Ministry of Environment

UNEP DTU PARTNERSHIP

Jordan

Technology Needs Assessment

For Climate Change

Report III

Technology Action Plans (TAPs)

(Final Version)

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ALMAKAN

شركة الماء والكلأ والنار لإدارة موارد البيئة

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ABBREVIATIONS

AEE	*Association of Energy Engineers*
BA & EF	*Barrier Analysis and Enabling Framework*
BOM	*Build-Operate-Maintain*
BRT	*Bus Rapid Transit*
CH_4	*Methane*
CO	*Carbon Monoxide*
CO_2	*Carbon Dioxide*
DTU	*Technical University of Denmark*
ED	*Electrodialysis*
EDR	*Electrodialysis Reversal*
GAM	*Greater Amman Municipality*
GHGs	*Greenhouse Gases*
GIZ	*German Technical Cooperation*
IMT	*Irrigation Management Transfer*
ISSP	*Institutional Support & Strengthening Program (of USAID-Jordan)*
JCC	*Jordan Cooperatives Corporation*
JCP	*Jordan Competitiveness Program*
JEA	*Jordan Engineers Association*
JGBC	*Jordan Green Building Council*
JISM	*Jordan Institution for Standards and Metrology*
JREEEF	*Jordan Renewable Energy and Energy Efficiency Fund*
JVA	*Jordan Valley Authority*
MCA	*Multi Criteria Analysis*
MEE	*Multiple-Effect Evaporation (distillation)*
MEMR	*Ministry of Energy and Mineral Resources*
MoEnv	*Ministry of Environment*
MOM	*Management, Operation and Maintenance*
MoPIC	*Ministry of Planning and International Cooperation*
MSF	*Multi-Stage Flash (distillation)*
MWI	*Ministry of Water and Irrigation*
NEPCO	*National Electrical Power Company*
NMVOCs	*Non-methane Volatile Organic Compounds*
NO_x	*Nitrogen Oxides*
PPA	*Power Purchase Agreement*
PPP	*Public-Private Partnership*
PV	*Photovoltaic*
R&D	*Research and Development*
RO	*Reverse Osmosis*
RWH	*Rainwater Harvesting*
SHS	*Solar Home System*
SO_2	*Sulphur Dioxide*
TTA	*Task Transfer Agreement*
UDP	*UNEP-DTU Partnership*
UNEP	*United Nations Environment Program*
USAID	*United States Agency for International Development*
VCD	*Vapour Compression Distillation*
WAJ	*Water Authority of Jordan*
WUAs	*Water Users Associations*

PREFACE

Jordan, one of the first developing countries ratifying the Paris Agreement, took several steps towards fulfilling the country's obligations and global commitments, working continuously towards developing institutional, technological and financial resources of the country.

In that approach, there was a lack of dedicated and good-quality sectoral-based studies that assess in particular climate change technology needs in sectors with high levels of GHG emissions and those that are most vulnerable to the impact of climate change. Therefore, conducting a systematic assessment of the country's needs for efficient and environmentally friendly technologies to facilitate Jordan's efforts in identifying and deploying the appropriate mitigation and adaptation technologies is highly required. Thus, this activity, the *Climate Change Technology Need Assessment (TNA) Project* of Jordan, sponsored by GEF, implemented by the UNEP-DTU Partnership and carried out by Ministry of Environment in Jordan from 2015-2017, came to cover the technology gap and to complement the integrated approach Jordan is following to address the impacts of climate change.

During this long process of country-driven TNA activities, the process encompassed working on the identification and prioritization of climate change mitigation and adaptation sectors and technologies in Jordan (phase I of the project) and presenting the outcomes in the *Technology Needs Assessment (TNA) Report*. Afterwards, the *Barrier Analysis and Enabling Framework (BA & EF) Report* was prepared aiming mainly at analyzing the potential barriers hindering the transfer of prioritized technologies, the removal of key barriers, and the analysis of potential market opportunities at the national level. Lastly, the *Technology Action Plans (TAPs)* formulated the current *Report,* which worked towards putting forward project ideas for the implementation covering both mitigation and adaptation. The Ministry of Environment, on behalf of the Government of Jordan, will advocate and provide all the policy support required for the translation of these action plans into fully-fledged proposals, and ultimately, onsite projects.

Most importantly, connection and integration will be preserved between the measures and actions proposed in the TAPs for prioritized technologies and related sustainable development and green economy-oriented national plans. For instance, the priority projects in the *2017 National Green Growth Plan for Jordan* (namely the Renewable Energy Desalination and Bus Rapid Transport Amman-Zarqa projects) were mentioned and supported by the provisions and outcomes of the TAPs developed through the TNA Project. The same perspective is expected to be applied to other national plans, such as NDCs, NAP, NAMA, and other national climate change response plans.

To conclude, the Ministry of Environment would like to thank all national officers and stakeholders from the line ministries, academia, NGOs and the private sector, as well as our partners from UDP and the consulting firm Almakan who led the execution of the TNA Project in Jordan and developed this crucial and enabling framework for progressing Jordan's climate change technology portfolio forward.

Sincerely,

Dr. Yaseen Khayyat
Minister of Environment

ملخص تنفيذي باللغة العربية

هذا التقرير يحتوي على خطة عمل التكنولوجيات ذات الأولوية لمشروع تقييم إحتياجات تكنولوجيات التغير المناخي للمملكة الأردنية الهاشمية، وهو التقرير الثالث والأخير للأنشطة التي باشر فيها الأردن في إطار هذا المشروع. والغرض من هذا التقرير هو توثيق الإجراءات والأنشطة اللازمة للاستجابة لنتائج عملية منهجية مطولة لتقييم العقبات والقيود التي تحول دون الانتشار الواسع لتكنولوجيات التعامل مع التغيرات المناخية في الأردن. ويتم تقديم هذه الإجراءات من أجل ترجمة التدابير (الحوافز) اللازمة للتغلب على العقبات التي تم تحديدها ولإزالة العقبات التي تواجه الأطر التمكينية لتعزيز نشر هذه التكنولوجيات بفعالية وبشكل مطرد في الطريق الطويل لمعالجة تبعات التغيرات المناخية في الأردن. ويقدم هذا التقرير وصفا شاملا لخطط العمل الخاصة بالتكنولوجيات التي تهدف إلى تقليل الآثار الناتجة عن التغير المناخي والتكيف مع هذه الآثار وتخفيف الانبعاثات المسببة لظاهرة التغير المناخي، وهذه التدابير والحوافز والإجراءات المقترحة تستند جزئيا على محتوى مكثف من التقرير الثاني للمشروع. والجهات المستهدفة من هذا التقرير هي صانعي السياسات الوطنية وأصحاب المصلحة المعنيين والمؤسسات المانحة الوطنية والدولية، فضلا عن المستثمرين في مجالات التغير المناخي والتنمية المستدامة وغيرهم من الأفراد والجماعات المهتمة بقضايا التغيرات المناخية.

ويحتوي هذا التقرير على أفكار لمشاريع محددة كمشاريع خضراء، يتم تقديمها في فصول منفصلة بعد كل خطة عمل لكل قطاع من القطاعات الأربعة التي تم تقييمها، مع تحديد الإجراءات اللازمة الملموسة التي يمكن أن تسهم في تحقيق الأهداف المحددة فيما يتعلق بتلك التكنولوجيا. ويورد التقرير أدناه موجزاً للإجراءات الرئيسية المقترحة في كل قطاع للتكنولوجيات ذات الأولوية.

قطاع الطاقة:

وقد تم تقييم ثلاث تكنولوجيات ذات أولوية وهي: الطاقة الشمسية الحرارية، والخلايا الكهروضوئية، وضخ المياه بواسطة الطاقة الشمسية. والإجراءات الرئيسية المقترحة هي:

- إزالة/تقليل العقبات المالية والاقتصادية؛
- تطبيق المعايير.
- برامج تدريبية مخصصة.
- برامج توعوية فعالة.

واستناداً إلى الحواجز والتدابير التي تم تحليلها، تم تصميم خطة عمل خاصة بقطاع الطاقة للتخفيف من إنبعاثات غازات الدفيئة بشكل خاص. ومن ثم، تم توضيح الانشطة الرئيسية للإجراءات المذكورة أعلاه. ومن أجل تحقيق النتائج الخاصة بقطاع الطاقة، يقترح تنفيذ بعض المشاريع التي ستعتبر فيها الأنشطة المترابطة وسيلة لتحويل الأفكار إلى حقائق. ونتيجة لذلك، تقترح أفكار المشاريع الرئيسية الثلاثة التالية:

- تصميم آليات مالية معينة لدعم الأنظمة التي تعمل بالطاقة الشمسية.
- تطوير صناعة الخلايا الكهروضوئية من السيليكون إلى الوحدة الكاملة؛
- تطوير صناعات تعتمد على الطاقة الشمسية عالية التقنية والتي تتكون من أنبوب مسطح، أنابيب مفرغة، الحوض المكافئ.

إن الهدف الأساسي المتوقع من خطة عمل تكنولوجيات قطاع الطاقة هو توسيع انتشار التطبيقات التي تعمل بالطاقة الشمسية في الأردن بحيث تطمح الخطة بحلول عام 2030 أن يتم تمتلك 25 % من الأسر الاردنية سخانات مياه تعمل بالطاقة الشمسية؛ و 10٪ من المنازل تمتلك أنظمة كهروضوئية. بالإضافة إلى أن 5٪ من المنازل سوف تحتوي على سيارات تعمل بالطاقة كهربائية. وسيستخدم 30% من المزارعين الطاقة الشمسية لضخ المياه وسيتحول ما نسبته 20٪ من المزارع المربوطة بشبكة الكهرباء الوطنية وكذلك 20٪ من محطات ضخ المياه الحكومية نحو ضخ المياه بواسطة الطاقة الشمسية والأنظمة الكهروضوئية.

قطاع النقل

واقترح لهذا القطاع أيضا خطة عمل تشمل ثلاث تكنولوجيات وهي: الباص السريع، والعمل على تطوير البنية التحتية للمشاة وتطوير نظام للتذاكر الإلكترونية في المواصلات العامة. والإجراءات الرئيسية المقترحة هي:

- وضع القواعد التنظيمية التي تستهدف المستخدمين المحتملين لوسائل النقل العام؛
- وضع خطط واستراتيجية تهدف لإعادة تأهيل الشوارع الرئيسية التي ستحتوي على ممرات خاصة للباص السريع؛
- إضفاء الطابع المؤسسي على أدوار أصحاب المصلحة، بدلا من تركها على أساس إجراءات غير منظمة؛
- تنظيم برنامج لتطوير قدرات السائقين والمشغلين؛
- تنظيم حملات توعية واسعة لتحفيز مستخدمي القطاع العام؛

ومن بين أفكار المشاريع المقترحة في قطاع النقل ما يلي:

- استحداث تخصصات أكاديمية جديدة تختص بعملية النقل المستدام مثل إنشاء وتطوير برامج ماجستير في الجامعات الاردنية وتزويده بكل ما يلزم؛
- العمل على إقامة مشروع الباص السريع بين مدينتي عمان واربد؛
- تطوير وتحديث مركبات النقل العام؛

قطاع المياه

التكنولوجيات الثلاث ذات الأولوية في قطاع المياه تمتاز بخصائص مميزة وجوانب فريدة من نوعها وتتطلب وجود موارد لازمة وطرق خاصة في عملية الإدارة وتحديد كل من الجهات المعنية والمستفيدين مع أخذ العقبات الحكومية بعين الاعتبار. وعلاوة على ذلك، فإن لكل واحدة من هذه التكنولوجيات نطاق تطبيقي خاص يسهم في انتشارها، وهي على النحو التالي:

- **تقنية حصاد مياه الأمطار من الأسطح**

من المتوقع أن تشتمل هذه التكنولوجيا على اختبار أنظمة متعددة لتصاميم مختلفة تتواجد في عدة مناطق حضرية وغير حضرية وأرياف وضواحي والتي تكون نسبة هطول الأمطار السنوية فيها اعلى من 200 مم. وسيسهم الاطار المنهجي العام المتبع في المواقع الريادية المختارة إلى اختبار إستخدام المواد التقنية والهندسية، ودور المؤسسات، والعمليات التنظيمية، وعملية إنفاذ القانون، وتطبيق كودات البناء، وعمليات الإشراف، واستحداث وظائف جديدة، مما سيؤدي إلى تحديد أنسب الطرق وأكثرها قابلية لتطبيق تكنولوجيات حصاد مياه الأمطار في مختلف أنواع المباني في الاردن. والأهم من ذلك، أن مثل هذه التقييمات ستساعد على سد الثغرات الناجمة عن الحواجز التي تعترض عملية إنفاذ القوانين، مع التركيز على مراقبة تطبيق قواعد وأنظمة البناء وعملية الإشراف.

ومن بين الإجراءات المقترحة لهذه التكنولوجيا ما يلي:

• إجراء دراسة وتقييم تقني لتحديد أنسب طريقة لتكنولوجيا الحصاد المائي في الأردن.
• تطوير كودة جديدة وعمل مراجعات للكودات القائمة وتطوير نظام للمباني بخصوص كفاءة استخدام المياه، بحيث يشتمل على الحوافز التنظيمية، وعمل تخفيضات على الضرائب والرسوم بهدف زيادة امتثال شركات الإسكان لمتطلبات هذه الأنظمة والكودات فيما يتعلق بالحصاد المائي.
• تطوير واستحداث برامج مكرسة من قبل الجهات المعنية مثل وزارة المياه والري، ونقابة المهندسين الأردنيين وجمعية المقاولين، وغيرها مخصصة للتوعية ونشر المعلومات.
• إنشاء مركز إقليمي للتدريب الهندسي التطبيقي لمبادئ المباني الخضراء بحيث يتم إنشاء المركز كمبنى أخضر كامل للأردن والمنطقة ككل يحتوي على تكنولوجيات الحصاد المائي من بين تقنيات مستدامة أخرى مثل المياه الرمادية، وتقنيات العزل ذات الكفاءة العالية وتطوير برامج تدريبية تستهدف جميع الجهات المعنية بشكل مباشر من مهندسين ومصممين ومتعهدين/مقاولين وطلاب تدريب مهني.

– **تمكين وتوسيع تقنيات جمعيات مستخدمي المياه**

وتهدف خطة عمل هذه التكنولوجيا إلى التوسع في تطبيق هذه التقنية في الأردن من خلال تصميم برنامج رئيسي بدلاً من مشروع واحد. ومن المتوقع أن تؤدي الأنشطة المقترحة في هذا البرنامج/مشروع إلى تحقيق عملية نقل للإدارة المتكاملة للري من قبل جمعيات مستخدمي المياه في جميع أنحاء وادي الأردن والتي تستند إلى تنفيذ برنامج شامل للأنشطة المختلفة في هذا المجال. وفي الواقع، يعتزم أصحاب المصلحة المشاركين في مناقشات هذه التقنية تطوير برنامج ت شامل لجميع الإجراءات المذكورة أدناه من أجل طرح نهج متكامل لإزالة الحواجز التي تعترض هذه التكنولوجيا وتيسير تمكينها وتوسيعها في البلد.

ومن بين الإجراءات المقترحة لهذه التكنولوجيا ما يلي:
• تغيير الإطار التشريعي الحالي والناظم لعمل جمعيات مستخدمي المياه في الأردن إلى إطار تشريعي آخر مناسب.
• تعزيز إمكانيات جمعيات مستخدمي المياه لتنفيذ المهام المنوطة بها.
• تحقيق وسائل فعالة للاستدامة المالية لدى جمعيات مستخدمي المياه وبناء قدراتها على تطوير الانشطة المدرة للدخل.
• وضع برنامج تدريبي مستمر لبناء القدرات، وتطوير وتفعيل منصات التنسيق والتواصل الفعالة لجمعيات مستخدمي المياه.
• وضع برامج لتمكين جمعيات مستخدمي المياه من تسويق المفهوم الأساسي لإدارة الري التشاركية وبناء القدرات والمهارات في تسويق منتجاتها.

ومن المتوقع أن يتم تجميع كل الإجراءات المذكورة أعلاه والأنشطة المفصلة في برنامج واحد شمولي وضخم يهدف إلى تسريع عملية النقل للصلاحيات المتعلقة بالإدارة التشاركية لأنظمة الري إلى جمعيات مستخدمي المياه في جميع أنحاء وادي الاردن بطريقة شاملة ومنظمة. وسيسهم ذلك في إزالة الحواجز التي تحول دون تطور ونشر هذه التكنولوجيا وتيسير تمكينها وتوسيعها في أجزاء أخرى من البلد، على سبيل المثال، جنوب الأردن. وتشمل فكرة المشروع المحددة لهذه التكنولوجيا برنامجا رئيسياً بشأن التمكين وتوسيع نطاق ممارسات جمعيات مستخدمي المياه في الأردن. وعلى وجه الخصوص، يتمثل أحد الأهداف الرئيسية في التحول من الإطار القانوني الحالي والذي يحكم شؤون جمعيات مستخدمي المياه في الأردن إلى قانون أكثر فعالية. وسيتيح ذلك أيضا تعزيز جمعيات مستخدمي المياه حتى تتمكن من أداء المهام المنوطة بها، فضلاً عن مساعدتها على تحقيق الاستدامة المالية الفعالة وبناء قدراتها على تطوير أنشطة ومشاريع مدرة للدخل.

– **تحلية المياه المالحة والمسوس وإعادة استخدامها**

نظراً لأن الاستثمار في هذه التكنولوجيا يتطلب رأس مال ضخم، سيتم اختبار التدابير المقترحة لمعالجة الحواجز والعقبات الهامة التي تعوق نشر هذه التكنولوجيا من خلال موقع ريادي تم اختياره من قبل سلطة المياه، على أن تكون مسؤولية التنفيذ على عاتق سلطة المياه لتعزيز هذه التكنولوجيا ومعالجة التحديات المتعلقة برأس المال.

ومن بين الإجراءات المقترحة لهذه التكنولوجيا ما يلي:
• التشجيع على تخفيض أسعار التشغيل من خلال استحداث وحدات تحلية مياه فعالة من حيث التكلفة ومتكاملة في استخدام الطاقة مثل الطاقة الشمسية؛
• تعزيز وتوفير حوافز لإنتاج وتجميع وحدات محلية لتحلية المياه؛
• التشجيع على استخدام التكنولوجيات ذات الأثر البيئي الأقل؛

وهناك فكرة مشروع جيدة لهذه التكنولوجيا، وهي تركيب خلايا ضوئية لتشغيل محطة تحلية المياه لموقع في وادي الأردن، تحديداً حقل سيل حسبان، وهو عبارة عن مجموعة من أربعة آبار للمياه الجوفية على حوض البحر الميت الجوفي بطاقة تصل من 3-3.5 م^3 في السنة. ويستخدم هذا الحقل لتوصيل مياه الشرب إلى عمان والمنطقة المحلية.

قطاع الزراعة

للتكنولوجيات الثلاث ذات الأولوية في قطاع الزراعة خصائص مميزة وجوانب فريدة من نوعها من حيث الموارد والطرق المستخدمة للإدارة ومجموعة المستفيدين الجهات المعنية، فضلاً عن الحواجز التقنية والحوكمة وهي:

– **تطبيق تقنيات توفير المياه مثل الري بالتنقيط أو تقنية الري تحت سطح الأرض**

وقد تم تحديد الهدف من هذه التكنولوجيا وهو "زيادة مساحة المناطق المروية في وادي الاردن والمرتفعات باستخدام التكنولوجيات الموفرة للمياه لتصل الى 60 ألف هكتار بحلول عام 2030". كما تعمل الخطة على توسيع الأنشطة المرتبطة بحصاد المياه إلى المناطق الجافة ومنطقة البادية لتقديم فوائد اجتماعية، واقتصادية، وبيئية للمناطق الصالحة للزراعة. ولتحقيق لهذه الغاية، تم تقديم الإجراءات التالية والمقترحة لهذه التكنولوجيا:

• تحسين خدمات الإرشاد الزراعي بشكل كبير لتقديم الخدمات الاستشارية اللازمة وأنشطة بناء القدرات اللازمة فيما يتعلق بمزايا التكنولوجيا؛
• تنظيم وتنفيذ حملات لتحسين القدرات المحلية تستهدف المزارعين بشكل خاص؛
• توفير الحوافز الاقتصادية لدعم الممارسات الصحيحة لتوفير مياه الري من أجل زيادة كفاءة استخدام أصحاب الأراضي والمزارعين.

وشملت أفكار المشروع التي تم تحديدها لهذه التكنولوجيا "إدخال تكنولوجيات مبتكرة لتوفير المياه في الري". ويهدف المشروع إلى زيادة القدرة على مواجهة آثار تغير المناخ على نظام إدارة المياه في الأردن، الذي يعتبر العامل الرئيسي لتحسين الإنتاج الزراعي.

- **حصاد المياه على مستوى المزرعة**

يرتكز حجم خطة عمل هذه التكنولوجيا وهدفها على مستجمعات المياه المحلية في المناطق الجافة ومنطقة البادية. ومن بين الإجراءات المقترحة لهذه التكنولوجيا ما يلي:

• تنفيذ مشاريع تجريبية لإثبات مزايا التكنولوجيا؛
• توفير القروض أو المنح طويلة الأجل ذات الفائدة المنخفضة من خلال أموال الدولة والمصادر الخاصة أو الصناديق الدولية مثل: البنك الدولي، والصندوق الدولي للتنمية الزراعية، وصندوق المناخ الأخضر وصندوق التكيف وغير ذلك؛
• دعم إنشاء شبكة للشركاء وأصحاب المصلحة لتطوير ونقل التكنولوجيا من خلال شبكة من الخبراء التقنيين.

وتشمل أفكار المشاريع المحددة لهذه التكنولوجيا مشروعا بعنوان "حصاد مياه الأمطار للاستخدامات الزراعية". وسيتكامل هذا المشروع مع الخطة الاستراتيجية لوزارة الزراعة من خلال زيادة إنتاجية الوحدة الزراعية وتحسين فرص الحصول على المياه. وستعمل الأحواض التجميعية كمورد تكميلي للمياه لري النباتات واستهلاك الماشية. وسيساعد ذلك في الحد من آثار الجفاف وتحسين سبل عيش وموارد الأسر المستهدفة. ويهدف المشروع إلى زيادة قدرة نظام المياه في الأردن على مواجهة آثار تغير المناخ من خلال حصاد وتخزين مياه الأمطار للاستخدام الصيفي (لأغراض الري واستهلاك الثروة الحيوانية)، وبالتالي زيادة الإنتاجية في المواسم الحارة والجافة.

- **الترويج لاستخدام أصناف نباتية مقاومة أو لديها القدرة للتكيف مع التغيرات المناخية**

يقتصر نطاق تطبيق هذه التكنولوجيا على المناطق الزراعية البعلية التي تكثر فيها زراعة الحبوب والبقوليات. وبناء على ذلك، تم اقتراح الإجراءات التالية لهذه التكنولوجيا:

• وضع برامج حديثة لإكثار أصناف نباتية تمتلك القادرة على التكيف مع التغيرات المناخية بالتعاون مع المنظمات الدولية ذات العلاقة؛
• وضع آليات لتوفير إعانات وحوافز للمزارعين لتشجيع استخدام ونشر الأصناف النباتية المقاومة والقادرة على التكيف مع التغيرات المناخية باستخدام مصادر مختصة بعلم الجينات النباتي؛
• تعزيز وتحسين القدرة المؤسسية لبرامج الإكثار الزراعي؛
• تعزيز نقل المعرفة وزيادة الوعي العام بشأن فوائد الأصناف المحسنة؛

وقد تم إقتراح فكرة المشروع "تنفيذ طرق الإكثار الحديثة لتسريع إنتاج أنواع المحاصيل المقاومة لتغييرات المناخية" لهذه التكنولوجيا. ومن بين أهداف المشروع تحديد الأصناف الوراثية المقاومة لمحصولي القمح والشعير، واعتماد تكنولوجيات تكثير حديثة لتسريع إنتاج أنواع مختلفة مقاومة للتغير المناخي من القمح والشعير، وتعزيز قدرات برامج التكثير الحالية من خلال تحسين المرافق واعتماد الأدوات الحديثة والتدريب.

EXECUTIVE SUMMARY

This Report, the *Technology Action Plan (TAP) Report*, is the third and final report of the activities on which Jordan embarked under the Technology Needs Assessment (TNA) Project. The purpose of this *TAP Report* is to document the actions and activities needed in response to the outcomes of a systematic and long process of assessing the obstacles and limitations that are hindering the widespread diffusion and deployment of climate change technologies in Jordan. Such actions are presented in order to translate the measures (incentives) needed to overcome the barriers that have been identified. They are being put forward as ways of removing the obstacles that are hindering the enabling frameworks in maximizing and enhancing the dissemination of such technologies effectively and steadily in the long path to dealing with climate change in Jordan. The TAPs presented provide a comprehensive description of the action plans for mitigation and adaptation technologies, partly based on condensed and edited content from Report no. II, the *Barrier Analysis and Enabling Framework (BA&EF) Report*. It is expected that the audience (target group) for this report will consist of national policy-makers and stakeholders and national and international donor institutions, as well as investors and other individuals and groups interested in climate change issues.

This TAP Report is supplemented by specific project ideas, submitted in separate chapters after each TAP, outlining concrete actions that can contribute to meeting the identified ambitions identified in relation to the TAP.

A quick summary of main actions proposed in each sector and the prioritized technologies is provided below.

Energy Sector:

A combined (bundled) TAP was proposed for the three priority technologies *of Solar Thermal, PV Electrification* and *Solar Water Pumping* in the energy sector. The main actions proposed are:

- Remove/minimise financial and economic barriers;
- Enforce standards;
- Focused training programs; and
- Effective awareness programs.

Based on the barriers and measures analyzed, the TAP for the energy sector has been designed for mitigation of GHGs particularly. Thus, several activities have been articulated for the main actions listed above. To achieve the Energy Sector TAP's results and main goal, it is proposed to implement some projects in which the tied activities will be considered as a way of turning ideas into realities. As a result, the following three main project ideas are suggested:

- Design financial support mechanisms and subsidies for solar-powered systems;
- Develop complete process PV industry, from silicon to module;
- Develop a comprehensive high-tech solar thermal industry with flat, evacuated tube and parabolic trough technologies.

The target set in the Energy Sector, "***Expanding the diffusion and penetration of solar-powered applications in Jordan*"** is ambitious. By 2030, 25% of households will be equipped with solar water heaters; 10% of houses will have installed PV electrification systems; 5% of houses will have electric cars charged from home; 30% of farmers located in off-grid regions will be using solar PV pumping systems; 20% of grid-connected farms will have switched to PV solar-water pumping; and 20% of government water-pumping stations will also have switched to solar pumping.

Transport Sector

A combined (bundled) TAP was also proposed for the three priority technologies of the *Bus Rapid Transit, Pedestrian Infrastructure* and *Ticketing System* in the Transportation Sector. The main actions proposed are:

- Set regulations that incentivize users and potential users of public transportation (PT);
- Set strategic rehabilitation plans for the main streets that will contains lanes for the BRT;
- Institutionalize the roles of stakeholders, instead of leaving them based on ad-hoc actions;
- Organize a capacity-building program for the drivers and operators; and
- Organize a wide awareness campaign to incentivize users and potential users of PT.

Among the project ideas proposed in the transportation sector are:

- Establish a new sustainable transportation major (such as a Masters' Program) in Jordanian universities to create new specialized practitioners in this understaffed field;
- Institute a new BRT project between the two major cities of Amman and Irbid;
- Improve and modernize the facilities of public transport vehicles.

Water Sector

The three technologies prioritized in the water sector have distinctive characteristics and unique aspects in terms of the resources, management modalities, beneficiary groups and stakeholders involved, as well as technical and governance barriers. Thus, the three technologies were addressed and assessed separately. Moreover, each technology has its unique scale and context of deployment, as follows.

— *Roof-top rainwater harvesting (RWH) technology*

It is anticipated that the scale and context of this technology will encompass the testing of different RWH designs representing a multi-modality of demonstration sites from urban, suburban and rural areas of rainfall rates above 200 mm/year. The pilot sites will enable the following to be introduced: technical and engineering materials and contractors; institutional, regulatory and law enforcement, building codes monitoring and supervision functions-related assessments, and screening studies to determine the most appropriate and viable modality of RWH technology for different types of building settings in Jordan. Most importantly, such assessments will help to fill the gaps due to barriers in enforcing the codes, with an emphasis on building code monitoring and supervision functions.

Among the actions proposed for this technology are:

- *Conduct a technical assessment and screening study to determine the most appropriate modality of RWH technology for different types of building settings in Jordan;*
- *Revise or develop a new water-efficiency code or by-law for buildings to regulate water efficiency, including RWH and regulatory incentives, tax cuts and fees deduction aimed at increasing compliance of housing construction companies with RWH directives (building codes) and enhancing the feasibility and payback period of the technology;*
- *Develop dedicated efforts and programs on the part of the relevant bodies (Ministry of Water and Irrigation, Jordan Engineers Association, Contractor Association, etc.) and embark on developing dedicated awareness and information dissemination programs;*
- *Establish a regional green building engineering training center as a fully-fledged demonstration green building for the region encompassing RWH technology and develop training programs targeting all the stakeholders directly involved (engineers, designers, contractors, and vocational training students).*

However, many actions were promoted for selection as project ideas. For example, the TAP for RWH was inspired to propose establishing a *Regional Green Building Engineering Training Center* in Jordan, which will be itself a fully-fledged demonstration green building for the region encompassing RWH technology among other sustainable building-oriented technologies (such as greywater, insulation technologies, RE & EE technologies, etc.).

— *Empowerment and Expansion of Water Users Associations' (WUA) Technology*

The size of the ambition for *Empowerment and Expansion of WUA Technology* in Jordan relates to the size of a major proposed program rather than a single project. It is anticipated that activities proposed in this TNA Project and the associated TAP for this technology will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUAs all over the Jordan Valley (JV) based on carrying out a holistic program of activities. In fact, the stakeholders involved in the discussions on developing the TAP for *Empowerment and Expansion of WUAs Technology in Jordan* intend to create a full package program of all the actions listed below in order to put forward a complete approach to removing the barriers to such technology and easing its empowerment and expansion in the country.

Among the actions proposed for this technology are:

- *Switching from the mandate of the existing* Jordan Cooperatives Corporation *(JCC) law governing WUAs in Jordan to a more suitable regulatory framework;*
- *Strengthening the WUAs in performing their mandated tasks (IMT);*
- *Attaining effective means of financial sustainability for WUAs and building their capacity to develop income-generating activities and projects;*
- *Establish a program of continuous training and capacity-building and develop and activate effective coordination and communication platforms for WUAs in the JV;*
- *Establish capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in Participatory Irrigation Management (PIM)* and *building the capacity and skills of WUAs in marketing their products.*

It is expected that all the above actions and detailed tied activities will be packaged into one mega-program aiming at accelerating transfer and achieving full IMT to WUA all over the JV in a holistic and organized manner. This will contribute to removing the barriers to such technology and ease its empowerment and expansion in other parts of the country, for instance, southern Jordan. The identified project idea for this technology encompasses a major program on ***Empowerment and Expansion of Water Users Associations (WUAs) Practice in Jordan***. The project will result in transferring and achieving full IMT to WUA all over JV based on forming a full package project of all the actions listed in the TAP section of this technology. This program is expected to contribute in removing the main barriers to such technology and easing its empowerment and expansion in the country. Particularly, one of the main objectives is switching from the mandate hindering the existing JCC law governing WUAs in Jordan to a more effective and suitable law. This will also enable the WUAs to be strengthened so that they can perform their mandated tasks, as well as helping them achieve effective financial sustainability and building their capacity to develop income-generating activities and projects.

— *Desalination/Brackish Water Treatment and Re-use*

Because investment in such technology requires high levels of capital, the measures introduced to tackle these important barriers and to enhance diffusion of this technology in accordance with the outcomes of the TNA project will be tested in a pilot site. The site is of promising readiness and is preferred by the

authorities in charge (the Water Authority of Jordan or WAJ) as a way of augmenting this technology and address these capital-related challenges.

Among the actions proposed for this technology are:

- *Promoting reasonable system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy);*
- *Promoting and providing incentives to produce and assemble desalination units locally; and*
- *Promoting technologies with less environmental impact*.

A well-identified project idea for this technology is the installation of a PV-powered desalination plant for a site in western Jordan close to the Jordan Valley (the Southern Jordan Valley), specifically the Al Husban Well Field, a set of four groundwater wells on the Dead Sea Groundwater Basin with a capacity of 3-3.5 MCM/year. This field is used to provide drinking water to Amman and the local area.

Agriculture Sector

The three technologies prioritized in the agriculture sector have distinctive characteristics and unique aspects in terms of the resources, management modalities, beneficiary groups and stakeholders involved, as well as the technical and governance barriers. Thus, the three technologies were addressed and assessed separately as well.

— *Application of Water Saving Technologies, such as Drip or Subsurface Irrigation Technology*

The ambition for the said technology was set as a target: "Increase the irrigated areas in the Jordan Valley and Highlands using water-saving technologies to 60,000 hectares by 2030". Also, expand water-harvesting activities to the catchments of dry areas and the Badia region to deliver socio-economic and environmental benefits to arable areas. To that end, the following were actions proposed for this technology:

- *Improving agricultural extension services significantly to provide the necessary advisory services and capacity-building activities in respect of the technology's advantages;*
- *Developing and implementing capacity-building campaigns (targeting farmers);*
- *Providing economic incentives and subsidized tariffs for irrigation water-saving practices in order to increase efficient use by land-owners and farmers.*

The project ideas identified for this technology encompassed "Introducing innovative irrigation-saving technologies". The project aims to increase the resilience to climate change impacts of Jordan's water system, which is acknowledged to be a key resource for agricultural production.

— *Farm-level Water Harvesting*

The scale and aim of this technology is centered in local catchments in dry areas and the Badia region. Thus, among the actions proposed for this technology are:

- *Implementation of pilot projects to demonstrate the advantages of the technology;*
- *Enable the provision of long-term and low-interest loans or grants through state funds, private sources (different banks) and international funds (WB, IFAD, GEF, GCF, Adaptation Fund, etc.); and*

- *Support the creation of a stakeholder network for the development and transfer of the technology through a network of technical experts.*

The project ideas identified for this technology encompass a project entitled "Rain Water Harvesting for Agricultural Uses". This proposed project will complement the strategic plan of the Ministry of Agriculture (MoA) by increasing the productivity of the agricultural unit and improving access to water. The targeted cisterns will act as a supplementary resource of water for the irrigation of plants and the consumption of livestock. This will assist in reducing the effects of drought and improve the livelihoods and resources of the targeted households. The project aims to increase resilience to climate change impact by Jordan's water system through harvesting and storing rainwater for summer use (for irrigation and livestock consumption) and thus increase productivity in the warm and dry seasons.

— *Introduction (or Promotion) of Plant Varieties Resistant (Adaptive) to Climate Change*

The scale of application of this technology will be restricted to rain-fed agricultural areas where cereal-legume cropping systems are predominant. Accordingly, the following actions were proposed for this technology:

- *Establishment of modern breeding programs to produce climate change-resilient varieties in collaboration with multinational and international organizations;*
- *Develop specific subsidy mechanisms and incentives to farmers to promote the use and dissemination of climate change-resilient crop varieties and landraces (plant Genetic Resources for Food and Agriculture).*
- *Strengthening the institutional capacity of breeding programs ; and*
- *Promoting knowledge transfer and increasing public awareness regarding the benefits of improved varieties.*

The project idea proposed for this technology was "**Implementing Modern Breeding Tools to Accelerate Production of Crop Varieties Resilient to Climate Change".** Among the objectives of the project are identification of climate-resilient wheat and barley germplasm, adoption of modern breeding technologies to accelerate the delivery of climate change-resilient wheat and barley varieties, and enhancing the capacities of current breeding programs through facility-upgrading and the adoption of modern tools and training.

1. INTRODUCTION

1.1. Summary of Outcomes from the TNA Report (Report I of Phase I of the TNA Project in Jordan) and BA&EF Report (Report II of Phase II of the TNA Project in Jordan)

The Technology Needs Assessment (TNA) process originated in the Poznan Strategic Programme on Technology Transfer established at the Fourteenth Conference of the Parties (COP 14) to the United Nations Framework Convention on Climate Change (UNFCCC). This had the aim of scaling up investment in technology transfer to enable developing countries to address their needs for environmentally sound technologies.[1] The TNA can be defined as a set of country-driven, participatory activities leading to the identification, selection and implementation of environmentally sound technologies to decrease CO_2 emissions (mitigation) and/or decrease vulnerability to climate change (adaptation). Thus, as a country-driven process, it should not be conducted in isolation but rather integrated with other similar ongoing processes that aim to support national sustainable development.

The first report produced from the activities of the Climate Change Technology Needs Assessment (TNA) Project in Jordan, which is being implemented through the UNEP-DTU Partnership (UDP), was submitted to Jordan's Ministry of Environment (MoEnv) in April 2016. The TNA activity was systematically conducted through a country-driven process involving all relevant stakeholders taking national sustainable development priorities into consideration. The national stakeholders were involved in the first phase of the TNA Project through two rounds of consultation. In the first round, the launch of the TNA project in Jordan took place on 17 November 2015, where the assignment's approach and work plan were presented and discussed to obtain feedback from stakeholders, brainstorm perspectives and identify relevant pools of stakeholder groups to be involved in the activities and discussions of the project. In this workshop, three exercises were conducted involving all attendees. The first exercise was conducted to enable selection of priority mitigation and adaptation sectors for TNA activities in Jordan, based on a dedicated multi-criteria analysis (MCA) exercise tailored deliberately for this purpose by the TNA Team in Jordan. This MCA exercise, which was aimed at determining the priority sectors, was conducted in addition to the systematic MCA exercise that UDP had proposed for selecting priority technologies. The two MCA exercises revealed that the top two priority mitigation sectors for carrying out climate change technology needs assessments in Jordan are *Energy* and *Transport,* while the top two priority adaptation sectors were *Water* and *Agriculture*. This conclusion was not unexpected in light of the status of the energy and transport sectors as the two largest emitters of GHGs in the country and their critical implications with regard to sustainable development (TNC 2014).[2] The same conclusion is valid for the water and agriculture sectors, as they are the two sectors that are most vulnerable to climate change in Jordan, as shown in the extensive assessments conducted in some national studies, mainly the TNC study (2014).[3]

In round two of the process of involving stakeholders in phase I of the project in Jordan, *Mitigation and Adaptation Technical Working Groups* were invited to a two-day workshop to discuss and prioritize an initial list of technologies for each priority sector based on the set criteria for each sector. Results of the four MCA exercises revealed the following top three technologies as priorities out of the long initial rosters of assessed technologies in each targeted sector. The top three mitigation technologies for the energy sector were (1) *Solar Thermal*, (2) *PV for Electrification*, and (3) *PV for Water Pumping*. The three top-ranked priority technologies for the transport sector were (1) *Bus Rapid Transit*, (2) *Improving Pedestrian Infrastructure*, and (3) *Ticketing Systems*. The final results for the water sector's top three priority adaptation technologies were (1) *Roof-top Rainwater Harvesting*, (2) *Augmenting and Expansion of Water Users Association*, and (3) *Desalination/Brackish Water Treatment and Re-use*. Finally, the results for the agriculture sector's top three priority adaptation technologies were (1) *Water Saving Technologies, such as Drip or Subsurface Irrigation*, (2) *Farm-level Water Harvesting*, and (3) *Plant Varieties Resistant to Climate Change*.

Water harvesting was a joint priority adaptation technology in both the water and agriculture sectors, revealing the critical importance of this technology to Jordan and at the same time indicating the robustness of adopting a holistic approach for rainwater harvesting at the watershed level and the farm-level in such a water-poor country. For detailed results and outcomes of the first phase (TNA Report) of the TNA Project of Jordan, the reader may refer to the TNA Report for Jordan published on the TNA Project's Hub at: http://www.tech-action.org/participating-countries

Having obtained the above results from the first phase of the TNA Project in Jordan, the Project Team and national stakeholders involved in the first phase, along with the newly identified stakeholders from the activities of that phase, proceeded to the second phase, that of the barrier analysis and enabling framework (*BA&EF* phase). The second phase aimed at assessing the obstacles and limitations hindering the wide dissemination and deployment of such technologies in order to identify the measures (incentives) needed to overcome these limitations and barriers and also to outline the enabling frameworks to maximize and enhance the dissemination of these technologies effectively and systematically to deal with climate change in Jordan. The *BA&EF Report* documented the results of a systematic barrier analysis assessment for each priority technology and explored options (incentives or measures) for addressing the barriers. In addition, the process entailed diagnosing the optimal enabling framework for each technology, as well as the three technologies together at the sector level. In the BA&EF Report, the barriers and enabling measures were thoroughly identified for each priority technology within each priority sector using a systematic process supported by tools selected from the literature and best industry practices for these types of assessment. The procedure was set so that the preliminary targets for each sector were first determined, before both the financial and non-financial barriers were diagnosed. Then measures and incentives to overcome these barriers were introduced accordingly, the preliminary targets being revisited and refined based on the results of the barrier analysis and the elaboration of an enabling framework.

In the BA&EF phase, the barrier analysis of the proposed technologies was conducted based initially on an extensive desk study and literature review. Then, deep analyses of policy papers and relevant studies were conducted to identify the primary reasons why each of the three top priority technologies in each selected priority sector is not currently in widespread use and why neither the private nor public sectors have invested significantly in it. In particular, economic assessments (economic and financial barriers) of the selected technologies were included in the desk study, as were other relevant assessments, for example, of the environmental and social impacts, as well as institutional capacity assessments. The summaries of the proper financial and other assessments of the selected technologies, which were made available by each sector's consultant before conducting the barrier identification process, were also of great value in decomposing the barriers. As an example, feasibility analyses illustrated the cost of capital, showing in particular why the cost might be considered too high for the public or potential investors. Thus decomposing the barrier's 'cost of capital' into its barrier elements and further into their dimensions was deduced from the feasibility summaries prepared by the consultants. Two specific tools proved useful in assisting the analysis of the decomposition of barriers: *root cause analysis* and *logical problem analysis or LPA*.[4] After conducting the barrier analyses, measures or incentives (solutions) were identified for each barrier (economic and financial measures and non-financial measures). All the described steps were aided by conducting dedicated stakeholder participation and engagement meetings in the format of focus-group discussions and results-oriented group exercises. The representatives of stakeholders that were to be invited to the BA&EF consultation workshop were carefully identified before holding the workshops. The main action was to identify all directly relevant active stakeholders and national experts for the particular technology under assessment so that they could cover all aspects of the technology being evaluated. These representative stakeholders were from companies involved in the market and supply chain, key players from policy making and government, research, innovation and technology development (incubator) institutions, regulatory and governance parties, representatives of NGOs and farmers, water-

users associations, and competent and well-known economists in each particular sector. Parallel to this brainstorming process and preparation of the workshop's materials, it was decided that a two-day extensive workshop involving consultations with stakeholders would provide the greatest benefit and added-value feedback from participants. Thus, a focused two-day workshop was held in the Dead Sea area from 10-11 May 2016. A total of 33 stakeholders attended the workshop, representing all the stakeholder categories mentioned above.

A cost benefit analysis (CBA) of the transfer and diffusion of selected consumer technologies was also conducted prior to and during the workshop, and input and outputs values as well as sensitivity analyses of the model were also discussed, supported by feedback from distinguished economists involved in the sector who highlighted the aspects and implications of the estimates. However, the economic experts stressed that the UDP models being used were basic ones and that more in-depth CBA estimates using advanced models might be needed at the project's full proposal preparation phase to provide better estimates of the real costs and benefits of particular technologies.

1.2. Overview of this report

This current report is the third and final report from the Jordan TNA project. Its aim is to document the actions and activities needed in response to the outcomes of the systematic and extensive consultative process of assessing the barriers hindering the wide diffusion and deployment of the priority technologies. The set of actions being proposed are presented plainly in order to promote the measures (incentives) required to overcome the barriers that have been identified as hindering the deployment of proper enabling frameworks to maximize and enhance the dissemination of such technologies effectively and systematically along the long road to dealing with climate change in Jordan. The TAPs presented in this report provide a comprehensive description of the action plans for mitigation and adaptation technologies, partly based on condensed and edited content from Report no. II, the *BA&EF Report*. The audience (target group) for this consists of is national policy-makers, national stakeholders and national and international donor institutions, as well as investors and other individuals and groups interested in climate change.

This *TAP Report* is supplemented by specific ideas for projects, submitted in separate chapters after each sector's TAP and outlining concrete actions that can contribute to meeting the identified aims of the TAP. It is expected that activists, stakeholders, and practitioners directly and indirectly involved in climate change and sustainable development will adopt and buy into the outcomes of this report, spontaneously embarking on proposal development and partnership identification activities by teaming up with each other to articulate concept notes and to approach potential donors and climate change funds in order to secure the funding needed to support a project of interest to their organizations.

2. TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR ENERGY SECTOR

2.1. TAP for Energy Sector

2.1.1. Energy sector overview

According to Jordan's Third National Communication (TNC) 2014 Report, energy-related activities have been classified as the dominant source of GHG emissions in the country from both fuel combustion and non-combustion (fugitive) emissions. In 2006 total emissions contributed around 72.9% of total emissions, i.e. about 20.938 Mt CO_2 eq. Carbon dioxide was the main contributor (20.896 Mt), representing 99.8% of total energy-sector emissions. On a per gas basis, in 2006 alone the energy sector contributed about 87.05% of the country's total CO_2 emissions, 1.4% of its CH_4 emissions, 47.7 % of its NMVOCs emissions and more than 99 % of its total emissions of NOx, CO and SO_2 each. On a per sub-sector basis, the largest contributor to emissions in the energy sector is the energy industries sub-sector, which accounted for 37.9% of energy emissions, followed by the transport sector, which contributed 22.5%.

Jordan has no hydropower or nuclear power stations. Heavy fuel oil with a high sulphur content of about 3-4% by weight was the main fuel used for public electricity generation in 2006, the baseline year taken for Jordan's TNC to the UNFCCC. New gas deposits were discovered in the Risha field. It is possible to realize a considerable saving in the overall costs of the generation expansion plan through the availability of additional quantities from the Risha field, as well as consumption rationalization programs and load management (MEMR, 2011). As the world's fourth biggest reserves, oil shale surface reserves in Jordan are more than 70 billion tons and contain more than 7 billion tons of shale oil (MEMR, 2012). Oil Shale in Jordan can be utilized commercially through direct incineration to produce electricity or by retorting to produce crude oil. With regard to renewable energy, Jordan is located within the *Sunbelt*, with average solar insolation of 5-7 Kwh/m^2·day·

A *Renewable Energy and Energy Efficiency Law* was enacted as a law under no. 13 for 2012. This law provides the legal, regulatory and legislative framework for investments in renewable energy in Jordan. It allows the Ministry of Energy and Mineral Resources (MEMR) to deal with direct proposals submitted to it for investors to invest in renewable energy projects without entering into a long tender process. The law enables tax and custom exemptions to be granted to renewable energy systems and equipment, in addition to many privileges regarding investments in renewable energy. MEMR has adopted an ambitious program to increase the renewable energy share to the energy mix to reach 10% by 2020.[5]

In aiming to reduce GHGs and encouraging clean renewable energy, the government has incentivised clean energy through laws, by-laws and regulations as follows:

- RE & EE Law N°13, 2012: The Law was issued in April 2012 and was amended in 2014. The following tied regulations emerged:

(1)- Tax Exemptions By-law in which "all systems and equipment of renewable energy sources and energy efficiency and its production inputs, whether manufactured locally and/or imported, will be exempt from all customs duties and sales tax."
(2)- Direct Proposal By-law in which "any person may submit a direct proposal to the ministry or to whomever is entrusted by the Council of Ministries to develop any site for the purpose of exploiting renewable energy resources."
(3)- RE & EE Fund By-law to provide the funding necessary for the exploitation of renewable energy resources.

Directives:

(1)- Reference Price List, which includes the indicative prices for each type of Renewable Source Technology;
(2)- Sale of Electrical Energy generated from Small RE Systems (Net Metering – Roof Tops);
(3)- Cost of Connecting RE Facility to Distribution Grid; and

(4)- Electric Power Wheeling Directives

- Jordan Renewable and Energy Efficiency Fund (JREEEF): designed to mobilize and provide financial and technical support;
- Energy Efficiency By-Law: concerns saving energy through energy efficiency measures;
- Energy Efficiency Code: technical measures for the energy efficiency aspects;
- Solar Energy Code: technical measures for the solar energy aspects;
- Insulation Code: technical measures for the insulation materials aspects;
- Green Building Manual: applying green measures in buildings to qualify for green building certificates

In Phase I of the TNA Project in Jordan, three prioritized technologies have been determined as follows:

Solar thermal technology. Uses the sun's energy to generate low-cost, environmentally friendly thermal energy. This energy is used to heat water or other fluids and can also power solar cooling. The two main types of collectors for low-temperature applications are evacuated tube solar thermal system and flat-plate solar system. As a system, other components, like storage tanks, piping systems, insulation and controllers, are integrated with the collectors.

There is a large potential for solar water-heater applications in both commercial and industrial sectors in Jordan. Many industries need hot water for processing, such as food, textile, and chemical factories. Solar thermal technology comes in many configurations and sizes, and is used in a wide variety of commercial applications. Common types of solar thermal applications include:

- Domestic Hot Water (DHW) systems: these include active and passive glycol systems (both closed and open loop), as well as drain-back systems;
- Swimming Pool/Hot Tub-Heating Systems: with closed loop glycol and drain-back varieties;
- Space Heating Systems (radiant): usually integrated with a DHW system;
- Combined Systems: combination of any of the above.

In general, solar thermal technologies can be used in:

- Space heating of commercial buildings, offices and greenhouses;
- Heating for commercial purposes. such as dairies and sheltered housing;
- Space heating in the service sector;
- Heating for indoor and outdoor swimming pools;
- Industrial process heating (low temperature heat up to 250°C);
- Solar cooking;
- Desalination;
- Agriculture (crop drying).

Solar water pumping system. This consists of photovoltaic (PV) solar panels that convert sunlight directly into electricity, a controller/inverter and a pump to transfer the water from one point to another. A storage tank or reservoirs may be used to store water during the day to be used at night or anytime needed. Solar water-pumping systems are attractive solutions for providing water in remote regions where the grid connection is limited or not available. Due to the unavailability of diesel fuel in rural areas, complications with transport, frequent failures of diesel systems and the high maintenance requirements, all this will encourage farmers to switch to solar water-pumping systems.

In the public sector, the Water Authority of Jordan (WAJ) consumes around one fifth of the country's total electricity production, almost all of which is used to pump water. It is considered the biggest energy consumer

in the country. The high diesel fuel prices make PV technology a strongly competitive alternative to diesel generators in remote areas. Moreover, the recent increase in electricity tariffs and the sharp reduction in PV prices are significantly improving the economic viability of solar water-pumping systems. Fields for the application of such technology include:

- Delivery of drinking water;
- Delivery of water to livestock;
- Agricultural irrigation;
- Desalination systems;
- Wastewater treatment plants; and
- Any industrial or commercial facility that needs water pumping and/or distribution.

PV electrification systems. Photovoltaic (PV) cells convert sunlight directly into electricity without causing air or water pollution. In general, PV cells can be classified as:

- Crystalline Silicon (c-Si) Modules: the modules are made from cells of either mono-crystalline or multi-crystalline silicon;
- Thin Film–Modules: the modules are made from a thin film deposit from a semiconductor on to a substrate.

PV power systems can be classified into:

- Off-grid domestic – providing electricity to households and villages that are not connected to the grid.
- Off-grid non-domestic – providing electricity for a wide range of applications such as telecommunications, pumping water and navigational aids.
- Grid-connected distributed PV – providing electricity to a specific grid-connected facility.
- Grid-connected centralized PV – providing centralized power generation for the supply of bulk power to the grid.

PV systems consist of PV modules, supporting structure, DC cables, DC connectors, DC junction boxes, DC switches, inverter/s, AC cables, AC connectors, AC switch gears, transformers, earthing systems and monitoring systems. The increased diesel fuel prices, the recent increase in the electricity tariff and the sharp reduction in PV prices are significantly improving the economic viability of grid-connected PV applications. Potential applications are as follows:

- Electricity production to support the grid;
- Electricity supply in remote areas where there is no access to grid connection;
- Energy efficient lighting and emergency call boxes;
- Water pumping and desalination;
- Solar refrigeration;
- Rooftop applications (industrial and commercial facilities).

Financial appraisal. The current average system costs are around JD 1000/kWp and may reach JD 600/kWp for mega-scale projects. The pay-back periods of such systems in Jordan range between two and six years depending on the application.

2.1.2. Technology Action Plan (TAP) for the Energy Sector's three technologies: Solar Thermal, Solar Water Pumping and PV for Electrification

2.1.2.1. Introduction

The three prioritized technologies to have been selected are *Solar Thermal*, *Solar Water Pumping* and *PV for Electrification*. They all share the same concept of zero fuel consumption, almost zero running costs and

zero pollution. Earlier, in the previous barrier analysis and enabling framework phase of the TNA project, it was found that almost all the three technologies share common major barriers and measures. It was therefore decided to join their action plans into one comprehensive program entitled **"*Expanding the diffusion and penetration of solar-powered applications in Jordan*".**

Solar-powered technologies use the sun's energy rather than fossil fuels to generate low-cost, environmentally friendly thermal or electrical energy. This energy is used to heat water as in solar thermal applications and generate electricity and pump water in water-pumping applications. The main advantages of these technologies include on-site, clean, modular, safe and rapid installation of the equipment. They provide an immediate and measurable reduction in fuel bills, together with reductions in carbon dioxide emissions. Although it needs a high initial investment cost, feasibility studies show clear advantages over the other conventional resources due to the zero fuel costs needed during the lifetime of the systems. One more advantage in Jordan is the high potential of solar radiation levels, which lead to higher system outputs and better feasibility compared to other regions.

2.1.2.2. Ambition for the TAP

The target set for "***Expanding the diffusion and penetration of solar-powered applications in Jordan*"** is ambitious**.** By 2030 25% of households will be equipped with solar water heaters, 10% of houses will have installed PV electrification systems, 5% of houses will have electric cars charged from home, 30% of farmers located in off-grid regions will be using solar PV pumping systems, 20% of grid-connected farms will have switched to PV solar water-pumping, and 20% of government water-pumping stations will have switched to solar pumping.

2.1.2.3. Actions and activities selected for inclusion in the TAP for the energy sector

Solar energy technologies face several challenges in economic, financial and market conditions, regulations, human skills, and the social and awareness fields. These barriers are hindering its widespread deployment around the globe. Strong markets are needed to stimulate the required investments in technological development and deployment, yet further technological advances are needed to increase market demand. The lack of sufficient market pull for solar energy, due to its comparatively higher costs, creates the need for policy-driven support to bridge this cost disadvantage. Training and awareness programs are key to increasing the penetration of their applications among users.

Barriers and measures were discussed earlier for the three technologies in the *BA&EF Report*. Table 1 below shows the main barriers and corresponding measures needed to facilitate the upscaling of the three priority technologies: *Solar Thermal, Solar Water Pumping System,* and *PV for Electrification systems.*

TABLE 1. OVERVIEW OF MAIN BARRIERS AND MEASURES OF SOLAR THERMAL, SOLAR WATER PUMPING SYSTEM, AND PV ELECTRIFICATION SYSTEMS

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	High initial system cost	Remove or mitigate financial and economic barriers (such as reducing or removing income taxes, minimizing interest rates by subsidies, etc.)
Market conditions	Existence of low-quality products in the market	Enforcement of standards

Legal and regulatory	Gaps between existing legislation and actual enforcement	Enforcement of standards
Human skills	Limited skilled labour	Focused training programs
Social, cultural and behavioural	Insecurity: theft of systems	Effective awareness programs
Information and awareness	Inadequate awareness programs	Effective awareness programs

As the three technologies are included in one general program, all the measures listed in Table 1 were found necessary for the following actions:
Action 1: Remove or mitigate financial and economic barriers;
Action 2: Enforcement of standards;
Action 3: Focused training programs; and
Action 4: Effective awareness programs.

Table 2 below describes the actions and their specific activities needed to expand the diffusion and penetration of solar-powered applications in Jordan.

TABLE 2. ACTIONS AND THEIR SPECIFIC ACTIVITIES NEEDED TO EXPAND THE DIFFUSION AND PENETRATION OF SOLAR POWERED APPLICATIONS IN JORDAN.

	Action 1:	**Remove or mitigate financial and economic barriers**
Activity 1.1	Preparation and implementation of a comprehensive program of incentives for users and manufacturers.	
Activity 1.2	Establish reliable renewable energy industries to decrease the cost and increase trust among users.	

	Action 2:	**Enforcement of standards**
Activity 2.1	Review standards, regulations and laws.	
Activity 2.2	Hold a conference or gathering for all governmental bodies and concerned parties to discuss the current situation and the required development and improvements.	
Activity 2.3	Based on Activity 2.2, conclusions and recommendations should be sent to the government with concrete solid proposals for enforcement.	

	Action 3:	**Focused training programs**
Activity 3.1	Review current training programs.	
Activity 3.2	Design and implement a focused, comprehensive program for technicians and engineers.	

	Action 4:	**Effective awareness programs**

Activity 4.1	Establish demonstration facilities for the public and users.
Activity 4.2	Design and implement an effective advertising program that can reach prospective and potential users.

2.1.2.4. Stakeholders and timeline for implementation of TAP

The technology action plan and program suggested to achieve this TAP mainly relate to solar projects. The main stakeholder is the Ministry of Energy and Mineral Resources (MEMR), which is responsible for all the laws and regulations in the energy sector. Other ministries, like the Ministry of Environment, also has some major roles in the TAP since most solar-energy projects aim to mitigate GHG emmissions. The private sector has a major role in establishing projects that will lead eventually to achieving the TAP argets.

The results of the analysis are shown in the overview in Table 3 below.

2.1.2.5. Estimate of resources needed for action and activities

Resources are varied, based on the action suggested. The results of the analysis are shown in the overview table below (Table 3).

2.1.2.6. Management planning

Articulation of risks and contingency planning are shown in the overview in Table 3 below.

2.1.2.7. TAP overview table for energy sector

Table 3 below elaborates and overviews the action plan put forward by Jordan to diffuse and accelerate the deployment and wide dissemination of prioritized clean solar-energy technologies in the country.

TABLE 3. TAP SUMMARY OVERVIEW OF THE ACTION PLAN PUT FORWARD IN JORDAN TO DIFFUSE AND ACCELERATE THE DEPLOYMENT AND WIDE DISSEMINATION OF SOLAR THERMAL, SOLAR WATER-PUMPING SYSTEM, AND PV ELECTRIFICATION TECHNOLOGIES IN JORDAN

Sector	Energy											
Technology	**Solar thermal, PV for electrification and Solar water pumping**											
Ambition	**By 2030: 25% of households are equipped with solar water heaters; 10% of houses installed PV electrification system; 5% of houses have electric cars charged from home; 30% of farmers located in off-grid regions are using solar PV pumping systems; 20% of grid-connected farms switch to PV solar water pumping; 20% of government pumping stations switch to solar PV.**											
Benefits	**Climate change mitigation**			**7 Mt CO_2 eq**								
	Climate change adaptation			**For solar water pumping, encourages users to save water**								
	Social development			**30,000 jobs**								
	Environmental protection			**Local health improvements, protecting the planet**								
	Economic development			**Improved balance of payments, political and social stability.**								
Action	**Activities**	**Responsible body and focal point preparation**	**Responsible body and focal point implementation**	**Time frame**		**Capacity needs**		**Cost summary**	**Sources of Funding**	**Risks**	**Success criteria**	**Indicators for monitoring implementation**
				start preparation	**complete implementation**	**preparation**	**implementation**					
1- Remove/mitigate financial and economic barriers	Preparation and implementation of a comprehensive program of incentives for users and manufacturers	Ministry of Energy and Mineral Resources, Ministry of Environment and local experts	Ministry of Energy and Mineral Resources, Ministry of Environment and local experts	Jan., 2018	Dec., 2018	training	technical support	JD 250,000	GCF, International fund with in-kind contribution from local	Risks: Delay in securing funding Contingency plans: Consider local funding sources such as Jordan Environment Protection Fund,	☐ Tangible experience of incentive programs ☐ Availability of highly trained Jordanian engineers	▪ No. of incentive program options ▪ % increase in users due to the economic viability of the systems ▪ Number of beneficiary

									minis-tries	Jordan Renew-able Energy and Energy Ef-ficiency Fund (JREEEF)		▪ sectors bene-fited. ▪ Number of new benefi-ciaries / users added within certain time after imple-menting the program ▪ Number of new direct and indirect jobs related to dif-fusion of the technology ▪ % decrease in energy bills of new users
	Establish reliable in-dustries to decrease the cost of systems and in-crease trust among cus-tomers	Private sec-tor	Private sector	Jan. 2019	Sept., 2019	Know-how and tech-nology trans-fer in solar energy fields	Know-how and tech-nol-ogy trans fer in solar en-ergy field	JD 10,000, 000	Private sector	Risks: • Reluctance of private sector to invest • Lower manu-facturing cost of competitors • Unclear long-term tax plan of the govern-ment. Contingency plans:	□ Establish-ment of new indus-tries □ Upgrading of existed industries	□ No. of new factories □ Number of upgraded workshops into facto-ries □ Number of new ben-eficiaries / users

										Start promotion at very early stages of project and put private sector in close coordination with government bodies		added within certain time after implementing the program Number of new direct and indirect jobs related to diffusion of the technology
2- Enforcement of standards	Review standards, regulations and laws	Ministry of energy, environment, JISMO and local experts	Ministry of energy, environment, JISMO and local experts	Jan., 2018	Sept., 2018	Existed	Existed	JD 50,000	International fund with in-kind contribution from local ministries	Risks: • Delay in securing funding • Changing or editing existed standards, regulations and laws during review, which may delay this activity. Contingency plans: Consider local funding sources such	Tangible experience in standards and availability of highly experienced Jordanian engineers	No. of standards, regulation and laws reviewed Number of stakeholders involved Number of experts and local engineers participated

										as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)		
	Hold a conference/gathering for all governmental bodies and concerned parties to discuss current situations and required development and improvements	Ministry of energy, environment, JISMO and local experts	Ministry of energy, environment, JISMO and local experts	Oct., 2018	Jan., 2019	Existed	Existed	JD 25,000	International fund with in-kind contribution from local ministries	<u>Risks:</u> • Delay in securing funding • Delay in stakeholders response. <u>Contingency plans:</u> • Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) • Early coordination during review stage	□ Efficient contribution and response by stakeholders □ Development of methods and options of enforcement	□ No. of standards, regulation and laws agreed to be directly enforced □ No. of standards, regulation and laws agreed to be enforced after certain waivered time □ Number of options suggested for implementation □ Number of stakeholders involved

	Dissemination of solid proposal and documents of enforcement to the concerned governmental bodies	Ministry of energy, environment, JISMO and local experts	Ministry of energy, environment, JISMO and local experts	Jan., 2019	Jan., 2019	Existed	Existed	JD 10,000	Local ministries	Risks: • Delay in securing funding • Delay in implementing enforcement. Contingency plans: • Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) • Effective communication and follow up with all concerned stakeholders	□ Efficient implementation of enforcement □	⍰ No. of standards, regulation and laws directly enforced ⍰ No. of standards, regulation and laws after certain waivered time ⍰ Number premises, projects and buildings checked within certain time ⍰ Number of stakeholders involved
3- Focused training programs	Review current training programs	Local experts from universities and private sector	Local experts from universities and private sector	Jan., 2018	June 2018	Existed	Existed	JD 25,000	International and/or national fund	Risks: • Delay in securing funding • Changing or editing existed training programs which	□ Tangible experience in standards and availability of highly experi-	⍰ No. of training programs available ⍰ Number of academic and training

										may delay this activity. Contingency plans: Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)	enced Jordanian engineers	institutions reviewed Number of experts and local engineers available for conducting training programs
	Design and implement a focused comprehensive training programme for technicians and engineers	Local experts from universities and private sector	Local experts from universities and private sector	August 2018	Continuous, but say two years for the sake of budget	Existed	Existed	JD 250,000	International and/or national funding and private sector	Risks: • Delay in securing funding • Delay in stakeholders response • Appearance of new technologies or new systems in the market. Contingency plans: • Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy	Existence of Quality f training programs	No. of training programs No. of technologies considered No. of trainees within certain time No. of institutes reached and cooperated with Number of stakeholders involved

										and Energy Efficiency Fund (JREEEF) • Keep continuous coordination with local and international relevant bodies		
4- Effective awareness programs	Establish demonstration facilities for the public and users	Local experts, universities and concerned ministries	Local experts, universities and concerned ministries	Jan., 2018	June 2019	Existed	Know-how and technology transfer	JD2,000,000	International fund with in-kind contribution from local ministries	<u>Risks:</u> • Delay in securing funding • Delay in licensing and approvals form government. <u>Contingency plans:</u> Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)	□ User friendly and efficient facilities □ Wide base of Target groups and beneficiaries □ How efficient the message is reached	⍰ No. of facilities / technologies considered ⍰ Number of users and beneficiaries used the demonstration facility in certain time ⍰ Number of experts and local engineers involved

	Design and implement an effective awareness program that can reach prospective users	Media agencies in cooperation with ministries	Media agencies in cooperation with ministries	Jan., 2018	Continuous, but say two years for the sake of budget	Existed	Existed	JD500,000	International fund with in-kind contribution from local ministries	<u>Risks:</u> • Delay in securing funding • Delay in stakeholders response • Delay in securing approvals from relevant governmental bodies <u>Contingency plans:</u> • Consider local funding sources such as Jordan Environment Protection Fund, Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) • Keep continuous coordination with relevant stakeholders and governmental bodies	□ professionality of the programs □ Level of dissemination among target groups	□ □ No. of programs □ No. of technologies considered □ No. of target groups reached □ number of stakeholder involved

2.2. Project Ideas for Energy Sector

2.2.1. Brief summary of project ideas for the energy sector

Based on the analyses of barriers and measures conducted in Phase II of the project, the technology action plan has been designed to mitigate GHGs and obtain other socioeconomic benefits. Several actions and activities have been determined accordingly. In achieving TAP's results and goal, certain projects need to be implemented in which activities are considered to turn ideas into realities. As a result, the following three main projects are suggested:

- ***Design financial support mechanisms and subsidizes for solar-powered systems;***
- ***Development of complete process PV industry, from silicon to module; and***
- ***Development of a high-tech comprehensive solar thermal industry; flat, evacuated tube and parabolic trough technologies.***

The following section briefly describes these projects.

2.2.2. Specific Project Ideas

- ***Designing financial support mechanisms and subsidies for solar-powered systems***

Introduction/background

One of the main barriers that still hinders the widespread applications of solar-powered systems in Jordan is the relatively high initial cost. Although several actions in policy, regulations and financing have been taken, many actions still need to be undertaken to incentivise these clean and attractive applications. This should include the three technologies: solar thermal, PV electrification and solar water-pumping

Objectives:

To improve affordability, reduce the cost of the systems and thus increase the penetration of solar-powered systems across the country.

Outputs:

Efficient incentives programs.

Relationship to the country's sustainable development priorities:

Solar-powered systems are clean applications and conform to the economic development orientation of cleaner production and environment. They play a considerable role in GHG mitigation, one of the country's current priorities, as set out in the country's 2015 NDCs and the Jordan Vision 2025. Moreover, dependence on energy imports is reduced, thus contributing to energy security.

Project deliverables:

- Creating an active solar energy market;
- Encouraging the development of solar-powered projects;
- Bringing important economic, social and environmental benefits.

Project scope and possible implementation:

Feasibility studies have already proved the viability of solar-powered systems. The existence of incentives and subsidies programs will lessen the high initial cost effect and encourage users to install these systems. This in its turn may encourage internal and external investors to participate actively in business transactions in the country. Eventually, this will contribute to mitigating GHG emissions.

Project activities:

- Review current regulations and incentives programs;
- Review international success stories;
- Determine relevant stakeholders and experts and invite them to share ideas; and
- Design the program in close collaboration with the ministries concerned and the relevant private sector.

Timelines:

One year during 2018

Budget/resource requirements:

Estimated budget: JD 250,000, to be funded from global funds such GCF and other international donors with in-kind local contribution.

Measurement/evaluation:

The main indicator for evaluation can be measured by comparing the increase in the penetration rate over a year after implementing the project, in comparison to the year before.

Possible complications/challenges:

Funding is the main challenge facing this project, since without funding it will be difficult to implement projects and achieve goals.

Responsibilities and coordination:

Ministry of Energy and Mineral Resources, Ministry of Environment and local experts.

- ***Development of complete process PV industry, from silicon to module***

Introduction/background:

In Jordan there is only one assembly factory importing wafers and assembling them into modules. This project suggests that a complete process factory should be established that starts from the raw material silicon needed to the cell (an abundant local resource) to the module.

Objectives:

To build local capacities, utilize local resources, decrease dependence on imported products and increase the penetration of solar-powered systems among the country.

Outputs:

PV industry and ready-to-use products.

Relationship to the country's sustainable development priorities:

Supporting the widespread utilization of PV increases the share of renewable energy and reduces fossil fuel dependency are all in line with Jordan's sustainable development priorities. . Solar-powered systems are clean applications and conform to the economic development orientation towards cleaner production and a cleaner environment. They play a considerable role in GHG mitigation, one of the country's current priorities as set out in the Jordan Vision 2025 and NDC 2015. Moreover, dependence on energy imports is reduced, thus contributing to energy security.

Project deliverables:

Develop solar cell industry and utilize the abundant silicon resources in the country.

Project scope and possible implementation:

Local industries will increase trust among users and investors. This in turn will increase local implementation and export opportunities in the region.

Project activities:

- Feasibility studies;
- Review international providers of turn-key PV factories;
- Licensing;
- Funding;
- Tendering;
- Building and operating the factory.

Timelines:

Two years during 2018 and 2019

Budget/resource requirements:

Estimated budget: JD 20,000,000, to be funded by banks and investors.

Measurement/evaluation

Ratio of market sales values to factory maximum capacity is a direct indicator of the success of the project.

Possible complications/challenges:

Financing and competition, especially from Chinese manufacturers.

Responsibilities and coordination:

Private sector

- ***Development of a high-tech comprehensive solar thermal industry; flat plate, evacuated tube and parabolic trough technologies***

Introduction/background:

In Jordan, the solar thermal industry is very primitive. Only one type of flat-plate solar collector is manufactured from steel. This technology has a lower efficiency than copper or aluminium and would not pass international certification standards such as the key mark that is required to export to Europe.

Evacuated tube and parabolic trough industries have not existed thus far locally. Penetration of solar water-heating systems has decreased from 20% to 12% due to the mistrust of users, especially after importing low-quality products.

Objectives:

To build local capacities, provide reliable systems and increase the penetration of solar-powered systems across the country.

Outputs:

Three types of solar thermal industries

Relationship to the country's sustainable development priorities:

Supporting the wide utilization of solar thermal applications increases the share of renewable energy and reduces fossil fuel dependency. Solar-powered systems are clean applications and conform to the economic development orientation towards cleaner production and a cleaner environment. They play a considerable role in GHG mitigation, one of country current priorities. Moreover, dependence on energy imports is reduced, thus contributing to energy security.

Project deliverables:

Technology transfer, capacity-building and develop three types of solar thermal industries.

Project scope and possible implementation:

Establishing local industries will increase trust among users and investors due to the ease of maintenance and the availability of spare parts. This in turn will increase local implementation and export opportunities to the region.

Project activities:

- Feasibility studies;
- Review international providers of turn-key solar thermal factories;
- Licensing;
- Funding;
- Tendering;
- Building and operating the factory.
-

Timelines:

Two years during 2018 and 2019

Budget/resource requirements:

Estimated budget: JD 5,000,000, to be funded from banks and investors.

Measurement/Evaluation

Ratio of market sales values to factory maximum capacity is a direct indicator of the success of the project.

Possible complications/challenges:

Lack of financial resources and opportunities, and competition, especially from Chinese factories

Responsibilities and coordination:

Private sector plays a major role in the establishment and operation of this project. However, the role of government bodies will be very important in facilitating the setting up of the project.

3. TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR TRANSPORT SECTOR

3.1. TAP for Transport Sector

3.1.1. Transport sector overview

The transport sector in Jordan is a major player in the country's economy, accounting for about 12% of GDP and employing about 10% of the workforce (TNC, 2014).[6] Land transport, in the form of the road network, is the predominant mode for passenger and freight transport in the country. The only seaport at Aqaba city, the two railway systems, the vast road networks totaling approximately 7200 km and the three international airports in the country are the major components of Jordan's transport system.

According to the MOT Annual Report 2012, the road network in Jordan is well developed, as there are 4,600 km of primary paved roads composed of main and side paved roads and 2,607 km of rural roads. There are around 7200 km of paved roads and highways in the Kingdom (TNC 2014).[7] Among the main problems in Jordan are the traffic accidents due to a lack of developed policies and infrastructure. In 2016, 144,521 traffic accidents occurred in the Kingdom, resulting in 750 deaths and 1841 serious injuries, together with 15,594 minor injuries, with an estimated cost of 323 million JD (Annual Traffic Accidents Report 2016).

In 2002, the Ministry of Public Works and Housing started carrying out its 25-year plan aimed at completing an extensive road network around the Kingdom. This includes building ring roads around major cities and development areas such as Amman, Salt and Irbid. According to Jordan's Third Competitiveness Report (2012),[8] investments in road improvements and road development are expected to reach more than USD 1.8 billion within the coming 25 years.

The Jordanian government has also drawn up a Railway Master Plan to build an entirely new standard-gauge railway network. The existing railway network in Jordan consists of 620 km of narrow-gauge tracks, operated by the Jordan Hejaz Railway, with 217 km of operational lines and 111 km of abandoned lines. It used to run two passenger trains per week between Amman and Damascus and freight trains upon request. The Aqaba Railway Corporation, with 293 km of operational lines, transports around three million tons of phosphate from the mines to Aqaba Port (Jordan's Third Competitiveness Report, 2012).[9]

All governorates and cities in the country are connected through the national road network, which also provides links to neighboring countries. According to Jordan's Third Competiveness Report (2012), for a capital city Amman has one of the lowest public transportation mode share ratios in the world, at 11.1%. It is assumed that not many changes will occur within the transport sector in Jordan in the coming few years; road transport will continue to be the main mode of transport, and public transport will continue at a low level, given the absence of railway transport and inefficient traffic management.

Based on TNC (2014) GHGs assessments, transport consumes about 39% of overall energy use, with passenger cars accounting for around 57% of this, and it contributes a large share of air emissions (estimated by the World Bank's Country Environmental Assessment at 80% for NOx, 20% for SOx and 40% for TSP).

As Figure 3.1 below illustrates, energy-related activities (including transport, which accounts for 16% of the energy total) produce the dominant share of GHG emissions in Jordan, totaling 73%, followed by very similar percentages for both waste and industrial activities, totaling 10% and 9% respectively. Activities from agriculture and LULUCF have the lowest percentages, also very similar, of 5% and 3.% respectively (Jordan INDCs, 2015[10]).

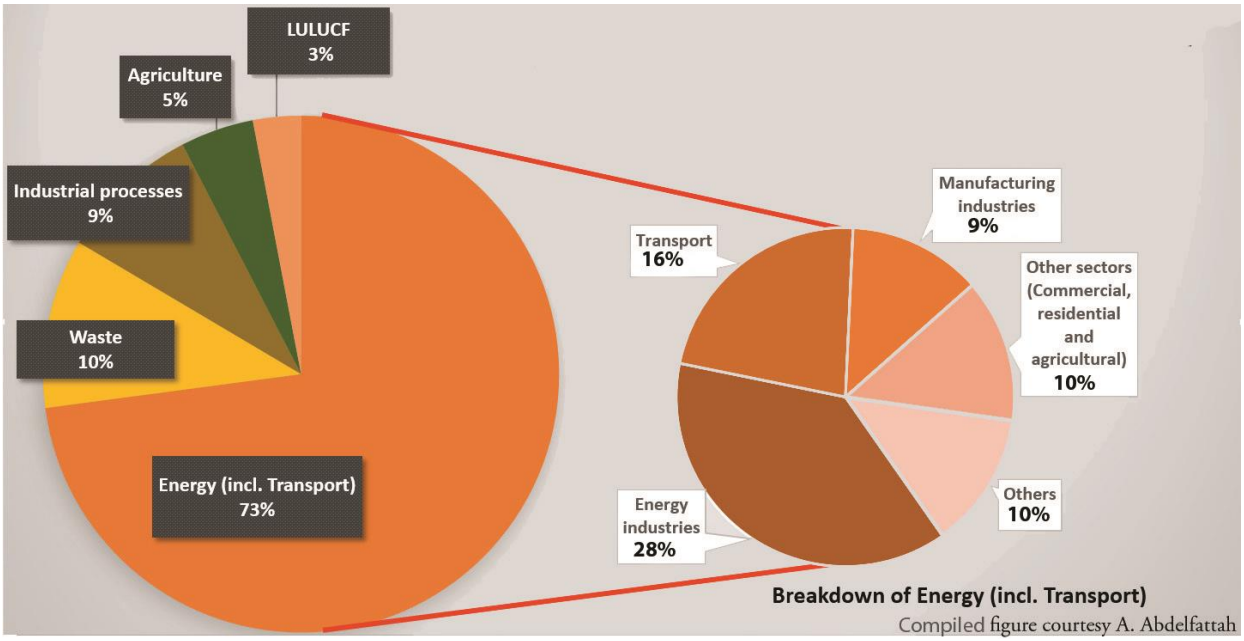

FIGURE 1. JORDAN'S GREENHOUSE GAS EMISSIONS BY SECTORS IN 2006. TRANSPORT PROCESSES ARE A MAIN CONTRIBUTOR TO ENERGY CONSUMPTION AND EMISSIONS IN THE COUNTRY.

The Land Transportation Regulatory Commission regulates the land transport sector by defining routes, issuing permissions and controlling the operations of the entire sector in Jordan. In addition, transportation within cities, especially by small cars (services and taxis), have their own regulations and are mostly controlled by the municipalities. In 2014, the Ministry of Transport (MoT) released its long-term national strategy, focusing on sustainable transport as one of its pillars. Thus, a widely shared goal among transport policy-makers in Jordan is the mobility of people and freight, meaning that the MoT is obliged to configure its policies in line with sustainable transport trends. Increasing the total number of commuters using public transport as a percentage of the total number is one of the major objectives of the MoT's long-term transport strategy. In 2010 this percentage in 2010 stood only at 13%, of which 9% were taxis. It is anticipated that this percentage can be increased by implementing programs and projects to enhance the quality of service of the whole public transport system to 25 percent by 2025 (MoT Strategy 2014).

In this regard, the environmental sustainability of Jordan's transport strategies is focused on three main aspects, namely emissions, energy consumption and reducing traffic congestion. The MoT believes it is important to reduce all emissions from the transport sector. The Ministry will also work on reducing specific fuel consumption, which might be achieved through the implementation of the transport strategy. With regard to reductions in traffic, the Ministry will endeavor to reduce the vehicle-km (V-km) rate at the national level, especially in densely populated areas, by type of vehicle (i.e. car, HGV and LGV, as expressed in 1000 v-km per day). The MoT believes that introducing higher order public transit systems such as bus rapid transit (BRT) is key to improving transportation services in the country. The MoT is already taking on the Zarqa- Amman project, which is to be linked to the Amman BRT system, already being implemented. Initial steps are being taken to tackle other probable viable routes, including Salt-Sweileh-Baqaa (INDCs, 2015[11]).

According to the sector's strategy for 2014, serious measures are being taken to introduce a national railway system as a cornerstone of the planned multimodal network, which would play a major role in easing the transport of goods within the country and the surrounding region. With such a system in place, reductions of emissions from these activities can be achieved. The MoT believes that utilizing the latest technology in the transit sector can add to the efficiency of operations. Introducing applications that connect taxis to customers, for instance, can limit idle time, thus reducing energy usage and thereby

reducing emissions. Acquiring accurate data for passenger origins and destinations can pave the way to better route planning, thereby increasing rideability and shortening trip distances. Moreover, the MoT is attempting to increase transport sector rideability. Adopting and implementing policies related to fleet characteristics would also enhance efficiency and reduce emissions. Issues related to fleet service life, replacement incentives and reconfigurations of technical elements will have a positive effect on energy consumption, thus reducing CO_2 and other greenhouse gas emissions.

Transport is a precondition for economic development. It cannot, by itself, create growth, but there will be no development if the country does not have good connections with the region and the rest of the world. A well-developed transport network can positively affect the country's productivity and competitiveness, giving it potential leverage in increasing international trade in the context of a global economy. At the same time, transport is influenced by the country's economy. Economic growth increases transport demand, not only in terms of trade and passenger volumes, but also of distance travelled by goods and passengers. Moreover, transport is an important sector in the Jordan economy in respect of employment, turnover and investments.

Transport supply needs to be continuously adapted to meet the changes occurring in transport demand and travel behaviour, otherwise the result will be an increasing number of negative effects, like cost increases, greater congestion, lack of reliability, etc. Thus the transport sector, instead of playing a major positive role in the growth of the economy, will become an obstacle to the country's development. To that end, in the past few years Jordan has formulated a number of different policies within the transport sector. This applies, for instance, to the trade and transport facilitation program, which addresses the integration of the country into the global economy, as well as to public transport and road freight. Nonetheless there is still a long way to go in order to guarantee the country, and the region, a seamless supply of transport that is genuinely capable of supporting the local and regional economy and easing citizens' lives.

3.1.2. Action plan for the three transport sector technologies: Bus Rapid Transit, Ticketing System, and Pedestrian Infrastructure

3.1.2.1. Introduction

Making progress with public transport (PT) in Jordan is a crucial part of the solution to the nation's economic, energy and environmental challenges, thus helping to bring about a better quality of life. As the numbers of people using public transport increases, local communities are expanding public transit needs. Every segment of Jordanian society – individuals, families, communities and businesses – would benefit from improvements to public transportation.

Transport is a precondition for economic development. It cannot create growth by itself, but there will be no development if the country lacks good connections with the region and the rest of the world. For example, as a capital city Amman has one of the lowest public transportation mode share ratios in the world, at 11.1%. It is assumed that not many changes will occur within the transport sector in Jordan in the coming few years. Road transport will continue to be the main mode of transport, and public transportation will continue at a low level, given the absence of railway transport and inefficient traffic management (Jordan's Third Competiveness Report, 2012).

Making progress with public transport would reduce energy consumption and harmful carbon dioxide (CO_2) greenhouse gas emissions that damage the environment, as well as other particles that harm human health, such as Black Carbon. Commuting using public transport consumes less energy and produces less pollution than comparable travel in private vehicles. In order to achieve progress in the reduction of dependence on foreign fossil fuels and their impact on climate change, public transport must be taken in

consideration as a major part of the solution. Moreover, public transport use is an important measure for the transport sector to mitigate its emissions, there being several technologies and modes of transport that could be integrated together to provide a more efficient system and enable more people to reach their destinations.

Technologies related to the public transport sector are aimed at improving the quality and the attractiveness of PT services. As mentioned in previous TNA Reports, stakeholders agreed that the three top priority technologies are *Bus Rapid Transit*, *Ticketing System* and *Pedestrian Infrastructure*, all of which could be considered under the public transport measure. Whereas, after the last meeting with stakeholders to draw up the action plan report, it was agreed that the plan should be a single integrated plan to improve public transport in Jordan that includes all of the priority technologies bundled together. An overview of each technology is provided below.

Bus Rapid Transit (BRT)

BRT has increasingly been used as a public transport technology to provide a faster, higher capacity bus service. BRTs require dedicated lanes, off-road stops, rapid boarding and alighting, level boarding, pre-board fair collection or checking, frequent services, large capacity, clear signage and real-time information displays. Moreover, they also require clean engine technologies, signal priorities, intelligent control systems and excellent customer service. In one dedicated BRT lane 10-20,000 passengers can be carried, with some carrying over 40,000 (Climate Techwiki, Mass Transit Fact Sheet).

Ticketing System

The ticketing system is an important public transport organizer tool for the implementation of a pricing policy that takes operational, commercial and social objectives into account. The ticketing system translates fares into concrete means of payment (for the passenger) and fare collection (for the operator).

Pedestrian Infrastructure

Jordan's pedestrian infrastructure has not yet received adequate attention in transport planning: several walkways are packed with trees and bushes, many are not wide enough for pedestrians, and many streets do not have pedestrian walkways in the first place. This is the case not only for the parts of the country with poor and weak infrastructure but also to affluent neighborhoods of Amman.

3.1.2.2. Ambition for the transport sector TAP

It was decided that the ambition for the TAP of the transport sector's' three priority technologies would be drawn up in conformity with the country's national agenda. The Land Transport Regularity Commission (LTRC) has developed an action plan to improve public transportation under the "Jordan Long Term National Transport Strategy and Action Plan" for 2014-2018. In that sense, the transport sector's stakeholders have agreed to build on what has been achieved, as well as on the highest priority technologies that mitigate climate change. Below, Table 4 shows the plan mentioned in the Long Term National Transport Strategy and Action Plan of Jordan.

TABLE 4. JORDAN LONG-TERM NATIONAL TRANSPORT STRATEGY AND ACTION PLAN

Bus services to be operated according to a timetable and with intermediate stops	**Type:** Service **Responsibility:** LTRC, Ministry of Transport	**Cost (Million JD) and time frame**					**Res. allocated**
		2014	**2015**	**2016**	**2017**	**2018**	
		0.2	0.2	0.5	0.5		✓ General budget
Detailed planning stage for national and local public transport networks	**KPI:** See following table						

New bus network, as proposed by the LTRC Jordan Bus Restructuring Interim Master Plan, with a hierarchical and integrated structure of services	**Type:** Service **Responsibility:** LTRC, Ministry of Transport, GAM, ASEZA	**Cost (Million JD) and time frame**					**Res. allocated**
		2014	**2015**	**2016**	**2017**	**2018**	
		N/Ap.	N/Ap.	N/Ap.	N/Ap.	N/Ap.	
Planning stage: Level 1 - Premium Inter City network	**KPI:** Project completion (100% within 2015)						
Implementation stage: Level 1 - Premium Inter City network	**KPI:** Restructured bus-km/pax-km (100% in 2017)						
Planning stage: Level 2 - Core National network	**KPI:** Project completion (100% within 2015)						
Implementation stage: Level 2 - Core National network	**KPI:** Restructured bus-km/pax-km (100% within 2017)						
Planning stage: Level 3 - Other Inter Governorate services	**KPI:** Projects completion (50% within 2015; 100% within 2017)						
Implementation stage: Level 3 - Other Inter Governorate services	**KPI:** Restructured bus-km/pax-km (50% within 2017; 75% within 2018)						
Planning stage: Level 4 - Intra Governorate services	**KPI:** Projects completion (35% within 2015; 100% within 2017)						
Implementation stage: Level 4 - Intra Governorate services	**KPI:** Restructured bus-km/pax-km (35% within 2017; 50% within 2018)						

Source: Jordan Long-Term National Transport Strategy and Action Plan (2014).

Based on that, the stakeholders identified and prioritized a set of actions and activities that build on the provisions of the national transport strategy. Below are the outcomes of this process.

3.1.2.3. Actions and activities selected for inclusion in the transport sector TAP

One major barrier in the current regulations which prevents would-be passengers from using public transport is the irregular scheduling of jouneys due to the huge uncontrolled private ownership of public transport in the country. The main measure that has been identified to overcome this barrier is to draw up regulations that incentivize users of public transport by introducing strict schedules and managing modes of public transport as an alternative to the current situation of unorganized scheduling controlled by individual operators.

Deciding on a strategic rehabilitation plan for the main streets in Jordan to overcome the lack of standardizatioon of streets, especially those which will have lanes for the BRT as a way of developing street infrastructure, is a national priority in develop the public transport sector. Allocating roles between stakeholders and institutionalizing them will strengthen networking among stakeholders from the regulatory, planning and implementing institutes.

Other measures include improving the quality of services by organizing a capacity-building program for drivers and operators and organizing a widespread awareness campaign to incentivize users and potential users of public transport. Most importantly, developing new academic and graduate programs to produce new generations of skilled engineers in this under-staffed sector is a crucial priority.

Actions selected for inclusion in the TAP

Actions related to policies and infrastructure:

- Set regulations that incentivize users of public transport;
- Draw up a strategic rehabilitation plan for the main streets that will contains lanes for the BRT.

Actions related to capacity and awareness:

- Allocate roles between stakeholders and institutionalize them, instead of leaving them to be based on ad-hoc actions. This implies distributing the tasks between the stakeholders and allocating a leading institution;
- Organize a capacity-building program for drivers and operators;
- Organize widespread awareness campaigns to incentivize users and potential users of public transport;
- Developing new academic and graduate programs to produce new generations of skilled engineers in this under-staffed sector is a crucial priority;
- Improve the quality of existing public transport prior to construction of the BRT infrastructure, paying attention to the public awareness.
- Improve the quality of safety measures in order to promote public transport and studies relating to points and hotspots to increase safety in the streets and find a solution to solving these.

Activities identified for the implementation of selected actions

Regulations that incentivize users and potential users of public transport can be implemented by subsidizing public transport for different segments of users, such as the elderly, students, the disabled and regular users, as well as regulating rules for pedestrians and setting regulations to consolidate individual operators. As well as regulating the behavior of public transport users, monitoring of the system should be enforced by the government (cameras, special mentors), and a standardization policy for the new modes of public transport should be created.

The Strategic Rehabilitation Plan for the main streets that contain lanes for the BRT can be implemented by developing public transport infrastructure (bus stations, bus stops, information system, ticketing system, bus lanes, etc.) and improving the quality of services through new buses and scheduled trips, for example. Moreover, a general assessment study can be made to select the streets that require BRT with reference to the Ministry of Transport's long-term Action Strategy and GAM's plans, where new plans can be prepared for the other urban cities like Irbid and Zarqa. Also, all BRT lanes should be linkde to sidewalks following international standards, and a study should be carried out to identify the hot spots and increase safety levels in the streets.

Actions taken in order to allocate and institutionalize roles between the stakeholders would include coordinating the street infrastructure among entities, preparing urban master plan studies for cities, specifically Irbid and Zarqa, and setting an institutional framework for a new law for public transport that will define the responsibilities among municipalities, LTRC/MoT, MoWPH and operators to insure a high level of coordination.

Organizing a capacity-building program for drivers and operators would include a capacity-building plan for public transport drivers and operators, setting out the criteria and qualifications for public transport drivers and regulations to compel drivers to participate in such training courses. As part of organizing a wide awareness campaign to incentivize the users and potential users of public transport, an awareness plan can be created to define the topics and identify the gaps to be covered. In addition, the licensing system can be restructured, public transport awareness campaigns can be introduced in schools and a national campaign devised to protect public resources.

3.1.2.4. Stakeholders and timeline for the implementation of TAP

A wide level of participation has led the public and private sectors to share their knowledge and experience to enrich this action plan. The main stakeholders involved are listed below:

Ministry of Transport: the main governmental body responsible for the transport sector. The main roles of this stakeholder will be regulation and infrastructure.

Land Transport Regulatory Commission LTRC: the main regulatory commission that organizes public transport in Jordan.

Greater Amman Municipality: responsible for public transport within its borders, covering the most highly populated areas in Amman.

Boloro Company: a private international company contracted by the goverement to implement some organizational technologies such as a ticketing system. Boloro is the first ever Global Mobile Payments system that allows mobile phone users to pay for physical goods and services using their mobile phone, including transport services and transactions.

Easy Solution For Travel and Transportation Problem Company: a technology solution company based in Jordan which aims to contribute to the development of public transport.

3.1.2.5. Scheduling and sequencing of specific activities

Jordan's Long-Term National Transport Strategy and Action Plan runs until 2018, so the proposed Action Plan will take run from 2018 till 2025. Table 5 below provides an overview of each action and activity timeframe.

3.1.2.6. Estimate of resources needed for action and activities

Estimate of capacity-building needs

Capacity-building for all private transport operators is the most important measure that will help motivate commuters to use public transport. While many people prefer not to use public transport because of the unsuitable behavior of most of the operators, current and the future operators should undertake specific training and qualifications to teach them to behave well to public transport users. Professional experts from countries with a lot of experience of public transport are required to describe their own success in developing public transport in their countries, as well as to review and analyze the barriers and the risk potential. Estimates of the actions needed for capacity-building are illustrated in the overview in Table 5 below.

Estimates of the costs of actions and activities

The total cost of implementing the public development plan is estimated at JD 100,300,000, as illustrated in the overview in Table 5 below.

3.1.2.7. TAP overview table

Table 5 also elaborates and overviews the action plan put forward by Jordan to diffuse and accelerate the deployment and wide dissemination of the transport-sector technologies that the country has prioritized.

TABLE 5. TAP SUMMARY OVERVIEW OF THE ACTION PLAN PUT FORWARD IN JORDAN TO DIFFUSE AND ACCELERATE DEPLOYMENT AND WIDE DISSEMINATION OF BUS RAPID TRANSIT, TICKETING SYSTEM AND PEDESTRIAN INFRASTRUCTURE TECHNOLOGIES

Sector: Transport								
Sub-sector: Public transport								
Technology (Program): Develop public transport								
Aim: increase the percentage of commuters using public transport to 25% by 2025								
Benefits: Decrease the number of Private vehicles and the energy consumed by the transport sector								
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time-frame**	**Risks**	**Criteria of success**	**Indicators for monitoring implementation**	**Budget per activity**
Set regulation that incentivizes users and potential users of public transport	Subsidize public transport regarding following user segments: "elderly, students, disabled, regular users…."	MoF	LTRC/GAM/ MoF	2018 – 2025	Lack of funding	Strong proposal	Low public transport pricing for all segments	40,000,000
	Regulate rules for pedestrians	MoF	MoM, GAM, MoPWH, traffic police	2018 – 2020	Lack of social acceptance	Raise awareness	Decree the private vehicle dependency	50,000
	Consolidate individual operators	Donor country	LTRC, GAM, traffic police	2018 – 2020	Lack of operators, cooperation	Strategic planning	Restructure the operational process	50,000,000
	Regulate behaviour of public transport users	MoF	GAM, LTRC	2018 – 2020	Lack of commitment	Raise awareness	High-quality public transport service	50,000

	Monitoring system enforced by the government (cameras, special mentors….)	MoPIC	GAM, LTRC Traffic Police	2018 – 2020	Lack of funding	Strong coordination	Efficient controlling system	5,000,000
	Standardization policy for new modes of public transport	MoPIC	LTRC/MoT	2018 – 2020	Lack of acceptance from old operators	Enforced policy	Standardized modes of public transport	150,000
Set Strategic Rehabilitation Plan for the main streets that will contain lanes for the BRT	Develop public transport infrastructure (bus stations, bus stops, information system, ticketing system, bus lanes…..)	donor country	MoPWH, GAM	2019 - 2021	Lack of funding	Direct implementation	Well-developed public transport infrastructure	500,000
	Improve the quality of services (new buses, scheduled trips…)	Donor country	LTRC	2019 - 2020	Lack of commitment to policies	Attractive modes of public transport	High-quality public transport services	500,000
	General assessment study to select the streets that need the BRT (utilize updated plans by MOT and GAM and prepare new plans for the other cities of Irbid and Zarqa)	Donor countries	MoT, GAM	2018 - 2019	Lack of experts	Detailed scientific and professional study	Selected streets that need the BRT	100,000

	Associate all of the BRT Lanes with sidewalks following international standards	Donor countries	MoPWH, GAM	2018 - 2022	Lack of funding, poor infrastructure	Including sidewalks during implementation	Safe and reachable sidewalks	1,000,000
	Conduct study to point out the hot spots and increase safety levels in the streets	Sponsors	LTRC	2018 - 2019	Lack of information and records	Enforced regulations	Safe streets, decree the accident ratio	500,000
Allocate and institutionalize roles between stakeholders	Coordinate the implementation and maintenance of street infrastructure between different entities	MoF	Ministry of Public Sector Development MoPSD	2019	Absence of leadership	Standardize street infrastructure	Well implemented street infrastructure	200,000
	Urban Master Plan studies for other cities (Irbid and Zarqa)	MoF	MoM	2018 - 2019	Poor infrastructure unable to fit new technologies	Professional consultants	Urban Master Plan studies for other cities (Irbid and Zarqa)	500,000 Added to plans
	Draw up an institutional framework for new law for public transport that will define the responsibilities among municipalities, LTRC/MoT,	MoF	Ministry of Public Sector Development MoPSD	2019	Absence of leadership	Enforced regulations and policies	High level of coordination	200,000

	MoWPH and operators to insure a high level of coordination.							
Organize capacity-building program for drivers and operators	Capacity-building plan for public transport drivers and operators	Donor country	MoT, LTRC	2019 - 2025	Lack of acceptance by operators; lack of finance	Incentivize the operators to participate	Professional operators and drivers	1,000,000
	Set criteria and qualifications for public transport drivers	LTRC	LTRC	2019	Lack of acceptance by operators	Develop tests for drivers	More people using public transport	50,000
	Set regulations to compel drivers to participate in these training courses	LTRC	LTRC	2019	Lack of acceptance by operators	Incentivize operators to participate	Strict regulations and committed operators	in kind cost
	Build new national capacities to create a body of experts and engineers capable of developing public transport in Jordan	Universities and research institutes	Universities and research institutes	2019	Lack of expert professors	Scholarships with advanced training	Body of public transport experts to allow the government to appoint them instead of juniors	50,000
Organize wide-reaching awareness	Set awareness plan to define topics and identify the gaps to be covered	Donor country	LTRC in cooperation with NGOs	2018 - 2025	Inefficient awareness tools	Strategic planning	Generating awareness of the benefits of public transport	100,000

campaign to incentivize users and potential users of public transport	Restructure the requirements of the licensing system	MoF	LTRC	2018 - 2020	Not accepted by some drivers	Make the test for a licence more difficult	Fewer private vehicles	100,000
	Include awareness of public transport in school curriculums	MoEdu	MoEdu, LTRC	2019	Lack of cooperation with MoEdu	Include awareness of public transport in school curriculums	Generating awareness of the benefits of public transport	50,000
	National Awareness Campaign to conserve public property	Donor country	MoEdu, LTRC	2019	Reaching the targeted segments	Effective awareness campaign	Increase in number of public transport users	200,000

3.2. Project Ideas for the Transport Sector

3.2.1. Brief summary of project ideas for transport sector

The stakeholders in the transport sector held more meetings after the major two-day workshop for the TAP exercise in order to focus on and identify solid actions supporting the realisation of the overall target indicated in the Technology Action Plan for Jordan's Transport Sector. The stakeholders, guided by the team leader, conducted extensive assessments and discussions of the measures identified above in the TAP Section of the Transport Sector in order to come up with the most viable set of project ideas. These will contribute to the transfer, diffusion and deployment targets of the agreed mitigation technologies elaborated above. The team came up with the following package of specific project ideas.

3.2.2. Specific project ideas for the transport sector

Project 1: *Sustainable Transportation Academic/Graduate Programs for Jordan*

Establish New Sustainable Transportation Majors to be added to the Master's programs in Jordanian universities.

Objectives

Build new national capacity to create a body of experts and engineers capable of developing public transport in Jordan.

Outputs

At least three different Master's programs related to sustainable transportation in Jordanian universities.

More than forty Master's certified students and engineers from these majors by 2025.

Relationship to the country's sustainable development priorities

Public transport has received the greatest amount of attention in the Ministry of Transport, and most of the current projects are designed to develop public transportation technologies, one of the main barriers being a lack of local experts and skilled engineers in this capacity.

Project scope and possible implementation

The main aim of this project is to build up a body of national experts and skilled engineers in the field of public transport. The Ministry of Higher Education will be the main ministry responsible for this project.

Project activities

Prepare a group of professional professors to plan for the program and prepare the syllabi.

Cooperate with expert universities from other countries.

Subsidize study fees to incentivize students.

Timelines

2018 to 2025.

Budget/resource requirements

300,000 JOD.

Challenges

Lack of awareness of the importance of these majors. Jordan has a lot of public transport mega projects to which unqualified employees have been appointed.

Selecting the best courses for the programs.

Project 2: ***A new sustainable transport project between Amman and Irbid***

Objectives

Create safe, comfortable and sustainable public transport services between the two major governorates through a rapid bus system.

Outputs

1. Provide sustainable, effective and efficient services of collective public transport between Amman and Irbid;
2. Introduce facilities and services, create an investment environment, support local employment;
3. Reduce accidents and environmental pollution; maintain the road network;
4. Reduce the number of modes of transportation, their operating costs and fuel consumption by providing a single mode to offer the best results at any moment, depending on passenger's immediate needs;
5. Solve the problems of traffic congestion and mass transit passengers security.

Relationship to the country's sustainable development priorities

The aim of this project is to provide public transport between Amman and Irbid in a safe, rapid and efficient service mode, as well as an environmentally sustainable mode of transportation in line with the Long-term Transport Strategy, NDCs and Jordan Vision 2025.

Project Deliverables

Feasibility studies;

Preliminary and detailed designs;

Infrastructure, modern buses and operation.

Project activities

In Jordan such projects usually depend on donor countries or private investor. This particular project it expected to take long time to be implemented, from institutionalizing the implementing institutes and designing and selecting the best technology to selecting the final operators. It is anticipated to be completed through of the following activities:

Fund-raising for the project

Planning and feasibility studies

Tender for construction

Procurement of buses and stations

Implementation; and

Operation

Timelines

Start date 2020

Completion date 2024

Budget/resource requirements

In comparison to similar projects implemented in Jordan and the surrounding countries, the estimated cost will be around JD 120 million (project budget).

Challenges

1. Insufficient budgetary allocations for the project
2. Delay in routine procedures in respect of tendering and construction.

Project 3: ***Modernization of Public Transport Vehicles***

Objectives

Improve the level of public safety and reduce traffic accidents; reduce emissions of exhaust gases from old vehicles; protect the environment; reduce vehicle maintenance costs.

Outputs

1. Minimize the negative socio-economic and environmental effects of the public transport sector;
2. Improve the level of service provided to citizens, encouraging them to use public transport and thus lower the oil import bill;
3. Reduce operational costs for operators in terms of maintenance and extend vehicle life.

Relationship to the country's sustainable development priorities

Renewing the fleet of public transport buses is fundamental to improving quality (comfort

and attractiveness) and safety while also reducing the environmental impacts and fuel consumption. This is all in line with the Long-term Transport Strategy, NDCs and Jordan Vision 2025.

Project activities

Modify regulations in order to reduce public transport operating times in a mor modern fashion and follow up the new technologies.

Enforce the new regulations.

Timelines

Start date: 2018

Completion date: 2020

Budget/resource requirements

1,000,000 JOD

Challenges

1. Inability of the operators to provide the necessary funds for the purchase of new vehicles;
2. Inability of the domestic market to meet the needs of operators in manufacturing buses in a timely fashion.

4. TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR THE WATER SECTOR

4.1. TAP for Water Sector

4.1.1. Water sector overview

The water sector in Jordan has thoroughly revised and updated its master strategy and associated action plans and policies, and in 2016 it enacted the 2016-2025 Water Strategy, which encompassed the following legal documents:

1. National Water Strategy 2016-2025;

2. Water Sector Capital Investment Program (2016-2025);

3. Water Demand Management Policy;

4. Policy for Energy Efficiency and Renewable Energy in the Water Sector;

5. Water Substitution and Re-Use Policy;

6. Water Reallocation Policy;

7. Surface Water Utilization Policy;

8. Groundwater Sustainability Policy;

9. Climate Change Policy for a Resilient Water Sector;

10. Decentralized Wastewater Management Policy; and

11. Action Plan to Reduce Water Sector Losses (Structural Benchmark).

Since there are a huge number of historical legal documents (strategies, policies, action plans, etc.) covering the water sector in Jordan, only the most recently produced documents linked to the *National Water Strategy 2016-2025* and other tied national water sector-related legal documents will be featured in this report.

The role of the sector is defined in the official mandate of the Ministry of Water and Irrigation (MWI), the official body in charge of: the overall development of water resources in the country; overall planning and management; monitoring of the water sector's functions and activities, including drinking and irrigation water supply, wastewater systems and related projects; the formulation of national water strategies, policies, and action plans, including investments programs; research and development; information systems; and the procurement of financial resources. Its role also includes the provision of centralized water-related data, as well as the standardization and consolidation of data.[12]

The climate change vulnerability of the water sector in Jordan has been assessed in detail in the *National Communication Report to UNFCCC* (2014)[13] and more briefly in the *National Climate Change Policy of the Hashemite Kingdom of Jordan 2013-2020*[14] as well as the *National Water Strategy 2016-2025*[15] and its daughter policies, mainly the *Climate Change Policy for a Resilient Water Sector 2016-2025*.[16]

The 3rd National Communication Report to the UNFCCC thoroughly assessed the vulnerability of the water sector to the impacts of climate change and listed the vulnerability aspects and more concrete adaptation measures. This report and previous TNA reports displayed only summaries of the results of the vulnerability assessments and the proposed adaptation measures for the TNA-selected adaptation sectors that

were considered vulnerable to climate change, namely water and agriculture. Full materials and detailed results of the TNC Project with regard to vulnerability assessments are set out in Jordan's TNC 2014.[17]

With regard to vulnerability assessments of specific water resources, and based on a climate trends analysis using CORDEx and RCP 4.5 and 8.5, the main climate hazards that the water sector faces in Jordan are temperature increases, decreases in precipitation, increased incidents of drought and increased evaporation. Climate sensitivity indicators in the water sector were determined to be reduced groundwater recharge, deterioration in groundwater quality, stream flow reductions and increased water demand. Assessment of sensitivity showed that the average sensitivity level is 3.71 (out of 5) and can be classified as *high*. This suggests that the system can be adversely impacted by the climate change hazards being investigated.

Adaptation strategies and measures suggested for the water sector in the TNC 2014 are as follows:[18]

- Rainwater harvesting
- Wastewater treatment
- Desalination
- Increasing efficiency of irrigation technologies
- Grey water reuse
- Public awareness

In addition to the legal documents listed above, the *National Water Strategy 2016-2025*, including the *Climate Change Policy for a Resilient Water Sector*, is now considered the holistic legal document that encompasses all existing water sector-related policies and measures relevant to the sector's development and deployment of technology.

The three priority adaptation technologies selected for the water sector in Jordan based on the TNA report were: *Roof-top Rainwater Harvesting (RWH), Desalination/Brackish Water Treatment and Re-use,* and *Water Users Associations* (*WUAs*). In this project, all descriptions of these technologies, including information elaborated in the fact sheets encompassed in the first report of the TNA project, Jordan's focus was primarily on RWH from residential rooftops for potable and other household uses.

Desalination/brackish water treatment and re-use was classified both as a consumer market technology if procured by individuals – mainly farmers in the Jordan Valley and industry – and a capital good if procured by government institutions and water utilities. The following preliminary objectives for the transfer and diffusion of these technologies were set as: (i) to investigate the potential of augmenting and accelerating desalination in Jordan, since to date desalination has been very limited; (ii) to assess such technologies in light of the fact that purification of seawater or brackish water is expensive, energy-intensive and often has large adverse impacts on ecosystems; and (iii) particularly to assess the cost of energy for desalination in Jordan, which, unlike many of its Arab neighbors, has virtually no indigenous sources of energy.

With regard to reorganizing WUAs and technology, a large number of countries around the world have adopted programs to transfer the management of irrigation systems from government agencies to WUAs or other private-sector entities. Participatory Irrigation Management (PIM) is a key term in the toolbox of current approaches to improve the efficiency and performance of water resource management in countries that will be faced with the issue of water scarcity or problems associated with global and climate change in the foreseeable future. A WUA is a group of individuals who have come together formally and voluntarily for the purposes of cooperatively sharing, managing and conserving a common water resource.[19] The core activity of a WUA is to run the waterworks under its responsibility and to monitor the allocation of water to its members. The key functions of a WUA include operating and maintaining a water

service or structure; managing a water distribution system, including setting tariffs and collecting fees; monitoring water availability and use under conditions of climate uncertainty; providing technical assistance in areas related to water use and irrigation; and resolving conflicts related to water use, among other functions. A WUA is generally run by institutions with experience of collective water management, such as irrigation boards. Where an appropriate national framework is in place (usually a water act/law or irrigation act/law or by-law), a WUA can become an independent legal entity upon application to a higher authority, such as the Ministry of Water and Irrigation (MWI)/Jordan Valley Authority (JVA) in Jordan. The WUA is then able to establish a governing document or constitution, a roster of membership and a bank account.

The e*mpowerment and expansion of WUAs* was classified like other non-market technologies. In such cases the following preliminary objectives for the transfer and diffusion of the technology were set. The first is to assess the potential for transferring the management of irrigation systems from government agencies to water-users associations (WUAs) or other private-sector entities. This aims to improve the efficiency and performance of water resources management in the country in order to cope with the issue of water scarcity and problems associated with climate change. The second objective is to assess the current status of the legal framework of WUAs in Jordan. There still is a widespread need for a clearer legal status, proper controlling legislation and the water rights of WUAs and farmers. Without a clear legal status, WUAs cannot operate properly because they do not know the extent of their responsibilities or the proper supervisor (e.g. the Jordan Valley Authority vs. Jordan Cooperatives Corporation). However, even given the success stories in the establishment of WUAs in Jordan, the tasks transferred to the WUAs remain limited to the distribution of irrigation water to farmers, and there is still a strong need for further empowerment through, among other things, the official re-orientation of the JVA mandate. A draft amendment to the Jordan Valley Development Law is presently under review involving changes to transfer JVA mandates, including retail distribution and network irrigation maintenance, to the WUAs. The said law will allow the JVA to provide a legal umbrella for the establishment and supervision of WUAs. This will also set the legal requirements for the WUAs to collect fees from farmers and thus acquire the right to enforce sanctions related to transferred functions such as illegal water use. Currently, WUAs simply report illegal activities to the JVA and are represented in its sanction committee, thus taking part in the related decision-making. The third objective is to assess the crucial financial sustainability aspects of WUAs and the potential measures to attain economic independence.

4.1.2. Action Plan for Roof-top Rainwater Harvesting Technology

4.1.2.1. Introduction

In rainwater harvesting (RWH), as already noted, the practice is to accumulate and store rainwater for reuse before it reaches the aquifer.[20] As the rooftop is the main catchment area, the amount and quality of rainwater collected depends on the area and type of roofing material. RWH is popular as a household option as the water source is close to people, so it is convenient and requires a minimum of energy to collect it. An added advantage is that users own, maintain and control their own systems without the need to rely on other members of the community or other stakeholders. In this project, the focus in the case of all descriptions of this technology was primarily on RWH from residential rooftops for potable and other household uses, including information elaborated in the fact sheets included in the first report of the TNA project in Jordan.

Roof-top Rainwater Harvesting Technology has been selected as a priority adaptation technology for the water sector in Jordan due to its crucial expected impact on securing a reliable fresh water source, especially in emergency situations in a country like Jordan, which is considered one of the top three water-poor countries in the world. It is also possible to select such technology as a priority technology when

promoting the slogan raised by the leader of the water sector's working group in this project: "*adaptation starts at home*". Moreover, as indicted above RWH is common as a household option, as the water source is close to people, "underneath their feet", so it is convenient and cost effective as minimal energy is needed to harvest water and store it. In the case of this simple and cheap technology, users own, maintain and control their own water systems without the intervention of other community members or other authorities.

RWH contributes to climate change adaptation at the household level primarily by means of two mechanisms: (1) diversification of household water supply; and (2) increased resilience to water quality degradation. It can also reduce the pressure on surface and groundwater resources (e.g. the reservoirs or aquifers used for piped water supply) by decreasing household demand and has been used as a means to recharge groundwater aquifers. Another possible benefit of roof-top RWH is that it can reduce flooding by capturing rooftop run-off during rainstorms. Economic growth in low-income countries is leading to increases in piped water coverage and per capita water use. If safe, reliable piped supplies are available, RWH for non-potable uses can partially offset the increase in household use.

The technology also has some benefits in respect of social development. In many settings, RWH can reduce both the tensions due to a lack of sufficient fresh and clean water and reduce exposure to waterborne pathogens by providing improved potable water quality and higher quality water for other household purposes, including hygiene, bathing and washing. It can also provide significant savings for households, which are sometimes forced to purchase vended or bottled water. The water can also contribute to productive and economic livelihood activities.

Economically speaking, roof-top RWH has an economic value as it provides a further source of water and will save money. It also saves expenditure on alternative water sources and provides job opportunities to water resources architects and engineers, as well as vocational manpower. Not only does it create jobs to support the construction of RWH systems, it also provides training and capacity-building opportunities to practitioners, as well as users and household members.

Apart from its environmental benefits, RWH enhances the availability of drinking water for domestic use and agricultural water for arid and semi-arid areas. Moreover, rainwater harvesting can also enhance groundwater recharge and improve the supply of water. It also reduces over-exploitation of ground and service water with consequent environmental benefits, alleviates water shortages and improves the resilience of communities. Rainwater storage can provide short-term security against periods of low rainfall and the failure or degradation of other water supplies.

4.1.2.2. Ambition for the RWH TAP

It is anticipated that the scale and context of this technology, now under advanced investigation, will include testing the multi-modality of demonstration sites from urban, suburban and rural areas with rainfall rates of over 200 mm/year (three demonstration sites in the north, center and south).

The pilot sites will enable technical, institutional, and regulatory or law enforcement-related assessments and screening studies to be conducted to work out the most appropriate and viable modalities of RWH technology for different types of building in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.).

The TAP for RWH inspired us to propose the establishment of a Regional Green Building Engineering Training Center in Jordan, which will itself be a fully-fledged demonstration green building for the region encompassing RWH technology, among other sustainable building-oriented technologies.

4.1.2.3. Actions and activities selected for inclusion in the RWH TAP

A summary of the barriers and measures to overcome the barriers in respect of roof-top RWH are presented in Table 6 below:

TABLE 6. SUMMARY OF BARRIERS AND MEASURES TO OVERCOME BARRIERS TO ROOF-TOP RWH.

Barrier categories	Identified barriers	Measures to overcome barriers
Economic and financial	• Unconvincing feasibility (payback period) • High cost of installation and maintenance • Need for a promising program of incentives	• Improve payback period • *Adequate program of incentives*: governmental and NGOs' or other institutes' incentives or direct monetary support or soft loans; • *Soft loans: introducing low-interest bank loans* to support purchases mainly of the reservoir; • *Other accompanying economic incentives such as a property tax reduction;* • *Incentives targeting investors in the housing sector* (cuts on sales taxes and other taxes associated with profits from house construction business, which is relatively high in Jordan); • *Governmental and governorate development funds should direct some of their allocations towards RWH support programs*; • *Fair and carefully estimated water utility prices* should be considered to alleviate the impact of cheap water prices in Jordan.
Market conditions	• Inadequate specialized or auxiliary markets • Clear absence of efforts from relevant bodies (MWI, Jordan Engineering Association, contractors' associations, etc.) in creating such underdeveloped markets.	• *Developing and augmenting specialized and auxiliary markets* • *Dedicated efforts and programs need to be developed by relevant bodies (MWI, Engineering Association, contractors' associations, etc.)* to boost creating and augmenting such markets.
Legal and regulatory	• Low compliance of builders of dwellings with RWH directives (building codes)	• *Revise or develop new water efficiency code or by-law to regulate water efficiency aspects, including RWH, and regulate tax cuts and fee deduction incentives.* • *Increasing enforcement of dwellings' builders with RWH directive.*

		• *Assessing the possibility of not granting construction and operating permits (occupational permits) for buildings not containing RWH layouts in the blueprints of such facilities.* • *Well-defined government programs to promote compliance with rainwater harvesting directives and codes*
Human skills	• Shortage of skilful engineers and contractors	• *Develop capacity-building programs targeting engineers and contractors* • *Introduce dedicated educational programs at universities and vocational training institutions*
Information and awareness	• Insufficient awareness of the importance of such simple water-saving technologies. • No household-targeted marketing campaigns	• *Embarking on awareness and information dissemination programs* on the importance of such simple water-saving technologies • *Well-defined government programs to promote compliance with rainwater harvesting directives*
Technical	• Lack of technical assessment and screening studies to identify the most appropriate modality of RWH technology for different types of building settings in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.)	• *Conduct a technical assessment and screening study to figure out the most appropriate modality of RWH technology for different types of building settings in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.)*

Actions selected for inclusion in the roof-top RWH TAP are presented below in Table 7.

TABLE 7. MEASURES SELECTED AS ACTIONS FOR INCLUSION IN RWH TAP.

Categories	**Identified measures to overcome barriers**	**Measures selected as actions for inclusion in RWH TAP**
Economic and financial	1) Feasibility and payback period; (2) Adequate program of incentives; (3) Soft loans: introducing low-interest bank loans; (4) Other accompanying economic incentives such as a	Enhance feasibility and payback period.

	cut in property tax; (5) Incentives targeting investors in housing sector; (6) Governmental and governoratedevelopment funds should direct some of their allocations towards RWH support programs; and (7) Fair and carefully estimated water utility prices	
Market conditions	Developing and augmenting specialized and auxiliary markets. Dedicated efforts and programs need to be developed by relevant bodies (MWI, Engineering Association, contractors' associations, etc.).	Dedicated efforts and programs need to be developed by relevant bodies (MWI, Engineering Association, contractors' associations, etc.).
Legal and regulatory	1) Increasing compliance of housing construction companies with RWH directives (building codes) (2) Assessing the possibility of not granting construction and operating permits (occupational permits) for buildings not containing RWH layouts in the blueprints of such facilities (3) Well-defined government programs to promote compliance with rainwater harvesting directives	Increasing compliance of Housing Construction companies with RWH directive (building codes).
Human skills	(1) Develop capacity-building programs targeting all involved stakeholders, engineers and contractors (2) Introducing dedicated educational programs at universities and vocational training institutions	1) Develop capacity-building programs targeting all involved stakeholders.
Information and awareness	1) Embarking on awareness and information dissemination programs of the importance of such simple water-saving technologies (2) Well-defined government programs to promote compliance with rainwater harvesting directives	Embarking on awareness and information dissemination programs.
Technical	Conduct technical assessments and screening to work	Conduct a technical assessment and screening study to work

	out the most appropriate mode of technology for different types of building (residential single homes, multi-story buildings, single houses, villas, etc.	out the most appropriate mode of RWH technology for different types of building in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.).

Activities identified for the implementation of selected actions are presented in Table 8 below

TABLE 8. SUMMARY OF ACTIONS AND ACTIVITIES FOR IMPLEMENTATION FOR ROOF-TOP RWH TECHNOLOGY ACTION PLAN IN JORDAN.

Summary of Actions Selected for Roof-top RWH technology action plan in Jordan	
Action 1:	• *Revise or develop new water efficiency code or by-law to regulate the water efficiency aspects, including RWH, and regulate tax-cut and fee-deduction incentives; increasing compliance of housing construction companies with RWH directives (building codes).*
Action 2:	*Develop dedicated efforts and programs by relevant bodies (MWI, Engineering Association, contractors' associations, etc.).*
Action 3:	Enhance feasibility and payback period.
Action 4:	*Develop capacity-building programs targeting all involved stakeholders.*
Action 5:	*Embarking on awareness and information dissemination programs.*
Action 6:	Conduct a technical assessment and screening study to work out the most appropriate mode of RWH technology for different types of building in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.).
Activities for action implementation for roof-top RWH technology action plan in Jordan	
	Action 1: *Revise or develop a new water efficiency code or by-law for buildings to regulate the water efficiency aspects, including RWH; regulate incentives, tax cuts and fees deductions aiming at increasing compliance of housing construction companies with roof-top RWH directives (building codes) and enhance feasibility and payback period*.
Activity 1.1	Contract a consulting firm or research institutions to conduct a baseline survey to assess the current building regulatory platform to recommend the best options to *revise or develop a new water efficiency code or by-law for buildings to regulate the water efficiency aspects, including RWH, and to regulate incentives, tax cuts and fees deductions, etc. aimed at* supporting enforcement mechanisms for existing and new building codes. The study should assess the establishment of a package of options of incentives, such as property tax cuts, as well as introducing a local subsidy program in Jordan to provide a financial contribution to housing companies and individuals intending to build a

	RWH system. Where applicable and feasible, this will support, for example, up to 50% of local subsidies and water service providers' discounts.
	Action 2: ***Develop dedicated efforts and programs by relevant bodies (MWI, Jordan Engineering Association, contractor associations, etc.) and embark on awareness and information dissemination programs***
Activity 2.1	Contract a consulting firm to develop a holistic awareness program targeting relevant bodies (MWI, Jordan Engineering Association, contractors' associations, academia and NGOs) to promote and disseminate the importance of RWH practice and enforcing the relevant codes.
	Action 3: ***Develop capacity-building programs targeting all involved stakeholders***
Activity 3.1	Contract a consulting firm or academic institution to develop new training curriculum and capacity-building program for engineers and vocational training centers involving academia and Jordan Engineering Association to build basic and advanced skills of RWH and transfer knowledge of best industry practices, of innovations in materials, etc.
	Action 4: **Conduct a technical assessment and screening study to work out the most appropriate mode of RWH technologies for different types of building in Jordan**
Activity 4.1	Contract a consortium of technical and engineering firms, contractors and academic institutions to conduct a technical assessment and screening study to work out the most appropriate modality of RWH technology for different types of building in Jordan (single-family homes, multi-family housing, including high-rise buildings, apartments, apartment flats, villas, etc.) at three demonstration sites from urban, suburban and rural areas with a rainfall rate above 200 mm/year (three demonstration locations in the north, center and south of Jordan).

- **Actions to be implemented as Project Ideas**

  In fact, the stakeholders involved in the discussions to develop the TAP for roof-top Rain Water Harvesting intend to draw up a full package project of all the actions listed above. The proposal is to promote a holistic approach to remove the barriers to such technologies and ease their deployment and dissemination throughout the country due to its crucial positive impacts.

4.1.2.4. Stakeholders and timeline for implementation of TAP

An overview of the stakeholders involved in implementing the RWH TAP, as well as scheduling and sequencing specific activities, can be found in TAP overview in Table 9 below.

4.1.2.5. Estimate of resources needed for action and activities

Estimates of capacity-building needed in order to carry out actions and activities, and estimates of the costs of actions and activities, are shown in the TAP overview in Table 9 below.

4.1.2.6. Management planning

4.1.2.6.1. Risks and contingency planning

A detailed description of the identified risks and the proposed contingency plans can be found in the TAP overview in Table 9.

4.1.2.6.2. Next steps

The immediate requirements in order to proceed with such an ambitious and promising action plan for roof-top rainwater harvesting technology in Jordan were disseminated to the lead stakeholders, namely the Jordan Green Building Council (JGBC) and the Jordan Engineering Association (JEA), to promote the proposal for this technology. The two organizations were instructed to form a joint committee to review the final draft of the TAP and provide comments and feedback, and, most importantly, to draw up a plan for the next actions. The joint committee will estimate the most precise costs possible for the implementation of TAP, with an emphasis on the infrastructure component of activities, such as the establishment of the proposed regional green and sustainable building engineering training center. The center will consist of a fully-fledged demonstration green building for the region encompassing RWH technologies and other green sustainable building codes and practices. It will also form a design and construction practices training center for water- and energy-efficient green building in order to train engineers and vocational centers in such skills.

TABLE 9. OVERVIEW TABLE FOR ROOF-TOP RAINWATER HARVESTING

TAP overview table for roof-top rainwater harvesting
Sector: Water
Sub-sector: Water efficiency/Rainwater Harvesting
Technology: Roof-top Rainwater Harvesting
Ambition: It is anticipated that the scale and context of this technology, now under advanced investigation, will include testing the multi-modality of demonstration sites from urban, suburban and rural areas with a rainfall rate of over 200 mm/year (three demonstration locations in the north, center and south). The pilot sites will enable the carrying out of assessments and screening studies into technical and engineering, materials, contractors, institutions, regulatory and law enforcement, and building codes monitoring and supervision functions to determine the most appropriate and viable modality of RWH technologies for different types of buildings in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.) and most importantly to fill the gaps with regard to the barriers to enforcing the codes, with an emphasis on the building code monitoring and supervision functions. The TAP for RWH inspired us to propose establishing a Regional Green Building Engineering Training Center in Jordan, which will itself consist of a fully-fledged demonstration green building for the region encompassing RWH technologies, among other sustainable building-oriented technologies.
Benefits: Roof-top Rainwater Harvesting Technology has been selected as a priority adaptation technology in the water sector in Jordan due to its crucial expected impact on ensuring a reliable freshwater source, especially in emergency situations in a country like Jordan, which is considered one of the top three water-poor countries in the world. It is also plausible to select this technology as a priority technology to promote the slogan raised by the leader of the water sector's working group in this project: "*adaptation starts at home*". Moreover, as indicted above RWH is common as a household option, as the water source is close to people, "underneath their feet", and is therefore convenient and cost effective, as it uses minimal energy for harvesting water and storing it. In respect of this simple and cheap technology, users literally own, maintain and control their own water systems without the intervention of other community members or other authorities. RWH contributes to climate change adaptation at the household level primarily through two mechanisms: (1) diversification of household water supplies; and (2) increased resilience to water quality degradation. It can also reduce the pressure on surface and groundwater resources (e.g. the reservoir or aquifer used for the piped water supply) by decreasing household demand and has been used as a means to recharge groundwater aquifers. Another possible benefit of roof-top RWH is that it can reduce flooding by capturing rooftop run-off during rainstorms. RWH can aid climate change adaptation even in the most developed countries. Economic growth in low-income countries leads to increases in piped water coverage and per capita water use. If safe, reliable piped supplies are available, RWH for non-potable uses can partially offset the increase in household use. The technology also has some social development benefits. In many settings, RWH can reduce the tensions due to a lack of enough fresh and clean water, as well as reduce exposure to waterborne pathogens by providing improved potable water quality and higher quality water for other household purposes, including hygiene, bathing and washing. It can provide significant savings for households that are sometimes forced to purchase vended or bottled water. The water can also contribute to productive and economic livelihood purposes.

Economically speaking, roof-top RWH has an economic value as it provides a further source of water and saves money. It also saves expenditure on alternative sources of water and provides job opportunities to water resource architects and engineers, as well as vocational manpower. It not only creates jobs to support the construction of RWH systems, but also provides training and capacity-building opportunities for practitioners, as well as users and households members.
In respect of the environmental benefits, RWH enhances the availability of drinking water for domestic and agricultural use, including water for arid and semi-arid areas. Moreover, rainwater harvesting can enhance groundwater recharge and improve water quantity. It also reduces the over-exploitation of ground and service water with consequent environmental benefits, alleviates water shortages and increases community resilience. Storage of rainwater can provide short-term security against periods of low rainfall and the failure or degradation of other water supplies.

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time-frame	Risks and contingency plans	Success criteria	Indicators for monitoring of implementation	Budget per activity (USD)
Action 1: *Conduct a technical assessment and screening study to identify the most appropriate modality of RWH technology for different types of building in Jordan*	**Activity 1.1:** Contract a consortium of international and local technical and engineering firms, contractors and academic institutions to conduct a technical assessment and screening study to work out the most appropriate mode of RWH technology for different types of building in Jordan by conducting pilot RWH testing and demonstration sites (single-family homes,	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	*Focal point: JGBC/JEA* *Partners: JUST, GAM & MOMA/ Jordanian National Building Council*	□ 2017: Develop project proposal and secure funding □ 2018-2019: Implementation	**Risks:** □ Delay in securing funding beyond 2018. □ Weak coordination between responsible bodies **Contingency plans:** □ Start writing the project proposal and search for funding immediatly □ Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewa-	□ Strong technical and reregulation experience at the five national institutions □ Availability of highly trained Jordanian engineers and contractors	□ Total quantity of roof-top rain water harvested (m^3) □ Number of beneficiaries that have benefited from the study and % increase in willingness to change (entities: engineering, materials, building and housing companies and contractors, institutions, building tax au-	1,500,000

	multi-family housing, including high-rise buildings -- apartments, apartment flats, villas, etc.) at three demonstration sites from urban, suburban and rural areas with a rainfall rate above 200 mm/year (three demonstration locations in the north, center and south of Jordan).				ble Energy and Energy Efficiency Fund (JREEEF) □ Lead focal point to keep strong coordination between responsible bodies		thorities and regulatory and law enforcement, building codes, monitoring supervision functions. □ Number of laws and regulation/codes revised in favour of sustainable (RWH-cantered) buildings □ Number of existing and new buildings deploying RWH technology in light of outcomes of study □ Number of new direct and indirect jobs related to diffusion of the technology	

							% Increase in incomes of sustainable building companies	
	Activity 1.2: Organize a national workshop or showcase celebration event to showcase results of the technical assessment and screening study from the pilot RWH testing and demonstration sites; invite representatives from technical, engineering and materials and building and housing companies and contractors, institutions, building tax authorities and regulatory/law enforcement**,** building codes monitoring and supervision functions to raise their awareness of lessons learned and to fill the gaps in the barriers	JEA and/or JGBC	*JGBC/JEA/JUST/GAM and MOMA/ Jordanian National Building Council*	2019	**Risks:** Failure to secure funding for the showcase celebration event. **Contingency plans:** Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)/JEA/JGBC own budgets	Strong event organization abilities of JEA and JGBC for examples	Number of beneficiaries that have benefited from the study and % increase in willingness to change (entities: engineering and materials, building and housing companies and contractors, institutions, building tax authorities and regulatory/law enforcement, building codes monitoring and supervision functions. Number of laws and regulations or codes revised in	5,000

	to enforcing the codes, with an emphasis on building codes and the monitoring and supervision functions.						favor of sustainable (RWH-cantered) buildings □ Number of existing or new buildings deploying RWH technology in light of outcomes of study □ Number of new direct and indirect jobs related to diffusion of the technology □ % Increase in incomes of sustainable building companies	

***Action 2**: Revise or develop a new water efficiency code or by-law for buildings to regulate water efficiency aspects, including RWH, and regulate incentives, tax cuts and fees deductions aimed at increasing compliance of housing construction companies with roof-top RWH directives (building codes); enhance feasibility and payback period of technology*	**Activity 2.1**: *Contract a consulting firm or research institutions to conduct baseline survey to assess current regulatory platform for buildings and recommend the best options to revise or develop new water efficiency code or by-law for buildings to regulate water efficiency aspects, including RWH, and to regulate incentives, tax cuts and fees deductions, etc. aimed at supporting enforcement mechanisms for existing and new building codes. The study should investigate establishment of a package of options of incentives, such as property tax cuts, as well as introducing a*	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	*JGBC and/or Jordanian National Building Council*	2019	**Risks:** □ Delay in securing funding beyond 2019. □ Weak cooperation from responsible bodies in providing information □ No acceptance by government of financial incentives **Contingency plans:** □ Start writing the project proposal and search for funding immediately □ Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) □ Lead focal point to keep strong coordi-	□ Make available a sufficient number of green building guide-books (codes) □ Could benefit from renewable energy sector regulations and incentives	□ Number of water efficiency codes and by-laws for buildings to regulate water efficiency aspects, including RWH, and regulating incentives, tax cuts and fees deductions, etc., revised in favor of sustainable (RWH-cantered) buildings □ Total quantity of roof-top rain water harvested (m^3) □ Number of beneficiaries that have benefited from the study and % increase in willingness to change (entities: engineering and materials, building and housing	70,000

	local subsidy program in Jordan to provide a financial contribution to housing companies and individuals intending to build an RWH system where applicable and feasible; supporting, for example, up to 50% of local subsidy and water service providers' discount. Activities should include drafting, considering, approving and putting into law the efficiency standard and subsidy program				nation between responsible bodies to guarantee high buy-in of study results and outcomes (incentives)		companies and contractors, institutions, building tax authorities and regulatory and law enforcement, building codes monitoring and supervision functions. □ Number of existing and new buildings deploying RWH technology in light of outcomes of study □ Number of new direct and indirect jobs related to diffusion of the technology □ % Increase in incomes of sustainable building companies	

Action 3: *Develop dedicated efforts and programs from relevant bodies (MWI, Jordan Engineering Association, contractors' association,* ***Jordanian National Building Council****, etc.); embark on awareness and information dissemination programs*	**Activity 3.1:** *Contract specialized communication and awareness program firms to design, develop and conduct a holistic awareness program targeting relevant bodies (MWI, Jordan Engineering Association, contractors' associations, academia and NGOs) to advocate and disseminate the importance of RWH practice and the advantages of enforcing the relevant codes.*	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	*JGBC and/or Jordanian National Building Council*	2019	**Risks:** □ Delay in securing funding beyond 2019 □ Communication and awareness programs not well prepared **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund □ Communication & awareness programs should be well prepared	□ Good experience of local companies in designing such communication and awareness programs	□ Total quantity of roof-top rain water harvested (m^3) □ Number of beneficiaries that have benefited from the study and % increase in willingness to change (entities: engineering and materials, building and housing companies and contractors, institutions, building tax authorities and regulatory/law enforcement, building codes monitoring and supervision functions. □ Number of laws and regulations or codes revised in	350,000

							favor of sustainable (RWH-centered) buildings □ Number of existing and new buildings deploying RWH technology in light of outcomes of study □ Number of new direct and indirect jobs related to diffusion of the technology □ % Increase in incomes of sustainable building companies	
***Action 4**: Establish a regional green building engineering training center as a fully-fledged*	Activity 4.1: *Establish a regional green and sustainable building engineering training center as a fully-fledged demonstration green building for the region encom-*	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	JEA and *Jordanian National Building Council*	2019	**Risks:** □ Delay in securing funding beyond 2019 □ Low buy-in of stakeholders to establish the centre **Contingency plans:**	Good experience in Jordan of green building demonstration sites and guidebooks for "codes"	□ Completion of the center on time	2,500,000

demonstration green building for the region encompassing RWH technology; develop training programs targeting all directly involved stakeholders (engineers, designers, contractors, and vocational training students)	*passing RWH technology, and other green sustainable building codes/practices, including a water (and energy) efficiency, green buildings design and construction practices training center for training engineers and vocational centers to train such skills (the center itself should be a green building)*				□ Start writing the project proposal and searching for funding immediately □ *JEA to keep buy-in high of stakeholders to establish the center*			
	Activity 4.2: Contract a consortium of international and/or national consulting firm(s) and academic institution(s) to develop new training curriculum and capacity-building program (ToT) for engineers and vocational training centers, involving academia	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	JEA and *Jordanian National Building Council*	2020	**Risks:** □ Delay in securing funding beyond 2020 □ Low buy-in of stakeholders in training program development **Contingency plans:** □ Start writing the project proposal and searching for funding immediately	□ Good experience in Jordan of green and sustainable buildings guidebooks for "codes"	□ Number of trainees who have benefited from the center	350,000

	and Jordan Engineering Association to build basic and advanced skills in RWH and transfer international industry best practices, innovation in RWH structures and materials, other innovations, etc.				□ JEA to maintain high buy-in by stakeholders into training program			
	Activity 4.3: Establish accreditation and certification program for engineers and assistant engineers to work on green and sustainable buildings	*Green Climate Fund* (*GCF*) or *Adaptation Fund* (*AF*)	JEA & JGBC/ *Jordanian National Building Council*	2020	**Risks:** □ Delay in securing funding beyond 2020 □ Low buy-in of stakeholders into accreditation and certification program **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ *JEA/JGBC to maintain high buy-in by stakeholders into the accreditation and certification program*	□ Good experience in Jordan in some sustainability accreditation and certification programs	□ Number of trainees who have benefited from the center's accreditation and certification program	500,000

4.1.3. Action Plan for Desalination, Brackish Water Treatment and Re-use Technology

4.1.3.1. Introduction

Desalination is the removal of sodium chloride and other dissolved constituents from seawater, brackish waters, wastewater or contaminated freshwater. Approximately 75 million people worldwide rely on desalination, and that number is expected to grow as freshwater resources become more and more stressed by population growth, and millions more move to coastal cities with inadequate freshwater resources.[21] The purification of brackish and saline water holds out the promise of nearly unlimited water resources for human settlements in both inland and coastal regions. Research and development will continue to make desalination less energy-intensive, more financially competitive and more environmentally benign.

The main reasons why such technology has become a priority in Jordan are summarized below.

- In many settings, desalination processes can provide access to abundant saline waters that have previously been unusable.
- The technology is adequate for current as well as future climate conditions, especially in light of the projections of climate models, which predict a reduction in precipitation rates of up to 15-20% by 2100, which makes every drop of water count.
- The benefits to the environment are evident in the potential of the technology to provide a source of fresh water and thus reduce the stress on other water resources. With regard to its potential for adaptation, the technology reduces the impact of climate change on limited water resources and contributes to boosting the resilience of communities. Desalination can greatly aid climate change adaptation, primarily through diversification of the water supply and resilience to water quality degradation. Diversification of water supply can provide alternative or supplementary sources of water when current water resources are inadequate in quantity or quality. Desalination technologies also provide resilience to the degradation of water quality because they can usually produce very pure water, even from highly contaminated sources. Increasing resilience to reductions in per capita freshwater availability is one of the key challenges of climate change adaptation. Both short-term drought and the longer-term climatic trend towards decreased precipitation can lead to reductions in water availability per capita. As these climatic trends are occurring in parallel with population growth, land-use change and groundwater depletion, rapid decreases in per capita freshwater availability are likely.
- However, the large demand of energy of current desalination processes will contribute to greenhouse gas emissions and could set back climate-change mitigation efforts. Nonetheless there has been incremental progress in desalination technology, resulting in consistent improvements in energy efficiency, durability and decreased operation and maintenance across many technologies. However, new technologies currently in research and development have the potential to result in large improvements.
- Economically speaking, even though the ability to generate economic benefits in respect of the feasibility of technology options is questionable because the costs are high, case by case assessments should be the norm. The technology still provides a good opportunity to create a well-established desalination industry if enough qualified manpower exists. Water companies will be urged to recruit qualified staff, thus providing a good number of job opportunities. There are good opportunities for investment in small- to medium-scale projects in small countries like Jordan with limited energy resources. Thus, the technology may pave the way for a large market potential since Jordan has considerable resources of brackish water. There is therefore considerable scope for both RO and EDR plants in the future, though the market potential still has some limitations for reasons given in the BA&EF Report.

- With regard to the social benefits, the technology will provide incomes to investors and provide training opportunities as well as research programs. Access to an adequate supply of freshwater for drinking, household, commercial and industrial use is essential for health, well-being and economic development.[22]
- Thus, the opportunities this technology provides to Jordan are:
  - Access to a nearly unlimited water resource.
  - The best opportunities for implementation are in water sectors that are functioning well, have a well-defined water policy and well-defined water resource availability and demand, with technical expertise and relatively little waste and inefficiency.
- Opportunities for desalination are greatest when:
  - Freshwater resources are inadequate to meet demand (water stress or water scarcity)
  - For membrane systems, where an abundant source of brackish water with low salt and TDS concentrations is available; or for thermal systems, where the population is located on a coastline with an adjacent facility (e.g., a power plant) that yields abundant waste heat
  - Consumers are opposed to the reuse of treated wastewater

- According to analysis conducted in Jordan, desalination is the most appropriate option for Jordan to adopt to alleviate its water scarcity and overcome its water budget deficit. Yet even this is not commercially viable for Middle Eastern agriculture at present. Perhaps a generation from now we will possess an economical technology for the mass desalination of water.[23]
- Jordan has considerable resources of brackish water. There is therefore considerable scope for both RO and EDR plants in the future.
- Studies and projects were carried out to evaluate the feasibility of water desalination in Jordan. Some of the proposed actions focused on utilizing the water in the Gulf of Aqaba for water supply and desalination to supply major industries.

This is why, all in all, some researchers have called the potential for desalination in Jordan the only realistic hope.[24]

4.1.3.2. Ambition for the Desalination/Brackish Water Treatment and Re-use technology TAP

Because investments in such technologies require large capital outlays, the scale for the potential diffusion of this technology based on the outcomes of the TNA project will be confined to a pilot site of promising readiness, preferably for the authorities in charge (WAJ) to augment such technologies. The aim will be to draw up a plan for the installation of a desalination plant for a site in western Jordan close to the Jordan Valley (the southern Jordan Valley), specifically in the Al Husban Well Field. This has four groundwater wells in the Dead Sea Groundwater Basin with a capacity of 3-3.5 MCM/year, utilized for drinking water supply to Amman and the local area.

The measures to be tested in the pilot site, such as utilizing renewable energy sources, will aim at identifying cost reduction alternatives to facilitate technological upscaling in the country.

4.1.3.3. Actions and activities selected for inclusion in the Desalination/Brackish Water Treatment and Re-use Technology TAP

Summary of barriers and measures to overcome barriers to the Desalination/Brackish Water Treatment and Re-use Technology are presented in Table 10 below.

TABLE 10. SUMMARY OF BARRIERS AND MEASURES TO OVERCOME BARRIERS TO DESALINATION/BRACKISH WATER TREATMENT AND RE-USE TECHNOLOGY

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	• **High investment cost**: the cost of a major desalination plant processing 1/4 billion m^3 /year is $1 billion. • Absence of a viable costing mechanism (costs must be decided in relation to the product output per m^3 of water used in agriculture (volume of water consumed per US$ of agricultural output). • Absence of directives to provide incentives to locally produced desalination units, specially spare parts.	• ***Promoting reasonable system prices in terms of both capital and operating costs through cost-effective desalination units integrated with energy solution (such as solar energy)*** to avoid long-distance transportation of pumped desalted water; • ***Developing new directives to provide incentives to promote locally produced desalination units***, specially spare parts. • ***Reducing costs through technologies that require less feed water pre-treatment***; • Costs may be reduced by ***training enough skilled workers and developing educational programs and vocational training centers*** in such fields; • ***Securing more international funding support***. • ***Encouraging salt-tolerant crops*** to take advantage of water available from desalination plants (e.g. Triticale “X Triticosecale Wittmack”)
Market conditions	• No support to locally manufactured units (their manufacture in Jordan is still expensive compared to imports)	• ***Support to locally assembled and manufactured units***

Legal and regulatory	• Absence of regulations for installation of licensed desalination units to control inappropriate and illegal disposal of waste water; • Absence of regulations to provide incentives to produce desalination units locally.	• ***Enact regulations to support the establishment of desalination in coastal areas*** since waste could be disposed into water bodies, compared to the highlands and Jordan Valley areas, where the reject is harder to deal with. • ***Directives should provide incentives to produce desalination units locally*** and grant customs tax waivers for spare parts and not only main units.
Human skills	• Jordan's experience in brackish water desalination has been fairly limited; • Limited skilled workforce; limited educational programs and vocational training centers.	• ***Training enough skilled workers; developing educational programs and vocational training centers*** with an emphasis on acquiring the skills and know-how to deal with the reject. • ***Research Programs on Desalination***
Information and awareness	• Limited awareness efforts on the importance of such technology and its potential in Jordan.	• ***Targeted awareness programs*** on the importance of such technology and its potential in Jordan.
Technical	• The major technical drawback of current desalination processes is their environmental impacts (disposal of the concentrated waste stream or brines) and the impact of intakes and outfalls on local ecosystems. • Clear shortage in skilled taskforce to deal with the waste and dispose it based on industry best practices. • In the case of seawater, Jordan has a very short shoreline on the Gulf of Aqaba, which is very distant from the main centers of population. This is further aggravated by the fact that these centers of population are at	• ***Promoting technologies with less environmental impact***, which produce less concentrated waste streams and minimize the effects of intakes and outfalls on local ecosystems. • ***Reducing impact of disposal of the brine and exploring the potential for using new techniques, such as solar power, to evaporate reject and dispose of salts correctly*** • ***Promoting integrated solution, such as, in the case of applications in agriculture, promoting the planting of salt-tolerant crops such as Triticale***; • Develop and identify technologies that require less feed water pre-treatment; • Due to the topography of the country and the distance between these ***scattered resources,***

	high elevations, and would therefore involve high pumping costs. The water also has to be transported 350 km to Amman and even further to other areas. The brackish water in Ghore is less costly than that from Aqaba, but it needs to be transported 45 km and pumped from 400 to 1000 (1400) m of static head. • Difficulties in exploiting the brackish water sources distributed all over the country due to the topography of the country, the distance between these scattered resources, and the need for special treatment to remove some types of chemicals, such as manganese, sulfates and iron, as well as gases such as hydrogen sulfide • The large energy demands of current desalination processes will contribute to greenhouse gas emissions	***such sources can supply desalted water for small communities by using solar energy and/or wind power*** • ***Exposure to regional and international experience*** in this regard and exploring industry best practices in the field of desalination, for example, the use of evaporators, especially those that do not imply additional cost

Actions selected for inclusion in the Desalination/Brackish Water Treatment and Re-use Technology TAP are presented below in Table 11.

TABLE 11. MEASURES SELECTED AS ACTIONS FOR INCLUSION IN DESALINATION/BRACKISH WATER TREATMENT AND RE-USE TECHNOLOGY TAP

Categories	Identified measures to overcome barriers	Measures selected as actions for inclusion in TAP and score
Economic and financial	***(1) Promoting reasonable system prices for capital and operating costs through cost-effective desalination units in-***	***Promoting reasonable system prices in respect of both capital and operating costs through cost-effective desalination units integrated with energy***

	tegrated with energy solutions (such as solar energy); (2) ***Developing new directives to provide incentives to produce desalination units locally*** (3) ***Reducing costs through technologies that require less feed water pre-treatment***; (4) ***training enough skilled workers; developing educational programs and vocational training centers; and*** (5) ***support to locally manufactured units.*** ***Also encouraging the planting of salt-tolerant crops*** to take advantage of water available from desalination plants ***(***	***solutions (such as solar energy)***.
Legal and regulatory	*1)* ***Directives should encourage desalination in coastal areas;*** (2) ***directives should provide incentives to produce and assemble desalination units locally***	***Directives should provide incentives to produce and assemble desalination units locally.***
Human skills	***Training enough skilled workers; developing educational programs and vocational training centers***	***Training enough skilled workers; developing educational programs and vocational training centers.***
Information and awareness	***Targeted awareness programs***	
Technical	(1) ***Promoting technologies of less environmental impact;*** (2) ***reducing impact of disposal of brine and exploring potential of using new techniques, such as solar power, to evaporate reject and dispose of salts correctly;*** (3) ***promoting integrated solutions, such as, in the case of applications in agriculture, promoting the planting of salt-tolerant crops such as Triticale;*** (4) ***scattered resources to supply desalted water for small communities by using solar energy and/or wind power*** (5); ***exposure to***	***Promoting technologies with less environmental impact.***

	regional and international experience	

- The activities that have been identified for the implementation of selected actions are presented in Table 12 below.

TABLE 12. SUMMARY OF ACTIONS AND ACTIVITIES FOR IMPLEMENTATION FOR DESALINATION/BRACKISH WATER TREATMENT AND RE-USE TECHNOLOGY ACTION PLAN IN JORDAN

Summary of Actions Selected for Desalination/Brackish Water Treatment and Re-use technology action plan in Jordan	
Action 1:	***Promoting reasonable system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy)***.
Action 2:	***Directives should provide incentives to produce and assemble desalination units locally.***
Action 3:	***Promoting technologies with less environmental impact.***
Activities for Action implementation	
	Action 1: ***Promoting reasonable system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy)***.
Activity 1.2	Contract a consulting firm to develop and recommend a standard for environmentally friendly technologies aimed specifically at reducing energy consumption
Activity 1.3	Conduct a training program for best practice O&M of new standardized technology above
Activity 1.4	Pilot the new EF technology in Husban Wells as a demonstration activity
Activity 1.5	Monitor and evaluate the pilot project and disseminate its results
	Action 2: ***Promote and provide incentives to produce and assemble desalination units locally.***
Activity 2.1	Contract a consulting firm to study the benefits of supporting locally produced and assembled desalination units in the context of the green economy and national industry, and present the best findings (incentives) as a recommendation
Activity 2.2	Organize a national workshop to raise awareness and showcase the results of the standardized EF technology together with the results of the green economy and national industry. Support studying the best findings (incentives) to increase the awareness of the MoF and Customs Dept. of the importance of climate change adaptation technologies; demonstrating the importance of supporting locally assembled plants by lowering customs and sales taxes (tax and customs exemptions), extended to all relevant parts and spare parts
	Action 3:

	Promoting technologies of less environmental impact.	
Activity 3.1	Contract a consulting firm to identify best practices for handling reject water (brine) based on the best environmentally friendly technologies	

Actions to be implemented as project ideas

It is anticipated that all three actions elaborated above will be packaged into one holistic project idea.

4.1.3.4. Stakeholders and Timeline for Implementation of TAP

An overview of stakeholders for implementation of the Desalination/Brackish Water Treatment and Re-use TAP, and of the scheduling and sequencing of specific activities, can be found in the TAP overview in Table 13 below.

4.1.3.5. Estimate of Resources Needed for Action and Activities

Estimate of capacity-building needs in order to carry out actions and activities, and estimates of the costs of actions and activities can be found in the TAP overview in Table 13 below.

4.1.3.6. Management Planning

A detailed description of the identified risks and proposed contingency plans is elaborated in the TAP overview in Table 13 below.

TABLE 13. OVERVIEW TABLE FOR DESALINATION/BRACKISH WATER TREATMENT AND RE-USE

TAP overview table for Desalination/Brackish Water Treatment and Re-use		
Sector: Water		
Sub-sector: Water desalination		
Technology: Desalination/Brackish Water Treatment and Re-use		
Ambition: Because investment in these technologies requires large amounts of capital, the potential scale of the diffusion of this technology per outcomes of TNA project will be restricted to the pilot site promising readiness, and preferably it will be for the authorities in charge (WAJ) to augment such technology. The aim will be to install a desalination plant for a site in western Jordan close to the Jordan Valley (the southern Jordan Valley), specifically in the Al Husban Well Field. This field has four groundwater wells in the Dead Sea Groundwater Basin with a capacity of 3-3.5 MCM/year utilized to supply drinking water to Amman and the local area.		
Benefits: • In many settings, desalination processes can provide access to abundant saline waters that have previously been unusable. • The technology is adequate for current as well as future climate conditions, especially in light of the projection results of climate models, which predicted reductions in precipitation rates of up to 15-20% by 2100, which makes every drop of water count. • The benefits to the environment are evident in the potential of the technology to providing a source of fresh water and thus reduce the stress on other water resources. With regard to the adaptation potential, the technology reduces the impact of climate change on limited water resources and contributes to making communities more resilient. Desalination can greatly aid climate change adaptation, primarily through diversification of the water supply and resilience to water quality degradation. Diversification of the water supply can provide alternative or supplementary sources of water when current water resources are inadequate in quantity or quality. Desalination technologies also provide resilience to water quality degradation because they can usually produce very pure water, even from highly contaminated sources. Increasing resilience to reductions in per capita freshwater availability is one of the key challenges of climate change adaptation. Both short-term drought and longer-term climatic trends towards decreased precipitation can lead to decreased per capita water availability. These climatic trends are occurring in parallel with population growth, land-use change and groundwater depletion; therefore, rapid decreases in per capita freshwater availability are likely. • However, the large energy demands of current desalination processes will contribute to greenhouse gas emissions and could set back climate-change mitigation efforts. Nonetheless progress in desalination technology has been incremental, resulting in consistent improvements in energy efficiency, durability and decreased operation and maintenance across many technologies. However, new technologies in research and development could potentially result in large improvements. • Economically speaking, even though economic benefits in terms of the feasibility of the technology option are uncertain because the costs are high, assessments should be made case by case, though the technology will still provide a good opportunity for creating a well-established desalination industry given sufficient qualified manpower. Water companies will be urged to recruit qualified staff, thus providing a good number of job opportunities. There are good opportunities for investment in small- to medium-scale projects in small countries like Jordan with limited energy resources. Thus, the technology may pave the way for a large market potential since Jordan has considerable sources of brackish water. There is therefore considerable scope for both RO and EDR plants in the future, though the market potential still has some limitations for the reasons assessed in the BA&EF Report.		

- With regard to the social benefits, the technology will provide incomes for investors and provide training opportunities as well as research programs. Access to an adequate supply of freshwater for drinking, household, commercial and industrial use is essential for health, well-being and economic development.[25]
- Thus, the opportunities this technology offers Jordan are:

— Access to a nearly unlimited water resource.

— The best opportunities for implementation are in water sectors that are functioning well, with a well-defined water policy and well-defined water resource availability and demand, technical expertise, and relatively little waste and inefficiency.

- Opportunities for desalination are greatest when:

— Freshwater resources are inadequate to meet demand (water stress or water scarcity)

— For membrane systems, where an abundant source of brackish water with low salt/TDS concentration is available; or, for thermal systems, where the population is located on a coastline with an adjacent facility (e.g., a power plant) that yields abundant waste heat

— Consumers are opposed to the reuse of treated wastewater

- According to analyses conducted by many academic researchers in Jordan, it was decided that desalination is the most appropriate option for Jordan to adopt to alleviate water scarcity and overcome water budget deficits. Yet even this is not commercially viable for Middle Eastern agriculture at present. Perhaps a generation from now we will possess economical technology for the mass desalination of water.[26]
- Jordan has a considerable sources of brackish water. There is therefore considerable scope for both RO and EDR plants in the future.
- Studies and projects have been carried out to evaluate the feasibility of water desalination in Jordan. Some of the proposed actions focus on utilizing the water in the Gulf of Aqaba for water supply and desalination for major industries.

Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks and contingency plans**	**Success criteria**	**Indicators for monitoring of implementation**	**Budget per activity (USD)**
Action 1: *Promoting reasonable system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy)*	**Activity 1.1:** *Contract a consulting firm to develop and recommend a standard for environmentally friendly desalination technologies aimed specifically at reducing energy consumption at desalination plants*	AF or GCF or GIZ	*Focal point:* WAJ	□ 2017: Develop project proposal and secure funding □ 2018 Implementation	**Risks:** □ Delay in securing funding beyond 2018. **Contingency plans:** □ Start writing the project propsoal and searching for funding immediately □ Consider local funding sources	□ Big brackish water reserve in Jordan □ Good amount of pilot-scale research	□ Number of standards developed for environmentally friendly desalination technologies aimed specifically at reducing energy consumption at desalination plants □ Total quantity of brackish water de-	50000

					such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)		salinated from environmentally friendly technologies (m^3) as a result of such standards □ Number of new direct and indirect jobs related to diffusion of the technology	
	Activity 1.2: *Conduct a training program for best practices of O&M of new standardized environmentally friendly desalination technologies aimed specifically at reducing energy consumption at desalination plants*	AF or GCF or GIZ	*Focal point:* WAJ Partners: JVA, WUAs, GIZ	2019	**Risks:** □ Delay in securing funding beyond 2018. □ Weak interest in training program **Contingency plans:** □ Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)	□ Good competence of local trainers	□ Number of beneficiaries that have benefited from the training program. □ Number of new direct and indirect jobs related to diffusion of the technology □ % Increase in incomes of environmentally friendly desalination technology companies	10000

	Activity 1.3: *Pilot the new EF-technology in Husban Wells as a demonstration case*	AF or GCF or GIZ	*Focal point:* WAJ Partners: JVA, WUAs, GIZ	2019-2020	**Risks:** - Delay in securing funding beyond 2019. - Weak interest in new EF technology **Contingency plans:** - Consider local funding sources such as the Jordan Environment Protection Fund and the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) - Focal point to keep high momentum of interest in the new EF technology	- Good competency of local desalination companies	Total quantity of brackish water desalinated by environmentally friendly technologies (m^3) % Increase in incomes of environmentally friendly desalination technology companies	2,500,000
	Activity 1.4: *Monitor and evaluate the pilot and disseminate results*	GIZ or WAJ	*Focal point:* WAJ Partners: JVA, WUAs, GIZ	2020	**Risks:** - Reluctance to develop M&E program **Contingency plans:** - An M&E program should gain inter-	- Good local experience in M&E practices	- At least one M&E established program	5000

					est by designating a focal point dedicated to M&E.			
Action 2: ***Promote and provide incentives to produce and assemble desalination units locally***	**Activity 2.1** *Contract a consulting firm to study the benefits of supporting locally produced and assembled desalination units in the context of promoting the green economy and supporting national industry; present best findings (incentives) as a recommendation*	AF or GCF or GIZ	*Focal point:* WAJ Partners: JVA, GIZ, Ministry of Finance/Tax Dept.	2018	**Risks:** □ Reluctance to support locally produced/assembled desalination units **Contingency plans:** □ WAJ to increase momentum of supporting locally produced and assembled desalination units	□ Good number of local manufactures of desalination units	□ At least one directive in support of locally produced/assembled desalination units	30,000

	Activity 2.2 *Organize a national workshop to raise awareness and to showcase the results of standardized environmentally friendly technology, together with the results of the green economy; national industry support study of best findings (incentives) to increase the awareness of the MoF and the Customs and Tax Depts. of the importance of this climate change adaptation technology; demonstrate the importance of supporting locally assembled plants by lowering customs and sales taxes (providing tax and customs exemptions), extended to all parts and spare parts; results of best practices to handle the reject water (brine) based on the best environmentally friendly technologies (from Action # 3)*	WAJ or GIZ	*Focal point:* WAJ Partners: JVA, GIZ, Ministry of Finance/Tax & Customs Depts.	2021	**Risks:** □ Low interest and buy-in from MoF, customs and tax depts. **Contingency plans:** □ WAJ to increase momentum of buy-in of MoF, customs and tax depts in supporting environmentally-friendly technology and locally assembled plants	□ Past experience of MoF, customs and tax depts in supporting environmentally - friendly technology, mainly in energy sector	□ At least one directive in support of locally produced/assembled desalination units (providing tax and customs exemptions)	5,000

Action 3: Promoting technologies with less environmental impact	**Activity 3.1:** *Contract a consulting firm to identifying best practices for handling the reject water (brine) based on best environmentally friendly technologies and aimed at increasing the diffusion of this technology*	WAJ or GIZ	*Focal point:* WAJ Partners: JVA, GIZ, WUAs	2020	**Risks:** □ Low interest and buy-in of desalination practitioners in best practices for handling the reject water (brine) based on best environmentally friendly technologies. □ lack of capacity to carry out promotion; □ the risk of the contracted company not finding suitable ways of disposal of waste water in the Jordanian context **Contingency plans:** □ WAJ to increase momentum of buy-in of desalination practitioners in best practices for handling the reject water (brine) based on best environmentally friendly	□ Some research exists on best environmentally friendly technologies	□ At least one viable solution on best practices for handling the reject water (brine) based on best environmentally friendly technologies	50,000

					technologies. - Developing capacity-building programs to carry out promotion; - Utilizing experience of international companies competent in solutions for disposal of waste water in the Jordanian context			

4.1.4. Action Plan for Empowerment and Expansion of WUAs Technology

4.1.4.1. Introduction

A large number of countries around the world have adopted programs to transfer the management of irrigation systems from government agencies to water users associations (WUAs) or other private-sector entities. Participatory Irrigation Management (PIM) is a key term in the toolbox of current approaches to improve the efficiency and performance of water resources management in countries that are faced with the issue of water scarcity or problems associated with global and climate change in the foreseeable future. A WUA is a unit of individuals who have formally and voluntarily associated together for the purposes of cooperatively sharing, managing and conserving a common water resource.[27]

In Jordan, the JVA, in association with GIZ, started forming WUAs in the JV about thirteen years ago.[28] To date they have formed around 25, with nineteen registered as cooperatives and five in the process of registration. Although legally registered as independent cooperatives, the JVA clearly sees these associations as an operational arm of the JVA, with control by the JVA. These WUAs cover about 65% of the irrigated area in the Jordan Valley (JV), with the expectation that in the long-run all of the irrigated area in the JV will be served by WUAs.[29]

The incumbent law regulating the WUAs in the country is the Jordan Cooperatives Corporation (JCC) Law. WUAs should be governed by Jordan Valley Law and not JCC Law for reasons that will follow. The JVA's interpretation of the law is that WUAs cannot collect water fees and, even though they are legally for-profit organizations, the JVA discourages them from carrying out any income generating activities. Therefore, WUAs are dependent upon the JVA for funding. At present twelve WUAs have signed Task Transfer (TT) agreements that provide a limited amount of income, primarily for operational staff salaries. Another four WUAs have signed TT agreements at no cost to the JVA, as all operational activities are carried out by volunteers. This technology has been prioritized in Jordan and has been selected for further analysis for the following reasons.

- The technology has been successfully introduced in different countries such as Jordan and Lebanon. The practice has a good level of maturity world-wide and is progressing well in Jordan, but it still needs empowerment and expansion. However, there are still many challenges to be overcome to the wide and effective diffusion of the technology.
- Economically and cost-wise, the cost of establishing and maintaining a WUA will depend on its size, management structure, area of operations and functions.[30] WUAs usually levy a joining fee, followed by an annual membership fee. During the initial formation phase, additional financial support may be required to ensure successful establishment of the WUA. Where setting up WUAs is supported by a national policy (such as a Water Act/Law or Irrigation Act/Law) there may be a mechanism in place for the provision of this funding support. Furthermore, such funding may be on-going, especially in countries where WUAs are considered part of a government-led decentralization program, such as Jordan.
- Independently, WUAs can generate an income by charging for water supply and distribution services and the provision of agricultural outreach services.
- WUAs provide better decentralized management of water resources and increase efficiency.
- Prioritization of investment needs for water management and adaptation strategies, such as irrigation, and monitoring their effectiveness.
- Coping with water shortages.
- Improved agricultural productivity.[31]
- Reducing the government’s financial and budgetary difficulties of and facilitating the collection of water fees.

- Improving irrigation management efficiency, as well as O&M of irrigation infrastructure.
- Changing farmer's attitudes regarding dependence on external assistance.
- O&M is expected to be at a relatively low cost.
- Environmentally speaking, the WUA practice fits well with both present and expected climate conditions. The technology can contribute to the provisioning of sustainable water sources for adaptive agriculture, as well as improvements to canal and irrigation schemes, which can reduce water logging and salinity problems. By providing technical assistance to local farmers, WUA members can also have a direct impact on improving soil, water and crop management practices.
- The technology is considered among the most sustainable alternatives when it comes to coping with water shortages. It has a number of advantages that include good management between water supply and demand, better allocation of water resources, and providing sound solutions to the problems of water scarcity and climate change. Moreover, improvements to canal and irrigation schemes can reduce water logging and salinity problems.
- With regard to the social benefits, the technology provides an indirect income to farmers by applying more efficient management systems and by allowing savings by reducing water losses. The technology can lead to improved agricultural productivity, which in turn helps to raise incomes.[32]

4.1.4.2. Ambition for the Empowerment and Expansion of WUAs Technology TAP

The aim for the Empowerment and Expansion of WUAs Technology in Jordan is large. It is anticipated that activities proposed in this TNA Project and the associated TAP for this technology will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUAs all over the JV area. In fact, the stakeholders involved in the discussions to develop the TAP for *Empowerment and Expansion of WUAs Technology* intend to form a full package project of all the actions listed below. This, it is suggested, will promote a holistic approach to remove the barriers to such technologies and ease its empowerment and expansion in the country.

4.1.4.3. Actions and activities selected for inclusion in the Empowerment and Expansion of WUAs Technology TAP

A summary of the barriers and measures to overcome barriers to Empowerment and Expansion of WUAs are presented in Table 14 below.

TABLE 14. SUMMARY OF BARRIERS AND MEASURES TO OVERCOME BARRIERS TO EMPOWERMENT AND EXPANSION OF WUA TECHNOLOGY

Barrier categories	Identified barriers	Measures to overcome barriers
Economic and financial	• ***Weak financial sustainability*** mainly due to: ○ inability to recover water costs; ○ limited access to finance, for instance, to rehabilitate the irrigation network; ○ weakness in developing income-generating projects; and ○ weakness of WUAs' marketing skills and competitive abilities of framers' products.	• ***Introducing effective financial instruments to attain effective means of financial sustainability*** (ability to recover water costs and rehabilitate the irrigation network) • ***A new and simpler contracting mechanism is needed*** based on lump-sum payments by WUAs to the JVA for the quantities of bulk water delivered to them;

	• ***Poorly designed contracts with JVA***. Current TTAs cover staff salaries, but include only limited amounts to cover other fixed and variable costs to WUAs. • ***Cost of improving system condition.*** Much of the JV irrigation network is more than thirty years old and in poor condition, with a substantial backlog of deferred maintenance.	• ***Building the capacity of WUAs to develop income-generating activities and projects*** with an emphasis on building their marketing capabilities and increasing product competitiveness. • ***Developing grant programs*** to enable WUAs' member farmers to own the equipment and vehicles necessary for their daily works such as loaders, etc., to complement daily functions; • ***Rehabilitation of the network is a top priority across the JV***
Market conditions	• ***Weakness in marketing the concept of WUA as an innovation in PIM*** as well as clear weakness in marketing WUA products and demonstrating added value.	• ***Developing capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in PIM***; • ***Building the capacity and skills of WUAs in marketing their products*** and demonstrating added value.
Legal and regulatory	• ***Problem with incumbent law***. The binding law regulating the WUAs is the Jordan Cooperatives Corporation (JCC) Law. The legal situation is complicated by the present arrangements of WUAs registered as for-profit cooperatives under the JCC umbrella that are allowed to collect fees for irrigation water services. This is not a good legal arrangement for WUAs, who, according to entities active in the water sector in Jordan, such as the JVA, should not be in charge of collecting fees for irrigation water services, as both the JVA and the WUAs recognize. • JCC recognizes that WUAs are not profitable and need some profitable projects to ensure their sustainability,	• ***Switching from the mandate of incumbent JCC law***, which is currently regulating the WUAs, to the sovereignty of a more suitable legal umbrella. This will: (i) provide backstopping to WUAs and support accommodating an expanded role in irrigation retail distribution to empower the mandate of WUAs to contract with JVA for bulk water services; (ii) empower WUAs to set their own rates and collect service fees and remove financial constraints (iii) remove conflicts of interests between the JVA and WUAs and eliminate competition over control of the number of activities assumed by WUAs.

	such as profit margins on the price of water • WUAs should be governed by the Jordan Valley Law and not the JCC Law, since this legal situation is causing the following institutional/organizational barriers: ➢ Minimizing JVA control of the number of activities assumed by WUAs. ➢ Threatening JVA staff's job security • Imposing financial constraints on WUAs. • Institutional obstacles for expansion of responsibilities and transfer of additional tasks.	(iv) enable some farmers' organizations to join together to form a bigger body such as an organization council. • Propose amendments to the JVA law and by-law to enable the empowerment of WUAs and their attaining administrative and financial independence; — establish a legal basis for the relationship between the WUA and the bulk water supplier, free from any conflict of interest; — promote attaining economies of scale for the operation and maintenance of the main irrigation infrastructure; — set out the legal basis for WUAs to form national associations to promote and protect the rights of the irrigation sector; • Or support other options currently under discussion, such as ***registering WUAs as non-profit companies under the Companies Law***. This appears to be a reasonable possibility, but it requires thorough legal vetting before moving forward. An important positive aspect of registering WUAs under the Companies Law is that they are not compelled to come under the umbrella of the JVA, which would involve a clear conflict of interest, since WUAs will be contracting directly with the JVA for water services.

Network structures	• **Weak coordination and communication platforms** between WUAs themselves and among each WUA's members;	• ***Developing and activating effective coordination and communication platforms*** between WUAs themselves and among each WUA's members;
Human skills	• ***Limited skills and lack of continuous training and capacity-building programs*** for WUA members, specifically for financial management and sustainability skills, grant-writing skills, governance and overall management skills, operation and maintenance of water distribution systems, and computer skills to enhance the overall managerial capabilities of WUA staff. • ***Low ability in archiving work documents*** and other documentation activities relating to information and transactions in a way that makes information available and useful to share;	• ***Establish a program of continuous training and capacity-building*** specifically for financial sustainability skills, grant-writing skills, management and governance, operation and maintenance of water distribution systems an,d computer skills to enhance the overall managerial capabilities and ***ability in archiving work documents*** • ***Support the establishment of a dedicated and expanded WUA support unit within the JVA*** to support WUA capacity-building and human skills development;
Social, cultural and behavioral	• **A socio-political barrier resulting from *strong effect of tribal system and personal connections which are jeopardizing the equitable distribution of services*** ; • ***Job security***. JVA staff members are concerned about their long-term employment security as WUAs take over more and more of their present tasks.	• ***Promote awareness campaign of good governance to minimize the effect of personal factors*** such as tribal system and personal connections;
Technical	• ***Obstacles in current operations and challenges to transfer maintenance and rehabilitation mandate*** to WUAs from the JVA for main irrigation networks and pumps. One major challenge is improving the system's condition	• ***Technical capacity-building programs to prepare farmers for a major mandate to transfer maintenance and rehabilitation*** to their authority for main irrigation networks and pumps; • ***Building technical capacity of WUA members in their overall ability to improve the condition of the thirty-year old system***. Other maintenance skills needing to be im-

		proved include enhancing responses to pipeline breaks and leaks using advanced techniques; • Other important technical needs include ***building capacity to operate some work-related vehicles, equipment (mainly maintenance equipment)*** and tools to measure and monitor water flow and pressure. Key technical training needs include computer skills and operational and maintenance skills for water distribution; • ***Training programs in skills relating to archiving work documents and other documentation activities*** relating to information and transactions in a way that make information available and useful to share; • ***Establishing distribution point (flow meters) for each WUA***

Actions selected for inclusion in the Empowerment and Expansion of WUAs Technology TAP are presented below in Table 15.

TABLE 15. MEASURES SELECTED AS ACTIONS FOR INCLUSION IN THE EMPOWERMENT AND EXPANSION OF WUA TECHNOLOGY TAP

Categories	Identified measures to overcome barriers	Measures selected as actions for inclusion in TAP
Economic and financial	(1) ***Attaining effective means of financial sustainability*** (2) ***build their capacity to develop income-generating activities and projects (3) grant programs should be available***	***Attaining effective means of financial sustainability and build the capacity of WUAs to develop income-generating activities and projects.***
Market conditions	(1) ***Capacity-building programs to empower WUAs in marketing the concept of the WUA as an innovation in PIM*** (2) ***building the capacity and***	***Capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in PIM and building***

	skills of WUAs in marketing their products	***the capacity and skills of WUAs in marketing their products.***
Legal and regulatory	(1) ***Switching from the mandate of incumbent JCC law to a suitable law*** (2) ***registering WUAs as non-profit companies under the Companies Law*** *(3)* ***a new and simpler contracting mechanism is needed***	***Switching from the mandate of incumbent JCC law to a suitable law.***
Network structures	***Developing and activating effective coordination and communication platforms***	***Developing and activating effective coordination and communication platforms.***
Institutional and organizational capacity	***Strengthening WUAs to perform their mandated tasks***	***Strengthening WUAs to perform their mandated tasks.***
Human skills	***Establish a program of continuous training and capacity-building***	***Establish a program of continuous training and capacity-building.***

- Activities identified for the implementation of selected actions are presented in Table 16 below.

TABLE 16. SUMMARY OF ACTIONS AND ACTIVITIES FOR IMPLEMENTATION FOR EMPOWERMENT AND EXPANSION OF WUA TECHNOLOGY ACTION PLAN IN JORDAN

Summary of Actions	
Action 1:	***Switching from the mandate of incumbent JCC law to a suitable law.***
Action 2:	***Strengthening WUAs to perform their mandated tasks.***
Action 3:	***Attaining effective means of financial sustainability and building their capacity to develop income-generating activities and projects.***
Action 4:	***Establish a program of continuous training and capacity-building and develop and activate effective coordination and communication platforms.***
Action 5	***Capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in PIM; building the capacity and skills of WUAs in marketing their products.***
Activities and actions for implementation of Empowerment and Expansion of WUA Technology action plan in Jordan	
	Action 1: ***Switching from the mandate of incumbent JCC law to a suitable law***
Activity 1.1	Contract a specialized legal or regulatory firm to review current incumbent legal framework and compare it with best international practices; identify scenarios for a suitable and applicable legal framework

Activity 1.2	Organize a national workshop to present the results of the legal study and discuss the best option based on stakeholders' involvement and perspectives and come up with recommendations for the best legal arrangement to present to the authority in charge for approval
Activity 1.3	Contract a legal or regulatory consultancy company or consultant to draft a suitable legal framework and submit it for approval by the institution in charge
Activity 1.4	Pilot implementation of the approved legal framework
	Action 2: ***Strengthening WUAs to perform their mandated tasks (IMT).***
Activity 2.1	Identify technical needs for each geographical area under the mandate of the WUAs
Activity 2.2	Identify area(s) for pilot implementation
Activity 2.3	Develop KPIs to monitor and evaluate the process of water management in the pilot area(s)
Activity 2.4	Procure technical needs for implementing the full IMT
Activity 2.5	IMT implementation in the pilot area(s)
	Action 3: ***Attaining effective means of financial sustainability and build their capacity to develop income-generating activities and projects***
Activity 3.1	Contract a specialized financial and administrative capacity-building consulting firm to help in attaining effective means of financial sustainability; build capacity of WUAs to develop income-generating activities and projects
Activity 3.2	Contract a specialized consultancy company to write proposals for income-generating projects for the WUAs
Activity 3.3	Implement project prototypes
	Action 4: ***Establish a program of continuous training and capacity-building and develop and activate effective coordination and communication platforms (20)***
Activity 4.1	Conduct a study to identify WUAs' capacity-building needs
Activity 4.2	Conduct a series of training programs (full package) covering, for example, leadership, conflict resolution, communication, time management, enhancement of skills and capacities, etc.
	Action 5:
	Capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in PIM; building the capacity and skills of WUAs in marketing their products.
Activity 5.1	Contract a specialized consultancy company to develop a plan for marketing the WUA concept and products

Actions to be implemented as Project Ideas

In fact, the stakeholders involved in the discussion for developing the TAP for *Empowerment and Expansion of WUAs Technology* intend to create a full package project of all the actions listed above. The aim is to adopt a holistic approach to removing the barriers to this technology and ease its empowerment and expansion in the country.

4.1.4.4. Stakeholders and Timeline for implementation of TAP

An overview of stakeholders for implementation of the empowerment and expansion of WUA Technology and of the scheduling and sequencing of specific activities can be found in the TAP overview in Table 17 below.

4.1.4.5. Estimate of Resources Needed for Action and Activities

Estimate of capacity-building needs to carry out Actions and Activities and estimates of costs of actions and activities can be found in the TAP overview in Table 17 below.

4.1.4.6. Management Planning

A detailed description of identified risks and proposed contingency plans is elaborated in the TAP overview in Table 17 below.

TABLE 17. OVERVIEW TABLE FOR EMPOWERMENT AND EXPANSION OF WUAS TECHNOLOGY

TAP overview table for roof-top Rainwater Harvesting
Sector: Water and agriculture
Sub-sector: Participatory Irrigation Management (PIM) /Water Users Associations (WUAs)
Technology: Empowerment and Expansion of WUA Technology
Ambition: The aim for Empowerment and Expansion of WUA Technology in Jordan is big. It is anticipated that the activities proposed in this TNA Project and the associated TAP for this technology will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUAs all over JV areas. In fact, the stakeholders involved in the discussions on developing the TAP for *Empowerment and Expansion of WUA Technology* intend to form a full package project of all the actions listed below. The proposal is to adopt a holistic approach to remove the barriers to this technology and ease its empowerment and expansion in the country.
Benefits: • The technology has been successfully introduced in different countries such as Jordan and Lebanon. The practice has a good level of maturity world-wide, progressing well in Jordan, but still needs empowerment and expansion. • Economically and cost-wise, the costs of establishing and maintaining a WUA will depend on its size, management structure, area of operations and functions.[33] WUAs usually levy a joining fee, followed by an annual membership fee. During the initial formation phase, additional financial support may be required to ensure the establishment of the WUA. Where the establishment of WUAs is supported by national policy (such as a Water Act/Law or Irrigation Act/Law) there may be a mechanism in place for the provision of this funding support. Furthermore, this funding support may be on-going, especially in countries where WUAs are considered part of a government-led decentralization program, such as Jordan. • Independently, WUAs can generate incomes by charging for water supply and distribution services and the provision of agricultural outreach services. • Provision of better decentralized management of water resources and increased efficiency. • Prioritization of investment needs for water management/adaptation strategies, such as irrigation, and monitoring their effectiveness. • Coping with water shortages. • Improved agricultural productivity.[34] • Reducing the government's financial and budgetary difficulties and facilitating the collection of water fees. • Improving irrigation management efficiency as well as O&M of irrigation infrastructure. • Changing farmer's attitudes regarding over-dependence on external assistance. • O&M is expected to be at relatively low cost. On the contrary, this practice may provide a better and more timely O&M of irrigation infrastructure, thus lowering O&M costs compared to a BAU settings. O&M can cover joint infrastructure maintenance, such as canal maintenance, pump operation and the monitoring and collection of water use charges. • Environmentally speaking, the WUA practice fits well with both present and expected climate conditions. The technology can contribute to the provision of sustainable water sources for adaptive agriculture, as well as improvements to canal and irrigation schemes, which can reduce water logging and salinity problems. By providing technical assistance to local farmers, WUA members can also have a direct impact on improving soil, water and crop management practices.

- The technology is considered to be among the most sustainable alternatives in coping with water shortages. It has a number of advantages, which include good management between water supply and demand, better allocation of water resources, and providing sound solutions to problems with water scarcity and climate change. Moreover, improvements to canal and irrigation schemes can reduce water logging and salinity problems.
- PIM/WUAs is a key term in the toolbox of current approaches to improve the efficiency and performance of water resources management in countries that are faced with the issue of water scarcity, or problems associated with global and climate change in the foreseeable future. WUAs can play a critical role in changing from the centralized control of natural resources to local management. This is particularly important for climate change adaptation efforts, as the local monitoring of water resources, improvements in infrastructure (such as canals and irrigation) and public participation in decision-making encourage the more reliable, timely and equitable distribution of supplies.
- With regard to the social benefits, the technology provides an indirect income to farmers by introducing more efficient management systems and from the savings produced by reducing water losses. The technology can lead to improved agricultural productivity, which in turn helps to raise incomes.[35]

Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time-frame	Risks and contingency plans	Success criteria	Indicators for monitoring of implementation	Budget per activity (USD)
Action 1: *Switching from the mandate of incumbent JCC law governing WUAs in Jordan to a suitable law*	**Activity 1.1:** *Contract a specialized legal or regulatory firm to review current incumbent legal framework to compare with best international practice and identify scenarios for a suitable and applicable legal framework*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2017: Develop project proposal and secure funding □ 2018-Implementation	**Risks:** □ Delay in securing funding beyond 2018 □ Weak coordination between responsible bodies **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead Focal point to keep strong coordina-	□ Good number of consulting firms specialized in assessing legal frameworks	□ At least one global best-industry practice model assessed to compare to Jordan's situation and transfer potential analyzed □ *At least one new suitable legal scheme enacted to govern Jordan's WUAs*	50,000

					tion between responsible bodies			
	Activity 1.2: *Organize a national workshop to present the results of the legal study and discuss the best option based on stakeholders' involvement and perspectives; come up with recommendations for the best legal arrangements to govern WUAs in Jordan to present to the authority in charge for approval*	*JVA or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2017: Develop project proposal and secure funding □ 2018-Implementation	**Risks:** □ Delay in securing funding beyond 2018 □ Weak coordination between responsible bodies □ Low buy-in of legal study results and outcomes **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to maintain strong coordination between responsible bodies and to guarantee high buy-in of legal study results and outcomes	□ High participation rates of national stakeholders in such types of workshop	□ At least one global best-industry practice model discussed in the workshop to compare to Jordan's situation, and transfer potential thoroughly discussed □ At least one *recommendation for the best legal arrangement to govern WUAs in Jordan to present to the authority in charge for approval* □ *At least one new suitable legal scheme enacted to govern Jordan's WUAs*	5,000
	Activity 1.3: *Contract a legal*	*JVA or* GIZ	*Focal point: JVA/WUA Directorate;*	□ 2017: Develop pro-	**Risks:** □ Delay in securing funding beyond 2018	□ Good number of legal consulting firms	□ *At least one new suitable legal scheme drafted and*	25,000

	or regulatory consultancy company or consultant to draft a suitable legal framework and submit it for approval by the institution in charge.		*Partners: GIZ*	ject proposal and secure funding □ 2018-Implementation	□ Weak coordination between responsible bodies □ Low buy-in of legal study results and outcomes **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to maintain strong coordination between responsible bodies and to guarantee high buy-in of legal study results and outcomes	specialized in drafting legal frameworks	*enacted to govern Jordan's WUAs*	
	Activity 1.4: *Pilot implementation of the approved new legal framework to govern WUAs in Jordan*	*JVA or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2017/2018: Develop project proposal and secure funding □ 2018/2019-	**Risks:** □ Delay in securing funding beyond 2018 □ Weak coordination between responsible bodies in piloting *new legal framework to*	□ Good experience in deploying legal and regulatory frameworks in Jordan	□ *At least one new suitable law drafted enacted and piloted to govern Jordan's WUAs*	25,000

				Implementation	*govern WUAs in Jordan* □ Low buy-in of stakeholders of new approved law **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to maintain strong coordination between responsible bodies and to guarantee high buy-in of new law			

***Action 2**: Strengthening WUAs to perform their mandated tasks (IMT)*	**Activity 2.1**: *Identify technical needs for each geographical area under the mandate of the WUAs*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2017/2018: Develop project proposal and secure funding □ 2018/2019- Implementation	**Risks:** □ Delay in securing funding beyond 2018 □ Low cooperation/buy-in of WUAs of capacity strengthening needs **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to keep strong cooperation/buy-in by WUAs of capacity strengthening needs	□ Good experience in conducting capacity-building and strengthening needs	□ *At least three major and diverse* capacity-building and strengthening needs identified and built or strengthened	70,000

	Activity 2.2: *Identify area(s) for implementation of pilot for technical needs in each geographical area*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2019-Implementation	**Risks:** □ Delay in securing funding beyond 2019 □ Low cooperation/buy-in by WUAs of capacity strengthening needs and desire to implement technical needs for each geographical area **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to keep strong high cooperation/buy-in by WUAs of capacity strengthening needs and desire to implement technical needs for each geographical area	□ Good experience in implementing capacity-building and strengthening needs	□ *At least three areas for pilot implementation for technical needs for different geographical area identified and pilots implemented*	300,000

	Activity 2.3: *Develop KPIs to monitor and evaluate the process of water management in the pilot area(s)*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2019-Implementation	**Risks:** □ Delay in securing funding beyond 2019 □ KPIs selected are not representative of best management practices in the context of IWRM **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ KPIs should be carefully assessed as to whether they are representative of best management practices in the context of IWRM.	□ Good experience in implementing capacity-building and strengthening needs	□ *At least three KPIs for pilot implementation to monitor and evaluate the process of water management in the pilot area(s) identified and implemented*	25,000

	Activity 2.4: Procurement of technical needs for implementing full IMT	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2018: Develop project proposal and secure funding □ 2019-Implementation	**Risks:** □ Delay in securing funding beyond 2018 □ Technical needs for implementing full IMT were not appropriately identified **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to make sure technical needs for implementing full IMT are appropriately identified	□ Good experience in procurement of technical needs	□ *At least three major and diverse sets of* technical needs for implementing full IMT procured	1,500,000

	Activity 2.5: *IMT implementation in the pilot area(s)*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2019/2020 Implementation	**Risks:** □ Delay in securing funding beyond 2019 □ Low coordination and buy-in of *IMT implementation aspects in the pilot area(s)* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to guarantee high coordination and buy-in of *IMT implementation aspects in the pilot area(s)*	□ Good experience in implementation of pilots	□ Full IMT implemented in at least three areas of JV	1,500,000

Action 3: *Attaining effective means of financial sustainability for WUAs; building their capacity to develop income-generating activities and projects*	**Activity 3.1:** *Contract a specialized financial and administrative capacity-building consulting firm to help WUAs attain effective means of administrative and financial sustainability*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	2019/2020-Implementation	**Risks:** Delay in securing funding beyond 2019 Weak buy-in and interest on part of WUA in *attaining effective means of administrative and financial sustainability* **Contingency plans:** Start writing the project proposal and searching for funding immediately Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds Lead focal point to guarantee strong buy-in and interest byof WUA in *attaining effective means of administrative and financial sustainability*	Good number of *financial and administrative capacity-building consulting firms*	At least three sets in each category of administrative and financial sustainability areas attained At least one global best-industry practice on an administrative and financial sustainability model assessed to compare to Jordan's situation and transfer potential analyzed *At least one new suitable administrative model and one new financial sustainability model to govern Jordan's WUAs developed and deployed*	200,000

	Activity 3.2: *Contract a specialized consultancy company to write proposals for income generating projects for WUAs*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2020-Implementation	**Risks:** □ Delay in securing funding beyond 2019 □ Weak buy-in and interest by WUA to be trained in *attaining effective means of administrative and financial sustainability and writing proposals for such conclusion* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to guarantee strong buy-in and interest of WUA to *attaining effective means of administrative and financial sustainability*	□ Good number of *financial and administrative capacity-building consulting firms specialized in training in write proposals for income-generating projects*	□ At least three WUAs in three geographical regions of JV managed to write at least two proposals each	60,000

	Activity 3.3: *Implement income generating project prototypes*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2020-Implementation	**Risks:** □ Delay in securing funding beyond 2020 □ Weak buy-in and interest by WUAs to implement *income-generating project prototypes* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to guarantee strong buy-in and high interest of WUAs in implementing *income-generating project prototypes*	□ Good experience in implementing *income-generating projects*	□ At least two WUAs in three geographical regions of JV managed to implement at least one project prototype each	1,000,000
***Action 4**: Establish a pro-*	**Activity 4.1:** *Conduct a study to identify the*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate;*	□ 2020/2021-Implementation	**Risks:** □ Delay in securing funding beyond 2020	Good experience in conducting training and capacity-building	*At least three major and diverse continuous training and* capacity-building needs	70,000

gram of continuous training and capacity building; develop and activate effective coordination and communication platforms for WUAs in JV.	*continuous training and capacity-building needs for WUAs with an emphasis on new emerging areas of need*		*Partners: GIZ*		□ Low cooperation/buy-in of WUAs in identifying *continuous training and capacity-building needs with an emphasis on new emerging areas of need* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to maintain strong cooperation/buy-in of WUAs in identifying *continuous training and capacity-building needs with an emphasis on new emerging areas of need*	and strengthening needs	identified and built	
	Activity 4.2: *Conduct a series of training programs covering, for example, leadership, conflict*	*GCF, Adaptation Fund or* GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2021-Implementation	**Risks:** □ Delay in securing funding beyond 2021 □ Low cooperation/buy-	□ Good experience in conducting training and capacity-building and strengthening programs	*At least three major and diverse continuous training and* capacity-building programs planned and conducted *(full package) covering, for example, leadership,*	150,000

	resolution, communication, time management, enhancement of skills and capacities, etc.				in of WUAs in conducting *continuous training and capacity-building programs with emphasis on new emerging areas of need* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to maintain strong cooperation/buy-in by WUAs in conducting *continuous training and capacity building needs with emphasis on new emerging areas of need*		*conflict resolution, communication, time management, enhancement of skills and capacities, etc.*	
Action 5 *Capacity building programs to empower WUAs in marketing the concept of the*	**Activity 5.1:** *Contract a specialized consultancy company to develop plans for marketing the WUA concept and*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2020/2021-Implementation	**Risks:** □ Delay in securing funding beyond 2019 □ Weak buy-in and interest of WUA in *marketing the WUA concept*	□ Good number of *financial and business management and marketing consulting firms specialized in such areas*	At least three WUAs in three geographical regions of JV managed to develop plans *for marketing the WUA concept and products*	150,000

WUA as an innovation in PIM; building the capacity and skills of WUAs in marketing their products	*products*				*and products* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to guarantee strong buy-in and interest of WUA in *marketing the WUA concept and products*			
	Activity 5.2: *Implement selected activities from the developed plans.*	*Green Climate Fund* (*GCF*), *Adaptation Fund* (*AF*) or GIZ	*Focal point: JVA/WUA Directorate; Partners: GIZ*	□ 2021/2022 Implementation	**Risks:** □ Delay in securing funding beyond 2021 □ Weak buy-in and interest of WUA in *marketing the WUA concept and products, and in implementing selected activities from the developed plans* **Contingency plans:** □ Start writing the project proposal and searching for funding immediately	□ Good number of *financial and business management and marketing consulting firms specialized in such areas*	At least two WUAs in three geographical regions of JV managed to *implement selected activities from their developed plans*	210,000

					□ □ Consider local funding sources such as *Jordan Environment Protection Fund* or MWI funds □ Lead focal point to guarantee strong buy-in and interest of WUA in *marketing the WUA concept and products, and in implementing selected activities from the developed plans*			

4.2. Project Ideas for the Water Sector

4.2.1. Brief summary of the project ideas for the water sector

A robust set of project ideas emerged systematically and gradually in the context of extensive assessments conducted in the last phase of the TNA project in Jordan, which is concerned to convert identified barriers into measures (incentives). The advanced package of project ideas came about as a result of a holistic barrier analysis and diagnoses of enabling environments and proposing measures. Such measures are presented as concrete actions supporting the realisation of the overall target indicated in the Technology Action Plan for the Water Sector described above. This full package of solutions will contribute significantly to the transfer, diffusion and deployment of the prioritized adaptation technologies and their agreed targets. Below specific project ideas are presented for each adaptation technology of roof-top Rain Water Harvesting, Desalination, and WUAs.

4.2.2. Specific project ideas for the water sector

Roof-top Rain Water Harvesting

Project 1: *Roof-top Rain Water Harvesting "Adaptation Starts at Home" Project*

- **Introduction/Background**

It is strongly advocated that adaptation should start at home. In this regard, *Roof-top Rain Water Harvesting* is considered a simple practice that can be implemented for any dwelling. It is relatively cheap and has a number of sustainable development-oriented advantages. To that end, it is anticipated that the scale and context of this thoroughly assessed technology will encompass testing of a multi-modality of demonstration sites from urban, suburban and rural areas with rainfall rates above 200 mm/year (three demonstration locations in the north, center and south of the country).

The pilot sites will enable technical, institutional and regulatory- or law enforcement-related assessments and screening studies to be conducted to determine the most appropriate and viable mode of RWH technology in Jordan for different types of buildings (residential single home, multi-story buildings, single houses, villas, etc.).

With regard to actions to be implemented as specific project idea(s) under this technology, as assessed in the TNA Project, the stakeholders involved in the discussion to develop the TAP for *Roof-top Rain Water Harvesting* actually intend to draw up a fully-fledged package project of all the actions listed above in the *Roof-top Rain Water Harvesting Technology* section. The suggestion is to adopt a holistic approach to remove the overwhelming majority of barriers to this technology in residential dwelling and possible work places, thus easing its deployment and dissemination in the country due to its crucial positive impacts.

One of the components of this comprehensive specific program for RWH, for example, is establishing a *Regional Green Building Engineering Training Center* in Jordan.

- **Objectives (what will the project accomplish?)**
  - Involving the public in adaptation activities, increasing awareness of possible adaptation measures in homes and adopting a holistic approach to remove the overwhelming majority of barriers to this technology in homes and possible places of work, and easing its deployment and dissemination in the country due to its crucial positive impacts.
  - Promoting a cheap and viable sustainable development-oriented technology of roof-top Rain Water Harvesting.

- Augmenting the scale and context of testing this technology by assessing and diagnosing the multi-modality of demonstration sites from urban, suburban and rural areas of Jordan.
- Conducting targeted technical, institutional and regulatory or law enforcement-related assessments and screening studies based on a pilot site modality to determine the most appropriate and viable modality of RWH technology in Jordan for different types of buildings (residential single homes, multi-story buildings, single houses, villas, etc.).
- Establishing a devoted training and capacity-building institution for green building concepts such as a *Regional Green Building Engineering Training Center* in Jordan, which will itself be a fully-fledged demonstration green building for the region encompassing RWH technology among other sustainable building-oriented technologies (such as greywater, thermal insulation, renewable energy, energy efficiency, water efficiency, etc.).

- **What are the outputs and are they measurable?**
  - Increased involvement of the public in adaptation activities and awareness of possible adaptation measures at homes.
  - Familiarity of the mass of such cheap and viable sustainable development-oriented roof-top Rain Water Harvesting technologies increased.
  - The scale and context of testing this technology by assessing and diagnosing the multi-modality of demonstration sites from urban, suburban and rural areas of Jordan augmented.
  - Policies, measures and standards related to the technical, institutional and regulatory or law enforcement aspects of these technologies reformed based on assessments and screening studies of pilot sites.
  - Dedicated training and capacity-building institutions for green building concepts established.

  The above outputs are measurable through a set of indicators to be fixed at the proposal development stage.

- **Relationship to the country's sustainable development priorities**

  The above project and its objectives and outcomes are in line with the country's sustainable development and climate change adaptation priorities as articulated in the national climate change policy of Jordan, the Third National Communication Report to the UNFCCC, INDCs and the Climate Change Adaptation Plan for the Water Sector.

  The rainwater harvesting option is articulated explicitly as a priority measure in national strategic plans and programs of the water sector such as *UPDATE: Water for Life Jordan's Water Strategy 2008 – 2022*, which states in the "Climate Change Adaptation and Mitigation" chapter of the strategy, under "Approach": "*Prepare for greater use of nonconventional resources such as desalination, reuse of treated wastewater and rainfall harvesting*."

  The proposed scale for assessing the technology is a new development in the country, as this technology has only been tested on very narrow scale.

- **Project Deliverables, e.g. Value, Benefits and Messages**
  - Knowledge products and dedicated awareness materials and campaigns for this technology targeting increased involvement of the public in adaptation activities and awareness programs;
  - Availability of demonstration and pilot-scale sites for assessing and diagnosing the multi-modality of diverse sites from urban, suburban and rural areas of Jordan, enabling the deployment of training programs and fostering research activities;

- New policies, measures and standards related to technical, institutional and regulatory or law enforcement aspects related to the technology;
- New distinguished training and capacity-building institutions for green building concepts, which will serve the country and the region;

- **Project Scope and Possible Implementation**

The scope and scale of the project will be the widest in the history of applying this technology in Jordan. It is anticipated that the scale and context of this technology will include testing the multi-modality of demonstration sites from urban, suburban and rural areas with a rainfall rate of above 200 mm/year (three demonstration sites in the north, center and south of the country). The pilot sites will enable technical, institutional and regulatory or law enforcement-related assessments and screening studies to be conducted to determine the most appropriate and viable modality of RWH technology for different types of buildings in Jordan (residential single homes, multi-story buildings, single houses, villas, etc.).

This project is new in its approach and will be feasible from the point of view of environmental necessity rather than from the financial angle. It will also be an educational activity rather than just a project focused on its benefits.

Implementation will entail establishing a steering committee to coordinate the responsibilities of different project partners, such as the Engineering Association, the National Building Council, municipalities and the Green Building Council. A Project Management Unit (PMU) will be established equipped with the required staff consisting of a project manager, assistants, finance officers and an M&E officer. A clear logical framework of components, actions and activities will be developed on which the outcomes, outputs, indicators, targets and budgetary aspects can be articulated.

An example of a major action is the establishment of a Regional Green Building Engineering Training Center in Jordan, which will itself be a fully-fledged demonstration green building for the region encompassing RWH technology, along with other sustainable building-oriented technologies.

- **Project activities**

The major project activities are all integrated activities elaborated in the TAP for this technology above, but some more detailed actions are listed below.

- Writing the project's concept note, full proposal, feasibility studies, and environmental and social impact studies, including a clear logical framework of components, actions, activities, outcomes, outputs, indicators, targets and budgetary aspects.
- Submitting the proposal to funding agencies.
- A clear logical framework of components, actions and activities will be revised in light of the latest developments after the proposal has been approved, with the outcomes, outputs, indicators, targets and budgetary aspects also being revisited and revised.
- Establishing a steering committee to coordinate the responsibilities of the different project partners, such as the Engineering Association, the National Building Council, municipalities and the Green Building Council.
- Establishing a Project Management Unit (PMU) equipped with the required staff consisting of a project manager, assistants, finance officers and an M&E officer accommodated on the implementing entity's premises.
- Electing a focal point from each executing entity and requesting developing action plans

- An example of a major action is the establishment of a Regional Green Building Engineering Training Center in Jordan, which will itself be a fully-fledged demonstration green building for the region encompassing RWH technology among other sustainable building-oriented technologies.

- **Timelines**

The project will run for at least four years to enable testing of the multi-modality of building settings and to cover more than one climatic season.

A detailed phased timeframe for the different components of the project is available in the TAP above.

- **Budget/Resource requirements (What is the budget? How is the project to be funded? Staff, consultants, partnerships, etc.)**

Potential sources of finance are elaborated in the TAP above, where a description of all the necessary consultancies is also given.

For staffing purposes, a steering committee will be established to coordinate the responsibilities of different project partners, such as the Engineering Association, the National Building Council, municipalities, the Green Building Council, MoEnv, etc. Personnel will be hired for a Project Management Unit (PMU).

- **Measurement/Evaluation (What tangible evaluation of accomplishments will be conducted? How will success be measured?)**

A robust M&E plan will be developed based on the GIZ's SNAP process, where the axis Monitoring and Evaluating (M&E) process ranked high in the success-factor axes in Jordan. The M&E process will be based on smart monitoring tool developed by GIZ and called the "MACC tool (Monitoring Adaptation to Climate Change)". This smart tool is based on the GIZ guidebook, *Adaptation Made to Measure*. Both guidebook and MACC Tool form part of the Adaptation M&E Toolbox, which includes ten tools for the M&E of climate adaptation efforts at the national and project levels. The MACC tool (Monitoring Adaptation to Climate Change) guides project managers in the design of adaptation projects and enables them to carry out the ongoing results-based monitoring using one electronic file. The tool can be used to enter monitoring data directly and maintain an overview of the progress of the project. Based on a theory of change approach, the tool allows up to fifteen intended results to be defined with up to three indicators each. Data can be directly entered into the Excel file, making it a very practical device for project monitoring.

- **Possible Complications/Challenges**
  - Delay in securing funding beyond 2018
  - Weak coordination between responsible bodies
  - Weak cooperation from responsible bodies in providing information
  - No acceptance by government of financial incentives
  - *Communication and awareness programs not well prepared*
  - *Low buy-in of stakeholders to task of establishing the demonstration green building center*

However, contingency plans to overcome the above complications and challenges are elaborated in

the TAP above.

- **Responsibilities and Coordination**

To coordinate responsibilities and implementation, a steering committee will be established to coordinate the responsibilities of different project partners, such as the Engineering Association, the National Building Council, municipalities, the Green Building Council, etc. A Project Management Unit (PMU) will be established equipped with the required staff. A clear logical framework of components, actions and activities will be developed on which outcomes, outputs, indicators, targets and budget aspects can be articulated. For on-the-ground implementation of different activities, a focal point for each executing entity will be nominated to take responsibility for developing a specific action plan for the said entity.

Project 2: ***A Pilot PV-Powered Desalination Plant for the Water Authority of Jordan***

- **Introduction/Background**

The project idea came about because of an immediate need on the part of the Water Authority of Jordan (WAJ). The representative of the WAJ in the stakeholders' engagement workshops identified this need after participating in the TAN Team-Water Sector regarding all the activities connected with the TNA process in Jordan.

It is anticipated that all three actions elaborated in the TAP for Desalination Technology above will be packaged in one holistic project idea. However, because investment in such technology requires large amounts of capital, the scale for the potential diffusion of this technology with respect to the outcomes of the TNA project will be restricted to a pilot site of promising readiness, with a preference for the authorities in charge (the WAJ) to augment this technology. The aim will be to install a desalination plant for a site in western Jordan close to the Jordan Valley (the southern Jordan Valley), specifically in the Al Husban Well Field, which has four groundwater wells in the Dead Sea Groundwater Basin of a capacity of 3-3.5 MCM/year utilized to supply drinking water to Amman and the local area. The plant will utilize power generated from PV technology.

- **Objectives**

  - Encouraging desalination as a technology that can provide access to abundant saline waters that have previously proved unusable;
  - Promoting reasonable desalination system prices for capital and operating costs through cost-effective desalination units integrated with energy solutions (such as solar energy) and providing an option for water resources development to the water authorities in Jordan through the installation of a PV-powered desalination plant;
  - Encouraging the authorities to provide incentives to produce and assemble desalination units locally;
  - Testing, promoting and deploying technologies with less environmental impact.

- **What are the outputs?**
  - Promoting and deploying viable environmentally friendly desalination solutions with an emphasis on best-industry practices for handling the reject water (brine);
  - Increasing the total quantity of freshwater generated from brackish water desalinated using clean technologies;
  - Securing more new direct and indirect jobs related to diffusion of the technology;

- Granting incentives to technology users, particularly for locally produced and assembled desalination units;
- Increasing the number of beneficiary persons and entities having benefited from the associated training program;
- Supporting increases in the incomes of environmentally friendly desalination companies.

All above outcomes are measurable; see indicators for the monitoring of implementation in the Technology TAP above.

- **Relationship to the country's sustainable development priorities**

The desalination option is articulated explicitly as a priority measure in the water sector's national strategic plans and programs, such as *UPDATE: Water for Life Jordan's Water Strategy 2008 – 2022*. The said strategy says the following in this regard: "Studies have shown the availability of significant stored volumes of brackish groundwater in Jordan. However, desalination is energy intensive and hence a costly undertaking. On one side, capital costs need to be mobilized and on the other side, with the current water tariffs, the necessary subsidies will put a heavy burden on the national budget. Furthermore, energy generation for large-scale desalination plants will be needed and environmental impacts mitigated, all necessitating the development of expertise which is currently lacking."

In the "Climate Change Adaptation and Mitigation" chapter of the strategy, under "Approach", a paragraph states: "Prepare for greater use of nonconventional resources such as desalination, reuse of treated wastewater and rainfall harvesting."

The integration of PV with desalination is not a widely disseminated technology in Jordan and is still at the pilot or research stages. It is expected that the TAP of this TNA Project will contribute to promoting this integrated approach supported by other environmental-enabling factors such as a package of incentives.

- **Project Deliverables, e.g. Value, Benefits and Messages (Why are they important and necessary?)**
  - Knowledge products and demonstration sites for promoting and deploying viable environmentally friendly desalination solutions with an emphasis on best-industry practices for handling the reject water (brine);
  - Environmental and socio-economic benefits from increasing the total quantity of fresh water generated from brackish water desalinated using clean technologies; securing more new direct and indirect jobs related to the diffusion of the clean technology; supporting increases in the incomes of environmentally friendly desalination companies
  - Granting incentives provided to technology users, particularly in respect of locally produced and assembled desalination units;
  - Increasing the number of beneficiary persons and entities having benefited from the associated training programs.

- **Project Scope and Possible Implementation (How broad is the project? How feasible is it? Is it linked to current or past projects?)**
  - Because investment in this technology requires large amounts of capital, the scale for potential diffusion of this technology per the outcomes of the TNA project will be restricted to a pilot site

of promising readiness, with a preference for the authorities in charge (the WAJ) to augment such technology. The aim is to install a desalination plant for a site in western Jordan close to the Jordan Valley (the southern Jordan Valley), specifically in the Al Husban Well Field. This technology will be utilized to supply drinking water to Amman and the local area. The plant will utilize power generated from PV technology.

- **Project activities**

  The major project activities are all integrated activities elaborated in the TAP for this technology above, but some more detailed actions are listed below.

  - Writing the project's concept note, full proposal, feasibility studies, and environmental and social impact studies, including a clear logical framework of the components, actions, activities, outcomes, outputs, indicators, targets and budgetary aspects.
  - Submitting the proposal to funding agencies.
  - A clear logical framework of components, actions and activities will be revised in light of the latest developments after the proposal has been approved, with the outcomes, outputs, indicators, targets and budgetary aspects also being re-visited and revised.
  - Assigning a focal point to the WAJ and the Desalination Directorate for them to host the activities of the project and supervise the tendering process to procure the technology.
  - *Contract a consulting firm to develop and recommend a standard for environmentally friendly desalination technologies aimed specifically at reducing energy consumption at desalination plants;*
  - *Conduct a training program for best practices of O&M for new, standardized, environmentally friendly desalination technologies aimed specifically at reducing energy consumption at desalination plants;*
  - *Pilot the new EF technology in Husban Wells as a demonstration case;*
  - *Monitor and evaluate the pilot and disseminate the results;*
  - *Contract a consulting firm to study the benefits of supporting locally produced and assembled desalination units in the context of promoting the green economy and supporting national industry; present the best findings (incentives) as a recommendation;*
  - *Organize a national workshop to raise awareness and to showcase the results of the standardized environmentally friendly technology, as well as the results of the study of the green economy and national industry support to identify the best findings (incentives). This will be done to increase the awareness of the MoF and the customs and tax departments of the importance of this climate change adaptation technology and to show the importance of supporting locally assembled plants by lowering customs and sales taxes (providing tax and customs exemptions) extended to all involved parts and spare parts; also determine results of best practices for handling reject water (brine) based on the most environmentally friendly technologies (from Action # 3 in the TAP of the technology);*
  - *Contract a consulting firm to identify best practices for handling the reject water (brine) based on the most environmentally friendly technologies.*

- **Timelines (What are the timelines e.g. a quarter, a year, several years?)**

This project will run for at least four years to enable all the activities above to be carried out.

A detailed phased timeframe of the different components of the project can be found in the TAP above.

- **Budget/Resource requirements (What is the budget? How is the project to be funded? Staff, consultants, partnerships, etc.)**

Potential budgetary sources are elaborated in the TAP above (Table 12), and a description of all the required consultancies.

For purposes of staffing, a focal point at the WAJ and Desalination Directorate will be assigned to host the activities of the project and supervise the tendering process to procure the technology.

- **Measurement/Evaluation (What tangible evaluations of accomplishments will be conducted? How will success be measured?)**

A robust M&E plan will be developed based on the GIZ's SNAP process, where the axis Monitoring and Evaluating (M&E) ranked high in the success-factor axes in Jordan. M&E will be based on a smart monitoring tool developed by GIZ called the "MACC tool (Monitoring Adaptation to Climate Change)".

- **Possible Complications/Challenges (What are the potential challenges and complications?)**
  - Delay in securing funding beyond 2018;
  - lack of acceptance by government of financial incentives and tools, and low interest and buy-in from the MoF and the customs and tax departments;
  - Weak interest in training program;
  - Weak interest in new environmentally friendly technologies, and low interest and buy-in by desalination practitioners in respect of best practices for handling the reject water (brine) based on the most environmentally friendly technologies;
  - Reluctance to develop an M&E program;
  - Reluctance to support locally produced and assembled desalination units.

  However, contingency plans to overcome these complications and challenges are elaborated in the TAP above.

- **Responsibilities and Coordination (Who does what, when and how?)**

To coordinate responsibilities and implementation, a focal point will be assigned to the WAJ and Desalination Directorate to host the activities of the project and supervise the tendering process to procure the technology, as well as coordination with all the relevant entities.

Project 3: ***Empowerment and Expansion of Water Users Associations (WUAs) Practise in Jordan***

- **Introduction/Background (brief description of the project and how it was developed)**

  A large number of countries around the world have adopted programs to transfer the management of irrigation systems from government agencies to water-users associations (WUAs) or other private-sector entities. Participatory Irrigation Management (PIM) is a key term in the toolbox of current approaches to improve the efficiency and performance of water resources management in countries that are faced with the issue of water scarcity, or problems associated with global and climate change in the foreseeable future.

- A WUA is a group of individuals who have formally and voluntarily associated together for the purposes of cooperatively sharing, managing and conserving a common water resource.[36]
- The core activity of a WUA is to operate the waterworks under its responsibility and to monitor the allocation of water to its members.
- Key functions of a WUA include:
  - Operate and maintain a water service or structure;
  - Manage a water distribution system, including setting tariffs and collecting fees;
  - Monitor water availability and use under conditions of climate uncertainty;

- Provide technical assistance in areas related to water use and irrigation;
- Resolve conflicts related to water use.

In Jordan, government strategies, supported by international programs and donors, to promote a demand management approach and a Public Private Partnership are driving the participatory process in the country's water sector. *The Irrigation Policy 1998* of MWI in Article 34 stipulates that "*Pilot irrigation areas shall be designated to test the workability of PIM, where farmers will assume the responsibility of water delivery to their farms. When found successful, PIM will be extended to the Jordan Valley irrigation systems*". Jordan's policy documents indicate a strong intention to shift toward greater participation and the establishment and enhancement of WUAs, including legitimizing legislation, as advocated in several documents. But evidence is being hindered, among other things, by the government's reluctance to move rapidly beyond transferring the distribution of irrigation water to the WUAs, and legal issues related to the JVA's lack of financial autonomy are pending. The Jordanian experience with WUAs is unique, but it still faces some difficulties. The national strategy on IMT and PPP is clear in the texts in that it encourages using experience with pilots to consolidate the transfer, as well as the performance of the associations. But the lack of a legal framework (the associations are registered under a cooperative arrangement) and a re-orientation of the Jordan Valley Authority (JVA) mandate, coupled with the government's reluctance to hand out significant responsibilities rapidly to the WUAs, are slowing down the process and confining the WUAs' role to routine, small-scale actions. There is still a need to establish a clearer legal status over the water rights given to WUAs and farmers, without which WUAs cannot operate properly because they do not know the extent of their responsibilities.

Attempts to consider end-users' demands in respect of irrigation management in the Jordan Valley produced a differentiation into two programs. The first started in 1998 with the so-called TO2 (Turn Out at Km 2 of King Abdallah Canal) Pilot project in the Adassyeh area (a Cooperation program between the JVA and the French Technical Cooperation – Water and Agriculture Regional Mission, based in Amman). It was focused on improving the technical premises of the on-farm distribution of water. Direct incorporation of farmers' views was restricted to a consultation in the course of a rapid appraisal of rural areas in 2000.

The second program in Jordan's attempts to involve farmers in irrigation management focuses on a form of participation that exceeds the role of information delivery and the reception of extension messages about improved irrigation methods. The GTZ-funded *Water Resource Management in Irrigated Agriculture* (WMIA) project, which started in 2001, supported the creation of farmer-owned WUAs in the Jordan Valley by building on knowledge of traditional and informal cooperation structures in rural Jordan. The responsibilities that were transferred to the associations comprised in the first phase the self-administration of water distribution within the respective irrigation area and handing over the keys to the concrete boxes (farm turnouts) that contain the meters and valves of each farm outlet to the farmers' fields. The WMIA project started negotiations with the farmers in the course of fourteen pilot plots in 2002 and supported them in establishing their formal WUAs until the end of 2003. Based on the service contracts between the JVA and the WUAs responsible for retail distribution, the JVA covers the operational costs and provides the WUAs with spare parts. With the support of the GTZ (currently GIZ) project, the JVA regularly provides technical training for WUAs in the distribution of irrigation water, the maintenance and monitoring of farm turnouts and the capacity-building of administrative skills.

However, despite success stories of the establishment of WUAs in Jordan, the tasks that have been transferred to the WUAs are still limited to the distribution of irrigation water to farmers. There is still a strong need for further empowerment through, among other things:

- Official re-orientation of the JVA mandate. A draft amendment to the Jordan Valley development law is presently under review, involving changes to transfers of JVA mandates for retail distribution to the WUAs. The revised law will allow the JVA to provide the legal umbrella for the establishment of WUAs and the legal requirement for the WUAs to collect fees from farmers.
- Acquisition of the right to enforce sanctions related to the transferred functions, such as illegal water use. Currently, WUAs simply report illegal activities to the JVA and are represented on its Sanctions Committee so it can take part in its decisions.
- As noted above, in Jordan the national strategy on IMT and PPP is clear, encouraging using experience from pilots to consolidate the transfer of retail distribution to performing associations. However, the lack of a re-orientation of the JVA mandate, and a reluctance to transfer tasks beyond the distribution of irrigation water, are slowing down the process, confining the WUAs' roles to routine, small-scale actions. The legal authority to legitimize WUAs is still awaiting, among other things, he resolution of the question of the JVA's financial autonomy. ..
- Moreover, in some targeted areas a low-performing irrigation system is the farmers' main preoccupation. Despite the success stories, these problems, coupled with farmer's technical and managerial skills, are still at the root of the process, being further slowed down by resistance to change on the part of some JVA officers and influential farmers who feel threatened by the establishment of a democratic process.
- What is needed in Jordan in this regard is to address the bottlenecks impeding transfer to higher levels by means of a clear legal framework, a re-orientation of the agencies' mandates and the training of agencies and WUAs. Success stories concerning, for example, Pump 55 *WUA* in the Jordan Valley, mainly concerned with making agriculture more productive, transparent management and continuous support by the agency should be built on.
- It is also necessary to work with government teams for the introduction of PIM*,* possibly supported by consultants, which is more effective in the long term. These teams are usually subjected to a powerful capacity-building process and become advocates of PIM within government organizations. This is clearly obvious in Jordan's experience, as the international programs somehow evolved into the organizational arrangements set up by the ministries.
- However, the reform should include both "hard" and "soft" interventions. This involves, inter alia, a strong political commitment, negotiations among stakeholders and continuous capacity-building. This initially long process can evolve into diverse processes: re-organization of the institutional arrangements in the agriculture sector, modernization of irrigation and economic changes in support of irrigation.[37]

For all of the above, and as a result of systematic analyses and assessments of the barriers to this practice incorporating the stakeholders directly involved from the JVA and GIZ, all the obstacles that are hindering the augmentation of this experience in Jordan and the barriers preventing the fulfilment of its ultimate objectives were presented and holistic solutions and incentives were proposed. The aim of ***Empowerment and Expansion of WUAs Practice in Jordan*** is large. It is anticipated that the activities proposed in this TNA Project and the associated TAP for this technology will result in achieving full Irrigation Management Transfer (IMT) to WUAs all over the JV's areas. In fact, the stakeholders involved in the discussion to develop the TAP for this practice (technology) intend to draw up a full package project of all the actions listed above in the TAP section. The aim is to adopt a holistic approach to remove the barriers to this technology and ease its empowerment and expansion in the country.

- **Objectives (What will the project accomplish?)**

- The project will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUAs all over the JV's areas based on forming a full package project of all the actions listed in the TAP section of this technology. The aim is to adopt a holistic approach to remove the barriers for this technology and ease its empowerment and expansion in the country.
- One of the main objectives is switching from the obstructive mandate of the existing Jordan Co-operative Company (JCC) law governing WUAs in Jordan to a suitable law;
- Strengthen WUAs to perform their mandated tasks (IMT);
- Attain effective means of financial sustainability for WUAs and build their capacity to develop income-generating activities and projects;
- Establish a program of continuous training and capacity-building; develop and activate effective coordination and communication platforms for WUAs in the JV; develop capacity-building programs to empower WUAs in marketing the concept of WUA as an innovation in PIM; build the capacity and skills of WUAs in marketing their products.

- **What are the outputs, and are they measurable?**

  - Full Irrigation Management Transfer (IMT) to WUA all over JV's areas achieved;
  - A new and efficient legal framework governing WUAs in Jordan based on switching from the obstructive mandate of the existing Jordan Cooperative Company (JCC) law governing WUAs in Jordan to a suitable law;
  - Capacities of WUAs in performing their mandated IMT tasks strengthened;
  - Effective means of financial sustainability for WUAs attained and their capacity to develop income-generating activities and projects built up;
  - A program of continuous training and capacity-building established and effective coordination and communication platforms for WUAs in JV developed and activated;
  - Capacity-building programs to empower WUAs in marketing the concept of the WUA as an innovation in PIM developed and the capacity and skills of WUAs in marketing their products built up.

  All the above outcomes are measurable; see indicators for the monitoring of implementation in the Technology TAP above.

- **Relationship to the country's sustainable development priorities (How does this technology relate to the mission and key strategies? Is it a new development?)**

In Jordan, government strategies, supported by international programs and donors, are promoting a demand management approach, and a Public Private Partnership is driving the participatory process in the country's water sector. Article 34 of *the Irrigation Policy 1998* of MWI stipulates that "*Pilot irrigation areas shall be designated to test the workability of PIM, where farmers will assume the responsibility for water delivery to their farms. When found successful, PIM will be extended to the Jordan Valley irrigation systems*". Jordan's policy documents indicate a strong intention to shift towards the greater participation, establishment and enhancement of WUAs, including legitimizing legislation, as advocated in several documents.

- **Project Deliverables, e.g. Value, Benefits and Messages (Why is it important and necessary?)**

  - The project will establish a holistic platform for full Irrigation Management Transfer (IMT) to WUA all over the JV's areas;

- The project will develop a new and efficient legal framework governing WUAs in Jordan based on switching from the obstructive mandate of the existing Jordan Cooperative Company (JCC) law governing WUAs in Jordan to a suitable law;
- A program for the capacity-building of WUAs to perform their mandated IMT tasks will be developed;
- Most importantly, the project will secure an effective means of maintaining the financial sustainability of WUAs with an emphasis on enabling WUA members to develop income-generating activities and projects;
- A program of continuous training and capacity-building will be established, and effective coordination and communication platforms for WUAs in the JV will be developed and activated;
- Capacity-building programs to empower WUAs in marketing the concept of the WUA as an innovation in PIM will be developed, and the capacity and skills of WUAs in marketing their products will be built up.

- **Project Scope and Possible Implementation (How broad is the project? How feasible is it? Is it linked to current or past projects?)**

The scope for *Empowerment and Expansion of WUA Technology* in Jordan is great. It is anticipated that the activities proposed in this TNA Project and the associated TAP for this technology will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUAs all over the JV's areas. In fact, the stakeholders involved in the discussions to develop the TAP for *Empowerment and Expansion of WUA Technology* intend to draw up a full package project of all the actions listed below. The aim is to adopt a holistic approach to remove the barriers to this technology and ease its empowerment and expansion in the country.

The project is a continuation of past donor-sponsored projects, but with a holistic vision. Two projects tackled end-users' demands in respect of irrigation management in the Jordan Valley. The first started in 1998 with the so-called TO2 (Turn Out at Km 2 of King Abdallah Canal) Pilot project in the area of Adassyeh (a cooperation program between the JVA and the French Technical Cooperation – Water and Agriculture Regional Mission, based in Amman) and was focused on improving the technical premises for on-farm water distribution. The direct incorporation of farmers' views was restricted to a consultation in the course of a rapid rural appraisal in 2000. The second program in Jordan's attempts to involve farmers in irrigation management focused on a form of participation that exceeded the role of information delivery and the reception of extension messages concerning improved irrigation methods. The GTZ-funded *Water Resource Management in Irrigated Agriculture* (WMIA) project, which started in 2001, supported the creation of farmer-owned WUAs in the Jordan Valley by building on knowledge of traditional and informal cooperation structures in rural Jordan. Responsibilities transferred to the associations comprised in the first phase the self-administration of water distribution within the respective irrigation area and the handing over of the keys to the concrete boxes (farm turnouts), which contain meters and valves for each farm outlet to the farmers' fields. The WMIA project started negotiations with the farmers in fourteen pilot plots in 2002 and supported them in establishing their formal WUAs until the end of 2003. Based on the service contracts between the JVA and the WUAs responsible for retail distribution, the JVA covers the operational costs and provides the WUAs with spare parts. With the support of the GTZ (currently GIZ) project, the JVA regularly provides technical training for WUAs in the distribution of irrigation water, the maintenance of farm turnouts and monitoring, as well as assisting in building up their administrative skills. However, the reform should include both "hard" and "soft" interventions, involving inter alia strong political commitment, negotiations among stakeholders and continuous capacity-building. This initially long process can evolve into diverse processes:

re-organization of institutional arrangements in the agricultural sector, modernization of irrigation and economic changes in support of irrigation.[38] For all of the above, and as a result of systematic analyses and assessments of the barriers facing this practice, incorporating stakeholders directly involved in the JVA and GIZ, all the obstacles hindering augmentation of this experience in Jordan and the barriers preventing the fulfilment of its ultimate objectives were presented, and holistic solutions, measures and incentives proposed. The ambition for *Empowerment and Expansion of WUA Practice* in Jordan is large. It is anticipated that activities proposed in this TNA Project and the associated TAP for this technology will result in transferring and achieving full Irrigation Management Transfer (IMT) to WUA all over the JV's areas. In fact, the stakeholders involved in the discussions to develop the TAP for this practice (technology) intend to draw up a full package project of all the actions listed above in the TAP section. The aim is to adopt a holistic approach to removing the barriers to such technology and ease its empowerment and expansion in the country.

- **Project activities**

  The major project activities are all the integrated activities elaborated in the TAP for this technology above, but some more detailed actions are listed below.

  - Writing the project's concept note, full proposal, feasibility studies, and environmental and social impact studies, including a clear logical framework of components, actions, activities, outcomes, outputs, indicators, targets and budgetary aspects.
  - Submitting the proposal to funding agencies;
  - A clear logical framework of components, actions and activities will be revised in light of the latest developments after the proposal has been approved, with the outcomes, outputs, indicators, targets and budgetary aspects also being re-visited and revised.
  - Assigning a focal point to the JVA and WUA Directorate to host the activities of the project and supervise the tendering process to procure the technology.

Action 1: ***Switching from the mandate of existing JCC law governing WUAs in Jordan to a suitable law***

- *Contract a legal or regulatory specialist firm to review the current legal framework, compare it with best international practice and identify scenarios for a suitable legal framework;*
- *Organize a national workshop to present the results of the legal study and discuss the best options based on stakeholders' involvement and perspectives; come up with recommendations for the best legal set-up for governing WUAs in Jordan to present to the authority in charge for approval;*
- *Contract a legal or regulatory consultancy company or consultant to draft a suitable legal framework and submit it for approval by the institution in charge;*
- *Pilot implementation of the new legal framework, once approved, to govern WUAs in Jordan*

*Action 2****: Strengthening WUAs to perform their mandated tasks (IMT)***

- *Identify technical needs for each geographical area under the mandate of the WUAs;*
- *Identify area(s) for pilot implementation regarding the technical needs of each geographical area;*
- *Develop KPIs to monitor and evaluate the process of water management in the pilot area(s);*
- Procurement of technical needs to implement full IMT;
- *IMT Implementation in the pilot area(s).*

Action 3: ***Attaining effective means of financial sustainability for WUAs and building their capacity to develop income-generating activities and projects***

- *Contract a specialized financial and administrative capacity-building consulting firm to help WUAs attain effective means of administrative and financial sustainability;*
- *Contract a specialized consultancy company to write proposals for income-generating projects for the WUAs*
- *Implement income-generating project prototypes*

Action 4: ***Establish a program of continuous training and capacity-building and develop and activate effective coordination and communication platforms for WUAs in the JV.***

- *Conduct a study to identify the continuous training and capacity-building needs of WUAs with an emphasis on new emerging areas of need;*
- *Conduct a series of training programs (full package) covering, for example, leadership, conflict resolution, communication, time management, enhancement of skills and capacities, etc.*

Action 5: ***Capacity-building programs to empower WUAs in marketing the concept of the WUA as an innovation in PIM; building the capacity and skills of WUAs in marketing their products***

- *Contract a specialized consultancy company to develop plans for marketing the WUA concept and products;*
- *Implement selected activities from the developed plans.*

- **Timelines (What are the timelines, e.g. a quarter, a year, several years?)**

This project will run for at least four years to enable all the activities of the holistic program above to be carried out. A detailed phased timeframe for the different components of the project can be found in the TAP above.

- **Budget/Resource requirements (What is the budget? How is the project to be funded? Staff, consultants, partnerships, etc.)**

The potential sources of the budget are elaborated in the TAP above, as is a description of all the necessary consultancies.

For purposes of staffing, a focal point will be assigned to the JVA and WUA Directorate to host the activities of the project and supervise the tendering process to procure the technology.

- **Measurement/Evaluation (What tangible evaluation of accomplishments will be conducted? How will success be measured?)**

A robust M&E plan will be developed based on the GIZ's SNAP process, where the axis Monitoring and Evaluating (M&E) ranked high in the success-factor axes in Jordan. M&E will be based on a smart monitoring tool developed by GIZ and called the "MACC tool (Monitoring Adaptation to Climate Change)".

- **Possible Complications/Challenges (What are the potential challenges and complications?)**
  - Delay in securing funding beyond 2018.
  - Low buy-in of results and outcomes of legal study, and specifically low buy-in of new approved law by stakeholders
  - Weak coordination between responsible bodies in piloting *new legal framework to govern WUAs in Jordan*
  - Low cooperation/buy-in by WUAs of capacity-strengthening needs and desire to implement technical needs for each geographical area
  - Selected KPIs not representative of best management practices in the context of IWRM
  - Technical needs to implement full IMT not appropriatly identified
  - Low coordination and buy-in of *IMT implementation aspects in the pilot area(s)*
  - Weak buy-in and interest of WUA in *attaining effective means of administrative and financial sustainability*
  - Weak buy-in and interest of WUA in being trained in *attaining effective means of administrative and financial sustainability and writing proposals for such conclusion*
  - Weak buy-in and interest of WUAs in implementing *income-generating project prototypes*
  - Low cooperation/buy-in by WUAs in identifying *continuous training and capacity-building needs with emphasis on new emerging areas of need*

- Low cooperation/buy-in by WUAs in conducting *continuous training and capacity-building programs with emphasis on new emerging areas of need*
- Weak buy-in and interest by WUA in *marketing the WUA concept and products*
- Weak buy-in and interest by WUA in *marketing the WUA concept and products and implementing selected activities from the developed plans.*

However, contingency plans to overcome the above complications and challenges are elaborated in the TAP above.

- **Responsibilities and Coordination (Who does what, when and how?)**

To coordinate responsibilities and implementation, a focal point will be assigned to the JVA and WUA Directorate to host the activities of the project and supervise the process of holistic practice deployment, as well as coordination with all relevant entities.

5. TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR THE AGRICULTURE SECTOR

5.1. TAP for the Agriculture Sector

5.1.1. Agriculture sector overview

Agricultural production is closely tied to climate, making agriculture one of the most climate-sensitive of all economic sectors. As illustrated in the TNC (2014),[39] the climate risks to the agricultural sector are immediate and significant because the majority of the rural population depends either directly or indirectly on agriculture for their livelihoods. The TNC analyses demonstrated that most agricultural areas of Jordan are rain-fed, making them more vulnerable to climate change.

As elaborated in Jordan's INDCs (2015),[40] the rural poor will be disproportionately affected because of their greater dependence on agriculture, their relatively lesser ability to adapt and the high share of their incomes they spend on food. The key adaptation targets that are related to the TNA objectives are in line with the measures set out in Jordan's INDCs to respond to climate change in the agricultural/food security sector, namely:

- Setting and implementing a sustainable agriculture policy;
- Developing agronomic and crop strategies that are intended to offset, either partially or completely, the loss of productivity caused by climate change through the application of defensive tools with different temporal scales, e.g. short-term adjustments and long-term adaptations, and different spatial scales, e.g. farm, regional or national level adaptation;
- Supporting environmentally friendly agriculture and permaculture designs, as well as the conservation and sustainable utilization of plant and animals genetic resources for food and agriculture that are climate resilient and adaptive to climate change, especially landraces to improve the adaptive capacity of the rural sector to the changing environment in order to enhance food security;
- Maintenance of old Roman wells for water-harvesting purposes and establishment of new wells in rural areas;
- Use of different crop varieties and modifications to cropping patterns and crop calendars, including planting and harvesting dates;
- Implementing supplemental irrigation and water-harvesting techniques; maximizing re-use of treated waste water in agriculture; improving efficiency in water use, increasing drip irrigation in irrigated areas and utilization of saline water in the irrigation of crops tolerant to salinity;

For rain-fed areas, adaptation measures include, but are not limited to, improving soil water storage to maximize plant water availability by maximizing infiltration of rainfall; introducing conservation agriculture, which involves minimum soil disturbance and encompasses land preparation techniques that improve soil fertility; managing crop residues and tillage and conserving soil and water; and using supplemental irrigation from harvested rainwater in the critical stages of crop growth through on-farm rainwater harvesting and management, i.e. small farm ponds for micro-irrigation using drip or sprinkler irrigation systems. Larger rainwater storage structures should be constructed to provide supplemental irrigation water to a number of small farms or fields by using micro-dams. Other measures include selection of tolerant crop varieties; shifting to cultivating crops that are more tolerant to drought or have lower water requirements; and raising awareness and declarations on Climate Intelligent Agriculture, etc.

The three prioritized technologies for the agriculture sector under the TNA project in Jordan have been determined as follows:

i) Support of Water-Saving Technologies, such as Drip or Subsurface Irrigation;
ii) Water-Harvesting; and
iii) Introduction of Plant Varieties Resistant to Climate Change.

Comments on these three priority technologies are provided below:

Support of Water-Saving Technologies

Drip-irrigation technology will support farmers in adapting to climate change by improving the efficiency of the water supply. Particularly in areas subject to climate change, impacts such as seasonal droughts and drip irrigation reduce the demand for water and losses from water evaporation losses, as evaporation increases at higher temperatures. Scheduled water applications will provide the necessary water direct to the plant when required. Furthermore, fertilizer application is also more efficient since it can be applied directly through the pipes.

Drip and subsurface irrigation are both based on the constant application of a specific and focused quantity of water to soil crops. The system uses pipes, valves and small drippers or emitters to transport water from the source (i.e. wells, tanks and/or reservoirs) to the root area and applying it in accordance with particular quantity and pressure specifications. The system should maintain adequate levels of soil moisture in the rooting areas, fostering the best use of the available nutrients and providing a suitable environment for healthy plant roots systems. Managing the moisture requirement for each plant as exactly as possible, the system significantly reduces water wastage and promotes efficient use. Compared to surface irrigation, which can provide 60% water-use efficiency, and sprinkler systems which can provide 75% efficiency, drip irrigation can provide as much as 90% water-use efficiency. There is good knowledge of the technology by local stakeholders, potentially making acceptance easy.

Water-Harvesting

Small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially an issue in arid and semi-arid regions, where rainfall, though minimal, is usually very intense and often seasonal. As such, run-off and *wadi* flows can be abundant for brief periods but non-existent throughout the rest of the year.

Water-harvesting has many benefits in terms of both food security and farmers' livelihoods in arid and semi-arid regions. It facilitates high-value cash-crop production in areas that would otherwise lie fallow due to a lack of water. It improves soil fertility when applied to the fields as it contains soil silt, manure and organic matter harvested along with the water runoff from farm lands into the water conservation zones. Water-harvesting techniques, such as terracing, retention ditches, stone bunds, and trash lines, reduce soil erosion and siltation downstream, as well as recharging groundwater aquifers, which may be used subsequently to irrigate crops in the vicinity of the harvested water.

The prolonged availability of water in the soil and in the water conservation zone ensures better conditions for the formation of stable humus, which enhances nutrient availability and water-holding capacity. In soils low in organic matter, it plays an important role in capturing atmospheric carbon dioxide through increased biomass production in both the water conservation zones and the surrounding land.

The technology can help to store and use water during periods of low water and thus increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into side wadis or other areas or from evaporating. This technology covers the collection, storage and use of rainwater that falls on the ground, utilizing "micro-catchments" to divert or slow run-off so that it can be stored before it evaporates. Collection and storage infrastructure can be natural or constructed and can take many forms. These include:

- Below-ground tanks (i.e. cisterns) and excavations into which rainwater is directed from the ground surface;
- Small reservoirs with earthen bunds or embankments to contain run-off or river flow;
- Groundwater aquifers being recharged by directing water downwards.

The collection and storage of rainwater can provide a convenient and reliable water supply during seasonal dry periods and droughts. Additionally, widespread rainwater storage capacity can greatly reduce land erosion and flooding. Rainwater collection can also contribute greatly to the stabilization of declining groundwater tables.

Introduction of plant varieties resistant to climate change

The agriculture sector is highly climate-sensitive, and there exist potential adverse changes in temperature, precipitation, and frequency of extreme events (e.g. droughts, heat waves, floods) with climate change. New plant varieties that are more resistant to high temperatures and drought will enable farmers to sustain and even increase productivity.

The introduction of new cultivated species and improved crop varieties is a technology aimed at enhancing plant productivity, quality, health and nutritional value, as well as building crop resilience to disease, pest organisms and environmental stresses.

Breeding new and improved crop varieties enhances the resistance of plants to a variety of stresses that could result from climate change. These potential stresses include water and heat stress, water salinity, and the emergence of new pests. Varieties developed to resist these conditions will help to ensure that agricultural production can continue and even improve despite uncertainties about the future impacts of climate change. Varieties with improved nutritional content can provide benefits to animals and humans alike, thus reducing vulnerability to illness and improving overall health.

- Agricultural research institutions must be involved in the process in order to provide analyses and experiment with new species.
- Capacity-building is required at both the institutional level, i.e. to increase research capacity, and the organizational level, i.e. to disseminate research findings and carry out field demonstrations.
- This technology requires substantial investments in skills, labor and equipment.
- Research institutions have the capacity to ensure operation and maintenance in, for example, NCARE and national universities.
- Varieties can be tested in experimental stations and in farmers' fields.
- Farmers need to be provided with the necessary capacity-building and awareness-raising activities in order to adapt new technologies.
- The technology is strongly endorsed by experts and practitioners.

5.1.2. Action plan for water-saving technologies

5.1.2.1. Introduction

The three technologies that were prioritized earlier are:

i) *Support of Water-Saving Technologies, such as Drip or Subsurface Irrigation*;
ii) *Water-Harvesting*; and
iii) *Introduction of Plant Varieties Resistant to Climate Change*.

In the previous barrier analysis, it was found that the three technologies share some common major barriers and measures. For instance, weak capacity and a lack of information on use and advantages of the technology are some of the main barriers to the deployment of all the prioritized technologies in the agricultural sector, as is unfamiliarity with the new technologies, as the local population is accustomed to traditional irrigation and cultivation practices.

With regard to water-saving technologies, regulatory actions on the part of the government are needed regarding the system of tariffs in order to increase the efficiency of irrigation water use. The high cost of investments and infrastructure is another barrier to the widespread application of the technology. Not having access to low interest rates and long-term finance, private farmers are unable to provide sufficient investment to develop the new technologies.

Social barriers are also important, as local farmers are unaware of the economic and environmental advantages of these technologies. These include enhancing plant productivity and quality, health and nutritional value and/or building crop resilience to diseases, pest organisms and environmental stresses. The technologies also contribute to giving water a priority by improving the quality and increasing the amounts of water, as well as to the strategy of diversifying the country's economy by improving the water sector within the economic system. Also, these technologies will reduce the demand for water, as well as water losses from evaporation.

The introduction of these technologies is successfully aligned with the country's economic, social and environmental development priorities. It also contributes to the food security priority by increasing productivity, and to the strategy of diversifying the economy by increasing the weight of the agricultural sector within the economic system, as well as increasing the incomes of the rural population.
Those technologies can potentially strengthen the farmers cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases as well as by capturing new market opportunities.

5.1.2.2. Ambition for the TAP

Increasing the irrigated areas in the Jordan Valley and Highlands using water-saving technologies to 60,000 hectares by 2030. Also, expanding water-harvesting activities to the catchments of dry areas and the Badia region to deliver socio-economic and environmental benefits to arable areas.

5.1.2.3. Actions and Activities selected for inclusion in the TAP

Agricultural climate change adaptation technologies face several challenges in the fields of the economy, finance, market conditions, regulations, human skills, society and awareness, with barriers hindering its dissemination throughout the country. Therefore, specific measures are necessary in order to overcome existing barriers to the implementation of the prioritized technologies.

This section discusses the vital elements of the enabling framework that should be enhanced to improve the quality and efficacy of the technologies for transfer and diffusion to the agricultural sector.

Barriers and measure to the three technologies were discussed earlier. Table 18 below shows the main barriers and measures to be considered in the action plan for each of the three technologies.

TABLE 18. OVERVIEW OF BARRIERS AND MEASURES TO OVERCOME SUCH BARRIERS.

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	High initial investment required for purchase of various units of equipment, transport and installation costs.	Specific tax regulations to promote private-sector investments for local manufacture of water-saving technologies; Subsidized tariff on water-saving practices for irrigation should be

	Lack of economic incentives for the purchase of irrigation equipment and efficient water use -High capital investment needed to create water sources for irrigation and investments in water storage and supply infrastructure. High interest rates on loans High costs involved in renewing and maintaining the irrigation system (drip). High costs involved in the design, installation and maintenance of equipment and irrigation system networks (high labor requirement)	provided by the Ministry of Water and Irrigation in order to increase efficient use by land-owners and farmers; Provision of long-term and low-interest loans through different state funds, private sources (different banks) and international funds (IFAD) to support farmers in introducing the technology. The Agricultural Credit Corporation and the microfinance institutes in the country are willing to support this.
Market conditions	Weak market purchasing capacity	Introduce economic incentives for water-saving technologies
Legal and regulatory	Absence of specifications and regulating mechanisms	Advocate regulations
Network structures	Absence of coordination mechanism	Define roles and responsibilities for stakeholders
Institutional and organizational capacity	Weak agricultural extension services related to water-use efficiency	Agricultural extension services must be significantly improved to provide the necessary advisory services and capacity-building activities regarding advantages of the technology
Social, cultural and behavioral	Unfamiliarity with new technology	Information campaigns on the advantages of this technology must be organized by NCARE and research institutes in order to increase the capacity of farmers (both small- and large-scale) by closely involving local authorities and NGOs in the process
Information and awareness	Limited access to information and weak agricultural extension services Low level of awareness of economic and ecological advantages	Information campaigns on the advantages of this technology must be organized and funded by NCARE and research institutes in order to increase the capacity of farmers (both small- and large-scale) by closely involving local authorities and NGOs in the process
Technical	Weak capacity and lack of technical knowledge and skills of farmers on use of water-saving technologies	Capacity-building campaigns for the installation and maintenance of the system

The measures presented in the table above were found to be necessary actions as follows:

Table 19 below describes the actions and the specific activities they require.

TABLE 19. IDENTIFICATION AND DESCRIPTION OF SPECIFIC ACTIVITIES TO SUPPORT ACTIONS.

	.
Activities for Action implementation	
	Action 1: Agricultural extension services must be significantly improved to provide the necessary advisory services and capacity-building activities regarding the advantages of the technology
Activity 1.1	Design training programs (including design, implementation and maintenance) for extension staff.
Activity 1.2	Assess extension service needs.
Activity 1.3	Provide extension officers with the necessary tools (including equipment and tools for dissemination of the technology).
Activity 1.4	Conduct training activities.
	Action 2: Capacity=building campaigns (farmers)
Activity 2.1	Needs assessment
Activity 2.2	Identify centers and experts to conduct the activities
Activity 2.3	Organize field days, demonstrations, brochures and leaflets
Activity 2.4	Conduct study tours and fairs to learn from others' experiences and new technology advances.
	Action 3: Introduce economic incentives and subsidized tariffs in water-saving practices for irrigation in order to increase efficient use by land-owners and farmers
Activity 3.1	Review regulations related to water pricing by related institutes to provide incentives for water-saving technologies
Activity 3.2	Provide tax exemptions for the equipment and materials needed for innovative water-saving technologies

An overview of a comprehensive TAP for water-saving technologies is depicted in Table 20 below.

TABLE 20. TAP OVERVIEW TABLE FOR WATER-SAVING TECHNOLOGIES

Sector	Agriculture							
Sub-sector	Irrigation							
Technology	Water-saving technologies							
Aim	Increase irrigated areas in the Jordan Valley and Highlands to 60,000 hectares by 2030 using water-saving technologies							
Benefits	• Overcome water scarcity • Increase water-use efficiency • Enhance climate change resilience of communities • Create at least 5,000 jobs. • Improve farmers' and farming community's livelihoods. • Improve incomes. • Reduce water run-off through deep percolation or evaporation • Less groundwater abstraction • Pollution conditions may become less favorable for the onset of diseases, including fungus • Reduced production costs • Increased yield and quality.							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time-frame**	**Risks**	**Success criteria**	**Indicators for monitoring implementation**	**Budget per activity**
Action 1 Agricultural extension services must be significantly im-	Activity 1.1. Design training programs (including design, implementation and maintenance) for extension staff.	International agencies, donors	Universities and private-sector experts	2017-2018	Lack of funding	After three years, agricultural extension services related	Training programs designed	25,000

proved to provide necessary advisory services and capacity-building activities regarding advantages of the technology	Activity 1.2. Assess extension service needs.	Government	NCARE	2018-2019	N/A	to this technology significantly improved	Extension service needs identified	5000
	Activity 1.3. Provide extension officers with necessary tools (including equipment, tools for dissemination of technology).	?? Government	NCARE	2018-2020	Lack of funding	After ten years, at least 70% of extension officers able to disseminate the technology, as intended	Necessary tools made available and used by extension officers	100,000
	Activity 1.4. Conduct training activities.	Donors	NCARE, experts from universities and private sector	2018-2020			Technical staff and farmers trained	50,000
Action 2 Capacity-building campaigns (farmers)	Activity 2.1. Develop new curriculum for engineer education programs	Government, donors	Universities	2018-2019	Lack of funding Number of skilled personnel capable of curriculum development	New courses related the technology have been incorporated into the engineering education curriculum	Curriculum developed	10,000
	Activity 2.2. Conduct needs assessment	Government, donors	NCARE	2017-2018			Training needs assessment conducted	5000
	Activity 2.3. Identify centers and experts to conduct the activities	Government, donors	NCARE and private sector	2017-2018			Experts' roster in place	1000
	Activity 2.4. Organize field days, demonstrations, brochures and leaflets	Government, donors	NCARE and private sector	2018-2019			Publications and field days conducted in major areas	50,000

Action 3 Economic incentives and subsidized tariffs in water-saving practices for irrigation in order to increase efficient use by landowners and farmers	Activity 3.1. Review regulations related to water pricing by related institutes to provide incentives for water-saving technologies	Government	MoA, MWI MoA, MWI, and NCARE and private sector	2018-2019	Reluctance by government and legislators	Government acceptance		5000
	Activity 3.2. Tax exemption for equipment and materials needed for innovative water saving technologies		MoA, MWI MoA, MWI, and NCARE and private sector	2018-2019				-

5.1.3. Action Plan for Water Harvesting Technology

5.1.3.1. Ambition for the TAP

Scale of implementation of prioritized technology: catchments in dry areas and the Badia region. Approximate area 10,000 hectares.

5.1.3.2. Actions and Activities selected for inclusion in the Water-Harvesting TAP

A summary of the barriers and measures to overcome such barriers are presented below in Table 21.

TABLE 21. OVERVIEW OF BARRIERS AND MEASURES TO OVERCOME THESE BARRIERS.

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	Insufficient government support for research activities limits diffusion of technology. High capital costs for large-scale harvesting projects. Limited access to financial sources	Increase government fiscal support to R & D institutions; Enable provision of long-term and low-interest loans or grants through state funds, private sources (different banks) and international funds (WB, IFAD, GEF, GCF, Adaptation Fund); Develop specific subsidy mechanism to promote application of the technology.
Market conditions		
Legal and regulatory	Lack of support for research institutions (state and private) to provide deeper analysis for selection of the most relevant technology.	Improve legislative and regulatory reforms to stimulate introduction of the technology.
Network structures	Lack of stakeholder network for the development and transfer of the technology.	Support the creation of a stakeholder network for the development and transfer of the technology through a network of technical experts.
Institutional and organizational capacity	Inadequate capacity and lack of skills of existing research institutions.	Develop support policies (specific subsidy mechanism) to encourage local deployment of the technology.
Human skills	High human skills requirement (low capacity for sustainable use of technology).	Support capacity-building activities for technology development and transfer through focused training.
Social, cultural and behavioral	Possible conflicts between communities over water access rights;	Encourage community co-management

	Land tenure and ownership problems which resulting in division of land among owners into small areas. This creates conflicts over land use.	
Information and awareness	Inadequate awareness of new technology.	Information campaigns to raise public awareness of the advantages of the applied technology.
Technical	Limited technical know-how by farmers regarding use of this technology.	Implementation of pilot projects to demonstrate the advantages of the technology.

Actions selected for inclusion in the Water-Harvesting TAP are presented the table below (Table 22).

It was found necessary to introduce the measures presented in the table above as actions, as follows:

- Action 1: Implement pilot projects to demonstrate the advantages of the technology;
- Action 2: Enable the provision of long-term and low-interest loans or grants through state funds, private sources (different banks) and international funds (WB, IFAD, GEF, GCF, Adaptation Fund);
- Action 3: Support the creation of a stakeholder network for the development and transfer of the technology (through a network of technical experts).

Activities identified for the implementation of selected actions are presented in Table 22 below.

TABLE 22. ACTIVITIES FOR ACTION IMPLEMENTATION

	Action 1: Implementation of pilot projects to demonstrate the advantages of the technology
Activity 1.1	Designate areas for water-harvesting pilot sites
Activity 1.2	Design and conduct cost-benefit analysis for technology
Activity 1.3	Implement the most suitable water-harvesting technique
Activity 1.4	Conduct on-site training and demonstrations
Activity 1.5	Disseminate technology needs and advantages
	Action 2: Enable provision of long-term and low-interest loans or grants through state funds, private sources (different banks) and international funds (WB, IFAD, GEF, GCF, Adaptation Fund);
Activity 2.1	Explore sources of funding (national and international funding agencies)
Activity 2.2	Training in preparation of proposals for funding
Activity 2.3	Prepare proposals to be submitted to fundraising programs

	Action 3: Support the creation of a stakeholder network for the development and transfer of the technology through a network of technical experts
Activity 3.1	Create a platform of national water harvesting experts, including major stakeholders (government and non-government organizations).
Activity 3.2	Exchange information and lessons learned, and coordinate activities (field days, campaigns, workshops and conferences).

TABLE 23. TAP OVERVIEW TABLE FOR WATER HARVESTING TECHNOLOGIES.

Sector							
Sector	Agriculture						
Sub-sector	Irrigation						
Technology	Water-harvesting technologies						
Ambition	In catchments in dry areas and the Badia region. Approximate area 10,000 hectares.						
Benefits	•Plays an important role in capturing atmospheric carbon dioxide through increased biomass production both in the water conservation zones and the surrounding land. • Increased resilience to water scarcity, especially in areas with potential risks of drought and high temperatures. • Contributes to water security priority by increasing water availability • Improves living standards of rural population and sanitation • Reduces use of drinking water from centralized system for other purposes • Reduces health and environmental issues related to lack of sanitation • Reduces soil erosion and siltation downstream • Recharges groundwater aquifers • Use for irrigation of crops in the vicinity of the harvested water • Improves soil fertility • Creates jobs to support construction of water-harvesting storage. • Leads to increases in incomes of rural population • Increases water productivity • Facilitates high-value cash-crop production. • Increases agricultural productivity and reduces depletion of groundwater resources •						
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time-frame**	**Risks and contingency measures**	**Indicators for monitoring implementation**	**Budget per activity**
Action 1 Implementation of pilot projects to demonstrate	Activity 1.1. Designate areas for water-harvesting pilot sites	International agencies, donors	MoA ,MWI NCARE	2017-2018	Risk: lack of funding Measures:	Potential areas designated	1000

the benefits of the technology	Activity 1.2. Design and conduct cost benefit analysis for technology	Government	MoA, MWI NCARE	2018-2019	Prepare solid proposals Approach multiple donors Consider local funding sources	Cost benefit analysis prepared	3000
	Activity 1.3. Implement the most suitable water-harvesting technique	Government and donors	MoA (L), MWI NCARE	2018 2019		Water-harvesting techniques implemented	100,000
	Activity 1.4. Conduct on-site training and demonstrations		MoA (L), MWI NCARE	2018 2019		Training programs conducted	20,000
	Activity 1.5. Disseminate technology needs and advantages		MoA (L), MWI NCARE	2019 2020			5000
Action 2 Enable provision of long-term and low-interest loans or grants through state funds, private sources (different banks) and international funds (WB,	Activity 2.1. Exploring funding sources (national and international funding agencies)	Donors	MoA, MoENV	2017-2018	Risk: lack of funding proposals Approach multiple donors	Data on funding sources prepared	--
	Activity 2.2- Training in preparation		MoA, MoEnv	2018-2019	Risk: lack of skilled human resources	Training program conducted	5000

IFAD, GEF, GCF, Adaptation Fund)	of proposals for funding				Measure: consider human resources mobilization among institutions		
	Activity 2.3 Prepare proposals to be submitted to fundraising programs		MoA, MoEnv	2019-2020		Project proposals developed	10,000
Action 3 Support the creation of a stakeholder network for the development and transfer of the technology through a network of technical experts	Activity 3.1. Create a platform including major stakeholders (government and non-government organizations).	Government	MoA	2018 2019	Risk: weak level of interest Measure: conduct focus-group meetings and awareness campaigns	A relevant unit established	--
	Activity 3.2. Exchange information and lessons learned and coordinate activities (field days, campaigns, workshops and conferences).	Government	MoA	2018- ongoing		Information disseminated to relevant stakeholders	1000

5.1.4. Action Plan for Plant Varieties that are Resilient to Climate Change

5.1.4.1. Ambition for the TAP

Scale of implementation of prioritized technology: rain-fed agricultural areas where cereal-legume cropping system is predominant. Approximate area 5000 hectares.

5.1.4.2. Actions and Activities selected for inclusion in the TAP

A Summary of the barriers and measures to overcome such barriers are presented below in Table 24.

TABLE 24 OVERVIEW OF BARRIERS AND MEASURES TO OVERCOME THESE BARRIERS.

Categories	Identified barriers	Measures to overcome barriers
Economic and financial	• Insufficient governmental and non-governmental support for enhancement research activities and infrastructure. • Weak or lack of financial support for local farmers to adopt such varieties and technologies. • Limited or inadequate financial support for the production and dissemination of these varieties.	• Increase government fiscal support to R & D institutions and upgrade infrastructure. • Enable provision of long-term and low-interest loans or securing grants through state funds, private sources and international funds (WB, IFAD, GEF, GCF, Adaptation Fund and GCF). • Develop specific subsidy mechanisms and incentives for farmers to promote the utilization and dissemination of the technology.
Market conditions	• Limited availability of climate-resilient varieties for resource-poor farmers in the market.	• Identify new genetic resources with improved resilience to climate change. • Breeding and dissemination of new varieties with improved tolerance to different stresses to cope with future climate change scenarios.
Legal and regulatory	• Lack of regulations for the adoption of climate change-resilient varieties produced by new breeding technologies.	• Develop new regulations for adoption of technology and promote their release and dissemination to farmers.
Network structures	• Inadequate coordination nationally and with international agencies and research institutes.	• Strengthen national and international research network program in order to adopt effective practices throughout the world.

Institutional and organizational capacity	• Current capacities and infrastructure of governmental research institutions are not up to date and do not meet requirements.	• Improve institutional capacity through staff enhancement programs, training courses and deployment of modern tools and technologies.
Human skills	• Current capacities of researcher and extension specialists are weak.	• Improve agricultural extension services and enhance them by bridging with leading national and international research institutes in order to provide necessary advisory services and capacity-building activities to researchers and farmers.
Social, cultural and behavioral	• Lack of community-based approaches for the effective utilization of resilient varieties as income-generating activities.	• Improved community-based approaches for the effect utilization of resilient varieties.
Information and awareness	• Inefficient or lacking agricultural extension services, documentation, knowledge and benefit-sharing system, and databases. • Public awareness of the benefits of new adapted varieties is lacking.	• Transfer knowledge and increase public awareness regarding the benefits of improved varieties through the media (private, public and social), field days, on-farm demonstrations and workshops. • Information campaigns on the advantages of the applied technology must be organized and funded in order to increase the capacity of farmers (both small- and large-scale) by closely involving local authorities and NGOs in the process
Technical	• Lack of studies on national germplasm material with climate change resilience potential. • Weak national breeding programs for the production of climate change-resilient varieties.	• Conduct research in the field of germplasm conversation, characterization and their utilization for climate change resilience. • Establish modern breeding programs to produce climate change-resilient varieties in collaboration with multinational and international organizations.

Activities identified for implementation of the selected actions are shown in Table 25, which describes the actions and the specific activities they require.

TABLE 25. IDENTIFICATION AND DESCRIPTION OF SPECIFIC ACTIVITIES TO SUPPORT ACTIONS

Identification and description of specific activities to support actions	
Activities for Action implementation	
	Action 1: **Establish modern breeding programs to produce climate change-resilient varieties in collaboration with multinational and international organizations**
Activity 1.1	Identify, evaluate, characterize and conserve genetic resources (establish pre-breeding program)
Activity 1.2	Develop modern breeding programs to produce climate change-resilient varieties
Activity 1.3	Introduce modern tools and new technologies to support national breeding programs
Activity 1.4	Use CGIAR centers, international nurseries and other collaborators' materials to identify climate change-resilient varieties
Activity 1.5	Improve seed production system, participatory approaches and disseminations strategies
Activity 1.6	Capacity development and improvement of current existing national breeders and researchers
	Action 2: **Develop specific subsidy mechanisms and incentives for farmers to promote the use and dissemination of climate-resilient varieties**
Activity 2.1	Establish a free of charge seed distribution system for climate-resilient varieties.
Activity 2.2	Launch a rewards program for the best farming practices using climate change-resilient varieties.
Activity 2.3	Establish a subsidy mechanism to promote the cultivation of climate change-resilient varieties.
	Action 3: **Strengthening institutional capacity through staff enhancement programs, training courses and deployment of modern tools and technologies**
Activity 3.1	Scholarship programs for national researchers and young breeders to obtain graduate degrees in the fields of climate change, genetic resources and breeding
Activity 3.2	Participation in international training courses in collaboration with leading national and international institutes
Activity 3.3	Strengthen capacity-building and adoption of modern technologies in educational and training systems
	Action 4: **Transfer knowledge and increase public awareness regarding the benefits of improved varieties through media (private,**

	public and social), field days, on-farm demonstrations and workshops
Activity 4.1	Workshops, field days and on-farm demonstrations for climate change-resilient varieties
Activity 4.2	Increase public awareness through governmental and private media and social media
Activity 4.3	Empower local community unions and women, networking and farmers' schools.

An overview of the water-harvesting technologies action plan is given in Table 26 below.

TABLE 26 TAP OVERVIEW TABLE FOR PLANT VARIETIES RESILIENT TO CLIMATE CHANGE

Sector	Agriculture							
Sub-sector								
Technology	Plant Varieties Resilient to Climate Change							
Ambition	Rain-fed agricultural areas where cereal-legume cropping system is predominant. Approximate area 5000 hectares.							
Benefits	• Improved tolerance to biotic and abiotic stresses • Improve livelihood of poor-resource farmers • Reduce the use of pesticides and fertilizers • Reduce water consumption • Biodiversity conservation • Improved poor farmers income and enhance national food security							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time-frame**	**Risks and contingency measures**	**Success criteria**	**Indicators for monitoring implementation**	**Budget per activity**
Action 1 Establishment of modern breeding programs to produce climate change-resilient varieties in collaboration with multinational and international organizations	1.1 Identification of genetic resources and their evaluation, characterization and conservation (pre-breeding programs); registration of new varieties	Treaty Fund Public Fund Adaptation Fund UNFCCC Scientific Research Fund	NCARE and Jordanian universities and CGIAR centres, UPOV, MOA	2017 2019	Risk: lack of funding Measure: prepare solid proposals Approach multi-donors and private sector	Discover climate resilient traits and crops	Availability of breeding material adapted to climate change, tolerant to stresses, enhance food security under changing environment; conservation of plant genetic resources for food and agriculture	1,000,000

							(PGRFA) *In-situ* and *Ex-situ* (gene bank)	
	Activity 1.2. Establish and develop breeding programs for climate change-resilient varieties suitable for dry areas	FAO (Treaty Fund); UNFCCC	NCARE and Jordanian universities and CGIAR centres	2017 2025	Lack of awareness by policy–makers; lack of funding	Release new varieties resilient to climate change and able to tolerate stresses	Breeding program established at NCARE	1,500,000
	Activity 1.3. Introducing modern tools and new technologies to support national breeding programs	USAID, European Union, UNFCCC	NCARE and Jordanian universities and CGIAR centres	2018-2019	Risk: lack of funding; lack of new technology; lack of qualified staff Measure: Consider multi-donors -Cooperate with local and regional research institutes	Availability of funds to introduce new technology; capacity-building	Establishment of modern national breeding program with qualified staff	250,000

	Activity 1.4. Utilization of CGIAR centres, international nurseries and other collaborators to identify climate change-resilient varieties	ICARDA , FAO (Treaty Fund) Biodiversity International, Trust Diversity Fund, UNFCCC	CGIAR centres	2018-2022	Weak collaboration and involvement of CGIAR centres in Jordan's national breeding program and PGR. Measure: create networks and platforms	Networking with CGIAR Centres, documentation and utilization of plant genetic resources (PGR) in the breeding program of CGIAR Centres	Integration and utilization of local plant genetic resources in CGIAR Centres' nurseries breeding programs	100000
	Activity 1.5. Improvement of seed production system and participatory approaches and dissemination	ICARDA Public Fund, FAO, UNFCCC, local finance	NCARE, MOA , Jordan Cooperative Corporation (JCC)	2020-2025	Risk: lack of funding, lack of good-quality and adapted pure seed for distribution to local	Support for seed production system and involvement of farmer's varieties (landraces) within it	Dissemination of high-quality and adapted pure seed at good prices for vulnerable farmers	1,000,000

					farmers at a good price Measure: Approach private sector for funding			
	1.6. Capacity development and improvement of current existing national breeders and researchers	Local finance from capacity-building program in MOA, NCARE, MoEnv, Scientific Research Fund	NCARE, Jordanian universities and CGIAR centers	2020-2025	Lack of highly qualified traditional and modern breeders and researchers, lack of local finance Measure: cooperate with local and regional research centers	Availability of finance, establish national capacity-building program for national breeders and researchers	Well-qualified national breeders and researchers in the field of crop improvement	250000
Action 2 Develop specific subsidy mechanisms and incentives	Activity 2.1. Establishment of a free of charge seed distribu-	Local finance, supported projects, FAO	Moa, JCC, MoEnv	2017-2025	Risks: lack of funding	Establish of community-based seed production	Food availability per person	--

to the farmers to promote the utilization and dissemination of the climate resilient	tion system for climate-resilient varieties				Lack of public awareness Measures: lobby for government funding conduct awareness campaigns	system supported by government.		
	Activity 2.2. Launching a rewards program for best farming practices using climate change-resilient varieties	Local finance, private sector, local bank	Moa, NCARE MoEnv	2018-2025		Pioneer farmers, pioneer researchers and breeders	Publicly advertise the rewards; distribution of rewards	5000
	Activity 2.3. Establishment of a subsidy mechanism to promote climate change-resilient varieties for cultivation	Local finance, private sector, local bank	Moa, MoEnv, NCARE	2020-2025		pioneer breeder , pioneer farmers, pioneer research centre	Distribution of awards	---
Action 3 Strengthening institutional capacity	Activity 3.1. Participation in international training courses in collaboration with leading institutes	Local Finance, supported projects	MoA, NCARE, MoEnv	2018-2020	Risks: lack of funding Measure: consider donors and private-sector investors	Well-trained and qualified breeders and researchers	Involvement of trained and expert breeders and researchers in the local capacity-building program	20,000
Action 4 Knowledge	Activity 4.1. Workshops, field days, on-	NCARE, MOA , universities	NCARE, MOA Pioneer farmers	2018-2020	Risks:	Capacity-building for		??

transfer and increase public awareness regarding the benefits of improved varieties	farm demonstrations of climate change-resilient varieties				lack of funding Measures: include activities in the yearly budget for the institutes involved	vulnerable groups	Adoption of climate resilient varieties; adapted communities; enhance food security under changing environmental conditions	
	4.2 Increase public awareness through governmental and private and social media	NCARE, social media CBOs, NGOs		2018-2020	Risks: lack of proper communication methods			5000
	4.3 Empowerment of local community unions; networking and farmer's schools	NCARE and CBOs, NGOs ,	Local finance, supporting agencies	2018-2020	Participation of community Measures: conduct awareness campaigns	Strengthen participation of CBOs	Strengthen team-building work	5000

5.2. Project Ideas for Agriculture Sector

Project 1: Introducing innovative irrigation-saving technologies.

Introduction/Background:

Jordan is one of the world's most water-scarce countries. Water scarcity is a leading constraint in the agriculture sector. The region is heavily dependent on seasonal rainfall; years of drought reduce yields sharply and leave smallholders food-insecure. Climate change impacts are expected to exacerbate water scarcity in Jordan further, negatively affecting agriculture, a sector that is one of the main consumers of water in the country.

In a country facing such a significant imbalance between limited supplies and ever-growing demand, increasing efficiency of water use is imperative. This is especially true for the agricultural sector, which consumes significant proportions of the national water supply and is central to the Jordanian economy.

Objectives:

The project aims to increase the resilience of Jordan's water system to climate change impacts, acknowledged to be a key resource for agricultural production.

- To reduce the vulnerability to climate change of the agricultural system in Jordan, particularly from its impacts on water resources, by testing innovative and efficient water-use technologies.
- To promote technically reliable, economically competitive, clean and sustainable irrigation technology for the agricultural sector in different agro-climatic production regions in Jordan
- To create awareness among the farming community of the need to conserve resources and help them to overcome their reluctance to adopt new technologies.

Outputs:

- Identification, implementation and expansion of irrigation technologies in Jordan
- Enhancing farmers' capacity to install, use and maintain the selected technologies
- Increasing awareness at the national and local levels of the potential of selected technologies as an adaptation measure
- General campaign at the national level using public media, events and workshops
- Targeted campaign implemented in the project pilot areas using multimedia material, seminars and study tours

Relationship to the country's sustainable development priorities:

The shift towards irrigated agriculture to meet the country's food requirements needs to be managed very carefully in light of the country's scarce water resources. Currently, irrigated agriculture consumes about 60 percent of these resources, a share that is expected to decrease as water will be prioritized for domestic and industrial uses. Research in Jordan indicate that an increase of temperature of 2ºC would increase irrigation demand by 18 percent, while a 10 percent reduction in precipitation would increase the demand for irrigation by approximately 5 percent.

Project Deliverables e.g. Value, Benefits and Messages:

Irrigated agriculture generates 90% of all agricultural value in Jordan from the 40% of national cropland which is irrigated. In addition, it provides significant rural employment, improves nutrition, generates substantial export earnings, and serves as the backbone of the Jordan Valley economy. At the same time, it accounts for more than half the Kingdom's annual water withdrawals. The irrigated area has expanded by more than 50% over the past sixteen years, driven by growth in groundwater irrigation in the highlands, where it plays a major role in depleting the high-value water resource stored in highland aquifers.

Project Scope and Possible Implementation:

The project will promote technically reliable, economically competitive, clean and sustainable irrigation technology for the agricultural sector in different agro-climatic production regions in Jordan and create awareness among the farming community of the need to conserve resources and help them overcome their reluctance to adopt new technologies.

Project activities:

The key activities are:

- Identification of implementation sites in proposed irrigated areas
- On-farm system design and preparation of required infrastructure
- Technical installation of irrigation technology in selected farms
- On-farm continuous technical support in demonstration farms
- Training of trainers and extension workers
- Training of targeted farmers in selected areas
- Designing the awareness campaign
- Delivering the awareness campaign at the pilot site and at the national level

Timeline:

- Three years from 2018-2020.

Budgetary/Resource requirements:

- Estimated budget: JD 2,500,000 to be funded by international donors and funding agencies through grants and government co-financing.

Measurement/Evaluation:

- The main indicator for evaluation purposes is the reduced vulnerability of the agricultural system in Jordan to climate change, particularly with regard to the impacts of climate change on water resources compared to the situation before project intervention.

Possible Complications/Challenges:

- Financial and human resources
- Lack of funding
- Lack of skilled human resources

Responsibilities and coordination:

- Ministry of Agriculture
- Academic and Research Institutes
- Ministry of Water and Irrigation

Project 2: Rain Water Harvesting for Agricultural Uses

Introduction/Background:

Jordan is one of the world's most water-scarce countries. Water scarcity is a leading constraint in the agriculture sector. The annual rate of rainfall in the project target areas range between 250 and 400 mm. Water in the targeted areas is the most important factor for agriculture. This project will help improve the rainwater harvesting systems in the targeted areas through the construction of 1500 cisterns.

The proposed project will complement the MoA's strategic plan by increasing the productivity of the agricultural unit and improving access to water. The cisterns will act as a supplementary water source for the irrigation of plants and livestock consumption. This will assist in reducing the effects of drought and improve the resources and livelihoods of the targeted households.

Objectives:

The project aims to increase the resilience of Jordan's water system to climate change impacts through the following objectives:

- To harvest and store rainwater for summer use (for irrigation and livestock
- consumption).
- To increase productivity in the warm and dry seasons.
- To increase the total agricultural area in the Bethlehem Governorate.
- To reduce the effects of drought.
- To combat the prevalence of drought in the area.
- To assist in reducing water scarcity problems, especially during the summer season.
- To improve the livelihood of the targeted families.

Outputs:

- 1500 cisterns for collecting and storing rainwater constructed in the targeted
- areas.
- Rainwater harvesting and storing capacity improved.
- Productivity of 1000 hectares of cultivated land increased by utilizing supplementary irrigation.
- General campaign at the national level using public media, events and workshops.
- Targeted campaign implemented in the project pilot areas using multimedia material, seminars and study tours.

Relationship to the country's sustainable development priorities:

The project will integrate climate change concerns and the related need to promote effective water-harvesting options in relevant national development plans, policies and adaptation measures (focusing on

water supply, management and particularly water-harvesting techniques) and feeding these and additional measures into the local water plans promoting the development of water harvesting in Jordan and its fully fledged integration into the national water budget.

Project Deliverables e.g. Value, Benefits and Messages:

Water-harvesting is particularly advantageous in the dry environments of the country, where low and poorly distributed rainfall normally makes agricultural production impossible. Provided other production factors such as soils and crops are favorable, water-harvesting can make farming possible despite the absence of other water resources. In rain-fed areas, where crops can be produced but with low yields and a high risk of failure, water-harvesting systems can provide enough water to supplement rainfall and thereby increase and stabilize production.

Project Scope and Possible Implementation:

The project will target several localities in three Agro-Eco zones clusters of the rain-fed areas of Jordan with a total of 1500 beneficiaries.

Project activities:

The key activities are:

- Launching the project in partnership with community committees
- Constructing 1500 cisterns and providing beneficiaries with the necessary technical support and agricultural extensions
- Training of trainers and extension workers
- Training of targeted farmers in selected areas
- Designing the awareness campaign
- Delivering the awareness campaign at the pilot site and at the national level
- Supervising, monitoring and evaluating the implementation process
- Preparing the final reports (technical and financial) and disseminating the results.

Timeline:

- Three years during 2018-2020.

Budget/Resource requirements:

- Estimated budget: the total estimated project budget is US $3,500,000.
  25% of the construction costs for the cisterns will constitute the beneficiaries' contribution.
- Funding source: to be funded by international donors and funding agencies through grants and government co-financing.

Measurement/Evaluation:

- The main indicator for evaluation is reduced vulnerability of the agricultural system in Jordan to climate change, particularly with regard to the impacts of climate change on water resources compared to the situation before project intervention.

Possible Complications/Challenges:

- Financial and Human resources
- Lack of funding
- Lack of skilled human resources

Responsibilities and coordination:

- Ministry of Agriculture
- Academic and Research Institutes
- Ministry of Water and Irrigation

Project 3: Implementing Modern Breeding Tools to Accelerate Production of Crop Varieties Resilient to Climate Change

Introduction/Background

- Climate change and associated climatic variability are growing concerns affecting many regions around the world, and they are expected to affect agriculture and farmers' livelihoods in dry areas, including in Jordan. Dryland farming systems around the world are expected to be severely affected by the adverse effects of climate change due to the scarcity of water and extreme temperature events. To cope with such conditions, there is an urgent need to produce new improved cultivars with enhanced productivity to mitigate and adapt to climate change.
- In this proposed study, an integrated approach that includes different modern breeding tools, including molecular, phenotypic and informatics, will be adopted to characterize genetic resources that are resilient to climate change with a special emphasis on two major cereal crops: barley and wheat. The study will seek to upgrade the current capacities of national breeding programs and to implement modern technologies. Accordingly it will benefit from long-lasting partnerships between different national and international organizations. This will help in accelerating the delivery of new crop varieties that are adapted to climate change-related challenges, with a particular emphasis on the use of modern tools, information exchange, technology transfer and capacity-building.

Objectives

1- Identification of climate-resilient wheat and barley germplasm.
2- Adoption of modern breeding technologies to accelerate the delivery of climate change-resilient wheat and barley varieties.
3- To enhance the capacities of current breeding programs through facilities-upgrading and the adoption of modern tools and training.

What are the outputs, and are they measurable?

1- Genetic resources for climate change-resilient wheat and barley using modern breeding tools are identified (Measure: at least five wheat and five barley genotypes identified and used in breeding programs).

2- National breeding programs based on modern genomics, phenotyping and informatics tools are established (Measure: current breeding programs upgraded by introducing modern molecular marker tools, new phenotyping technologies and informatics).
3- Increased capacity of national institutions and breeders in using modern breeding tools to produce climate change-resilient varieties (Measure: training courses in the field of modern breeding to be conducted, with at least four post-graduate degrees for national scientists and breeders).

Relationship to the country's sustainable development priorities

- The identification of new lines with improved resilience to climate change and associated conditions is needed for better food security and sustainable productivity. The upgrading of the capacities of current national breeding programs through the adoption of new tools will accelerate the production of improved varieties that are adapted to climate change. This will eventually improve the productivity of crops in smallholder farming systems and improve the livelihoods of low-income communities in the region that are currently suffering from climate change-associated conditions such as drought and heat. Finally, poor farmers growing wheat and barley in a drylands environment will be the ultimate beneficiaries of this project.

Project Deliverables e.g. Value, Benefits and Messages (Why is it important and necessary?)

Messages:

- This initiative will address how knowledge of crop genetics can assist breeding to accelerate the production of climate-resilient crop varieties through the identification of new alleles in national germplasm that possess potential drought- and heat-adaptive traits using modern tools. This will help identify important genes in the national germplasm that are associated with stress tolerance and adaptation to dry and hot environments.
- Furthermore, upgrading the capacities of current breeding programs by introducing recent developments in genomics, phenomics and informatics will help breeders and scientists to select their material precisely and aid in accelerating the delivery of climate-smart crop varieties to farmers.

Value:

- This exotic material and the adoption of new breeding technologies will increase the capacities of national breeding programs to adapt wheat and barley to environmental variability with a particular emphasis on heat and drought. In the long term this will help in producing varieties with improved resilience to climate change conditions and this achieve longer term changes in low-income communities, resulting in improved food security and livelihoods for poor farmers.

Benefits:

- The utilization of modern breeding tools to produce climate-resilient wheat and barley germplasm is expected to contribute to enhanced crop production and food security in Jordan, as well as improving the livelihoods of tens of thousands of poor farmers. The anticipated results will be presented to national decision-makers to promote the adoption of any newly released climate-resilient varieties in their future plans. Finally, poor farmers growing cereals in dryland environments will be the ultimate beneficiaries of this project.

Project Scope and Possible Implementation

- In Jordan, the impacts of climate change on rain-fed agriculture are clear and will affect dryland mixed systems by excluding wheat and barley cultivation. Therefore, the proposed project is establishing a strategy to accelerate the genetic gains in the national breeding program that come from the use of modern tools, including Marker Assisted Breeding, to produce heat- and drought-tolerant varieties. Accordingly, the strategic goal of this project is to facilitate the government's food-security goals for wheat and barley by providing breeders and other plant scientists with the tools they need to deliver new varieties that are adapted to climate-related challenges.
- The scope of the project at the national level is to target current governmental breeding activities implemented by NCARE and the University of Jordan in collaboration with international centres (CIMMYT and ICARDA) in order to breed and introduce improved wheat and barley varieties for use by local farmers.
- The project will be based on upgrading the current capacities and ongoing breeding activities of national programs, its feasibility stemming from the introduction of new molecular and phenotyping tools to existing facilities that is currently lacking but is possible to implement based on funding.

Project activities

1. Identification, evaluation and characterization of genetic resources:

- New and existing genetic resources (landraces and cultivars) of Jordanian wheat and barley that are expected to possess resilience to climate change (with a special emphasis on drought and heat stress tolerance traits) will be retrieved from the material conserved and maintained within national and international gene banks.
- The genetic diversity in the collected wheat and barley germplasm will be assessed by using molecular markers and different bioinformatics tools. The two panels will be genotyped using the Illumina iSelecte 15k SNP chip, and the genetic diversity analysis will be carried using different software, such as DARWin, STRUCTURE and TASSEL.
- The wheat and barley genetic material will be evaluated for two years regarding their agronomical performance and yield potential at different research stations across Jordan. The research stations involved will be selected where drought and heat stresses are frequent and expected.
- New phenotyping technologies for assessing drought and heat tolerance in the field will be deployed, including thermal imaging, photosynthesis parameters, etc.
- Furthermore, the two panels will be evaluated for stress tolerance in pots under controlled greenhouse conditions using different modern phenotyping technologies related to stress tolerance.
- Molecular markers associated with yield performance under heat and drought conditions in the wheat and barley panels will be identified by using the association mapping analysis for drought and heat stress tolerance related-traits. For this purpose, the genotypic and phenotypic information will be subjected to different bioinformatics tools to identify true and significant marker-trait associations.

2. Introducing modern tools and new technologies to support national breeding programs.

- The most promising lines and the SNP molecular markers that are identified will be used in national wheat and barley programs to accumulate favourable traits associated with high yields and stability under drought and heat stresses. For this purpose, the most informative SNP sequences

that are identified will be converted into KASP® markers suitable for high-throughput genotyping assays.

- Breeding populations will be developed using existing and released varieties, and promising breeding lines will be obtained from international nurseries (CIMMYT and ICARDA material) and the most promising accessions identified above.
- An accelerated breeding-cycle platform based on short-life cycling and plantation in controlled greenhouses and tissue culture techniques will be implemented to produce several generations per year.
- Furthermore the utilization of newly identified simple nucleotide poly-morphism (snp) markers using the association mapping approach (above), alongside existing molecular markers associated with major agnomical traits, will be deployed using modern genotyping platforms to allow precise selection of material and their adoption.
- The resulting lines will be tested under field conditions in different stations across Jordan, and the most promising lines with improved drought and heat tolerance will be further selected and considered for release and registration.

3. Capacity development and the development of a national information sharing system

- Training of young researchers and breeders from national institutes in genetic resources management, breeding, biotechnology and informatics.
- Incorporation of graduate students, with scholarships for the breeding-related activities described in this project.

Timelines

- Project duration is eight years.

Budget/Resource requirements

- Project's total budget is estimated at around USD 2 million.
- Funding source: to be funded by international donors and funding agencies through grants and government co-financing.

Measurement/Evaluation (What tangible evaluation of achievements will be conducted? New wheat and barley genetic material with improved tolerance to different stresses associated with climate change. For this purpose, at least five wheat and five barley accessions with improved resilience to climate change-associated conditions will be identified.

- New SNP markers associated with stress tolerance will be identified (at least five mapped quantitative trait locus QTLs will be identified and used).
- Upgrading of existing facilities associated with national breeding programs, including modern molecular laboratories, controlled greenhouses for accelerated breeding cycles and upgrading phenotyping technologies in field stations.
- At least four students having graduated with a Master's or Ph.D. degree in the field of plant breeding and biotechnology.

Possible Complications/Challenges

The proposed project will depend on coordination between different parties to build an integrated approach for the delivery of climate change-resilient crop varieties. Therefore, a proper planning and task management system will be needed.

Responsibilities and Coordination

- National Centre for Agricultural Research and Extension
- University of Jordan
- Jordan University for Science and Technology and ICARDA

Management planning

Risks and contingency planning

A detailed description of the identified risks and proposed contingency plans can be found in the TAP overview tables for each technology.

6. Cross-cutting Issues

Bearing in mind that the top four sectors that have been prioritized and assessed with regard to TAN in Jordan were water, agriculture, energy and transport, the obvious cross-cutting issues are the great need for regulatory reforms and the promotion of a robust incentive system to help improve the diffusion of such technologies as national priorities. Most importantly, coordinated action is greatly needed so that implementation takes place in harmony in all sectors and in line with the national development strategies.

With a focus on the most highly interlinked three sectors of water, agriculture (or food) and energy, with transport being considered less interlinked, the prospect of identifying cross-cutting issues and benchmarking common enabling policies, measures and actions in the four sectors in respect of climate change adaptation and mitigation technologies becomes more challenging if tackled from the perspective of the Water, Food, Energy and Climate Nexus. Globally, but also particularly in a country like Jordan, accelerated trends in population growth, amplified by waves of refugees fleeing surrounding areas of chaos, and coupled with increased demands for water, food and energy – despite their deterioration because of climate change, which will have huge impacts on water and food availability – all pose barriers to technologies from multiple sectors that utilize the Water, Food, Energy and Climate Nexus. As Dodds and Bartram have stated (2016[41]), it is increasingly clear that there is no place in an interlinked world for isolated solutions aimed at just one sector. In recent years the idea of a "nexus" has emerged as a powerful concept to capture these inter-linkages between resources, and it is now a key feature of policy-making.

Thus, we believe that the idea of the Water, Food, Energy and Climate Nexus represents a unique approach whereby both the global and Jordanian situations can address these technologies and the policy barriers in the three sectors, thus encouraging holistic thinking and providing a platform for action. For example, integrating the measures and solutions that emerge from assessing the barriers to the technologies in the three interlinked sectors (particularly solar PV, solar thermal, and solar pumping in the energy sector; desalination and water-users' associations in the water sector, and efficient irrigation in the agriculture sector) will have a powerful effect, instead of addressing each set of barriers and solutions separately. Thus, adopting a PV-powered brackish water pumping system and reverse osmosis desalination for efficient (drip) irrigation would represent a very influential and viable approach. Thus, it is evident that the nexus perspective is primarily about seeking opportunities and achieving multiple benefits through the better and more efficient management of resources. This demands new approaches that take us beyond the predominant, traditional silo thinking (or sector thinking) and management approaches.

This perspective offers innovative practical approaches and solutions to the management of these key resources from a wider systems perspective.

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Agenda

Climate Change *Technology Needs Assessment* (TNA) Project

National Workshop no. IV (TAPs Development)

December 18-19, 2016

Jordan Valley Marriott Resort and Spa Hotel

Dead Sea Area

DAY ONE: Sunday Dec 18th 2016:

8:30-9:00	**Take off from Amman to Dead Sea**
9:45-10:00	Arrive in Dead Sea (Jordan Valley Marriott Resort and Spa Hotel) and Check In/Registration for the Workshop
10:00-10:30	Resume Check in/Registration for the Workshop (**Coffee Break 1: Morning Coffee Break**)
10:30-10:40	Start of workshop program: ***Welcoming Remarks***
10:40-11:30	Lecture no. 1. Introduction (slides 1- 30)
11:30-1:00	Break for ***Praying and LUNCH***
1:00-1:45	***Step 1:*** *Exercise/***Table 1** *"**Starting Point**", Exercise/**Table 2** "**Aim**"—*(slides 31-35)---(15 minuteS each technology, total time ***45 minS)***
1:45-2:00	*Lecture* no. 2: **Step 2 – *Identify Actions and Activities to include in the TAP*, *Prioritize/Rank measures*** (slides 36-44)
2:00-2:30	(**Coffee Break 2:** Afternoon Coffee Break)
2:30-4:00	*Step 2 Exercise/***Table 3 "Overview-list- of measures",** *Exercise/***Table 4 "Framework for ranking measures"; and** *Exercise/***Table 5 "Final selection of measures" (Step 2.2)** (slides 45-46) *(30 minutes each technology, total time 90 minutes)*

7:00-8:00 Dinner

Day TWO Monday Dec 19th 2016:

7:00-8:00	**Breakfast and room check out + (Coffee Break 1: Morning Coffee Break)**
8:00-8:30	Lecture no. 3: **(Step 2.3) Identifying Activities for the Selected Priority Measures (Actions)** (slides 48-52)
8:30-11:30	Exercise/Table 6: **Identification and description of specific Activities to support Actions** (slide 53)--- *(60 minutes each technology, total time 180 minutes)*
11:30-12:00	Salah & Coffee Break no. 2 (**Coffee Break 2:** Afternoon Coffee Break)
12:00-12:30	Lecture no 4. **Identify stakeholders & Step 4 – Determining Capacity Need and Estimating Costs and Funding Needs,** slides (54-69)
12:30-2:00	Exercise/**Table 7 "Planning table: characterization of activities for implementation of actions—stakeholders, capacity needs, cost, funding needs)** (slide 70)—(30 minute each technology, total 120 minutes)
2:00-2:10	*Lecture no. 5 "**Step 5 - Management Planning:*** **risk categories and contingencies (Step 5) & Next Steps: Immediate Requirements to Proceed and Critical Steps to Succeed** (slide 71-77)
2:10-2:30	Exercise/**Table 8. Overview of risk categories and possible contingencies (Step 5) &** Exercise/**Table 9. Identify immediate requirements and critical next steps (Step 5) (slide 78)**
2:30-3:30	**Lunch**
3:30-3:45	Boarding bus leaving to Amman

APPENDIX 2: ROSTER OF STAKEHOLDERS PARTICIPATING IN THE TAPS DEVELOPMENT CONSULTATION WORKSHOP HELD IN THE DEAD SEA AREA FROM 18-19 DECEMBER 2016.

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