Manufacturing Readiness Assessment (MRA) in support of the FCH-JU Review

In the context of this review, MRA can provide

- information on weaknesses and risk areas in the overall manufacturing capability of the EU industry, to be used as input for identifying and ranking priorities for manufacturing R&D funding
- a metric for reporting status against manufacturing goals. This will be useful for defining the current level of manufacturing maturity, identifying appropriate indicators with associated targets and for monitoring progress on the identified priorities during the implementation phase of Action #7
- a metric that enables decision makers to identify optimal entry ("jump-in") and exit ("jump-out") points for supporting (financially or otherwise) the EU battery e-mobility market

Background information on Manufacturing Readiness Assessment is given below.

MRA is a structured evaluation process to gauge the status of production processes and costs of an emerging technology using a standard set of metrics (Manufacturing Readiness Levels, MRLs) with associated risk elements.

MRA evaluates the status of the overall manufacturing activity and assigns a MRL on a 1-10 scale by considering the maturity of the manufacturing process, the maturity of the system or component design, the maturity or readiness of personnel and facilities, and the readiness to provide a quality product that fulfils commercial requirements. A key function of MRA is to assess industry's ability to manufacture at a (set of) given production volume(s), (e.g. pilot phase, full rate production) whose value(s) depend(s) on the specific market being addressed by the product. The end goal of an MRA is to define activities by identifying weaknesses in the manufacturing process or concurring with the transition to the identified production volume(s).

The risks associated with a manufacturing process are contained in a set of 9 risk elements that need be assessed for passage from one MRL to the next. The risk elements are consistent for all the MRLs, but the assessment questions of the risk elements change as a more sophisticated manufacturing capability, and higher MRL ranking, is achieved.

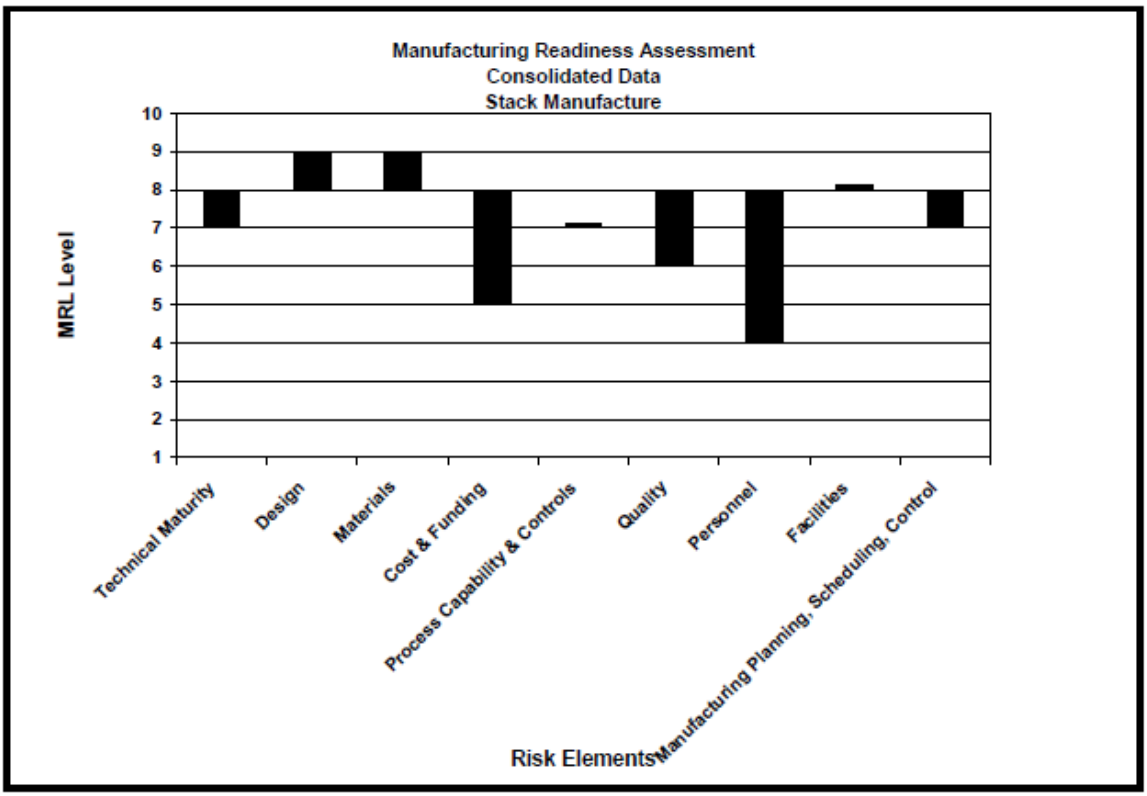
Definition of Manufacturing Readiness Levels (MRL)

MRL - 1	Manufacturing Feasibility Assessed
MRL - 2	Manufacturing Concepts Defined
MRL - 3	Manufacturing Concepts Developed
MRL - 4	Laboratory Manufacturing Process Demonstration
MRL - 5	Manufacturing Process Development
MRL - 6	Critical Manufacturing Process Prototyped
MRL - 7	Prototype Manufacturing System
MRL - 8	Manufacturing Process Maturity Demonstration
MRL - 9	Manufacturing Processes Proven
MRL - 10	Full Rate Production demonstrated and lean production practices in place

Risk Elements to be considered at each MRL:

Risk element	Subject of required risk analysis
Technology & the Industrial Base	capabilities to support the design, development, and production of the technology (product, system)
Design	system design to meet user requirements, incorporation of design for manufacturing rigour
Materials	availability of materials, components, sub-systems
Cost & Funding	current and full scale production cost, identification and development of pathways to meet manufacturing cost goals, access to finance
Process Capability and Control	sufficiency of manufacturing processes to produce at required cost
Quality Management	adequacy of pathways to control quality, and foster continuous quality improvement
Manufacturing Personnel	availability of personnel skills to support the manufacturing effort and of appropriate education and training program
Facilities	identification of facility capabilities and needs to support manufacturing efforts
Manufacturing Planning, Scheduling, and Control	implementation of planning schedules and control of scheduling needs to meet cost and production goals

An example of the outcome of a MRA is shown in the graph below.



Source: NREL report

References:

US-DoE: Manufacturing Readiness Assessment for Fuel Cell Stacks and Systems for the Back-up Power and Material Handling Equipment Emerging Markets, Technical Report NREL/TP-560-45406 (2010)

US-DoD: Manufacturing Readiness Level (MRL) Deskbook, Version 2.0, May 2011