Neckar AG)
- Rheinkraftwerke Iffezheim und Kehl (RKI GmbH)
- Rheinkraftwerke Gambsheim und Breisach (CERGA)
- Obere Donau-Kraftwerke
- Schluchseewerke
- Vorarlberger Illwerke
- Hochrheinkraftwerke

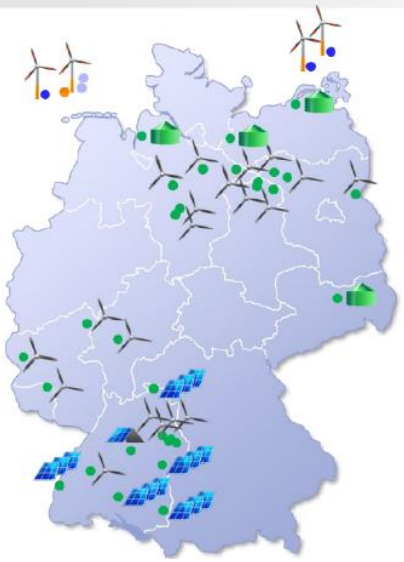

Laufwasserkraftwerk Kiebingen


Rheinkraftwerk Iffezheim


Rudolf-Fettweis-Werk Forbach

8

EnBW Generation – Overview of Power Plant Sites
Power Plants Utilizing Other Renewable Energies



Offshore
- installed capacity: 336,3 MW
- 101 turbines at 2 sites
- 3rd party service für OSS BO 1

Onshore
- installed capacity: 270MW
- 156 turbines, 31 sites

Photovoltaics
- installed capacity: > 40 MW
- 50 sites

Bio Energy
- installed capacity: >2 MW
- 7 Standorte

9

EnBW Generation – Overview Sites
Offshore Wind in Germany

Project Name	Distance / Depth	Turbines
EnBW Baltic 1 (48,7MW)	16 km / 18 m	21 Siemens 2,3-93
EnBW Baltic 2 (288MW)	32 km / 20 -40m	80 Siemens 3,6-120
EnBW Hohe See (497MW)	90 km / 40 m	71 Siemens 7,0-154
EnBW Albatros (112MW)	100 km / 40 m	16 Siemens 7,0-154
EnBW He Dreiht (~900MW)	85 km / 40 m	119 permitted

- Installed capacity 2017: **336 MW**
- In construction: **609 MW**
- Secured pipeline: **900 MW**

10

EnBW Generation Technology Division

>Engineering and Consulting

EnBW

EnBW Energie Baden-Württemberg AG
Areas of Competence

EnBW

Thermal power stations

Environmental technologies (e. g. emission control equipment, water treatment)

District heating/ process steam systems

Industrial power stations

Renewable Energies

District heating plants

Thermal waste treatment plants, waste incineration

Combined heat and power stations

Motor-driven CHP

New technologies (e. g. fuel cells, batteries)

12

EnBW Energie Baden-Württemberg AG
Services and Products

- **Energy economic studies**
- **Basis determination (pre-feasibility studies)**
- **Conceptual planning (feasibility studies)**
- **Project development**
- **Due Diligence, risk assessment**
- **Project management and implementation**
  - Preliminary planning
  - Permitting planning
  - Specification/tendering
  - Construction supervision
  - Site management
  - Co-ordination/supervision start-up & trial operation
  - Co-ordination/supervision acceptance tests
  - Claim management
- **General consulting services, operational optimization**
- **Owner's/Lender's engineering**
- **Quality Assurance and Expediting**






13

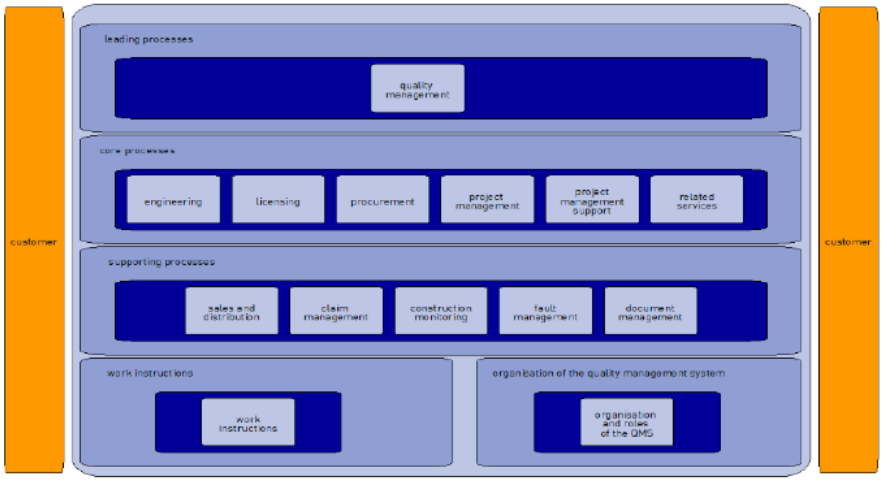
What Makes the Difference?

- **Many years of experience** in engineering, construction, operation and maintenance of power stations are one of our excellent competitive advantages. We are neither new to the industry nor purely a planning office. Our **expertise in planning** and our **direct access to the business experience of our neighbor divisions with power stations** of some 10,000 megawatts installed capacity is the base on which our customers and we can build.
- For us, **customer orientation** is not just a meaningless phrase but is a maxim by which we work. Personal contact is provided for all questions and requests. He or she is available at any time for advice or action. The attention is entirely focused on the customer and we make sure that everything is being done to your satisfaction behind the scenes at EnBW.
- Our **expertise is extremely extensive**. We develop, assess, project manage, monitor, control and co-ordinate the construction and operation of plants and ensure optimization. Our experience is your advantage– in generating heat and electricity, as well as in related areas, you have come to the right place. Our range of services fulfils every desire, irrespective of whether it involves **thermal power stations, industrial and combined heat and power stations, thermal waste treatment plants or renewable energies such as hydro, offshore and onshore wind, solar or biomass.**
- As a technical service provider, advising the customer is the highest priority for our organization. We offer **tailor-made and individual concepts and solutions**. The offer extends from project development, through project management, to organizing the plant operation and maintenance of power stations.

14

Approach and Methodology
Quality Management System

Following DIN ISO 9001:2015/EN 29000 the engineering and the project management division of EnBW AG is working according to a certified process-oriented quality management system.




Certificate

EnBW Energie Baden-Württemberg AG

ISO 9001

Project management and engineering services

15

EnBW Generation Technology Division

Reference Projects

16

Reference Projects
EnBW Baltic 1

EnBW

EnBW Baltic 1

Location	Baltic Sea, Germany
Capacity (gross)	48,3 MW
Number of turbines	21 x 2.3 MW
Wind turbine (WTG)	Siemens SWT-2.3-93
Foundation	monopiles
Park size	7 km²
Water depth	16 - 19 m
Distance to shore	16 km
Wind velocity	∅ 9 m/s
Wind yield	∅ 185 GWh/year
Availability	> 96% (meanwhile with own service team)
Commissioning	2011

Prize for the best OWF in operation 2014 and 2015 (Wirtschafts-forum Offshore)

A municipality partnership approach:

17

Reference Projects
EnBW Baltic 2

EnBW

EnBW Baltic 2

Location	Baltic Sea, Germany
Capacity (gross)	288 MW
Number of turbines	80 x 3.6 MW
Wind turbine (WTG)	Siemens SWT-3.6-120
Foundation	39 monopiles and 41 jackets
Park size	27 km²
Water depth	23 - 44 m
Distance to shore	32 km
Wind velocity	∅ 9.7 m/s
Wind yield	∅ 1.186 GWh/year
Construction time	approx. 2 years
Commissioning	2015

An institutional investor partnership approach:

MACQUARIE

18

Reference Projects
EnBW Hohe See

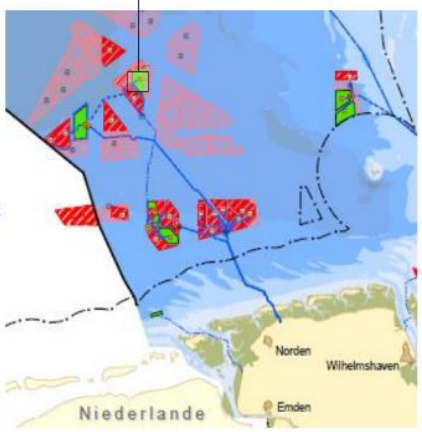
EnBW

EnBW Hohe See

Location	North Sea, Germany
Capacity (gross)	497 MW
Number of turbines	71 x 7.0 MW
Wind turbine (WTG)	Siemens SWT-7.0-154
Foundation	monopiles
Park size	42 km²
Water depth	40 m
Sea-bed conditions	very homogenous (dense sand)
Distance to shore	98 km
Remuneration	EEG –compression model: 18.4 ct/kWh for 8 years 14.9 ct/kWh for 4.5 years
Grid Connection (secured)	500 MW, BorWin 3 (TenneT)
Permit	issued in 2006, fully valid
FID	end of 2016
Start offshore installation	April 2018
Operating phase	starting H2/2019

An industrial partnership approach:

ENBRIDGE



Reference Projects
EnBW Albatros

EnBW

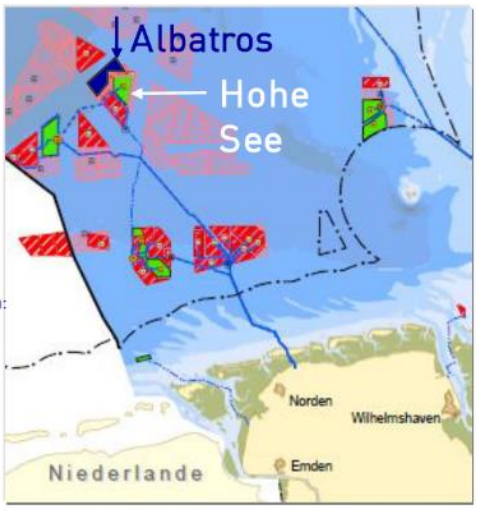
EnBW Albatros

Location	North Sea, Germany
Capacity (gross)	112 MW
Number of turbines	16 x 7.0 MW
Wind turbine (WTG)	Siemens SWT-7.0-154
Foundation	monopiles
Park size	39 km²
Water depth	40 m
Distance to shore	105 km
Grid Connection	BorWin 2 (TenneT)
FID	Q1/2017
Operating phase	starting H2/2019

With its proximity to Hohe See, Albatros benefits from synergies with the EnBW OWF Hohe See, both during construction and O&M.

An industrial partnership approach:

ENBRIDGE

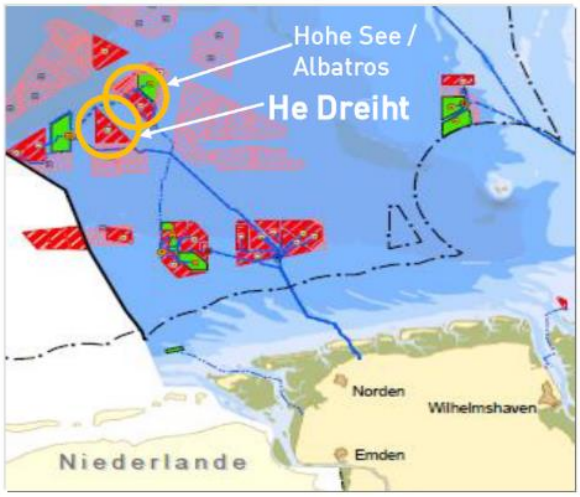


Reference Projects
EnBW He Dreiht

EnBW

EnBW He Dreiht

Location	North Sea, Germany
Capacity (gross)	900 MW
Number of turbines	up to 119
Wind turbine (WTG)	to be tendered
Foundation	monopiles
Park size	63 km²
Water depth	40 m
Distance to shore	85 km
Grid Connection	BorWin 5 (TenneT)
Planned FID	latest 2023
Operating phase	starting 2025



21

Reference Projects
Karlsruhe Power Plant Unit 8

EnBW

- **Project:** RDK8 **Client:** EnBW
- **Country:** Germany **Period:** 2006 - 2014
- **Technical specifications:**

Electric power:	912 MWel
Use of steam for district heating:	220 MWth
Efficiency (net):	> 46 %
Steam parameter (main steam):	275 bar / 600 °C
Steam parameter (reheat cycle):	58 bar / 620 °C

- **Engineering:**
- For the significant components like combustion chamber, coal mills, flue gas cleaning, cleaning of condensate, wastewater plant:
- Project development, basic engineering, tendering, project management, construction management and supervision, commissioning, interface management

22

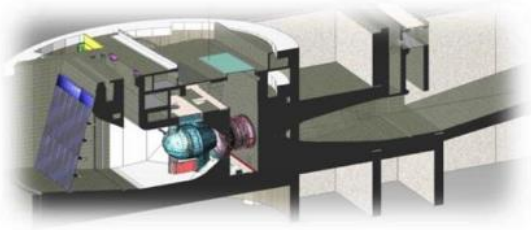
Reference Projects
Lausward Power Plant

Project:	Combined Cycle Power Plant (CCPP) Lausward , Düsseldorf
Client/Owner:	**SWD**
Engineering:	Project management, engineering, procurement and construction supervision (consortium with STEAG)

23

Reference Projects
Iffezheim Hydro Power Plant

Project:	Hydro power plant Iffezheim (Rhine) Extension of machine 5 (38 MW)
Client/Owner:	**RKI GmbH**
Engineering:	Project development and management, feasibility studies, preliminary design, construction supervision

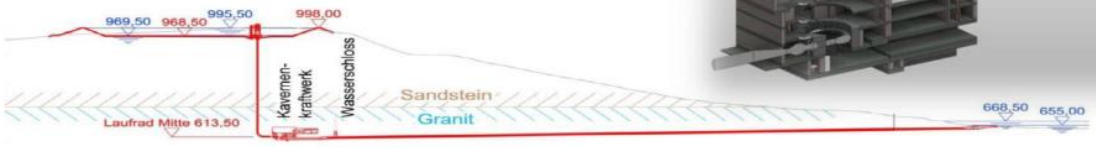


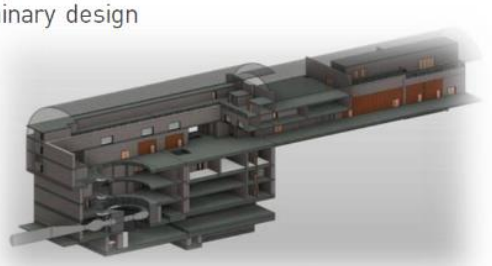
24

Reference Projects
Forbach Hydro Power Plant

EnBW

Project:	Pumped storage power plants Forbach (black forest) 2 Cavern power plants (225 MW and 50 MW)
Client/Owner:	**EnBW AG**
Engineering:	Project development and management, feasibility-studies, preliminary design



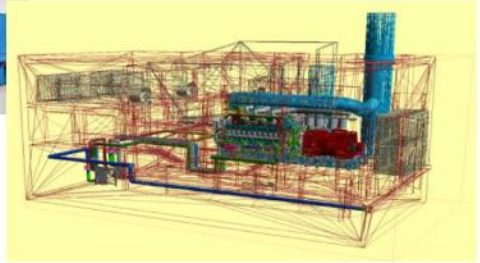


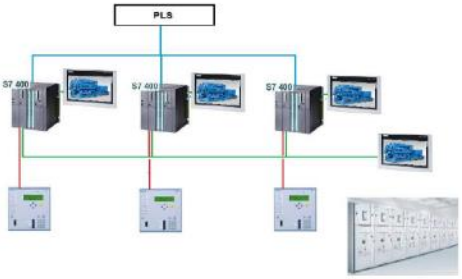
25

Reference Projects
Sipplingen Water Facility

EnBW

Project:	Implementation of a new 6,5 MW diesel emergency power supply unit, into an existing emergency system, with already two machines up to 4,4 MW each
Client/owner:	**Bodenseewasserversorgung**
Engineering:	Project management, design (civil, diesel engine, electrical and I&C equipment), procurement, construction supervision





26